Integrating Landscape Change and Food-Systems Change: Modifiers of Food Choice in a Swidden – Oil Palm Transition in West Kalimantan, Indonesia

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For Sol and Nuria – the best results of this PhD.

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Chapter 1: Introduction

A confluence of factors has driven a surge in interest in smallholder oil palm farmers, who now produce around 40% of Indonesia's palm oil. For proponents, smallholders are "sustainable palm oil's secret ingredient" (Solidaridad, 2022) and offer a tantalising reconciliation of developmental and environmental objectives. Indeed, increasing evidence shows that, in certain contexts, independent smallholder adoption results in economic benefits for farmers, as well as for non-farmers in surrounding areas (Qaim et al., 2020). Likewise, closing yield gaps between smallholder farmers and commercial farmers would theoretically allow for increased production on existing land without the need for expansion into forests (Fosch et al., 2023). As a result, proponents are increasingly adopting a development-based narrative which emphasises the contributions of the industry towards poverty alleviation and the Sustainable Development Goals (SDGs) to counteract negative international perceptions of oil palm (Tyson et al., 2018; Chiriacò et al., 2022) and to lobby against trade barriers, tariffs and boycotts (Darmawan, 2019; Liu et al., 2020; Lusiana et al., 2023).

While the promise of pro-poor, sustainable palm oil is seductive, the reality is complex. Firstly, it is entirely possible that, far from reducing pressure on forests, greater smallholder productivity may simply further incentivise forest conversion – an effect known as "Jevons paradox" (Varkkey et al., 2018; Hamant, 2020; Purnomo et al., 2020). Secondly, characterising smallholder oil palm is "pro-poor" is to group together a vast range of contractual models, ranging from fully independent wealthy landowners through to contract farmers tied to companies operating under difficult and often exploitative conditions (Cahyadi and Waibel, 2016; Nurhasan et al., 2020a). Likewise, there is increasing evidence that welfare effects are strongly mediated by contextual factors – one of the most important being the degree of subsistence and market integration of farmers prior to adoption (Santika et al., 2019b,a; Sibhatu, 2023).

In addition to poverty reduction, the adoption of oil palm by smallholder farmers has been proposed as a mechanism for improving the food security, diets and nutrition of rural farmers in Indonesia (Qaim et al., 2020; Tabe-Ojong et al., 2023). The potential for "leveraging agriculture for improved nutrition" has been confirmed by recent systematic reviews of the evidence Ruel et al. (2018); Gillespie et al. (2019); Sharma et al. (2021). However, they have also drawn attention to the importance of mediating and modifying contextual factors – particularly the role of food systems and food environments, women's empowerment and women's time allocation (Ruel et al., 2018). The current evidence suggests that the impacts of oil palm adoption on diets and nutrition are mixed – resulting in both beneficial and adverse impacts on health. Existing empirical research, however, remains limited to a narrow range of geographical, economic and smallholder model contexts and often overlooks outcomes related to overnutrition (Nurhasan et al., 2020b). Almost all the research is situated in contexts where farmers produce little to none of their food and where markets are assumed to function well. As such, studies have primarily focused on income-mediated pathways between oil palm adoption and nutrition.

While income and market-based pathways are the dominant mechanisms through which oil palm engagement influences diets for market-oriented farmers in regions with well-functioning markets, much less is understood about agriculture–nutrition dynamics in contexts where farmers are traditionally been subsistence or semi-subsistence oriented. Understanding these effects are critical given the areas and regions in which oil palm expansion is occurring most rapidly, and the types of farmers who will thus encounter and engage with oil palm over the coming decades. For these people, oil palm development will likely precipitate dietary transitions different in nature and cause to those in regions with long histories of plantation agriculture. For subsistence-based swidden communities, oil palm adoption precipitates a dramatic livelihood and agrarian transition. This results in rapid, substantive changes in household and intra-household labour allocation and a broader shift in the nature and location of farm production systems (Maharani et al., 2019). At the same time, oil palm development dramatically alters the landscape, bringing changes in infrastructure, land use, ecology, soil and hydrology. Oil palm development also transforms the social, demographic and economic contexts of a region, as newly developed oil palm regions experience rapid economic growth, migration as well as, often, political upheaval and tension between political and customary regimes (Li, 2015; Rietberg and Hospes, 2018; Li, 2018; Meijaard and Sheil, 2019). This process can be understood as a set of transitions in a dynamic social-ecological system (Lambin and Meyfroidt, 2010), including interconnected cultural, economic, social, demographic, and agrarian transitions (Rasmussen et al., 2017; Sunderland et al., 2017). Diets are affected by changes in local food production as intensified production systems replace more traditional, diverse and extensive forms of agriculture. Forest loss or loss of forest access may also affect the availability and accessibility of wild foods, which contribute towards dietary quality and diversity (Gitz et al., 2021; Ickowitz et al., 2022; Rosenstock et al., 2023).

This thesis aims to explore key mechanisms linking oil palm adoption and diets which have been neglected by the existing literature. Specifically, the focus is on analysing how changes in women's time allocation, local food systems and food environments modify the effects of oil palm adoption on food choice, in the context of "partnership". This research is explicitly situated in the context of swidden transitions, accelerated and modified by the adoption of smallholder "plasma" oil palm. The project is interdisciplinary and uses a mixed-methods research strategy. It takes as its conceptual framework, work conducted in the fields of agri-health and public health nutrition, as well as drawing on debates from environmental science and agrarian studies. It uses methods from various disciplines, in particular, agricultural and environmental economics, ethnobotany, anthropology, sociology and development studies.

Research aim and research questions

This research aims to address the following research questions:

1. How does oil palm adoption by smallholder swidden farmers affect the intra-household allocation of time?
2. What effects does community-wide adoption of oil palm have on local food systems?
3. How do changes in food systems and time use impact food choice decisions?

Thesis Structure

Chapter 2 focuses on the context of Indonesian oil palm in which the study is situated. First, I provide a brief overview of oil palm expansion and deforestation in Indonesia as well as the food and nutrition security context, before focusing on the sub-set of Indonesian oil palm adopters upon whom this research focuses – participants in smallholder plasma schemes who were former swidden farmers cultivating rice and rubber in relatively traditional forest and agroforestry-based livelihoods.

Chapter 3 is a critical review of research into the effects of oil palm expansion in Indonesia on diets and nutrition. I argue that general conclusions have been over-extrapolated from a narrow range of contexts and data sources and that the explicit and implicit mechanisms in such research over-simplify the complex set of factors which determine dietary intake.

Chapter 4 presents the theoretical framework for the thesis and identifies current methodological and empirical gaps in research. This thesis is an attempt to synthesise three related theoretical literatures: (1) Systems approaches to agriculture-nutrition linkages, which have been studied primarily in the context of finding potential interventions which can leverage agricultural changes to improve nutrition; (2) Linkages between landscape change, forest loss and nutrition, which has been primarily focused on the contributions of diverse landscapes, wild foods and agroecological and agrobiodiversity pathways between land use change and diets and; (3) The food systems and food environments literature which has primarily focused on urban and HIC environments and contributions of food systems and food environments to dietary choice. It also consolidates the evidence and methodological gaps identified to produce the main research questions and research aims.

Chapter 5 outlines the methodological approach and study design. It discusses and justifies the interdisciplinary mixed-method approach of this research and justifies the overall study design, site and respondent selection process. The chapter includes reflections on how research objectives and methods evolved over the course of the research, as well as upon ethical considerations and research limitations. It also outlines the steps taken to mitigate endogeneity and bias, as well as to adhere to best-practice research ethics. The chapter concludes with personal reflections on fieldwork challenges and ethical dilemmas encountered during the research.

Chapter 6 situates the study within the context of swidden transitions in Kapuas Hulu. It is divided into two parts. The first part provides a historical context for contemporary oil palm-driven swidden transitions. The second part presents selected results of a livelihood analysis and describes the salient characteristics of the swidden transitions in the study site villages.

Chapter 7 is the first empirical chapter. It compares the allocation of men's and women's time in the oil palm and non-oil palm villages using a mixed-methods analysis using specialised time allocation survey instruments combined with in-depth qualitative analysis. To my knowledge, this is the first full-accounting time allocation study conducted in rural Indonesia (and particularly in the context of oil palm) with both men and women using specialised, validated time allocation survey tools which can capture concurrent activities throughout a 24-hour period. Using both quantitative and qualitative data, I show how oil palm adoption generates time scarcity, which in turn results in additional modifications to livelihoods and agrarian change. I describe the coping strategies employed by women in both oil palm and non-oil palm villages in response to time scarcity, showing that many of these coping strategies may affect diets and nutrition. I also present both quantitative and qualitative evidence that these coping strategies are employed more frequently in the oil palm-adopting villages and, thus, that oil palm may affect diets via time-use pathways.

Chapter 8 explores the effects of the landscape, livelihood and agrarian transitions discussed in previous chapters on local food systems. By analysing three sub-systems of the food system (the production sub-system, the market-subsystem and the wild-food sub-system) I explore how oil palm adoption results in changes to the local availability and prices of foods.

Chapter 9 focuses on the ways in which individual livelihoods, altered by the adoption of oil palm, result in changes to food choice. This chapter explores the interface between livelihood changes and the food system (i.e. the food environment). The chapter builds upon the preceding two chapters by examining how food availability and prices manifest themselves in food choice decisions, as well as exploring the role that changes in time allocation create constraints and friction on food choice via changes in activity spaces and time scarcity.

Chapter 10 is used to reflect on the study approach and findings. It discusses the weaknesses and limitations of the studies and proposes directions for future research and future methodological approaches.

Chapter 11 concludes the thesis by returning to the main thesis problem, research questions and evidence gaps which the thesis was intended to address, discusses weaknesses and caveats of the research and suggests potential directions for future research and policy implications.

Chapter 2: Background: The Diversity of Smallholder Oil Palm in Indonesia

Contents

Introduction

At the macro scale, two recognisable trends are occurring in the Indonesian oil palm industry. First, there is a geographical shift in new oil palm development away from heavily deforested regions with long histories of oil palm development eastward towards regions with greater intact forests[1]. The trend is visible by examining provincial-level deforestation rates. While national deforestation rates are decreasing, there is significant variation in deforestation rates between regions. In regions with long histories of oil palm (e.g. Jambi, Sumatra), deforestation rates are falling – primarily because there is little remaining forest into which it can expand (Mongabay, 2021; KIM, 2021). However, in provinces with more recent histories of oil palm, deforestation rates are increasing dramatically[I] (Austin et al., 2019; Daemeter and TFA, 2020; KIM, 2021). Secondly, smallholder farmers now account for a substantial proportion of Indonesian oil palm production comprising 42% of oil palm land and 35% of Crude Palm Oil (CPO) [2]. Their role in the industry are increasingly promoted by government and industry alike who view supporting and emphasizing smallholders as vital to their interests (UNDP, 2021, 2019; Sukiyono et al., 2022) and who view smallholder success as a way to counteract negative perceptions of the oil palm industry Susanti and Maryudi (2016); Castellanos-Navarrete and Jansen (2017); Tyson et al. (2018). Smallholders are often described as the fastest-growing sector of the Indonesian oil palm industry. Commonly cited "predictions" are that smallholders will replace corporate oil palm as the dominant model by 2030, comprising as much as 60% of oil palm area[3] (Saragih, 2017; Schoneveld et al., 2019a). However, in reality, while their prominence and importance is certainly growing, their total share (of all types of smallholders) of oil palm production has changed little over the past decade (Figure 2-1).

The surge of interest in smallholder oil palm has been driven by a confluence of factors. For proponents, smallholder oil palm promises to be an unparalleled engine of rural development. There is evidence that, in certain contexts, independent smallholder adoption results in economic benefits for farmers, as well as benefits spilling over to non-farmers in surrounding areas (Qaim et al., 2020). Secondly, closing yield gaps[II] between smallholders and large producers provides a potential path to increasing oil palm production with reduced environmental impacts[4] (Daemeter, 2016; Purnomo et al., 2020; Fosch et al., 2023) – offering a tantalising reconciliation of Indonesia's economic and environmental aspirations[III]. Thirdly, there has been a subtle shift in emphasis in much of the framing of opposition to oil palm. Organisations that previously advocated for total boycotts or bans of palm oil are increasingly moving towards "engagement" and "partnerships" – primarily through advocacy for and asserting influence in "spaces of engagement" such as multi-stakeholder forums and Voluntary Sustainability Standards (VSS) such as the Roundtable For Sustainable Palm Oil (RSPO) and Indonesia Sustainable Palm Oil) (ISPO)[IV], yet only a fraction of smallholders are certified[5]. Reducing barriers to certification, therefore, is seen as a vital step towards placing the industry on a more sustainable footing (Hutabarat et al., 2018; Schoneveld et al., 2019b). Finally, there is a broader commercial and geo-political motivation to accentuate the benefits of smallholder oil palm. By focusing on the apparent economic benefits to smallholder farmers, it allows proponents of oil palm to counteract and undermine international criticism and trade barriers

[1] Just two islands (Sumatra and Kalimantan) account for over 95% of oil palm production (see Appendix Table B.1)

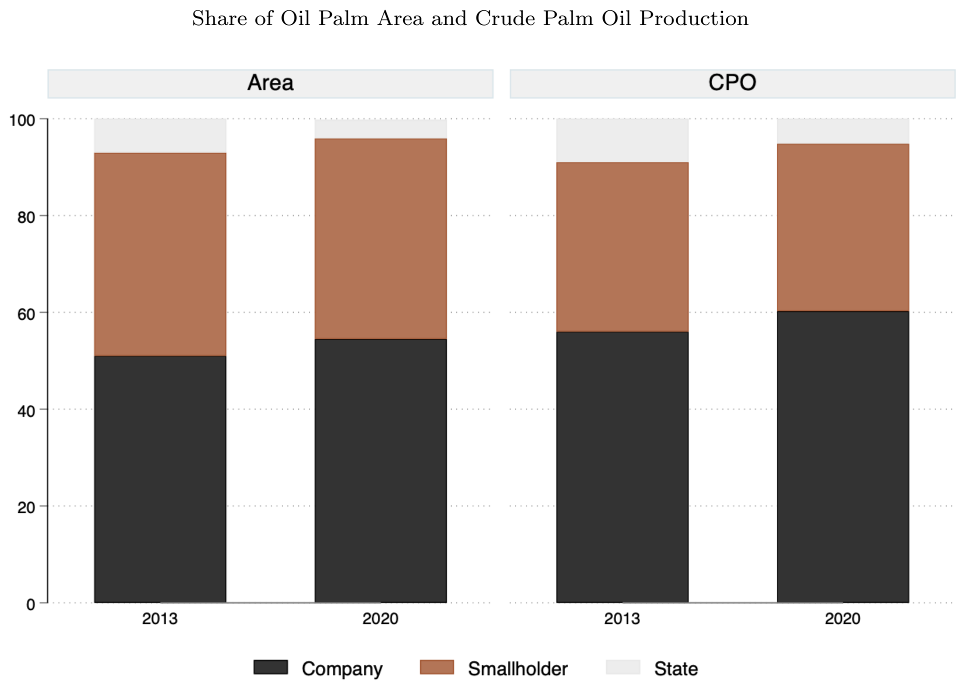
[2] This disparity between area and yields may reflects both the lower yields per hectare for smallholders as well as the growth of the smallholder sector – i.e. that a greater proportion of smallholders have planted recently (and are therefore yet to harvest).

[3] Such statistics rarely provide a justification or methodology for these predicted figures, and often contradict more realistic government estimates. Nor do they distinguish between different models of smallholders (e.g. independent or company-tied contract farmers). Nevertheless, the narrative that smallholders are rising has taken hold within both the academic and non-academic literature. Some authors posit that smallholders will be the dominant form of oil palm production in the future, suggesting that today's corporate-dominated industry is merely a "temporary aberration" (Byerlee, 2014). However, evaluating the likeliness of such claims is challenging due to the lack of clarity in official reporting, definitions, and statistics (Potter, 2016a).

[4] Actually, this is far from guaranteed due to "Jevons Paradox" in which increased efficiency/productivity from intensification may make the incentives to expand even greater (Varkkey et al., 2018; Hamant, 2020; Purnomo et al., 2020)

[5] Only 1% are certified by the RSPO (RSPO, 2023)

Figure 2-1: Share of Smallholders in Indonesian Oil Palm Industry



Source: Data taken from the Indonesian Ministry of Agriculture (Bps, 2013) and (BPS, 2022). Note that the official figures do not distinguish between different smallholder oil palm models.

of the oil palm industry by painting critics as anti-development (Tyson et al., 2018).

This chapter focuses specifically on smallholder oil palm production in Indonesia[6]. The chapter is structured as follows: **Section 2.1** gives a brief overview of historical oil palm development. In **Section 2.2,** I examine the diversity of different oil palm models in Indonesia, which exist in a spectrum between fully-tied contract farmers and fully independent smallholders as well as discussing best estimates at their numbers and distribution in **Section 2.3**. Finally, in **Section 2.4** I discuss the smallholder narrative itself, showing how pro-industry lobbyists and governments weaponise academic evidence relating to oil palm smallholders to counter-act and undermine what it sees as a cynically motivated anti-oil palm agenda orchestrated by the European Union. I argue for improved reporting of study contexts to prevent the misinterpretation and misrepresentation of research.

2.1 Brief Historical Context

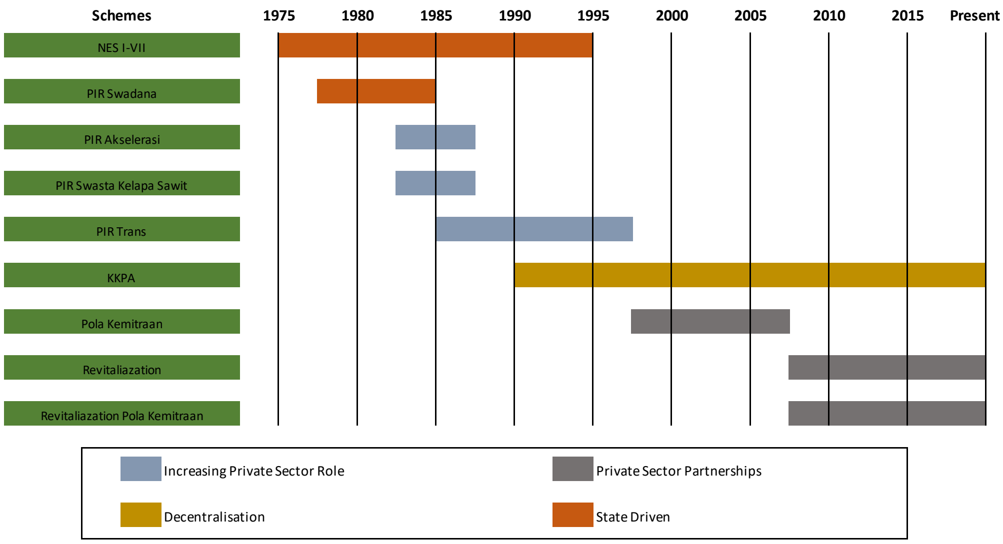
Large-scale commercial oil palm was established in the 1970s, but the origins of the plantation system originate from colonial times. A brief overview of the history of oil palm and other plantation crops in Indonesia from Dutch colonialism through to independence is available in Appendix B.1. Several aspects of the colonial era remain important in contemporary oil palm production. These include the 1870 Agrarian Law, which established the state ownership of land and a system of fixed-term land leases – the forerunner of the modern-day system of licensed concessions. The claim of state ownership of lands was reconfirmed in the post-independence constitution – the wording of which has become a contentious issue in legal battles between indigenous groups claiming customary land tenure and the state.

Industrial-scale scale oil palm production began with Suharto's New Order government, supported by

[6]The broader context of corporate plantations and other aspects of the contemporary oil palm industry in Indonesia has been omitted for the sake of conciseness, but a summary is provided in Appendix B.1.

Figure 2-2: Timeline of Smallholder Models.

Adapted from Daemeter (2015)



the World Bank and the Asian Development Bank, who promoted oil palm cultivation on state land in outer islands as a mechanism of stimulating regional economic growth and reducing population pressure in Java (Casson, 2005). An integral part of this strategy was the policy of *transmigrasi* (transmigration), which, though originated in Dutch colonial times and continued under Soekarno, was championed by Suharto and supported by World Bank funding[7]. Under the policy, poor populations from overpopulated areas were offered incentives in the form of free housing and land, along with technical support to establish smallholder plantations. Initially, state-owned oil palm companies operating core plantations and mills provided support and backing for smallholders, though from the late 1980s, responsibilities were transferred to private companies. More details of the transmigration policy, including its effects on land use change and social and ethnic conflicts, are discussed in Appendix B.1.

Since their conception in the late 1970s, smallholder schemes have undergone several stages of evolution, with varying levels of state vs private sector control, financing mechanisms, and revenue sharing arrangements (IFC, 2011, 2013; Daemeter, 2015; Zen et al., 2016). Figure 2-2 below shows the evolution of this process, with the state-backed enterprises of the 1970s and 1980s replaced during the 1990s by models which increased private sector involvement. A significant change occurred in 1999 with the introduction of Pola Kemitraan (Partnership Mechanism), which aimed to decentralise management to organisations of cooperative farmer groups. However, companies have increasingly resisted decentralised approaches, preferring to centralise control at the company level, reducing the input of smallholder farmers in plantation management (Hasudungan, 2018). It is these later schemes in which supposed smallholder farmers are treated more akin to shareholders, which are the dominant form of oil palm today in West Kalimantan.

2.2 Smallholder Oil Palm Models

Indonesia has a vast array of different oil palm models, differing by island, region, and date of inception. Smallholders lie on a continuum between farmers fully tied to corporate plantations as participants in smallholder plasma schemes to fully independent smallholders (IFC, 2013; Daemeter, 2015; Zen and

[7]Estimates of world Bank funding of the scheme are around US$ 560 million (Fearnside, 1997)

Nibulan, 2018; Naylor et al., 2019). Figure 2-3 depicts the five transactional models of smallholder farmers identified by Suharno et al. (2015) and Daemeter (2015), with the main characteristics of each type shown in Table 2.1. The five models can be separated into those operating independently or in cooperative groups (models 1, 2 and 3) and those who are participants in some form of smallholder scheme (models 4 and 5).

Table 2.1: Transaction Models of Different Types of Smallholder Farmers

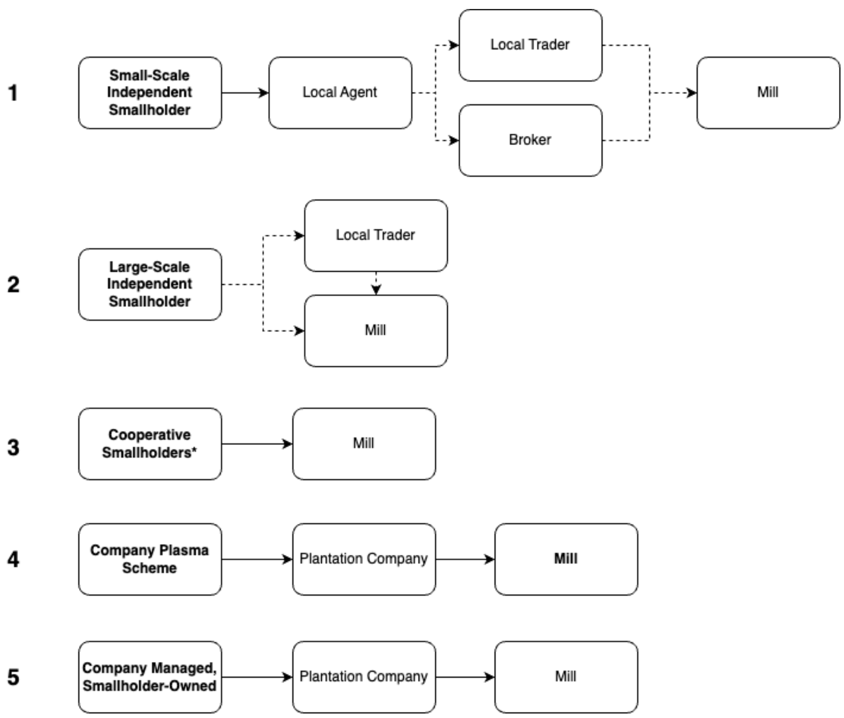
Adapted from Daemeter (2015)

Model	Size (ha)	Infomal Ties	Formal Ties	Technical Assistance	Chemical Inputs	Labour	Tenure
1 Small-Scale Independent	2-5	Agents†	–	–	Purchase	Household	–
2 Larger-Scale Independent	10-100s	Mills/Invest.	Small FI	Growers†	Purchase	Hired	+/-
3 Farmer Groups or Co-ops							
3(a) Koperasi (collective)	Varied*	Mills/Invest.	–	Household	Co-op	Co-op	++/-
3(b) Co-ops (contiguous)	>1000	Mills/Invest.	Small FI	Co-op	Co-op	Co-op	++/-
4 Farmer Managed Plasma	2-4	Company	Company	Company	Household++/-		
5 Company Managed Plasma	>1000	Company	Company	Company	Company	Hired	++/-

Notes: *Approximately 300-500 farmers, but of varying estate sizes. *Ties* FI = Financial Institution †Large-scale growers may operate as agents or traders with smaller farmers *Tenure:* – = Unlikely to have legal tenure; +/- = may or may not have legal tenure; ++/- = more likely to have legal tenure

Figure 2-3: Transaction Models of Different Types of Smallholder Farmers

Adapted from Suharno et al. (2015) and Daemeter (2015)



2.2.1 Independent and Cooperative Oil Palm

Independent smallholders are farmers who sell palm Fresh Fruit Bunchs (FFBs) who sell to mills in the absence of formal partnerships or ties. Independent farmers are "rarely autochthonous and often rely on informal land transactions and illegal encroachment" (Pacheco et al., 2020). While they are one of the most rapidly growing groups of smallholders in terms of numbers and planted area[8], yields tend to be

[8] As far as can be deduced from imperfect statistics (see Section 2.3)

lower (and thus share of CPO production), due partially to the lack of formal tenure certificates, which create barriers to accessing public and private funding and technical assistance programmes (Pacheco et al., 2020; Schoneveld et al., 2019b). Furthermore, independent smallholders are facing increasing challenges in accessing markets due to the high technical, administrative and regulatory requirements required to meet certification standards (Gnych et al., 2015; Sahara et al., 2017; Hutabarat et al., 2018; Hidayat et al., 2015; Hidayat, 2018).

While theoretically, independent smallholders do not have formal ties, many still do. The great majority, however, have informal ties with companies, mills and/or investors as well as with networks of middlemen mediate relationships between farmers and mills (Jelsma et al., 2017; Naylor et al., 2019) taking a small percentage of profits[9]. As will be discussed in Section 2.3, many so-called "independent" smallholders may be neither small nor fully independent. While often classified as a single entity in the literature, in reality, the term covers a wide range of different types of farmers.

There are multiple potential pathways farmers may come to grow oil palm independently (see Appendix Table B.2 for a full list). However, much of the literature focuses (or assumes) that independent farmers are either novice oil palm farmers (i.e. smallholders of other descriptions who add oil palm) or graduates of plasma schemes who have now become independent. However, this neglects the reality that many independent farmers simultaneously manage different parcels of different models and may retain formal and informal ties (Beekmans et al., 2014; Jelsma et al., 2017). Similarly, studies often ignore how oil palm is often accumulated by wealthy local farmers or, increasingly, outside investors. Without considering how oil palm land was acquired, and who originally owned or planted it, it can be difficult to determine benefits or otherwise for adoption.

The nature of informal ties with middlemen depends on two key factors: farm size and oil palm context. In contexts where there are multiple established mills, middlemen and associated oil palm infrastructure and services, farmers may have the means and ability to choose who to sell to and for what price. However, in regions where there are few mills (or mills are linked to plantation companies) or logistics are prohibitive – independent smallholders may find themselves de-facto tied to particular companies or mills. Relationships between farmers, middlemen and mills are mediated through local officials, often under the pressure and influence of dominant company actors[10]. Farm size affects ties due to the wealth of the farmers and the quantity of FFBs they produce. Larger land owners (particularly those with legal title) are better able to secure formal loans by using their land as collateral[11]. Additionally, wealthier farmers may be able to wait between the sale of FFBs and payments from mills without the need for farm-gate payments and may also be able to assume more risk (of not selling in time and yields decreasing[12]) Middlemen, therefore, provide three functions which are of greater importance to smaller scale farmers – they ensure prompt and guaranteed payments; assume risk; and handle time-sensitive logistics and negotiations with mills.

2.2.2 Smallholder Schemes

While independent smallholders (theoretically at least) sell FFBs directly to mills, participants in smallholder plasma schemes are tied to corporate plantations. As discussed in Section 2.1, the origins of smallholder schemes are intimately connected to transmigration policies. Since 2007, all companies wish-

[9] Daemeter (2015) report from their survey of middlemen that "contrary to theories that these middle players take significant profits" they have "modest profit margins", while also assuming some risk (except in the case of brokers).

[10] Baudoin et al. (2017) report that while farmers preferred the informal ties to company-relationships, companies pressure local officials – some of whom may be linked to companies "through corruption in the form of bribes for favourable discretionary behaviour" – to reduce the influence of middlemen (as well as reduce competition from other mills which would raise farm-gate prices)

[11] This is also one of the reasons why cooperatives are better able to access formal credit.

[12] FFBs needed to be sold within 24-48 hours, before oil yields begin to decline (Daemeter, 2015)

ing to plant oil palm must, by law, dedicate 20% of the area new plantations to local smallholders[13] . In recent years, several investigations have revealed the extent to which companies have evaded this legal obligation. Investigations by the Gecko Project (2022a,b) – later confirmed by the Indonesian Government's audit of schemes – reveal around only 21% of oil palm companies had complied with the legislation[14] (Mongabay, 2023). Government statistics show that only around 40% of land area which should have been allocated to smallholders has been allocated – a shortfall of over almost one million hectares (Kementerian Pertanian, 2021).

Though contractual terms and management arrangements vary significantly, all smallholder schemes share the same basic premise. They consist of a core company plantation "*inti*" surrounded by a collection of small parcels of smallholder oil palm "*plasma*" which is owned and/or managed and/or farmed by smallholders. All smallholder schemes, in theory, provide the following as part of the package: local infrastructure and social facilities (roads, schools, medical facilities), support with high-yielding varieties, agricultural extension services including training and support planting and managing plantations, bulk purchasing of inputs, collection and processing of FFBs, and access to credit and financing (Jelsma et al., 2017). Smallholder schemes can be subdivided into two broad categories: those which farm their own plasma land (outgrower models), and those whose plasma land is farmed on their behalf and receive the profits theoretically derived from this land (partnership models). Confusingly, the terms Nucleus Estate and Smallholder (NES) Schemes and Plasma Schemes are often used interchangeably in the literature for both types of models.

(a) Outgrower Models

Under outgrower models, smallholders cede land to the core plantation in return for a few hectares of plantation, serviced by a 'package' of support from the company. The company provides the required capital (in the form of loans), technical support, seedlings and inputs for farmers to begin planting oil palm, the costs of which are deducted from the price obtained from selling FFBs to the company mill. There are substantial differences between different iterations of outgrower models over time and between regions and companies. Most differences boil down to the percentage of land which is core and the percentage of land which is plasma, the terms and conditions of the development loans, cost deductions and financial support during the period between planting and harvesting, whether the plasma is owned/managed by individuals or cooperatives, and to whom land is granted at the end of the cycle.

(b) Partnership Models

Over time, outgrower models have become increasingly less generous, and since the 1990s they have been largely replaced by partnership models (Zen and Nibulan, 2018) – a trend accelerated in the mid-2000s by the 2007 law requiring companies to set aside 20% of new plantations for smallholders (Baudoin et al., 2017; Hasudungan, 2018; German et al., 2020). In partnership models, the smallholder allows the company to plant and manage the land on their behalf – essentially annexing the farmer's land into the company's estate – in return for a share of the profit (theoretically derived from the plasma plot). Profits are typically split 60/40 to the company/farmer, but inflated deductions for costs are not uncommon. Indeed, unfair deductions, lack of clear contracts, and lack of transparency over the calculations are often the source of conflict between local people and companies (Barreiro et al., 2016; Grasse, 2022; Berenschot et al., 2021; Kenny et al., 2022; Gecko Project, 2022a). This second form of model is the model dominant

[13]Ministry of Agriculture Regulation No. 26/Permentan/OT.140/2/2007. Many provinces and districts have similar laws (Potter, 2016a; Jong, 2020a,b)

[14]Larger companies appear to be better than smaller companies at meeting obligations, with the top-25 companies broadly having met their obligations (TUK, 2019).

in the oil palm villages of this study.

In partnership models, land is pooled with other farmers into a larger plantation managed by the company. Farmers then receive a share of profits, which are derived from the area of land that they have leased to the company. While there have been numerous iterations of this type of scheme, the Kredit Koperasi Primer Anggota (KKPA) has become the dominant model since the 1990s, whereby the partnership arrangement is mediated through village cooperatives. KKPA schemes were aimed at solving two pressing problems. Firstly, many transmigrant communities cultivating oil palm had become substantially wealthier than the indigenous populations located nearby who had received no such support, leading to resentment and ethnic and social conflict. Secondly, smallholder models with local communities are viewed as a way of circumventing the contentious, opaque and divisive issues of land tenure generated through the establishment of plantations on customary land. Official government policy has not until recently recognised customary ownership of land, and plantations were often developed on land cultivated with little to no compensation and rarely any documentation – often under intimidation and threats of violence (Zen et al., 2016). In addition, enclosures of traditional land were tightly and violently enforced, generating a substantial source of political and social tension (McCarthy et al., 2012; Eilenberg, 2022).

Plasma plots in partnership models – which in effect operate like shares in a company plantation – are frequently sold and resold, either to wealthier local smallholders, outside investors or back to the company (Cramb and Mccarthy, 2016; Naylor et al., 2019) and many so-called independent smallholders may simultaneously own plasma plots, even if they themselves have never participated in plasma schemes (Schoneveld et al., 2019b). The fact that profits are theoretically derived from plots which are not demarcated and that debt repayments and surcharges are deducted before profits are distributed means that partnership plasma provides very little income compared to other oil palm models. For example, one investigation (Gecko Project, 2022a) found that partnership schemes provided around one-tenth of the revenue per hectare of outgrower schemes (see Figure 2-4). Though the small plasma revenues from partnerships are obtained without having to allocate labour to their cultivation, it is unlikely that such small profits genuinely reflect a 60/40 split in profits. Indeed, reports suggest that many farmers never receive such any payments as long as a decade after giving up land, and many struggle to escape high-interest payments of debt[15] (Sahara et al., 2017). With little-to-no plasma revenue and often having ceded valuable land to companies, it appears (though is impossible to quantify) that many, if not most, farmers proceed to work as plantation labourers on the company estate – often alongside subsistence cultivation (Li, 2015).

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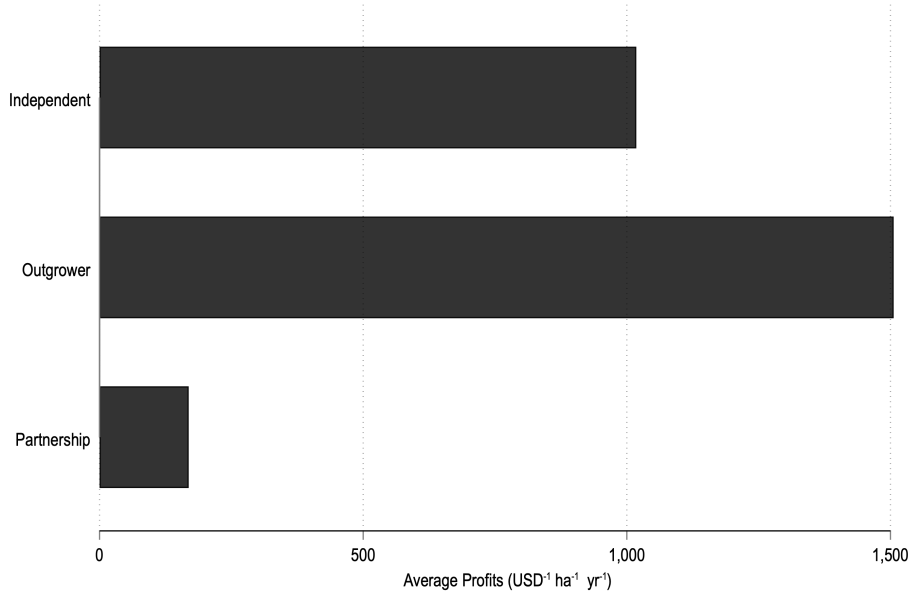
2.3 Numbers and Distribution of Smallholder Oil Palm Farmers

While, officially, the national share of smallholder oil palm is around 40% of planted area (BPS, 2022), some caution should be exercised when interpreting this statistic. Official statistics probably do not reflect the true nature of smallholder oil palm. Legal ambiguity and lack of clear definitions can result in an array of medium and large-scale farmers, city investors, and proxy owners also being classified as smallholder farmers (Jelsma et al., 2017; Schoneveld et al., 2019a). This may be especially the case for the emerging class of medium-sized farmers, with plots of several hundred hectares are often mistakenly included in smallholder statistics (IFC, 2013; Potter, 2016a; Jelsma et al., 2017). Additionally, most estimates are based on household surveys of in-village residents rather than area-based approaches – and as such, systematically underestimate the scale of smallholder oil palm under the control of outside side

[15]Cooperatives appear to obtain credit at between 10-13% interest (Glenday et al., 2015; Sahara et al., 2017)

Figure 2-4: Estimated Financial Returns From Different Oil Palm Models

Adapted from (Gecko Project, 2022a)



No official data is available. Gecko Project (2022a), therefore, estimated profits of farmer models based upon a combination of peer-reviewed papers and primary field surveys in the following manner: Estimates of plasma (outgrower) smallholders profits are calculated by averaging two independent studies (Glenday et al., 2015; Suharno and Anggreini, 2020) and adjusting for inflation. Estimated profits for independent smallholders are derived from (Grass et al., 2020). Estimated earnings for partnership models were obtained by interviews conducted by (Gecko Project, 2022a), averaged across ten cooperatives in partnership schemes with companies.

owners and investors (Andrianto et al., 2019a).

It is difficult to determine the share of oil palm production under different types of smallholder models as national statistics are aggregated to include all smallholders[16] and (to my knowledge) no recent nationally representative surveys have been conducted. The closest to representative sample dates from 2012-2013 (IFC, 2013), which surveyed 1069 smallholders across Sumatra and Kalimantan , finding that 30% were fully tied, 57% fully independent, while 13% owned both tied and independent plots. However, as with other resident-based sampling methods, probably under-estimates the extent of outside owners and investors[17]. More recently, a handful of studies have used primary field surveys to understand the nature and type of smallholder farmers (Jelsma et al., 2017; Andrianto et al., 2019a; Schoneveld et al., 2019a) – however, these remain limited to a handful of provinces[18]. While in different contexts, all studies

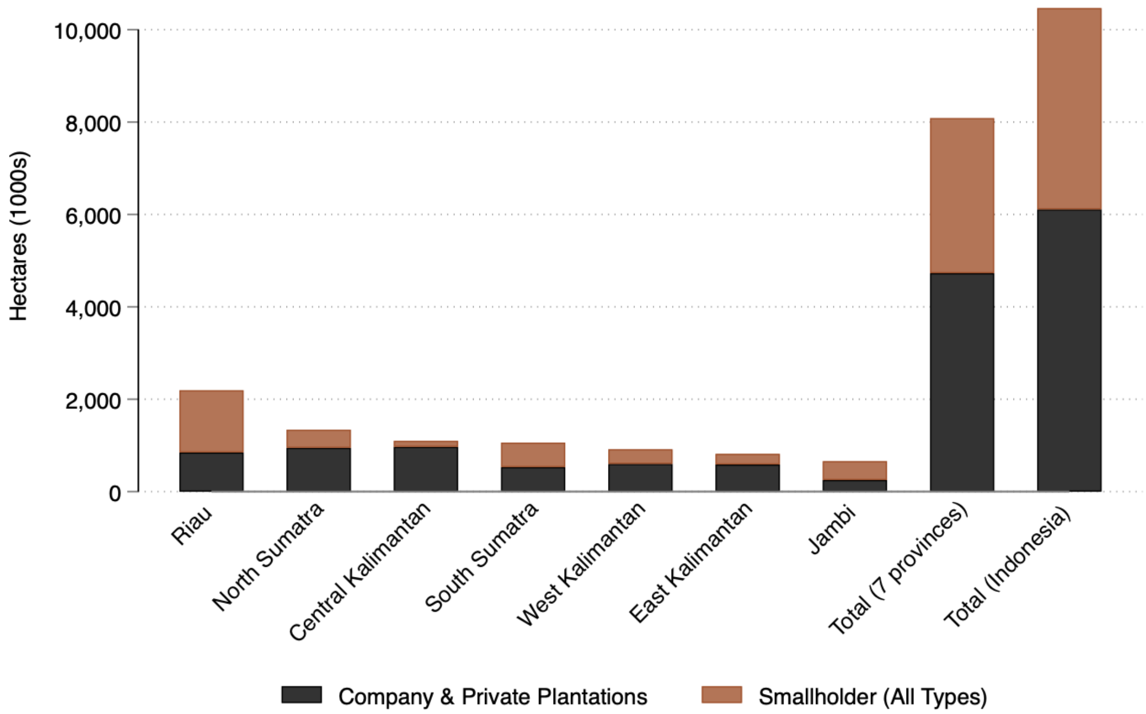
[16]Naylor et al. (2019) report a figure of “89% of oil palm-producing households operated without any formal partnership with private companies”, citing the 2013 Agricultural Census Data as the source of this figure. I have expended considerable time and effort in attempting to track down the data behind this statistic and cannot find the original data. To the best of my knowledge, the 2013 Agricultural Census does not report this data (at least in publicly available datasets and reports). I have attempted to contact the paper’s corresponding author, but at the time of submission, I have not received a reply (they are on sabbatical). As I cannot find the source, and the figure seems somewhat high compared with other sources of data, I have ignored it for now. My best guess is the figure is based upon a survey or sample of one district or province and does not represent Indonesian oil palm as a whole. Alternatively, it could be that the nature of the sampling frame which may include any farm with a single oil palm tree a single palm as a smallholder farmer. However, if I am wrong, and this figure is correct and nationally representative, it does qualify many of may arguments made in this Chapter as well as Chapter 3 – though it does not undermine the central message as this is still likely to be weighted significantly towards current production – which is by definition located in the provinces with greatest share of independent smallholders while future oil palm expansion in forested regions will continue to be associated with partnership models.

[17]As this study dates from 10 years ago, the supplementary materials which describe the sampling strategy do not appear to be available online. The study, however, appears to use a household survey methodology rather than an area-based sampling method – and thus likely suffers the same bias described by Andrianto et al. (2019a) and discussed above.

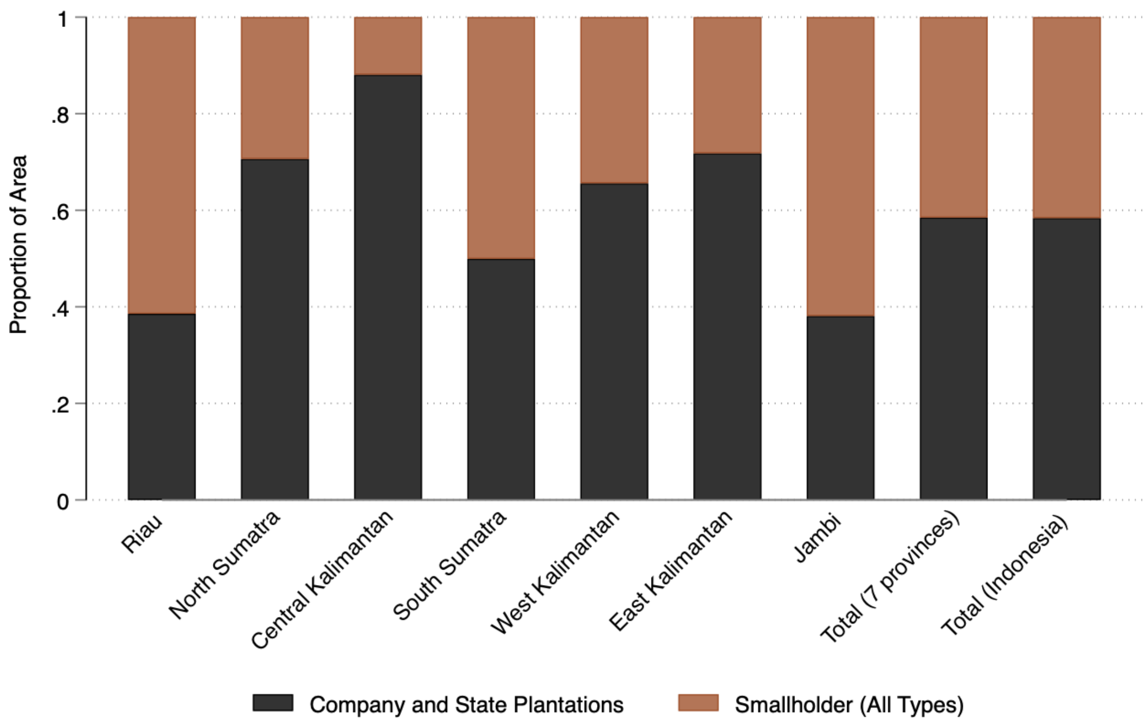
[18]Jelsma et al. (2017) = RIAU; Schoneveld et al. (2019a) West and Central Kalimantan; Andrianto et al. (2019a) Central Kalimantan (independent farmers only). Additionally, other studies, while not systematically designed for this purpose, created typologies of smallholders within their study sites in Riau and South Sumatra (Hidayat, 2018), Riau and Jambi

Figure 2-5: Smallholder Oil Palm by Province

(a) Area of Production



(b) Share of oil palm Area



Data Source: Direktorat Jenderal Perkebunan (2016) highlight the dominance of local elites, wealthy outside investors, and entrepreneurs over independent smallholders. Indeed, one investigation in Riau concluded that many smallholder farmers "fit the legal nor popular definition of 'smallholders'" (Jelsma et al., 2017).

The lack of nationally representative data is made more problematic by the fact that not all provinces report independent and tied smallholders separately – especially in Kalimantan where oil palm is more recent and where the proportion of independent smallholders are likely to be lower (Potter, 2016a). Independent oil palm farming is most closely associated with regions with long histories of oil palm. For example, in Riau, independent smallholders are the largest group of producers Potter (2016a). There are several reasons for this. Firstly, farmers may have built up knowledge and experience of cultivating oil palm[19] through plantation labour and/or participating in contract schemes. Secondly, given that schemes were initiated longer ago, it follows that there will be more graduates of these schemes who may plant independently (or more investors who have bought the plasma plots). Thirdly, those graduating from outgrower schemes are more likely to be successful producers who go on to grow independently, as schemes initiated many decades ago are far more generous than schemes initiated more recently. Gatto et al. (2015a) explicitly analyse this problem, comparing the benefits of oil palm among adopters of smallholder contracts from different eras, concluding that:

> ...contracts adopted during the government-led phase (before 1999) were more beneficial than contracts adopted during the more recent market-oriented phase ... During the government-led phase, contracted farmers benefited from input provision, technical support, subsidized loans, and public investments in infrastructure. During the market-oriented phase, the government exerted less control over contract formation, resulting in more variable contractual terms that much depended on the negotiating skills of community leaders.

Finally, and perhaps most importantly, independent farmers benefit from the associated infrastructure which forms around it, allowing independent oil palm farmers to benefit from spill-over effects and selling directly to mills (Gatto et al., 2015b). For instance, Potter (2016a) highlights the importance of "*pabrik kelapa sawit tanpa lahan*" (mills without plantations), which operated on the verge of legality[20] in stimulating the growth of the independent sector in Riau. Smallholders often prefer such mills because they offer higher prices than tied mills[21] (Daemeter, 2015; Baudoin et al., 2017).

2.3.1 Smallholder Oil Palm Models in West Kalimantan

Precise data on the extent of different smallholder models in West Kalimantan is not available. Official data, which combines independent and plasma models, suggest that smallholder oil palm is increasing throughout Kalimantan. For example, 57% of planted oil palm area between 2005 and 2015 was classified as smallholder lands (Schoneveld et al., 2019b). However, smallholder oil palm is still relatively under-developed in Kalimantan relative to Sumatra, with around half of planted oil palm area being occupied by smallholders in Sumatra but around one-quarter in Kalimantan overall (Purwanto et al., 2020). In West Kalimantan, the figure is around one-third (34%) (see Figure 2-5b).

As well as heterogeneity between islands and provinces, there is considerable heterogeneity within

(Baudoin et al., 2017).

[19] For instance, in one study in Riau and South Sumatra, smallholder farmers were found to have more than 15 years of oil palm cultivating experience on average (Hidayat, 2018). Additionally, second-generation Javanese migrants (many of whose parents or grandparents were part of colonial-era plantation schemes) migrating into Riau who had long experience as plantation workers were among those contributing to the rapid growth of independent smallholders (Li, 2011; Potter, 2016a).

[20] One way of circumventing legal difficulties was to plant the minimum size of qualifying plantation (500 ha) connected to mills with much greater processing capacity.

[21] Due to not having to invest in plantations

provinces. Within West Kalimantan, the district-level distribution of smallholder models reflects the local histories of oil palm development, infrastructure development, and transmigration, as well as histories of opposition. In areas with more recent oil palm expansion, such as Kapuas Hulu Regency, oil palm expansion continues to be driven by the expansion of company oil palm, with less than 10% of oil palm area occupied by smallholders (Purwanto et al., 2020). As the growth of plasma schemes accompanies corporate expansion, most smallholders are likely to be plasma farmers rather than independent smallholders (Hasudungan, 2018; Hasudungan and Neilson, 2020). Furthermore, as more recent scheme holders are disproportionately likely to be enrolled in partnership rather than outgrower models (Gecko Project, 2022b), smallholder oil palm in Kapuas Hulu is likely to be dominated by this model. Indeed, companies in the region overwhelmingly favour such models – even putting pressure on communities enrolled in outgrower schemes to switch (Hasudungan, 2018; Hasudungan and Neilson, 2020).

2.4 Promotion of the Smallholder Narrative

In response to what it views as an unfair and cynically motivated[22] environmental and social criticism of the industry, a well-funded, well-organised, pro-oil palm growth lobby has emerged. In recent years, several studies have begun to analyse the media relations and PR strategy of this lobby, noting its similarity to climate-denialism disinformation campaigns (Goldstein, 2016; Liu et al., 2020; Schouten et al., 2023; Lusiana et al., 2023). A central part of this strategy is a public-relations battle designed to undermine NGOs calling for boycotts, restrictions or trade barriers to oil palm (Kinseng et al., 2023; Schouten et al., 2023). The ultimate aim is “regain sovereignty” and to challenge the “global sustainability regime framed and dominated by European non-state actors” (Hospes et al., 2014) by forging bilateral agreements and setting up competing regulatory frameworks such as the ISPO (Hospes et al., 2014; Schouten and Hospes, 2018).

The strategy has two main components: (1) Challenging “myths” relating to the health effects of consuming oil palm and its links with forest loss and deforestation (Sipayung and Ulfa, 2023) and (2) Promoting smallholders as the public face of the oil palm industry and advocating for expanding and improving smallholder production as an instrument for sustainable rural development (Pye, 2019a; Dauvergne, 2018). In order to challenge “myths” about oil palm development[23], the lobby expends considerable resources funding a network of institutions producing “divergent expertise”, discrediting scientists and foreign researchers and strategically promoting selective citing scientific research (Goldstein, 2016; Tyson et al., 2018). The promotion of the “smallholder narrative” is done by refocusing media and political attention away from large agribusiness towards smallholders. This is done through the selective propagation and promotion of facts and evidence considered supportive of this narrative. These arguments are often made in the media by “smallholder associations”, which purport to be unions and farmer groups, despite often being established, funded and managed by public relations companies (Reuters, 2019a,b, 2023).

Elevating the prominence of smallholders within the oil palm industry serves two purposes. It counters widely believed narratives surrounding indigenous, human and labour rights abuses and recasts oil palm as “pro-poor” – and thus recasts critics as malign forces keeping subsistence farmers in poverty. Simultaneously – under the guise of supporting smallholders to improve practices, increase yields, and obtain certification – it highlights the (controversial) links between smallholder expansion, forest fires and forest loss, thus shifting the blame for oil palm-driven deforestation onto smallholder producers (Dauvergne,

[22]Often not without justification, the most common claim found is that social and environmental criticism is a cynical attempt (especially by the EU) to justify protectionism of vegetable oil producers (rapeseed in the EU, soy in the U.S.A.) (Kinseng et al., 2023).

[23]See for example, Sipayung and Ulfa (2023) for an overview of the main “myth-busting” arguments.

2018).

While smallholders are instrumentalised in a larger battle of perceptions, many of the critiques presented are not without merit. For instance, it is certainly true that smallholders are those who are most adversely impacted by the E.U.'s policies aimed at stopping "imported deforestation", as they face significant barriers to demonstrating compliance with certification standards (Schoneveld et al., 2019a; Choiruzzad et al., 2021). However, smallholders are merely a convenient device in a larger battle against, in the view of many Indonesians and Malaysians, the E.U.'s protectionist policies to support its own rapeseed farmers (Choiruzzad, 2019; Tyson and Meganingtyas, 2022). As such, the impact on smallholders has proven a compelling narrative, allowing advocates of oil palm to recast environmental opposition as a cynical ploy by anti-development, colonial outsiders who are selfishly preventing poor, small-scale farmers from escaping poverty (Choiruzzad, 2019; Liu et al., 2020; Schouten et al., 2023).

2.4.1 Use of Academic Research in Bolstering Pro-Oil Palm Narratives

In a review of oil palm narratives in Indonesia, Tyson et al. (2018) summarise the pro-oil palm public relations machine thus:

> In response to these political and consumer pressures, pro-growth discourses targeting domestic audiences serve to remind the Indonesian public that palm oil production generates billions of dollars in annual revenues and lifts millions of rural smallholders out of poverty. Pro-growth trade associations and ministries claim that the livelihoods of anywhere from 10 to 24 million Indonesians depend on the palm oil sector. It is unclear where these figures come from... but given the discrepancy between industry employment figures and the 2–3 million figure cited by the World Bank, there is a concerted public–private effort to construct a developmental narrative that positions the Indonesian palm oil sector as an indispensable force for good.

A common practice is the selective use of statistics and quotes from academic researchers working in oil palm research, often selectively or misleadingly presented in what Tyson et al. (2018) terms "a pattern of obscurantism and the use of vague figures that are inconsistent and difficult to independently verify". Quotes, figures and even sometimes photos of these researchers are used for the purpose of lending credibility to the "myth-busting" claims[24]. Tyson et al. (2018) identifies several "arbitrary figures" of unknown origin cited by CPOPC in press releases – for example that oil palm development has resulted in "ten million Indonesians being lifted out of poverty" by oil palm[25].

In reviewing this literature, two of the most commonly cited statistics I have encountered are that "1.3 million rural people [in Indonesia] have escaped poverty due to growth in the palm oil sector" or that "palm oil has lifted 2.6 million Indonesians out of poverty". These claims are often accompanied by the phrase "According to research conducted by Stanford University"[26]. Both of these figures come from a

[24]For example, in one of only twelve infographics on the website of the Council of Palm Oil Producing Countries (CPOPC), a named photo of a Professor from Hohenheim University appears alongside a quote from their paper, which discusses the potential benefits of mosaic landscapes and agroforestry configurations on biodiversity to imply that the researcher is in favour of oil palm for biodiversity reasons. This was done without the researcher's knowledge or consent (Grass, I, personal communication, November 27, 2023).

[25]This particular example comes from a press release issued by the CPOPC and picked up widely by regional media following a conference with the Vatican on the Sustainable Development Goals – amusingly given the grossly misleading headline "Vatican Stands Behind Palm Oil" (Tyson et al., 2018)

[26]For the 1.3 million people claim, see for example, the Indonesian Government's use of the figures in Indonesia-EU negotiations here, here and here as well as by government-affiliated oil palm lobby groups outside the EU, for example Russia. A quick google search also sees the claim made widely by oil palm companies (e.g. SMART). For the 2.6 million claim, see for example, the *"Indonesia Palm Oil Facts"* website funded by the Indonesian Palm Oil Association (a major lobbying group for Indonesian palm oil producers). A simple news search also reveals the 2.6 million claim repeated in The Asean Post, The Jakarta Post (in an article co-written by an Indonesian government minister ahead of an EU-ASEAN meeting on vegetable oils).

well-known, well-cited econometric analysis by a respected economist published in working papers in 2017 and 2019 respectively. However, at the time of writing (2024), neither of the figures are yet published in peer-reviewed articles[27]. The original studies from which they taken, while rigorous analyses, are not definitive and need to be interpreted with the study limitations and caveats in mind. Firstly, they originate from an idiosyncratic – and arguably unrepresentative oil palm context – and may therefore have "limited transferability" (Santika et al., 2019a) to other Indonesian oil palm contexts (see Chapter 3, Section 3.1.3). Secondly, like all observational studies, they are subject to a degree of unavoidable risk of endogeneity and selection bias (see Chapter 5, Section 5.3.1). Unobserved underlying reasons may explain why some farmers have adopted oil palm, and others have not, and these latent variables may also influence outcomes of interest. While the studies employ generally well-thought-through and rigorously tested econometric techniques (such as propensity score matching or instrumental variable approaches) to simulate counterfactual scenarios, these are inherently imperfect solutions. Likewise, these approaches cannot control for the survivorship bias inherent in sampling existing oil palm farmers. The accumulation of oil palm land by a wealthy few and the creation of a landless waged labour class has been widely documented (McCarthy, 2010; McCarthy et al., 2012; Schoneveld et al., 2019b). Households with limited access to capital often struggle to endure the initial phase between planting and harvesting (especially if given up land) and sell land to weather farmers who can (Li, 2015; Elmhirst et al., 2015, 2017). Any study which measures the welfare or livelihoods of smallholder oil palm farmers is, by definition, measuring only those farmers who are successful and, by definition excludes those who sold their land and have either migrated away from the region or work as landless waged plantation labourers.

Within the context of the papers themselves, these figures are couched in the necessary caveats and methodological explanations, enabling other academics to interpret the findings appropriately. However, such figures provide highly useful hooks for pro-oil palm lobbyists who are able to strip them of the nuanced academic debate and present them as indisputable facts. For example, the latter (2.6 million) claim is, in fact, based on (in the author's own words) a "back of the envelope calculation" which is clearly explained in the paper[28] – yet is widely reported as an authoritative, incontrovertible official estimate.

2.5 Chapter Conclusion

This background chapter has shown the diversity of smallholder partnership models, which differ by location and era in which they were initiated. Likewise, independent smallholders range from new farmers switching crops to grow oil palm to graduates of one of the myriad partnership schemes. Further complicating the issue is the fact that participation/membership in partnership schemes can be bought and sold (along with the theoretical or actual ownership of the plasma land). There is a startling lack of data about the nature of smallholder oil palm in Indonesia. The small handful of systematic attempts to quantify which smallholders by model indicate that significant proportions of independent smallholder farmers are neither small nor independent. Many so-called smallholder oil palm farmers are in fact, outside owners or investors or local political and economic elites who have accumulated plasma land by purchasing them from poorer farmers. Many so-called independent smallholders may simultaneously

[27]Although revised versions may soon be forthcoming (Edwards, Personal Communication, April 2023). The 2.6 million figure is published in a working paper (Edwards, 2019) published on the author's personal website. As of April, 2023, the paper is listed as "Revise and Resubmit at the Journal of International Economics" on the author's author's personal website. The 1.3 million figure originates from Edwards (2019) and was published as a "job market paper" and then later on the non-peer-reviewed social science research repository which aims for the rapid dissemination of preprint publications SSRN.

[28]The footnote explaining the figure in the working paper is as follows: "This back-of-the-envelope calculation was done by multiplying the change in area under cultivation by the estimated coefficient on palm land in Column to get the predicted percentage poverty reduction for each district. I then multiplied that by district population and summed over rural, non-Java districts to get the total number of poor lifted from poverty."

own plasma oil palm land. Many scheme participants seem unable to survive the initial period between giving up their land and receiving the rewards from oil palm harvests. It is these farmers who likely sell their land to wealthier farmers who can weather the years between planting and harvest. Thus, these models may drive the dispossession of poorer farmers from their land and the accumulation of land by the wealthy and politically connected.

The accumulation of land by the successful and the dispossession of land by the unsuccessful have profound implications for studies of smallholder oil palm in Indonesia. In my review of the oil palm diets literature in Chapter 3, I will show that many studies do not report – or, more likely, do not know – the exact nature of the smallholder oil palm that they are investigating. This has serious implications. An independent smallholder who is a graduate of a plasma scheme beginning in the 1970s has so little in common with a member of a contemporary plasma farmer operating under a "shareholder" partnership model today that it renders generalisations of the "*effects of smallholder oil palm adoption*" meaningless.

There are two serious consequences of this oversight in the literature, both of which are discussed in detail in Chapter 3. Firstly, caution should be exercised not to generalise the findings of studies based upon smallholder models which no longer exist – or which apply only to smallholders in a particular region or context. While the number of so-called "independent" smallholders is increasing, it is not clear from where these smallholders are coming. Some will be cash-crop farmers, some subsistence farmers. Some will be landless labourers on oil palm plantations (some of which will be autochthonous, some of which will be migrants). In regions with long histories of smallholder schemes, a proportion will come from graduates of schemes more generous than those which predominate today. In regions on oil palms expanding frontier, a great many will be those who have accumulated land from those unable to make ends meet in the predominant contemporary form of partnership schemes. The second serious implication that will be discussed in the next chapter is that studies of smallholder oil palm adoption likely suffer from extreme selection bias. Any study which measures the welfare or livelihoods of smallholder oil palm farmers is, by definition, measuring only those farmers who are successful and, by definition excludes those who sold their land and have either migrated away from the region or work as landless waged plantation labourers. Additional caution is warranted due to the way "smallholders" have become a locus of a global dispute over trade and tariffs (EEAS, 2023) – in which well-funded and well-organised public relations strategies are strategically promoting findings and statements made by academic researchers.

that a significant proportion (perhaps the majority) of contemporary and future smallholder oil palm adoption differs from the previously studied models in two ways: Firstly, the independent oil palm adopters studied in previous research are mainly graduates of smallholder oil palm schemes which no longer exist – and whose terms were significantly more advantageous to farmers than their contemporary equivalents. Secondly, the existing studies have focused almost exclusively on farmers who were already highly commercialised rubber farmers and who grew little to none of their own foods prior to adopting oil palm.

Endnotes for Chapter 2

[I] Ten provinces were identified in the report by KIM (2021): Papua, West Papua, Central Kalimantan, East Kalimantan, North Kalimantan, West Kalimantan, Central Sulawesi, Aceh, Maluku and North Maluku. Together, these provinces host 80% of Indonesia's remaining forests, and deforestation rates are increasing in each.

[II] **Oil palm Yields**: Oil palm can produce yields per hectare that far surpass any other vegetable oil. One hectare of palm produces on average 3.6 tonnes yr^{-1} of palm oil. The highest yielding plantations are capable of producing 6 tonnes $ha^{-1}\,yr^{-1}$ and genetic trials suggest 10 tonnes $ha^{-1}\,yr^{-1}$ are possible. (Rival and Levang, 2014). In comparison, the next most productive oil crop, rapeseed, produces an average of 0.5 tonnes $ha^{-1}\,yr^{-1}$. Despite its relative productivity, average yields of oil palm in Indonesia and Malaysia are significantly lower than their theoretical potential and increasing yields as long been considered a "low-hanging fruit" (Oberthur et al., 2012). Smallholders consistently produce lower yields than corporate plantations, thus offering the greatest potential gain in yield increases.

[III] **Reconciling Economic and Environmental Objectives:**Palm oil is vitally important for Indonesia's economy, contributing around 4.5% of national GDP, 17% of agricultural GDP and employing around 30 million people (Kementerian Pertanian, 2015; FAO, 2021). The Government of Indonesia (GoI) has set a target of producing 60 million tonnes of CPO by 2045 – roughly a 30% increase on today's production (GAPKI, 2022). At the same time, oil palm expansion continues to be a significant driver of forest loss. The GoI is facing considerable trade and buyer pressure to halt the expansion of oil palm into forests and has signed up to legally binding international commitments to reduce emissions (UNFCCC, 2016). While Indonesia did have a moratorium on oil palm expansion into forests between 2018 and 2021. The moratorium was allowed to expire without being renewed, with the GoI announcing that existing regulations would be used instead (Reuters, 2021). As well as increasing smallholder productivity, reconciling these two objectives requires several other interventions in the sector, including halting planting on peat and controlling fires (Purnomo et al., 2020)

[IV] **Changing Nature of oil palm Opposition:** The fact that the Indonesian palm oil industry will continue to grow has become more widely accepted – even amongst civil society groups staunchly opposed to it. Many previously virulent campaigners against palm oil now lobby for "best practice" rather than opposing oil palm completely (Rival and Levang, 2014). Some strident environmental NGOs now even collaborate with companies they previously campaigned against to improve management practices, ensure compliance with sustainability criteria and increase supply chain transparency (Greenpeace International, 2014). At the same time, development organisations – who from the 1970s and 1980s explicitly supported oil palm development before nervously distancing themselves in the face of international pressure – have renewed interest in leveraging oil palm for poverty reduction economic growth (albeit with additional commitments to 'sustainability') (World Bank, 2011) The recognition that palm oil may be more complex than the binary narratives often presented has led to renewed interest in 'landscape approaches' to managing oil palm. In the same way, the promise of palm oil as a poverty reduction strategy has led to a rise in the emphasis on smallholder production. The success of the smallholder narrative is due to three main factors: smallholders are intrinsically harder for NGOs to argue against than companies; the model is in keeping with the neoliberal ideology of international development organizations; and supporting small-scale farmers popular, nationalist position for Indonesia's politicians (especially when framed as resisting the neoliberal and neocolonial interference of the RSPO and iNGOs). (Pesqueira and Glasbergen, 2013; Wijaya and Glasbergen, 2016; Pye, 2019b)

Chapter 3:
Pathways Between Oil Palm And Diets: A Critical Review

Contents

3.1 Introduction

This chapter presents a mixed-methods critical review of one aspect of the oil palm – livelihoods literature. Critical reviews are similar to narrative reviews, but diverge in approach at key criteria. Critical reviews tend to use a more diverse range of sources than traditional narrative reviews. Additionally, rather than producing a summary and appraisal of quality, they focus on producing "analysis and conceptual innovation", which tend to result in a "hypothesis or model" (Grant and Booth, 2009; Gough et al., 2012). In the words of Grant and Booth (2009), they are an "opportunity to 'take stock' and evaluate what is of value from the previous body of work" as well as an attempt to "resolve competing schools of thought". My starting point is the lack of consensus among researchers on the social and welfare outcomes of oil palm expansion. This critical review is partially an attempt to "resolve" (or at least somewhat unravel) how researchers have arrived at such wildly different interpretations. I posit that a combination of disciplinary, methodological and geographical factors explain the division and that existing research can be broadly classified into two clusters along these axes.

While aspects of this review are relevant to much of the oil palm livelihoods literature, I primarily analyse studies which report dietary or nutritional outcomes. My focus here is not on the impacts on dietary outcomes themselves, but on the ways in which they have been explored. I argue that there is a risk of engaging in errors of "generalisation" (Polit and Beck, 2010) by privileging quantitative findings from a limited number of contexts over qualitative studies which explore a more diverse range of contexts and pathways.

3.1.1 Lack of Consensus In Oil Palm – Livelihoods Research

Despite two decades of research, there remains no consensus regarding the social, economic and welfare impacts of oil palm expansion on local communities in Indonesia (Meijaard and Sheil, 2019). Advocates for oil palm promote expansion and adoption on development grounds (Anderson et al., 2016; Susanti and Maryudi, 2016; Tyson et al., 2018; Qaim et al., 2020) – citing evidence that adoption of oil palm by independent smallholders increases household incomes (Qaim et al., 2020). While arguments in favour have traditionally relied on economic narratives of growth, employment and poverty-reduction (Susanti and Maryudi, 2016; Liu et al., 2020), increasingly, food security and nutrition have been incorporated, emphasising oil palm's contributions to the SDGs both in terms of global vegetable oil supply and in terms of improving food security of producers via income-pathways (Chiriacò et al., 2022; Sukiyono et al., 2022; Alamsyah et al., 2023). Conversely, critics argue that oil palm benefits mainly rich farmers, displacing poor farmers from their land, and increases social, economic and gendered inequality (Meijaard and Sheil, 2019).

The lack of consensus on the social impacts of oil palm is partially attributable to the relatively narrow range of welfare indicators used (Meijaard and Sheil, 2019; Ayompe et al., 2021; Reiss-Woolever et al., 2021) and the limited diversity of geographical locations and oil palm models in which they have been studied (Ayompe et al., 2021). A recent systematic map of oil palm studies identified major knowledge gaps – especially for broader human health and welfare outcomes (Reiss-Woolever et al., 2021). Additionally, the review found that only a small minority of studies reported gender-disaggregated outcomes. Research tends to be geographically clustered, with certain outcomes extensively studied in some locations and contexts but barely studied in others . This holds especially for quantitative studies that allow for causal inference – which necessitate costly and time-intensive surveys and complex study designs and analysis. For example, the overwhelming majority of research drawing causal inferences on labour and nutrition comes from just one province in Sumatra – all of which focused on a particular form of independent smallholder oil palm adoption.

Several scholars have argued that there is a tendency for results to be over-generalised from specific contexts (Santika et al., 2019a; Nurhasan et al., 2022). Conclusions drawn from one location or smallholder model are not necessarily transferable to other contexts in Indonesia – particularly where there are idiosyncratic histories of plantation development and migrant labour dynamics (Potter, 2016a). Chapter 2 described the complexity and diversity of oil palm smallholder as well as their heterogeneous distribution across Indonesia. The most significant determinant of the composition of smallholder types in any region is the length of time since the establishment of the local oil palm industry. In regions with long histories, the context favours the adoption of independent smallholders who can take advantage of spill-over effects including the establishment of independent mills and the network of agents and middlemen that facilitate transactions (Euler et al., 2016). In these contexts, smallholders are also more likely to be graduates of smallholder schemes which are far more generous than today's equivalents – or else be wealthy farmers, elites and outside investors who have managed to accumulate land from less wealthy smallholders (Jelsma et al., 2017, 2019). Conversely, in regions where oil palm expansion is more recent, smallholder oil palm adoption consists mostly of tied plasma farmers (outgrowers) or, increasingly, participants in vastly less generous "partnership" shareholder models (Hasudungan, 2018; Schoneveld et al., 2019a,b).

The absence of consensus is further confounded by the lack of attention to the nature of livelihoods prior to oil palm adoption and to the nature of the counterfactual "non-adopter" upon which comparisons are made. The benefits or drawbacks depend greatly on who the farmer was before they adopted and the context in which they operate. Santika et al. (2019a,b), for instance, shows that the welfare benefits of oil palm are greatest for communities which were already deeply market-integrated, but that impacts are often negative for former subsistence communities. Economic benefits of oil palm are driven primarily through labour efficiencies allowing for farm expansion and greater participation in off-farm work (Krishna et al., 2017; Chrisendo et al., 2021). The ability to expand farms depends on the degree of land scarcity, forest cover, and customary and legal tenure regimes. Likewise, obtaining a good price for FFBs depends on farmers not being tied to particular agents, companies, or mills – and crucially the presence of multiple (competing) independent mills within close proximity (Colchester and Jiwan, 2006; Sahara et al., 2017; German et al., 2020). Without such arrangements, growers – whose oil-yields rapidly depreciate with time after harvesting, have poor bargaining power and obtain lower prices[1] Oil palm labour adoption is also, for the most part, not solely a decision by an individual farmer or household over which crop to grow but part of broad economic, agrarian and geographical transitions. These transitions have emergent properties and effects that resonate beyond individual farmers and create feedback loops between individuals, communities, and their landscapes. These transitions also affect different households in different ways, as they intersect with wealth, race, ethnicity, class, education level, and gender (Elmhirst et al., 2017).

3.1.2 Search Strategy and Inclusion Criteria

It was not necessary to conduct a full systematic search of the literature before 2020 as three relatively recent papers have been published that mapped the entire evidence base for the welfare effects of oil palm adoption. Two recent systematic maps have been published (one for Indonesia and one for global oil palm), that include studies with social and welfare studies (Ayompe et al., 2021; Reiss-Woolever et al., 2021). Additionally, a study by Santika et al. (2019a) includes a comprehensive review of the relevant literature[2]. Together, these three sources provide a comprehensive list of relevant papers published before 2020. Papers published after the cut-off dates for these reviews were captured through forward

[1] Li and Semedi (2021) even reports farmers having to bribe mill officials or colluding with them to take the FFBs "off the books".

[2] Included in the Supplementary Information

snowballing (Wohlin, 2014; Felizardo et al., 2016).

Table 3.1 summarises existing studies of oil palm adoption and the diets and nutrition of local people that use quantitative methods. I include all studies which met my inclusion criteria that they should: (a) Measure outcomes of dietary quality an/or nutritional status and (b) Should make causal inferences between oil palm expansion and dietary intake. Based upon my review of studies, I divided quantitative studies into two groups: (1) Quantitative studies that used statistical/econometric approaches to causal inferences and (2) Mixed method studies that simply reported dietary trends, associations or differences between groups quantitatively and used qualitative methods to posit causal pathways. No mixed-method studies were found which also drew causal inference. The selection criteria for qualitative studies is more difficult. Very few studies qualitative studies focus specifically on dietary and nutritional pathways, but most, if not all, will reference some form of effects on agriculture, wild foods or markets. Working from the list of studies compiled from previous reviews and my own search, I, therefore, selected studies for inclusion based upon the pathways discussed with them (whether or not diets and nutrition were a focus of the research itself) with the aim of showing the diversity of different pathways through which diets could theoretically be influenced by oil palm adoption and expansion. The selected qualitative studies are shown in Table 3.2.

Table 3.1: Implicit/Explicit Pathways in Quantitative Dietary Studies

Study Description			**Context**					**Included**			**Pathways**			
Study	**Location**	**Method**	**Markets**	**Model**	**Subsistence**	**Forest Cover**	**Dietary Context**	**Over-nutrition**	**Gender Dynamics**	**Heterogeneity[§]**	**Income**	**Food Production**	**Loss of Land**	**Wild Foods**
Studies With Statistical Causal Inference														
Sibhatu et al. (2015a)*	Jambi	EC	WFM	IS-2	x	L	x	x	x	MA, SFP[†]	✓	✓	x	x
Euler et al. (2017)*	Jambi	EC	WFM	RSI-1	x	L	x	x	x	W	✓	x	x	x
Sibhatu (2019)*	Jambi	EC	WFM	IS-2	x	L	x	x	x	M	✓	✓	x	x
Santika et al. (2019a,b)	National	EC	-	-	x	L	NA	x	x	SFP	✓	x	x	x
Chrisendo et al. (2020)*	Jambi	EC	WFM	IS-2	x	L	x	x	✓	W,M	✓	✓	x	x
Chrisendo et al. (2022)*	Jambi	EC	WFM	IS-2	x	L	x	x	✓	W,M	✓	✓	x	x
Mixed-Method Studies with Descriptive Quantitative Component														
Purwanto (2018)	W. Kalimantan	NS[‡]	IPM	P	✓x	H	NA	✓	x	x	-	-	-	✓
	Papua	NS[‡]	IPM	✓	C x	H	NA	✓	x	x	-	-	-	✓
Nurhasan et al. (2022)	W.Papua	NRS[‡]	-	-	✓	H	x	✓	x	x	-	-	-	✓

Notes: Where studies contain sub-studies from two or more distinct locations (i.e. results are not pooled), these have been reported separately. **Study Types:** *Studies appear to share (at least some) of the same data and are based on the same study and sampling design; [†] ([‡])Mixed-method studies where the quantitative component does not ascribe causal inference and where pathways are explored in the qualitative component.
makes no causal inference between oil palm expansion and diets premised on pathways – i.e. quantitative study is not descriptive diets or associative only. Papers marked with
Codes for Methods: EC = Econometric studies using panel data and statistical techniques to control for endogeneity; NS = Nutrition Survey (Dietary Recall); NRS = Nationally Representative Survey data
Codes for Markets: WFM = Well Functioning Markets ; IPM = Imperfect Markets
Oil Palm Model: IS-1 = Randomly Selected Independent smallholders: i.e. households were randomly selected, and non-independent smallholders were excluded from the sample; IS-2 = Described as independent smallholders – no indication given of exclusion or inclusion criteria; P= Plasma Smallhplder; C = Company Workers or Company Affected Communities (i.e. not smallholders) **Heterogeneity:** [§] Analyses within-sample heterogeneity (e.g. effects of wealth, migration, prior farming type, migration status); *Codes:* Study explicitly examines heterogeneous effects for M= Migrants, Transmigrants or Autochthonous; W = Wealth Effects and Capital Accumulation; SFP = Subsistance Food Production; MA = Market Access
Pathways: ✓= Study attempts to quantity pathway; x = study mentions pathway but does not analyse as assumed not to be relevant in study context; - = study makes no mention of pathway

Table 3.2: Selected* Qualitative Studies Containing Pathways Between Oil Palm and FSN

Study	Location	Model	Impacts and Pathways
Orth 2007	C. Kalimantan	Company[1]	• **Tenure insecurity** leads to hesitancy to plant crops near plantation • Lack of available fresh foods on plantations due to poor **infrastructure** connecting with fresh **food shed** • Reduced access/availability of wild foods leads to: Reduced fresh food availability; Increased cost of living (**loss of environmental income**); Increased food insecurity (**loss of forest safety net**) and **seasonal vulnerability** • **Swidden intensification** (caused by land scarcity) leads to: Reduced **Soil Fertility**; Reduced **crop diversity** (both cultivated and **agrobiodiversity**); Increased food insecurity (food sufficiency, enrollment in government assistance scheme)
Julia and White 2012	W. Kalimantan	KKPA[2]	• **Land scarcity**/loss of agricultural land • **Feminisation of subsistence production** • **Foodshed and food system changes** from loss of aggregate production
Li 2015	W. Kalimantan	NES + Trans	• Insufficient **income** to abandon subsistence • Loss of **food on credit** available from rubber traders • **Land scarcity** (dependent on village & ethnicity) leads to reduced food crop production • Mixed (oil-palm & subsistence) strategies more resilient and food secure – but dependent on land availability • Oil-palm adoption shifts the **gendered distribution of income generation** within household. However, as far as could be determined, researchers found that women (mostly) retained significant **input into decision-making and control of expenditure**.
Obidzinski et al. 2012	(i) W. Kalimantan (ii) Papua (iii) W. Papua	(i) NES[3] (ii) NES[4] (iii) Company	• Increased **distance and time to access forest products** • Decreased opportunities (**encounters with wild foods**) • Loss of **income from forest products** • Reduced **time spent on-farm** due to plantation work • Increased time spent in farm-related activities due to **loss of forest foods**
Potter 2015	W. Kalimantan	Mixed	• Both **land scarcity** and **time scarcity** drive swidden transitions • Food insecurity results from **increased weeds and pests** – including serious rat infestations
Puspitasari et al. 2019	S. Sulawesi	Partnership	• Reduced food security (coping strategies) • **Loss of agricultural land** (conversion rice to palm) • Lack of / insufficient **income** from plasma revenues & low-availability/**access to off-farm labour** (maintenance phase)
Sinaga 2013	Riau	Mixed[3]	• **Income** from oil palm insufficient to compensate for the loss of crop production

Notes: *Many studies discuss food, land, crops and agricultural production in general terms. These studies have been selected because they explicitly or implicitly demonstrate pathways or linkages connecting oil-palm development and changes in food intake.
[1] Study examined three non-oil-palm adopting communities along a gradient of proximity to company plantation. In the closest plantation, some residents were also plantation workers; [2] Smallholders were promised parcels of oil-palm land under earlier schemes but were never allocated the land. Following 15 years of delay, protests legal action and settlement was brokered by local authorities to enroll the community in KKPA schemes. Not all villagers received parcels and land and some received parcels land that were smaller than others. Following more legal action and protests some compensation was provided to those who had received nothing. [3] Ratio 27:73 PIR Trans: PIR KKPA; [3] Ratio 70:30 PIR:PIR KKPA; [4]Mixed sample of 21 workers, 6 plasma farmers and independent farmers.

Table Continued on Page 40

Continuation of Table 3.2

Study	Location	Model	Impacts and Pathways
PurWestri et al. 2019	(i) W. Kalimantan (ii) Papua	(i) KKPA (ii) Company	• Decreased availability of WEP and bushmeat due to **forest loss**. Decreased availability of fish due to **oil-palm-related pollution** • Increased **distance/time** required to obtain wild foods • Improved **market infrastructure** leads to increased access to healthy foods such as eggs and chicken but also UPFs • **Time scarcity** from working in oil-palm leads to reduced wild food acquisition • **Changes in food preferences** towards "modern" foods and away from traditional food
Toumbourou and Dressler 2020	E.Kalimantan	Company	• **Land scarcity** drives swidden transitions and shorter fallow periods leading to reduced **soil fertility and lower yeilds** as well as increased women's time spent weeding • **Forest loss** leads food scarcity due to **intensively harvesting NTFPs** from remaining forest patches • Reduced fish availability due to oil-palm related pollution and siltation • Women's concerns over food security and vulnerability to income and price shocks led women to **diversify production and income** sources as a form of **risk mitigation** including establishing **homegardens** for vegetables around the house and aspired to create **fish ponds**
Chao 2022	W.Papua	Company	• Loss of forest-based livelihoods and access to forests (**land conversion**) • Government and Corporate Social Responsibility (CSR) schemes provide access to **subsidised foods** to ameliorate for loss of forest foods leads to shift towards UPFs and away from diverse traditional diets • Modernisation narratives and development schemes accompany oil-palm expansion – in part to justify expansion, in part to ameliorate negative effects encourage and shame recipients to leave behind forest-based livelihoods (and associated dietary patterns). These include **messaging by health authorities** encouraging greater calorie intake (from "modern" foods such as rice as well as UPFs). Advice given is often accompanied by racist and colonialist attitudes by health education authorities, which influence child-feeding practices. • Changes in **food system and food environment** resulting new types of shops owned by outsiders perceived as having judgemental and racist attitudes towards locals **(perceptions of vendors**) influences consumption patterns
Nurhasan et al. 2022	W.Papua	Company	• Changing intergenerational **social and cultural preferences** • Loss of **traditional skills and food-culture** • **Convenience and practicality** of rice compared with traditional Sago • Changing preferences to tubers influenced by **food-system changes** through the provision of tuber-based snacks • Land-use change dynamics between export-orientated rice estates and oil-palm leads to **land scarcity** for agricultural production and **loss of forests** • **Marketing** of UPFs and SSBs to children

3.1.3 Study Contexts

In comparing the quantitative and qualitative studies, several observations are immediately apparent. First is the high concentration of studies in one particular oil palm context among the econometric studies – that of independent smallholders. Furthermore, the literature is skewed by a heavy focus on Sumatra – in particular, Jambi Province, a province with a long and particular history of oil palm development, little remaining forest and a low prevalence of subsistence agriculture. In fact, all the econometric studies linking oil palm adoption and diets appear to be based on a single data set[3]. The degree to which findings from this context can be extrapolated to other contexts has been debated (Nurhasan et al., 2020a; Sibhatu, 2020). In the areas with the greatest expansion of oil palm in past decades, the rate of oil palm development is plateauing – limited to some extent by available land (Gaveau et al., 2021). As such, they are not necessarily representative of where future oil palm expansion will occur. They also have their own particular histories of plantation agriculture, land use trajectories, demographics and labour patterns (Potter, 2016b).

Discussing the disproportionate dominance of studies from a handful of locations, Santika et al. (2019a) summarises the issue in the following way:

> Studies that apply a counterfactual analysis approach for evaluating the social impact of oil palm are mostly based on data from Sumatra, and geographically based around transmigrant areas in the province of Riau and Jambi... These provinces are not only recognized as the hotspots of Indonesia's recent oil palm boom, but also the hotspots of transmigration programs during the New Order regime in 1965–1998... Thus, the baseline socioeconomic context and socio-political history of the oil palm growing areas associated with these studies likely have limited transferability of the resulting conclusions to other oil palm areas where recent migration was considered to be less prevalent prior to oil palm developments, such as in many parts of Kalimantan and Papua.

In contrast to the quantitative studies, most qualitative studies discussing food and nutrition are situated in contexts where oil palm development is more recent – particularly in Kalimantan and Papua. These are also the contexts in which oil palm is expanding most rapidly (Gaveau et al., 2022). In these contexts, very few smallholders will be independent, and those enrolled in smallholder schemes are more likely to be enrolled in modern iterations of NES schemes – "partnership" schemes – the vastly less generous modern iterations of the NES schemes from which many independent smallholders in Jambi will have graduated from. Most qualitative studies embed their research within the complex local histories of oil palm development. Many qualitative studies in contexts of smallholder schemes identify heterogeneity within communities in terms of how and when they engaged with company schemes and that different community members may be enrolled in different schemes (or even multiple schemes) at different times. As well as providing more detailed contextual histories, qualitative accounts also tend to pay more attention to the type of schemes respondents are part of and their histories in engaging with plantation labour. In contrast, the econometric studies attempt to control for such variation either by the inclusion of dummy variables (e.g. Chrisendo et al., 2020, with transmigrants), or by excluding plasma participants

[3] Or at least, related data sets. All published econometric studies come from a single research group (primarily PhD candidates with a common supervisor).

entirely (e.g. Euler et al., 2017) or those not owning farm-land prior to adoption (Chrisendo et al., 2020). However, as discussed in Chapter 3, many plasma smallholders are also independent smallholders (and vice versa – many independent smallholders may purchase active plasma plots).

3.1.4 Outcomes

Two studies measure nutritional status: Purwanto (2018) directly, and Santika et al. (2019a) using the incidence of child malnutrition from government village-level statistics[4]. The former is also the only study to measure dietary intake directly. All other studies measure diet quality via proxies through a combination of food expenditure and food group measures of dietary diversity. The use of non-standard and non-validated measurement approaches is widespread. Indeed, this has sparked some debate within the literature[!]. This review does not intend to weigh into this debate but simply to document pathways and outcomes. However, it is worth noting that those objecting to their use tend to be nutritionists, while those defending it tend to be economists. The prosaic truth is that, in many cases, these indicators are not being used to measure nutrition at all but serve as proxies for broader socio-economic and welfare outcomes. Thus, the meticulous technicalities of nutritional epidemiology are less pertinent.

Only two studies explicitly discuss overnutrition and diet-related Non-Communicable Diseases (NCDs) – the most detailed of which (Nurhasan et al., 2022) uses NOVA classifications of processed food groups associated with diet-related diseases (Poti et al., 2017; Monteiro et al., 2019). However, neither of these studies makes quantitative causal inferences between oil palm expansion and dietary changes. Of the studies that do, several reported nutritional outcomes in terms of calories, but none report consumption of unhealthy foods such as Ultra Processed Foods (UPFs) and Sugar-Sweetened Beverages (SSBs). Even when calories are measured, in some cases, they are reported only as relative increases and effect sizes without reporting the average caloric intake of study participants. For example, Chrisendo et al. (2022) find oil palm adoption results in an increase in calorie intake of 7.5% (relative to the rubber-farming non-oil palm adopters[5]). To know whether this is meaningful and in what direction, it is necessary to know the dietary and nutritional context of the study participants (i.e. do these individuals suffer from a calorie deficit or are they at risk of over-consumption).

None of the included econometric studies reported this dietary context, which is necessary to interpret these results.

The lack of reporting on overnutrition is especially perplexing when considering this data was available from comprehensive food expenditure surveys. In some cases, metrics were even modified for the express purpose of excluding unhealthy foods. For instance, Sibhatu (2020) exclude unhealthy food groups from the dietary diversity counts. This decision is justifiable as it makes interpreting the dietary diversity score easier (a higher score means a diet more diverse in nutritious foods). However, it also begs the

[4]Definitions of child malnutrition are not provided, but it can be presumed that it relates to under-nutrition – most likely underweight or stunting.

[5]Although this calculation is based upon converting quantities derived from 7-day recall expenditure surveys – a method not considered standard within nutrition research (Verger et al., 2019).

question, why not additionally report this expenditure? Given the dynamics of nutrition transitions in Indonesia, it is highly probable that these households (who were also getting wealthier) were increasing their expenditure on such foods (Roemling and Qaim, 2013; Oddo et al., 2019). Indeed, given the burden of diet-related NCDs in Indonesia – such findings could potentially be more significant in terms of health outcomes than small increases in the diversity of healthy food groups consumed.

3.1.5 Pathways Considered Between Oil Palm and Dietary Intake

Almost all of the quantitative papers provide a brief discussion of the potential pathways between diets and nutrition – but the context in which these studies are conducted means that they are not explored analytically. For example, in the framing of their analysis Chrisendo et al. (2020), drawing on Ruel et al. (2013), outlines four mechanisms between agricultural changes and dietary intake: (1) Food production on-farm; (2) Local food prices; (3) Household income and; (4) Gender roles. However, the first two of these were not examined in the analysis because they are assumed not to be pertinent in this particular context. In the words of the authors:

> The mechanisms related to own food production and food market prices are relevant in general but do not apply to the particular context in Jambi. Food crop production in Jambi was very low even before the oil palm boom started.

In the context of Jambi, not explicitly analysing market pathways is not unreasonable as it can be assumed that markets are fairly well-developed within the sample sites – a product of Jambi's unique history of plantations and associated infrastructure and due to the fact that little food is produced locally, even by non-oil palm adopters. Food systems, therefore, may well be more-or-less similar across locations and mediated through similar market systems (with similar food prices and availability). However, in a great many other contexts in Indonesia where oil palm is being adopted, this is not the case. The effect of imperfectly functioning markets on nutritional outcomes can be significant and depends on context (Jones, 2017a). While the foods themselves are not recorded, Obidzinski et al. (2012) wildly different perceptions of the effects of oil palm on access to foods between sites.

In some cases, greater access to markets will provide access to more nutritious foods, but in other cases, the reverse can be true. In a cogent example of this, Reyes-García et al. (2019) finds that for remote forest-centric communities in East Kalimantan, the availability of nutritious foods decreases with increased integration into markets, while the availability of unhealthy UPFs and SSBs increases. In Papua province, PurWestri et al. (2019) finds improved market access accompanies oil palm development, which results in mixed effects – with greater access to healthy foods such as eggs and chicken, but also greater access and consumption of UPFs.

Several qualitative studies of oil palm adoption were situated in contexts with imperfect market functionality and showed the effects of oil palm development on the availability and affordability of foods (Orth, 2007; Julia and White, 2012; Puspitasari et al., 2019; Chao, 2022). For example, Julia and White

(2012) find oil palm effects on local food availability as local farmers no longer produce surplus fresh foods which are sold locally. This effect could be considered "food shed"[6] impact of oil palm. In contexts with imperfect market functionality, the food shed of perishable foods tends to be smaller than for non-perishable foods – thus loss of a local production surplus may impact food availability (Ickowitz et al., 2019).

With the exception of Sibhatu et al. (2015a), who explicitly explores the relative importance of income vs own-production pathways, all the remaining econometric studies are focused primarily on income-mediated pathways and assume that markets function adequately. As discussed in Chapter 2, oil palm adoption increases income not due to superior profitability but due to its superior labour efficiency (compared with rubber), allowing households to reallocate this labour to off-farm work (most likely plantation labour) or to expanding their farm size (Kubitza et al., 2019). Indeed, this appears to be the mechanism driving nutritional effects via income pathways. Euler et al. (2017) demonstrate the importance of off-farm labour in driving nutritional effects. When controlling for income derived from off-farm labour, the effect of oil palm adoption is reduced – and for some outcomes, no longer significant.

While all but one of the quantitative studies assumed that self-production was not a relevant pathway in the context of Jambi, multiple qualitative studies find that land scarcity and loss of access to forests impact food supplies – either directly through giving up cropland as a condition of enrolling in smallholder schemes (e.g. Julia and White, 2012; Li, 2015) or indirectly through oil palm's effect on increasing land scarcity and reducing tenure security. Additionally, several studies reported reduced fish availability in local rivers due to pollution from oil palm plantations and /or mills PurWestri et al. (2019); Toumbourou and Dressler (2020). Several studies note that access to forests and agricultural land are not simple binaries but operate along gradients which can be measured in terms of the distance and time required to access them (Obidzinski et al., 2012; Nurhasan et al., 2022) – factors which affect the convenience and accessibility of foods as well as participation in production systems.

Qualitative papers which discuss income pathways did so in terms of the net effect of income gained from oil palm-related activities and "environmental income" lost from forest loss and reduced own-production due to land scarcity/competition.(e.g. Puspitasari et al., 2019). Most such studies also reported that income gains from off-farm income or plasma revenues were insufficient to compensate for the loss of this on-farm production or "environmental income" resulting in an increased cost of living. This highlights the importance of considering ecological income when conducting analyses of income and affordability in biodiverse contexts – and suggests that food expenditure surveys should not be used as proxies of consumption in such contexts.

Toumbourou and Dressler (2020) highlight the gendered effects of managing tighter food budgets, since this falls within women's cultural responsibilities. Additionally, the study reports women's concern over income specialisation and thus vulnerability to price fluctuations and shocks as a driver of risk-diversifying actions such as planting home gardens and starting small enterprises. Other gendered effects include the "feminisation" of subsistence agriculture (women taking on a greater share of agricultural

[6]Defined by Peters et al. (2009a) as "the geographic area from which a population derives its food supply".

food production) due to differential access to off-farm labour between men and women (Julia and White, 2012).

Several studies discuss the effects of the social and political context in which changes take place and their effects on food systems and food environments. The most extreme example is Chao (2022) who provides a vivid account of the way in which racist and colonial attitudes by (predominantly Javanese) local authorities and shop vendors affect dietary behaviours and perceptions of vendors in West Papua. All three of the included studies from Papua and West Papua provinces PurWestri et al. (2019); Chao (2022); Nurhasan et al. (2022) describe changing social and cultural trends away from traditional foods (sago, fish, bushmeat) towards diets high in rice. Such trends appear to be partially generational and have complex origins – some of which relate to oil palm, some of which may be independent of it. These include increased marketing of UPFs (especially to children) and the promotion of these diets by local health authorities, loss of access to forests, and increased need and desire for convenience foods – partially driven by time scarcity due to working in oil palm (Nurhasan et al., 2022).

Only a small handful of studies touch upon aspects of the food environment and food systems which may affect food choice. Nurhasan et al. (2022), reports perceptions by local stakeholders that there had been an increase in marketing of UPFs to children, resulting in parents changing purchasing patterns due to "pester power". While not attributable to oil palm expansion alone, oil palm-related development has resulted in an increased frequency of visiting mobile vendors selling these products (due to improved infrastructure), the emergence of mini-marts selling a wide variety of these products and increased cash incomes with which to buy them (from plantation labour).

Vendor products and properties are discussed in only two qualitative studies as potential mediators of food accessibility and food choice. Li (2015) notes that the transition away from rubber and towards oil palm results in the loss of informal credit systems with rubber traders who also own shops – meaning that food can no longer be purchased on credit. As discussed above, Chao (2022) discusses how racist and discriminatory behaviour by shop owners affects consumers' perceptions of shops. Respondents in the study report feelings of alienation and humiliation when purchasing food (often through small holes and barbed-wired screens in kiosk walls) as well as when obtaining food from oil palm companies. Additionally, the study reports a widely held belief that shop owners withhold some types of foods from Papuans and increase prices for Papuans compared with non-Papuans. However, the dietary implications of these effects are not examined.

3.2 Discussion

A wide range of studies have examined different contexts, using different methods and examining different outcomes. Broadly, existing studies can be classified into three groups: quantitative studies using case-control survey designs that compare oil palm adopters (or communities) with non-oil palm adopters, econometric analyses which use propensity score matching or instrumental variables to simulate counterfactual scenarios, or social and economic studies (predominantly qualitative) which examine oil palm adoption as a transition with winners and losers alongside complex interactions with social, cultural, economic and ecological forces. To date, these three approaches have tended to yield different findings and come with their own benefits and drawbacks. Case-control studies, for example, often generally show positive effects on welfare outcomes despite associated rising inequalities, but are often constrained by considerable selection bias and endogeneity. Econometric analyses that utilise simulated counterfactuals attempt to overcome some of the challenges of selection bias and endogeneity but are constrained by the lack of resolution of available data. Such studies have also shown generally positive effects at regional levels of oil palm but fail in explaining nuanced responses for different types of households or adequately account for differing outcomes in different contexts. There is a more nuanced literature that utilises qualitative research to examine social effects of oil palm. The majority of this literature shows how processes of transition occur and affect the livelihoods of local people, resulting in diverging outcomes for different people, often dramatically increasing rural inequality. These studies often fail to account for the fact on-the-whole, people continue to desire oil palm (Feintrenie et al., 2010b). However, recent research has exposed the gap between what communities are promised and what communities desire

Within the oil palm – livelihoods literature it is increasingly common to encounter claims such as oil palm "contributes to the improvement in the nutrition of local populations" (Chiriacò et al., 2022), leads to "decreased malnutrition in the countryside"(Yanita and Ningsih, 2021) and has been shown to "markedly improve rural livelihoods" (Dalheimer, 2020). These generalisations have occurred despite study authors acknowledging the dangers of extrapolating findings to other contexts (Qaim et al., 2020). Recently, there have been calls to pay more attention to the context in which studies have taken place and to avoid making general statements based upon single locations (Santika et al., 2019a; Sibhatu, 2023; Tabe-Ojong, 2023).

This review shows that most existing quantitative and econometric studies of oil palm diets and nutrition are premised on a limited number of implicit pathways – primarily income-based pathways. In contrast, the qualitative literature has demonstrated a wide range of pathways through which oil palm expansion may affect diets and nutrition. The pathways explored by different types of studies and the main contexts in which studies took place are summarised in Table 3.3.

The narrow range of pathways studied in quantitative studies is primarily due to the context in which they have been situated. Virtually all such studies have taken place among fully commercialised farmers who grow little to none of their own foods and in contexts with good access to markets. As such, farmers in these contexts are not exposed to the effects of land use and agrarian change on local production (either at the individual level or the aggregate effect on local food supply), nor changes in the food markets and food systems which may affect consumption. In particular, the majority of causal studies have been conducted using comparisons between commercialised rubber farmers and oil palm adopters. Only one study (Santika et al., 2019a) compares the effects of adoption between subsistence and non-subsistence farmers – and this study uses a single broad indicator. Furthermore, the literature is skewed by a heavy focus upon Sumatra – and in particular Jambi Province. In this province, most farm households did not

Table 3.3: Pathways Between Oil Palm Adoption and Dietary Intake in Existing Studies

	Quantitative		
Pathway	**Survey[1]**	**Mixed-Methods[2]**	**Qualitative**
Income Pathways			
Financial returns on land and labour	✓(MO)		
Food expenditure	✓(MO)		
Vulnerability to price and economic shocks			✓(S)
Agrarian Change			
Land Tenure			✓(S)
Intensification			✓(S)
Soil Fertility			✓(S)
Land Use Change			
Reduced access to forests			✓(S)
Increased distance/time to forests		✓(S)	✓(S)
Reduced bushmeat abundance		✓(S)	✓(S)
Reduced wild fish abundance		✓(S)	✓(S)
Gendered Pathways			
Feminisation of agricultural production			✓(S)
Gendered income distribution/control over expenditure			✓(S)
Food Systems and Food Environments			
Aggregate effects of local production			✓(S)
Composition of market foods (UPFs)			✓(S)
Marketing of foods			✓(S)
Official health messaging			✓(S)
Development assistance and food subsidies			
Vendor products and Properties			
- *Attitudes to food sources*			✓(S)
- *Access to foods on credit*			✓(S)
Social and Cultural Changes			
Changing food preferences		✓(S)	✓(S)
Loss of traditional skills and food culture		✓(S)	✓(S)
Time Scarcity and Activity Spaces			
Time scarcity and changes in food acquisition			✓(S)
Time scarcity and changes in food preferences			✓(S)
Activity spaces and wild food encounters		✓(S)	✓(S)

Notes: [1] Quantitative studies based on survey data which uses statistical techniques to establish causal inference; [2] Mixed method studies which report dietary differences/changes – but which rely on qualitative methods for causal inference; MO = Market-Orientated Farmers; S = Subsistence-Orientated Farmers cultivate food crops and have relied primarily on market-sources for their foods for many years prior to the oil palm boom (Sibhatu et al. 2015). There are also important specificities regarding the prevailing oil palm model. There is some debate surrounding the extent to which results from one context can be extrapolated to other models and regions of oil palm in Indonesia (Nurhasan et al., 2020a; Sibhatu, 2020). The oil palm model examined (fully independent smallholders) is certainly a growing part of the oil palm sector in Indonesia (Schoneveld et al., 2019a), but is to a large (though unquantifiable) part driven by oil palm adoption by already wealthy cash-crop farmers – or by the accumulation of smallholder land by wealthy elites, and outside investors (Jelsma et al., 2017, 2019). Fully independent oil palm of the nature described in the Jambi studies remains a distant, unlikely and perhaps impossible dream for the majority of farmers who will take up oil palm farming over the next few decades, many if not most of whom will be former subsistence, or semi-subsistence farmers located in Papua and Kalimantan provinces (Austin et al., 2019) adopting oil palm as part of smallholder oil palm plasma schemes legally mandated (Rahayu et al., 2022). Qualitative evidence, however, comes from a range of different locations (but almost all of which take place among former subsistence farmers). These studies indicate that a wide range of pathways drastically affect local food supply. The qualitative studies demonstrate that the assumptions underlying studies of independent adopters in Jambi – namely that oil palm adoption does not result in changes in local production of foods, nor structural changes to food markets – do not apply in many other areas of Indonesia experiencing rapid growth in oil palm development. This suggests that, in contexts with more imperfect markets, income pathways may be less effective at improving nutrition. Indeed, in such situations, the income pathways may come at the cost of a more diverse production system, which negatively affects diets (Jones, 2017b).

In Indonesia, overnutrition is as much part of the burden of malnutrition as under-nutrition. None of the econometric studies examined over-nutrition as an outcome, nor discussed potential pathways leading to over-nutrition. Furthermore, several studies reported higher calorie consumption as an indicator of good diets – despite average caloric intakes being above nationally recommended thresholds. There is also a lack of focus in the consumption of UPFs despite expenditure data used almost certainly including at least some data on UPF. Inclusion of UPF in the analysis would have most likely nuanced some findings regarding dietary quality. For example, (e.g. Euler et al., 2017) found heterogeneous impacts, with wealthier households having higher expenditures on foods overall, and higher expenditures on nutritionally rich foods such as Animal Source Foodss (ASFs). It is highly likely, in the context of Indonesian nutrition transition dynamics, that wealthier households with higher expenditures on ASFs also have higher expenditures on UPFs.

Within the field of agri-health, there has been concern that interdisciplinary research tends to result in a “hierarchical ranking and power relation between disciplines” (Picchioni, 2017). The tendency of quantitative economics to imply its approaches are “superior” to qualitative approaches to researching the same topic has been termed “disciplinary imperialism” (Schoenberger, 2001; Mäki and Marchionni, 2010). This tendency for readers to view quantitative research as more “rigorous” than qualitative studies has significant implications for how research is synthesised (Adais and Panolong, 2022). In many ways, I view this review as an attempt to push back against such disciplinary imperialism within the study of social impacts of oil palm adoption and expansion. The issue of how to "generalize" research to other contexts and higher levels of abstraction is especially difficult in mixed-methods research or interdisciplinary topics given the different traditions of doing (Polit and Beck, 2010; Slaney and Tafreshi, 2021). Polit and Beck (2010) encourages reflexive engagement with how researchers generalise findings, suggesting that:

> Rather than disdaining the possibility of generalizability (some qualitative researchers) or unfairly assailing the limitations of qualitative research to yield general truths (some quantitative researchers), researchers with roots in all paradigms can take steps to enrich the readiness of their studies for 'reasonable extrapolation'.

3.2.1 The Need For Explicit Reporting of Context

All of the studies contained discussions of data limitations, and many contained explicit qualifiers about the lack of generalisability of the results to other oil palm contexts. However, they also make bold and definitive claims in titles and abstracts which get repeated in reviews of the literature. Crucially, these reviews tend to focus discussion only on the quantitative studies and, while occasionally citing qualitative studies as caveats, often do not critically engage with the research itself. Many of the studies included in this review have been cited within the academic sphere as partial supporting evidence of grandiose statements; for instance, that oil palm "also contributes to the improvement in the nutrition of local populations" (Yanita and Ningsih, 2021) and has been shown to "markedly improve rural livelihoods". The previous chapter has shown how dangerous this can be in a context where well-funded and highly motivated professional lobbies and disinformation campaigns weaponise academic findings. While most studies of the effects of oil palm development on welfare and well-being outcomes responsibly report the context, assumptions and caveats of the research, this has not stopped them being used to propagate an uncritical pro-oil palm agenda. Authors are not responsible for how their studies are cited, nor how they are used by partisan interest groups to serve their agendas. Nevertheless, in such a charged and polarised debate, caution should be exercised in how findings are presented and how assumptions and limitations are discussed. Scholars, myself included, must resist the temptation to discuss *"Oil Palm in Indonesia"* or *"farm households in the tropics"* (Nurhasan et al., 2020a; Sibhatu, 2020).

This review has identified a crucial bias in the econometric literature towards the contexts and types of small-holder oil palm schemes which most are likely to result in positive outcomes for farmers and communities – independent smallholders who produce little to none of their own foods. There is a danger, therefore, that a premature consensus could be reached without further investigation of the impacts under different models of smallholder oil palm, by different types of farmers, in different market and ecological contexts.

While the evidence supports the idea that oil palm development can spur economic development, poverty reduction and improve food security of many rural areas of Indonesia, the studies themselves are nuanced, often limited to specific locations, circumstances and oil palm models and often make major assumptions.

Finally, it is perhaps worth critically reflecting on why most studies are using dietary indicators at all. Many of the studies in this review are not focused on dietary intake as a means of examining nutritional status and public health needs. In very few of the studies is the health of populations a primary subject of discussion. In many cases, it is not even mentioned. None of the econometric studies describe the nutritional needs of the target population, nor consider over-nutrition which is likely to be one the most important health outcomes of any dietary transition in Indonesia. As such, it is almost impossible to interpret findings from a public health perspective. Rather than being focused on public health, the studies bundle dietary outcomes alongside other welfare outcomes as a proxy for the overall development effects of oil palm adoption. Clearly, nutrition has become a proxy for other debates surrounding oil palm adoption being played out in academic literature and beyond. As an outcome more inherently measurable than many other aspects of well-being outcomes, it has come to represent the very "goodness" or not, of oil palm development – and more generally of the structural transformation of economies.

3.3 Conclusion

This chapter presented a critical review of the oil palm – diets literature. My focus was not on evaluating findings but rather on mapping the existing evidence in terms of study context and methodological approach, as well as the pathways and assumptions (both explicit and implicit) which underpin them. This review demonstrates that far less is known about the effects of oil palm expansion on diets and nutrition than is often stated. Contrary to some of the ways this literature is being cited, it is premature to generalise findings that smallholder oil palm has beneficial effects on diets. Only a handful of study contexts have been examined – many of which arguably are not representative of Indonesian oil palm more generally, and particularly not of regions where oil palm is most rapidly expanding.

The effects of oil palm adoption on diets and nutrition are likely to differ greatly according to the degree of prior market integration of farmers, access to and use of wild foods, including forest foods, as well as spill-over effects of historical oil palm development. More studies are needed in different oil palm contexts (type of smallholder adoption, local histories of plantation labour) with a more diverse range of prior livelihoods. There is a particular need for studies making causal inferences where oil palm adopters were formally subsistence-orientated and in contexts of imperfect functioning markets.

Future studies are also needed to examine causal mechanisms beyond the effects of income and wealth, integrating measures of food prices and availability as well as other dimensions of food environments. The qualitative set of studies reveal a wide range of potential pathways through which oil palm adoption may affect dietary intake. Oil palm development dramatically alters the landscape, bringing with it changes in land and forest tenure. Markets bring with them structural changes to food systems, which alter access to both healthy foods and unhealthy foods, as well as changes in the promotional and information environment, which influence food choice decisions. At the same time, development brings with it demographic changes, affecting exposure to different food cultures, social norms and influences.

As it stands, the oil palm and diets literature exists in two parallel realities, one based upon econometric analysis of large data sets and one based upon focused qualitative investigations. Both types of studies have made significant contributions, but interpreting one in the light of the other is made difficult due to the lack of integration within studies. This problem is exacerbated by the fact that different types of studies are often geographically separated and focused on different oil palm models in different regions with different contexts. This review, therefore, suggests there is an urgent need for mixed-method approaches to studying oil palm and diets.

For the most part, neither type of study appears particularly focused on diets and nutrition from a public health perspective. Rather, nutrition serves as a proxy for well-being outcomes of oil palm development more generally. For some, apparent improvements in nutrition among smallholders signify the potential of oil palm to transform rural livelihoods, reduce poverty and improve human well-being. For others, negative impacts on food security and diets exemplify inequities in the way oil palm transformations have uprooted traditional livelihoods and agricultural systems, displacing farmers from their land and encroaching upon forests.

The use of food and diets as an indicator of well-being is understandable. Relative to other well-being outcomes, it is easy to measure, quantify and model. It is also evocative and narratively appealing. While its use in this way has its place, there should also be a renewed focus on nutrition from a public health perspective. This requires reporting and addressing the health and nutritional challenges of target populations, such as specific micronutrient deficiencies, as well as the growing burden of diseases of overnutrition. Additionally, outcomes based upon household-level indicators should be abandoned in favour of more targeted measures of dietary quality for particular at-risk populations such as children and adolescents and the critical first 1000 days of life.

Endnotes for Chapter 3

[I] **Debate on Methods and Metrics:** The debate has two dimensions. Firstly, the use of non-standard, non-validated measures as well as the use of validated indicators for different purposes (e.g. household food security indicates as proxies of individual dietary quality). Secondly, the underlying data used to construct these indicators (e.g. 7-day food expenditure vs 24-hour recall dietary intake). For a discussion of the use/misuse of dietary indicators, see Verger et al. (2017, 2019) as well as the counter-argument from Koppmair and Qaim (2017). See also the exchange between Nurhasan et al. (2020a) and Sibhatu (2020) for both sides of the debate in this context. A brief overview is also provided in Chapter 5 (Section 5.5)

Chapter 4: Theoretical Framework

Contents

4.1 Introduction

This chapter summarises the main theoretical and conceptual frameworks used in this thesis and presents the integrative framework of landscape transitions and diets which form the basis of this research. Central to my approach are the three following elements:

Firstly, I view oil palm adoption as not merely an agricultural change but an entire landscape and livelihood transition. Oil palm adoption among smallholders is rarely a case of simply substituting or adding an additional crop. For many new smallholders today – particularly former subsistence farmers – oil palm adoption necessitates a total reorientation of livelihoods and a total change in the social, economic, demographic and environmental conditions, including massive transfers of the ownership and use of land and the abandonment of customary tenure regimes for titled tenure. I therefore examine oil palm adoption **as a socio-ecological system of landscape transition.**

Secondly, I adopt a food systems perspective to analyse the collective effects of the landscape transitions on local food systems and food choice. The adoption of oil palm by a community results in dramatic changes to the local food system. Local production (of mostly healthy perishable foods) is reduced dramatically, while aggregate changes in income, combined with changes in infrastructure and development, stimulate changes in the market food system. At the same time, natural habitats and diverse extensive agricultural production systems are replaced with more intensive and less diverse production systems.

Thirdly, I incorporate the effects of oil palm adoption on gender roles and intra-household allocation of time which are known to significantly modify pathways between agricultural commercialisation and nutrition. I explicitly explore these effects with a focus on how they influence women's food choice decisions.

Chapter Purpose and Structure

This chapter is structured as follows:

In **Section 4.2**, I first provide an overview of complex systems and systems approaches that underpin all of the theoretical frameworks which support this thesis. **Section 4.3 examines how changes in food systems and food environments may alter diets** beyond agricultural production. In **Section 4.3**, I introduce the concepts of "food systems" and "food environments" as well as the food-sub-system model, which is the foundation of this research, as well as presenting empirical, theoretical and methodological gaps in current food systems and food environments research. **Section 4.4 focuses on nutrition-sensitive agriculture**, and discusses the ways in which agricultural changes can impact nutrition – and the ways in which these effects are mediated by contextual factors. Recognising that agrarian change in many contexts consists of more than simply changes to agriculture, **Section 4.5 examines frameworks of how wild and forest landscapes affect diets**. I also discuss current gaps in theory and evidence in the ways in which agriculture and nutrition pathways are modified (4.4.2), including contextual factors such as women's empowerment, gender roles and gendered time and labour allocation and food environments. Finally, I bring these literatures and frameworks together in **Section 4.6, which presents my integrative conceptual framework** for the thesis, before showing in **Section 4.7 how my research questions and approach** are designed to address existing gaps in research.

4.2 Complex Systems and Systems Approaches

There is growing recognition of the need to view the global food and environmental systems as interrelated “complex systems” and to employ “systems thinking” and “systems approaches” in their analysis. (Ingram, 2011; van Berkum et al., 2018; Canfield et al., 2021; Molenaar and Kessler, 2021; Borman et al., 2022). Mitchell (2009) identifies four key characteristics of complex systems:

1. Emergence: Emergent properties which are not easily predicted from the behaviour of component parts of the system alone.
2. Modularity and Hierarchical Organization: Emergent properties arise out of the interaction between multiple, inter-connected, nested sub-systems, which operate autonomously while interacting with one another.
3. Non-Linearity: Non-linear relationships between system components result in unpredictable relationships between inputs and outputs. Changes in inputs may result in small changes to outputs at certain levels but rapid changes above certain thresholds or ’tipping points.’
4. Robustness: Within certain parameters, stable states display substantial robustness (i.e. can withstand changes to components). However, if parameters are changed beyond certain “tipping points”, the system may switch into a different stable state configuration.

The definitions of systems thinking and systems approaches vary widely. In a comprehensive review of existing definitions, Arnold and Wade (2015) identified eight “elements” of systems thinking: (1) Recognizing interconnections; (2) Identifying and understanding feedback; (3) Understanding system structure; (4) Differentiating types of stocks, flows, and variables; (5) Identifying and understanding non-linear relationships; (6) Understanding dynamic behavior; (7) Reducing complexity by modelling systems conceptually and; (8)Understanding systems at different scales.

Systems thinking and systems approaches (the application of systems thinking) have major advantages over “reductionist” thinking and approaches as they focus “on the properties of the whole that are neither attributable to nor predictable from the properties of the components” (Monat and Gannon, 2015). Agrarian, livelihood and landscape change complex systems, each comprised of sub-systems with incalculable interacting components, relationships and feedback loops. Adopting a systems approach allows the researcher to analyse the way in which interactions between systems and sub-systems may result in unpredictable outcomes.

4.3 Food Systems, Food Environments and Food Choice

All consumption of food is influenced in some way by the environmental surroundings, either by constraining the available options or by influencing choice. Different disciplines and traditions have focused on how and why people make choices about what foods to consume. Mainstream public health nutrition has historically focused on individual preferences, knowledge and attitudes as the target for behaviour change interventions (Brug et al., 2008). Meanwhile, economists have produced alternative farmings such as food preferences, choice architecture, opportunity costs of time, and discount rates (Drewnowski, 2012; List and Samek, 2015). Over the past three decades, however, a wide range of evidence from multiple disciplines has accumulated of the importance of environmental factors in influencing food consumption behaviours (Ball et al., 2006). This heterogeneous body of research has been broadly grouped in the literature under terms such as “food environments”, “nutrition environments”, “food choices”, and “social determinants of nutrition”.

Food systems are defined as all the actors, institutions, infrastructure, policies and processes relating to the production, processing and distribution of foods (Global Panel, 2017; HLPE, 2017). Fanzo and Davis (2021) make a distinction between “a food system” (*a* food system in a specific context or region), “*the* food system” (the complete set of interconnected actors and processes between production and consumption) and the modern interpretation of “food *systems*” (a network of connected and food systems operating at different scales).

Inherent in the analysis of “food systems” is a “food systems approach”, defined by “food systems thinking”[!] In other words, food system approaches recognise that food systems have the characteristics of complex systems defined in Section 4.2 above. While a systems approach to analysis of the production, distribution and consumption of food is not new (Kneen, 1993; Sobal, 1999), it has gained increasing prominence over the past few years, driven by concerns that the food system is in “crisis” – in that it is both failing to deliver sufficient healthy and affordable foods while also dependent on upon increasingly unsustainable production systems (Béné et al., 2019). Multiple high-profile reports have advocated for a “radical transformation” (HLPE, 2020) of global food systems (Summarised in Appendix D.1). Food systems approaches have subsequently been mainstreamed into global development agendas, facilitated by the global Food Systems Summit convened by the United Nations in 2021 (Canfield et al., 2021; UN, 2021). The latter, crucially, draws explicit links between food systems and forest loss with calls to “boost nature-positive production” – rooted in systems thinking.

Table 4.1: Definitions of Food Environments

Author	**Definition**
Swinburn et al. (2013)	“The collective physical, economic, policy and socio-cultural surroundings, opportunities and conditions that influence people’s food and beverage choices and nutritional status”
Grace (2016)	“All the foods which are available and accessible to people in the settings in which they go about their daily lives. That is, the range of foods in supermarkets, small retail outlets, wet markets, street food stalls, coffee shops, tea houses, school canteens, restaurants and all the other venues where people procure and eat food. Food environments differ enormously depending on context... they determine what foods consumers can access at a given time, at what price and with what degree of convenience, food environments both constrain and prompt food choices.”
HLPE (2017)	“The physical, economic, political and socio-cultural context in which consumers engage with the food system to acquire, prepare and consume food”
Turner et al. (2017)	“The interface that mediates one’s food acquisition and consumption within the wider food system. It encompasses multiple dimensions such as the availability, accessibility, affordability, desirability, convenience, marketing, and properties of food sources and products”

Food environments are the “interface between consumers and wider food system” (Turner et al., 2017). Changes in food systems result in changes in dietary intake via changes in the food environment. As such, they can be used as an intervention point in the food system to influence dietary intake. The food environment describes both the physical spaces in which food acquisition and consumption occur, as well as the personal circumstances which influence food choice (e.g. time pressure, social norms, activity spaces.

The origins of food environment research lie in the study of obesity in High-Income Countrys (HICs), in particular, studies of the underlying socio-economic determinants of obesity and poor nutrition in poor and marginalised populations (see Appendix D.5). The field grew out of the failure of individual and psychological interventions to reduce obesity (Garner and Wooley, 1991) and to counteract the narrative that personal failures and lack of responsibility caused obesity (Brownell et al., 2010). This field of study, termed obesogenic environments, aimed to study "the sum of influences that the surroundings, opportunities and conditions of life have on promoting obesity in individuals or populations" (Swinburn et al., 1999). Early iterations of food environments focused on relatively crude notions of "food deserts" and "food swamps"[1]. More recent iterations have incorporated a more sophisticated understanding of the forces influencing dietary choice – either negatively affecting the consumption of healthy foods by introducing constraints and frictions or facilitating and promoting the consumption of unhealthy foods.

Food environment research is a rapidly evolving field. As such, no consensus has yet emerged over a precise definition, with different frameworks and approaches including different aspects (Ahmed et al., 2021). Table 4.1 shows some commonly found definitions of food environments. Some definitions of the food environment focus solely on the constraints and prompts that influence food choice that exist in the consumer's physical surroundings, while others also include socio-cultural and livelihood factors which may constrain or influence food choice decisions. The distinction between environmental (i.e. external) and individual (i.e.personal) food environments has become a contentious part of the food environments literature[2]. While widely recognised as important determinants of diets, as yet there is no consensus over whether personal food environments belong within the food environment framework[ii]

While many studies acknowledge the importance of personal and individual-level influences on food choice, the overwhelming majority of research has focused on external influences (Chen and Antonelli, 2020; Osei-Kwasi et al., 2020; Mackenbach et al., 2019; Turner et al., 2019; Westbury et al., 2021; Sparling et al., 2021) – partially because of the lack of available methods for measuring individual influences (see Section 4.3.3).

Food environments overlap with similar fields of study, including "food choice" and "food preferences". As with the distinction between external and personal food environments, there remains debate in the literature over which of the many known factors which may influence food choice at the individual level should be included within food environments, which are preferences and which come under the umbrella term of "food choice" (Chen and Antonelli, 2020; Karanja et al., 2022). Many factors which influence dietary intake do not fall into the category of food environments. A recent systematic review of food choice literature in Low and Middle Income Countries (LMICs) Karanja et al. (2022) identified 40 individual-based motives which may influence food choice in LMICs, categorised into seven clusters: health and nutrition; psychological factors; socio-cultural factors; sensory appeal; social interactions; socio-demographic; ethical concerns. Each of these clusters contains multiple individual-level motivations – i.e. reasons why an individual may choose one food over another.

For this thesis, I favour the distinction proposed by Blake et al. (2021) who define food choice as "the processes by which people consider, acquire, prepare, store, distribute, and consume foods and beverages" while food environments "serve as the contexts of food choice". There is some overlap between individual factors and food environment characteristics. However, for the most part, food environments research is interested in "intervention points" through which changes in the food environment can be "leveraged" (Li et al., 2016; Ruben et al., 2018), while food choice encompasses all of the factors which may influence food acquisition and consumption decisions – whether in the food system or environment, individual circumstances or personal preferences.

[1]Food deserts and food swamps are areas in which it is difficult to obtain healthy food and areas in which unhealthy foods are highly prevalent, respectively. However, the effects of dietary intake have only been established in a handful of cases (almost exclusively low-income areas of the USA) (Cummins and Macintyre, 2002; Beaulac et al., 2009)

[2]See Appendix D.5 for a more detailed discussion.

4.3.1 Conceptual Frameworks of Food Systems and Food Environments

As food environment research is still an emerging field, there is no one definition or conceptual framework which has been universally adopted. Table 4.2 shows differences between commonly used conceptual frameworks in food environments for research in LMICs taken from a review of frameworks adapted for LMIC contexts by Toure et al. (2021). The table highlights the lack of consensus over what is and what isn't part of the food environment discussed above. However, there is a consensus emerging on the main domains – food availability, affordability, convenience and promotion and marketing.

Table 4.2: Domains Included in Conceptual Frameworks Focused on LMICs

Table taken from review of existing frameworks by Toure et al. (2021)

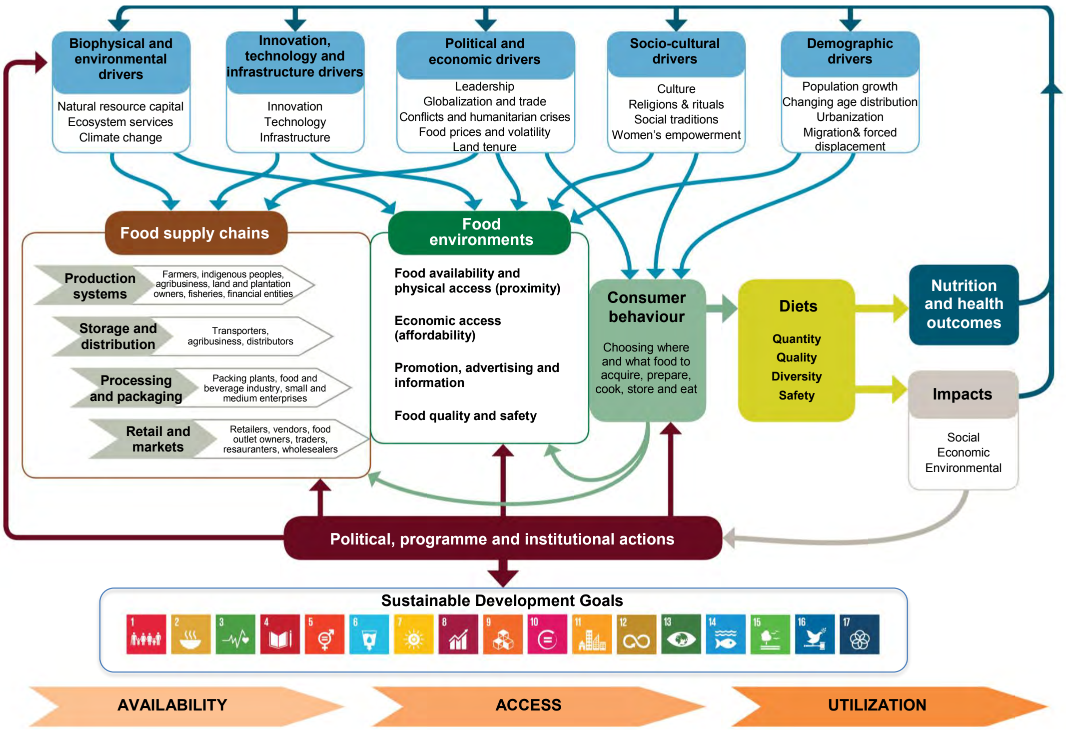
Domain	Turner et al. (2018)	Herforth and Ahmed (2015)	Downs et al. (2020)	HLPE (2020)
Accessibility	✓			✓
Affordability	✓	✓	✓	✓
Availability	✓	✓	✓	✓
Convenience	✓	✓	✓	
Desirability	✓	✓		
Price	✓			✓
Product characteristics	✓	✓		✓
Quality	✓		✓	✓
Safety	✓			
Taste	✓			✓
Packaging	✓			
Processing	✓			
Sustainability properties			✓	
Promotion/marketing	✓		✓	✓

The two most widely used conceptual frameworks showing the relationship between food systems and food environments are shown the High-Level Panel of Experts on Food Security and Nutrition (HLPE) and Turner et al. (2017) frameworks, shown in Figures 4-1a and 4-1b respectively. Both models are, in many ways, extensions of preceding socio-ecological models of social-determinants of nutrition (e.g. Story et al., 2008; Glanz et al., 2005, 2007) discussed in Appendix D.4. While the former originates from a food-systems perspective focused primarily on food value chains and markets, the latter builds upon the social determinants of health literature, which often distinguishes between the "structural" (i.e. external determinants), "social-cultural" (i.e. group determinants) and "psychological" (i.e. individual determinants) perspectives (Antin and Hunt, 2012). The critical difference between the models is the extent to which consumer behaviour is considered separate from the food environment. Whereas Turner et al. (2017) see the food environment as the interaction between the food system and consumer behaviour and circumstances, the HLPE (2017) separates these two aspects, restricting the concept of the food environment solely to physical characteristics of foods, food vendors and food information and promotion. Distinctions between the external and personal food environments are discussed further in Appendix D.5.

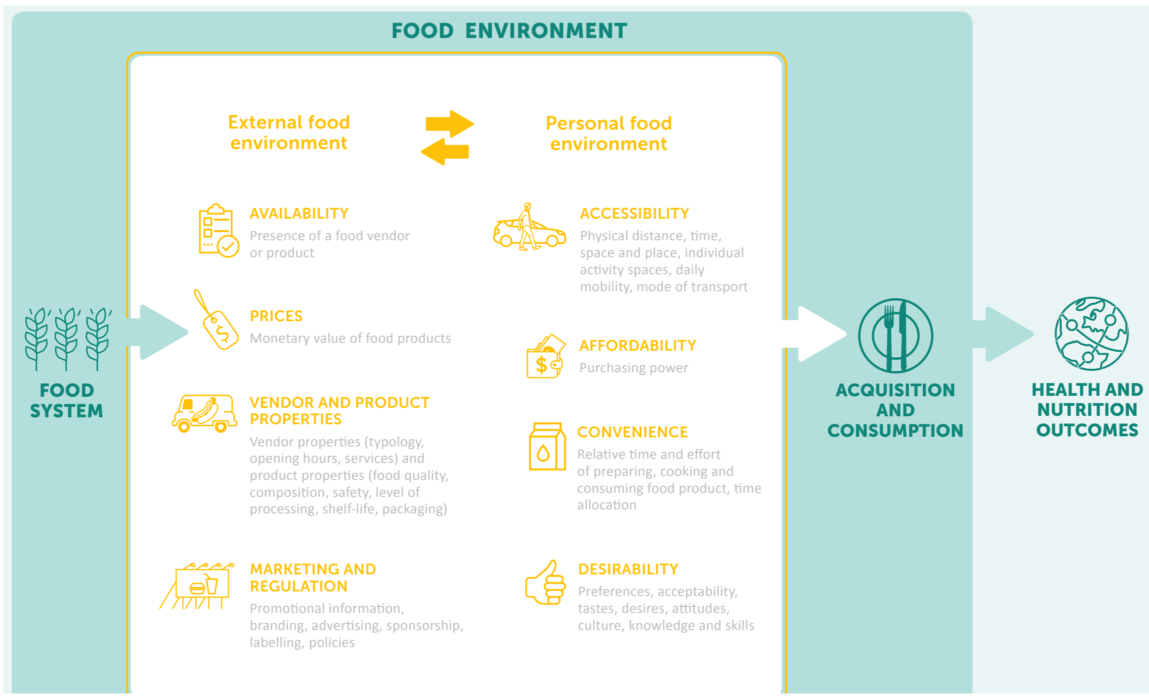
The starting point for my investigation of food choice is the Turner et al. (2017) framework. Though, as I describe in the following section, it requires adapting for my specific context, the framework has proven useful in identifying and framing aspects which influence food choice (Constantinides et al., 2021). As such, it is a reasonable overview of factors which should be considered when conducting investigations of food choice – both because these factors are known to have some influence on food choice and because they represent "food entry points" – i.e. potential levers which can be targeted by interventions to influence dietary choice (Fanzo and Davis, 2021). However, conceptual frameworks are simply "abstract graphical representations of complex realities" which aim to provide "the breadth and depth of content necessary

Figure 4-1: Food Environment Frameworks

(a) HLPE (2017) Framework for Food Environments



(b) Turner et al. (2017) Framework for Food Environments



to synthesize understanding" in different contexts (Constantinides et al., 2021).

4.3.2 Gaps in Theory and Evidence

LMICs are experiencing nutrition transitions at a faster rate than HICs, including a dramatic increase in childhood obesity (Popkin, 2017, 2021; Batal et al., 2023; Kumar et al., 2023). The role of the food systems and food environments in driving this transition is still unclear. It is clear, however, that global trends in food prices, markets, trade and food systems are having significant effects on the availability, affordability, convenience and desirability of foods at the aggregate scale. Studies of the effects of food price fluctuations have shown that consumers in LICs are highly responsive to food prices. Analyses of price elasticities for both staple foods and micronutrient-rich foods suggest price is a barrier to the consumption of healthier foods (Green et al., 2013; Cornelsen et al., 2015). Cost of diet analysis has shown that healthy diets can cost substantially more than unhealthy diets in many countries in sub-Saharan Africa and are unaffordable for many households (Chastre et al., 2007; Temple and Steyn, 2011). Food marketing in LMICs is becoming increasingly sophisticated and well-funded, using many of the same techniques as in HICs – including direct marketing to children (Bankole et al., 2023).

The vast majority of research into food preferences has taken place in HICs (Hough and Sosa, 2015; Turner et al., 2019). Of the studies conducted LMICs, the majority are concentrated in a handful of upper-middle-income countries. In a systematic review, Westbury et al. (2021) found almost all the studies had been conducted in upper-middle income countries, with 65% of studies coming from just one of two countries (Brazil and China). For studies which have been conducted in LMICs, the majority focus on obesogenic environments in low-income urban populations such as slums (e.g. Yadav and Krishnan, 2008; Yulia and H., 2016). In rural, agricultural areas of LMICs, a great deal of research has been carried out on nutrition, local and cultural attitudes to traditional diets, wild foods – but little research is directed towards what happens when markets penetrate to these areas. In addition, much of the research that examines traditional diets is not framed in terms of food environments.

4.3.3 Methodological Gaps

Despite food environment and food system frameworks being conceptually robust, issues arise when translating food environment concepts into measures of the food environment. Brouwer et al. (2020) reviewed 32 of the most highly cited papers and reports featuring food environment and food systems frameworks. The review found a vast diversity of frameworks which did not easily translate into measurable properties and leverage points for food system change and dietary interventions. Additionally, the review found "a fairly linear and generic view of supply-demand networks" with the large majority of studies "ignoring or underestimating" the effect of consumer demand. Similar findings were found in a recent consultation on developing metrics for measuring food environments (GCRF AASH, 2021) which highlighted several conceptual issues which are hindering the translation of conceptual frameworks into empirical evidence: the lack of validated survey instruments for LMICs; the focus on fixed spatial units rather than activity spaces; and the over-reliance on uni-directional "exposure-based" pathways and lack of focus on market supply and demand dynamics. The lack of bidirectional causality is a major issue when translating food environment frameworks into measurable exposures for research linking food environments and dietary and nutritional outcomes. Many food environment studies tend to assume a unidirectional causal model between properties of the food environment and food choice decisions – when in fact, food environments are also shaped by aggregate consumer demand[iii]. Another methodological issue is the limited utility of place-based measures of food environments compared to activity-space-based approaches – especially in urban contexts (Perchoux et al., 2013). Boundaries between food environments are highly fluid (Downs et al., 2018) and people living in shared geographical locations may be exposed to vastly different food environments (Surendran et al., 2020). As such, there have been calls to move towards activity-space approaches to food environments research (Cummins et al., 2017). Activity spaces can be defined as "the local areas within which people move or travel in the course of their daily activities" (Gesler and Albert, 2000; Sherman et al., 2005). Crucially, the activity space is not restricted to the actual times and places which people go, but the places which they could opt to go – sometimes called the "potential path area" Kwan (1999); Gesler and Albert (2000).

Research Gap 1: Methodological Gaps in Food Environment Research

1. **A lack of tools for measuring food environments in biodiverse rural contexts** resulting from the historical focus on HIC contexts and urban contexts in MICs.
2. **Accounting for reverse causality and supply and demand relationships** recognising both that individuals seek out food environments and that food environments partially reflect market responses to local demand.
3. **Need for activity space approaches** which take into account individual's movements in space and time and their resulting exposures to different food environments.

4.4 Agriculture-Nutrition Linkages

Interventions designed to improve nutrition have proven to have measurable effects upon dietary intake (Ruel et al., 2013, 2018) – although impacts on final nutrition outcomes are less clear (Girard et al., 2012; Carletto et al., 2015; Ruel et al., 2018). However, the effects appear to be heterogeneous and highly sensitive to context — particularly when considering all forms of malnutrition, including micronutrient deficiencies and overnutrition.

4.4.1 Conceptual Definitions and Frameworks

A major focus of the literature on agriculture-nutrition linkages is the relative role of markets and own-production in contributing to dietary quality among smallholder farming households (Jones, 2017a; Nandi et al., 2021). Their relative importance is salient because smallholders often face trade-offs between farm specialisation and farm diversification (Qaim et al., 2016). One option is to diversify farm production, ensuring access to a wider range of foods and nutrients (for example, by developing homegardens) (Jones et al., 2014). Another option is to specialise in cash crops (or off-farm income) and use the income generated to purchase foods from markets – which may provide access to foods and food groups not produced locally (Sibhatu et al., 2015a; Sibhatu and Qaim, 2018b).

Both diversifying agricultural production and specialising in commercialised crops have been shown to improve dietary outcomes. However, some authors have argued that the benefits of market pathways are greater than those of diversification (Sibhatu et al., 2015a). Thus, by diversifying production, smallholders may improve diets but may forgo the potentially greater benefits of greater market access. More recently, several reviews have noted that – while generally, the evidence supports this position – the effects are heavily modified by (among other things[3]) the local market context and the context of local food production and diets (Ruel et al., 2018; Nandi et al., 2021).

[3]See Chapter 4, Section 4.4.3.

Contemporary debates are largely centred around the conditions under which it is preferable to diversify diets through diversifying agricultural production and under which conditions it is preferable to diversify diets via increasing access to markets via agricultural commercialisation. In recent years, a slight consensus has emerged that – where markets are functioning well – commercialisation may be more effective than diversification (Ruel et al., 2018) (though debate still continues). In such contexts, therefore, attempts to diversify agricultural production may incur an opportunity cost of specialisation (Sibhatu et al., 2015a). However, in contexts where households have poor market access, these effects are greatly modified by market access diversification may be more beneficial (Ruel et al., 2018).

This position, however, has proven to be highly controversial and has generated considerable pushback. The relative effects of both market access (i.e. distance to markets) and market participation (i.e. commercialisation) appear to be dependent on market context. In some contexts, the benefits of diversification may, in fact, be greater than the benefits of commercialisation (Jones et al., 2014) – including more recent evidence (e.g. Islam et al., 2018; Sekabira and Nalunga, 2020). This is particularly the case where market failures or imperfect markets prevent households from fully benefiting from specialisation or result in poor provision of healthy foods (Ecker, 2018; Ickowitz et al., 2019). Likewise, under some market conditions, commercialisation and diversification can go hand-in-hand (Jones, 2017b; Sibhatu and Qaim, 2018b,a) and may in-fact "complement rather than replace one another" (Bellon et al., 2016). Several authors have noted the extent to which local market food systems in rural areas often contain foods which are grown locally. This local "food shed" is often critically important for perishable foods, which market sources from further away may be less able to provide (Ickowitz et al., 2019).

Such debates have now been superseded by systems approaches to understanding food systems from production to consumption (Dangour et al., 2012; McDermott et al., 2015; Haddad et al., 2016; Horton et al., 2017; Waage, 2022). This renewed focus on systems approaches to agriculture-nutrition linkages as led to a better understanding of the possibilities of leveraging agriculture for food security and nutrition (Kanter et al., 2015; Ruel et al., 2013, 2018) via Nutrition Sensitive Agriculture Programmes (NSAP).

This new approach, which can be characterised as an "interdisciplinary systems approach to nutrition-sensitive agriculture" (Jaenicke and Virchow, 2013; Balz et al., 2015; Sharma et al., 2021) breaks from the previous debates in several key ways. Firstly, it goes beyond a focus on food production and calorie intake and is focused on specific nutritional challenges, including micronutrient deficiencies and overnutrition. Secondly, it is inherently an interdisciplinary system approach – i.e. it recognises that multiple pathways can act simultaneously in non-linear ways on an outcome of interest and that a single agricultural change or intervention may affect multiple pathways simultaneously in synergistic or antagonistic ways. This may result in trade-offs between desired outcomes. Thirdly, the approach foregrounds the important role of context, recognising that similar interventions may have different effects in different circumstances. Finally, the approach is multi-scalar, going beyond household-level production and examining how households and farmers interact with food market systems at local and regional scales.

To establish and effectively monitor the effects of agriculture on nutrition, a comprehensive understanding of the pathways is required. To this end, dozens of conceptual frameworks have been put forward to examine the pathways through which agriculture affects nutrition; one such conceptual framework from Kanter et al. (2015) is shown in 4-2, which aims to synthesise and build upon previously published versions in the literature. The conceptual framework offers an overview of the mechanisms through which agricultural production leads to food consumption and nutrition, classifying pathways into the market, own-production, agricultural income and non-agricultural income. All food consumption, whether self-produced or purchased via the market pathways, is filtered through the local food environment, which includes intra-household dynamics such as gender relations and household care. This conceptual framework is just one of many ways of looking at the complex relationships between economic, food-producing and social and cultural roles of agriculture and their effect on nutrition. As such, it is part

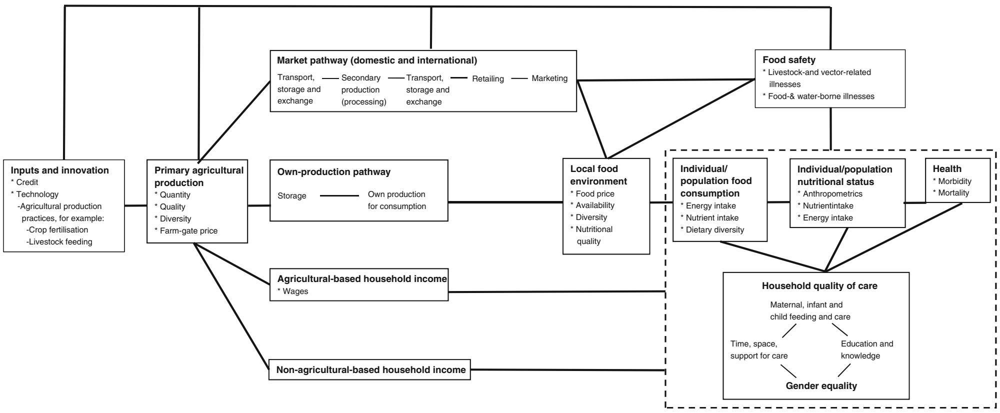


Figure 4-2: Pathways between Agriculture and Nutrition. Source: Kanter et al. (2015)

of an "evolving paradigm" of Agri-Health, that seeks to "unify research approaches and methodologies between agriculture and health" (Picchioni et al., 2017).

Another way of looking at the potential ways to leverage agriculture for nutrition is by identifying specific pathways. Box 4.1, lists the six specific pathways between agriculture and nutrition and health originally from Kadiyala et al. (2014) and updated in Gillespie et al. (2019). The links between agriculture and nutrition outlined offer opportunities to leverage agriculture to improve nutrition. To this end, a range of approaches have been suggested, many of which have been implemented in trial settings or studied in observational studies. In the next section, I examine the existing evidence for these pathways before discussing evidence gaps and current research needs.

Box 4.1: Agriculture – Nutrition Pathways

Pathways through which agricultural agriculture impacts nutrition Source: Kadiyala et al. (2014)

1. Agriculture as a source of food for own consumption.
2. Agriculture as a source of income (from sales or waged labour).
3. Food price effects of agricultural production (i.e. through affecting supply and demand dynamics).
4. Intra-household decision-making, women's socio-economic status and ability and influence over household decisions and allocations for food, health and care
5. Women's ability to manage care, feeding and health of children.
6. Women's own nutritional status through dietary intake and quality, energy expenditure and health.

4.4.2 Current Evidence and Gaps on Agriculture-Nutrition Linkages

While the conceptual links between agriculture and nutrition are now well understood, leveraging agriculture for nutrition has proven more difficult than anticipated. The links between agriculture and food are complex and bidirectional (Dangour et al., 2012; Pinstrup-Andersen, 2013). Furthermore, a single intervention may well affect multiple pathways at the same time but in different directions (Cooper et al., 2024).

Over the past two decades, a number of NSAP have been implemented and evaluated – many in the form of Randomised Controlled Trials (RCTs) – as well as a wide range of observational studies. Early evidence suggested weak support that they could positively affect nutritional status – primarily due to poor study designs (Berti et al., 2004; Masset et al., 2012). However, the following decade built up a significant body of evidence. The accumulating bodies of evidence have been evaluated in a number of systematic reviews. For example, evidence from South Asia is reviewed by Pandey et al. (2016), updated by Bird et al. (2019) to include studies published after 2014. Perhaps the most comprehensive overview is found in Ruel et al. (2018), which updates the findings of their earlier review (Ruel et al., 2013). A brief summary of the state of current evidence and research gaps identified by these reviews is displayed in Box 4.2.

Box 4.2: Current Evidence for Nutrition-Sensitive Agriculture Programmes

- Strong evidence that NSAPs can improve access to and consumption of healthy foods and improve diet quality (e.g. dietary diversity, consumption of ASF).
- Weaker evidence that interventions can improve final nutritional outcomes, e.g. stunting, anaemia.
- Studies suggest potential for NSAPs such as homegardens and livestock integration, but mainly in remote areas with poor market access.
- NSAPs at risk of producing adverse impacts via changes in women's empowerment, access to income and time allocation.
- Effects of NSAPs are heavily modified by context, including market access and women's empowerment.

(a) Potential for Unintended Adverse Impacts

The network of interconnected pathways shown in Figure 4-2 opens up the possibility that changes in the agricultural system could result in unforeseen adverse impacts upon diets and nutrition. Box 4.3 summarises the ways the potential mechanisms through which such adverse impacts may occur.

It cannot be assumed that increased incomes automatically leads to better nutritional outcomes. Three factors mediate these effects (Ruel et al., 2018; Ickowitz et al., 2019): (1) Market failures and lack of access to affordable, safe and nutritious foods; (2) Constraints, friction and influences on food choice which lead people to select less healthy foods from the markets; and (3) Gendered changes over the access to income and control over expenditure.

Reduced diversification of crops and farm strategies may reduce farm-level resilience to economic and climatic shocks. There is some evidence that the fluctuation of prices for commercialised crops can adversely affect nutritional outcomes among specialised farmers. Reduced diversification of crops and farm strategies may reduce farm-level resilience to economic and climatic shocks. There is some evidence that the fluctuation of prices for commercialised crops can adversely affect nutritional outcomes among specialised farmers (e.g. Wood et al., 2013).

The COVID-19 pandemic provides a salient example of the benefits of diversification of smallholder farming livelihoods – with diverse livelihood portfolios more resilient to economic shocks than highly specialised livelihoods (Heck et al., 2020; Kumar et al., 2020; Marsden et al., 2023). It should be noted, however, that this is not necessarily an argument against commercialisation – but an argument about livelihood specialisation. Agricultural changes which provide commercialised crops to multiple different

Box 4.3: Potential Adverse Impacts of Agricultural Interventions

1. Opportunity costs of commercialisation or diversification
   (a) Commercialisation may decrease the production of crops for own consumption (competition)
   (b) Diversification may come with an opportunity cost of income from commercialisation and/or off-farm labour
2. Interventions which increase income may not necessarily result in increased expenditure on healthy food groups, but may result in increased non-food expenditure or increased expenditure on unhealthy foods
3. Specialisation may result in reduced resilience – e.g. to climatic, pest, price or economic shocks
4. Interventions risk increasing labour demands for women resulting in
   (a) Poorer childcare and child feeding practices
   (b) Decrease in women's own nutritional status due to increased energy expenditure

   (a) Aggregate effects of lower PD in food shed result in a reduced availability of perishable healthy foods in local food market system

markets would also be more resilient to shocks, as would agricultural changes which free up time for off-farm labour.

4.4.3 Modifiers of Agriculture-Nutrition Linkages

Many studies treat agriculture as a "black box" (Rao et al., 2019). The effect of different contexts – in particular, the context of local markets, farming systems, social and cultural gender norms and women's existing productive and reproductive labour – has been under-researched. Recent systematic reviews of the evidence of agriculture-nutrition pathways have identified a number of research gaps. In the most recent systematic review of the whole literature, Ruel et al. (2018) state that there is an urgent need for research into the potential "unintended negative impacts of agriculture programs on nutrition". These include the danger that agricultural interventions designed to improve nutrition may adversely affect child nutrition by increasing the women's time in agriculture and thus reducing time available for feeding and childcare. Similarly, in a systematic review of women's work in agriculture and maternal and child nutrition in South Asia, Rao et al. (2019) highlight the "importance of paying attention to producing deep contextual knowledge of household circumstances and decision-making dynamics within particular farming systems in food and nutrition research.".

Women's Empowerment

Gender equality can undoubtedly be a powerful driver of and consequence of development, but such effects are not automatic[IV]. Women's empowerment is a vital pathway leading to better maternal and child nutritional outcomes. However, agricultural interventions may have different effects on women's empowerment depending on the context. Figure 4-3 shows the framework proposed by Rao et al. (2019) showing how household socioeconomic status, labour arrangements, and time and care interact with food security, women's health and nutrition status and child nutrition. The combination of positive and negative pathways results in complex and unpredictable outcomes, which vary greatly by context.

Research Gap 2: Contextual Modifiers of Agriculture-Nutrition Linkages

Women's Empowerment and Time Use
Agricultural interventions or transitions may have unintended, adverse effects on child feeding and nutrition by:

1. Creating time scarcity for women, reducing the time available for cooking and feeding
2. Increasing women's energy expenditure, reducing women's overall nutritional status
3. Changing women's status, gender roles, access to income and control over expenditure
4. In some situations, there may be trade-offs between women's nutrition and child nutrition via time use pathways

Modifying Effect of Food Systems and Food Environments
Effects of NSAP appear to be modified by the food environment context. NSAPs in different food environment contexts result in different changes to food acquisition and consumption behaviours. Income mediate pathways between agriculture and nutrition depend on local market and food-system conditions. Where market access is poor:

1. The availability and affordability of healthy and nutritious foods may be reduced
2. There may be an aggregate effect of reduced production diversity within an area – leading to the reduction of healthy foods within a local food shed

Agrodiversity and Wild Foods

1. Many types of edible foods produced and consumed in agricultural settings are not captured by existing tools (see Box 1 methods gap). Current tools only capture a fraction of wild and semi-cultivated foods which contribute to dietary intake.
2. The long-term of effects of reduced landscape-level and farm-system level diversity on ecosystem service provision which supports agricultural production is unknown

Time use is increasingly used as a measure of women's well-being and empowerment (Alkire et al., 2013b; Williams et al., 2016). Time-use surveys have been vital in understanding the 'invisible' role of women's labour in agricultural livelihoods. When unpaid household labour and unmeasured agricultural labour are included, the labour of rural women is greater than that of men (Doss et al., 2011). Like income, time is a scarce resource whose allocation greatly affects the welfare of individuals, as well as their dependents (Williams et al., 2016). Lack of time can negatively affect a multitude of subjective and objective well-being outcomes, including health (Strazdins et al., 2011). Time can also be invested, with individuals voluntarily entering into time scarcity with a view towards future rewards for themselves or others. Lack of time can be indicative of the degree of agency and control individuals have over their livelihoods. As such, time use has become an important measure of women's well-being and empowerment (Alkire et al., 2013b).

Time allocation is also an important pathway between agricultural livelihoods and maternal and child nutrition. Agricultural transitions (such as oil palm development) can create trade-offs for time allocation between agricultural work and activities which affect maternal and child nutritional outcomes such as the acquisition, preparation and cooking of nutritious foods, as well as child care activities (Kadiyala et al., 2014; Johnston et al., 2015). Women's time allocation also affects women's own nutritional status via energy expenditure (Picchioni et al., 2020; Srinivasan et al., 2020). Women may also increase their time burdens in order to mitigate against economic shocks, which may improve child nutrition to the detriment of mothers (Seymour et al., 2019). As such, there may be counter-intuitive trade-offs between development goals such as women's participation in agriculture and off-farm labour and women's own health, and nutrition.

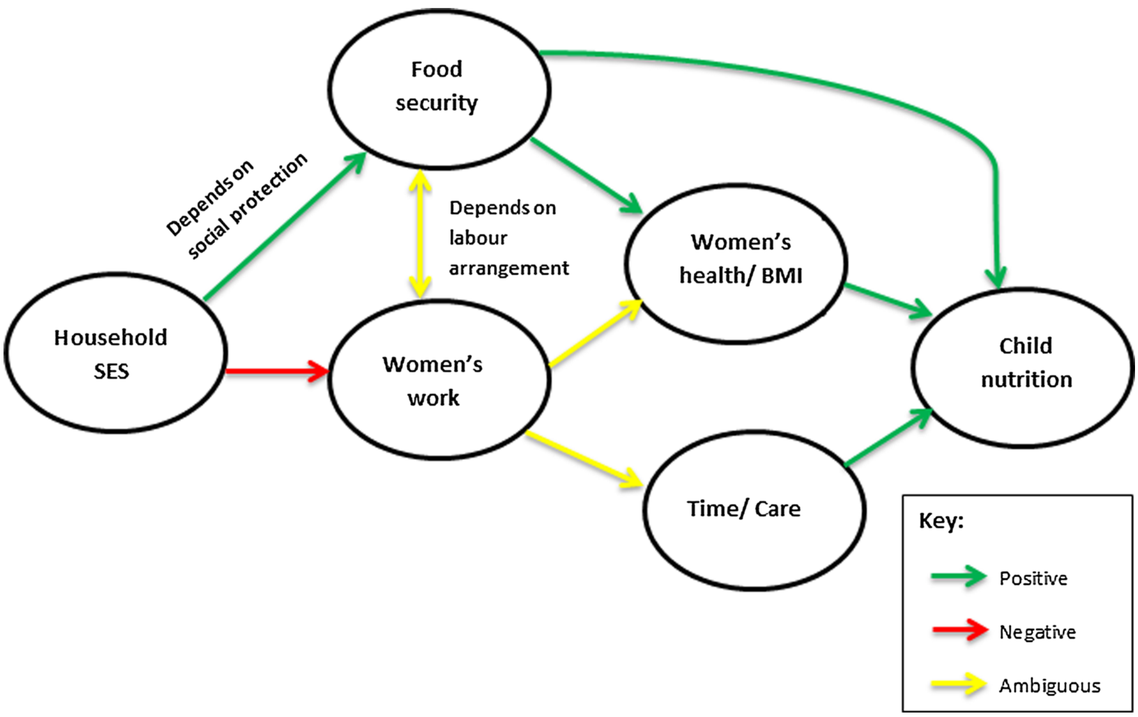


Figure 4-3: Women's Agricultural Work as a Mediator of Nutrition. Source: Rao et al. (2019)

Reviews of the literature have found that agricultural interventions often increase labour time for men, women and children, resulting in longer working days, and reduced time spent in rest, leisure and sleep (Johnston et al., 2015; Carletto et al., 2016). However, links between this labour time and nutritional outcomes are complex and varied. Many pathways were bidirectional, and interventions could simultaneously increase and reduce different pathways. In a systematic review of the evidence, Johnston et al. (2018) identified four "modes of management" by which women cope with increased time burdens: (a) reducing time in feeding and cooking; (b) extending the working day; (c) devolving tasks to other family members and; (d) increased reliance on purchased and prepared foods. However, the impacts of these pathways on nutrition did result in "unequivocal negative shifts in nutritional outcomes" (Johnston et al., 2018) due to differences in contextual and mediating factors. These factors include (i) managing time constraints by spending income generated by agricultural changes – either through purchasing foods, hiring domestic or farm labour; (ii) differences in household composition which affect the ability of other household members to take on tasks such as unpaid domestic and care roles no longer carried out by women. Thus, the increased time burden manifests itself differently according to different cultures, household compositions, and socio-economic status. Rao et al. (2019) extend the framework further, highlighting how different agrarian systems, labour market conditions, gender relations and social groups result in differential outcomes.

Transitions from diverse, traditional production systems towards commercialised agriculture involve multiple trade-offs that depend strongly on the local context (Anderman et al., 2014). Food environments are the context in which dietary choices are made – they influence food choice decisions via a range of constraints, fictions and influences (see 4.3). Several pieces of evidence suggest that food environments may be important modifiers of the effect of agricultural interventions. The optimum strategy for promoting diverse and healthy diets depends on managing trade-offs in the local context(Groot et al., 2012).

Agrobiodiversity and wild foods

Interventions promoting production diversity also have co-benefits that are often overlooked and unmeasured as outcomes. These include protecting and/or restoring agrodiversity. Fanzo et al. (2013) define agrobiodiversity as "the biological variety exhibited among crops, animals and other organisms used for food and agriculture, as well as the web of relationships that bind these forms of life at the ecosystem, species, and genetic levels. It includes not only crops and livestock directly relevant to agriculture but also many other organisms that have indirect effects on agriculture, such as soil fauna, weeds, pollinators, pests and predators." Agrodiversity may have broader effects on nutrition than can be detected in studies of production diversity. For instance, in protecting and restoring ecosystem services to agriculture and creating agricultural systems that are more resilient to climatic and economic shocks.

Food Systems and Food Environments

Another market-mediated effect is the contribution that locally produced foods make to market food availability. Healthy and nutritious perishable foods tend to have smaller food sheds than less healthy, non-perishable foods. In poor-functioning markets, the local supply of healthy foods could be reduced, therefore, by regional-level reductions in production diversity. Concern over this potential impact is growing – particularly in low-income settings, where food systems are consisted mainly of locally or regionally produced foods (Grace, 2016; Ickowitz et al., 2019). In countries with globalized and liberalized trade policies and food systems, cash crops can be exported while cheap, processed, and nutritious foods are imported (Tschirley et al., 2015). This situation could lead to an association between agricultural intensification, a focus on cash crops, and lower household dietary diversity (Duriaux and Baudron., 2016), as well as an association between agricultural specialization and rural food deserts (Dutko et al., 2012).

4.5 Landscapes, Land Use and Land Cover Change

4.5.1 Conceptual Definitions

The study of land use change and landscape transitions contains a confusing array of overlapping terms and definitions. Throughout this thesis, I will use the terms land use, land use change, landscapes and landscape transitions. I use land use to mean the classification of land based on biophysical and ecological characteristics as well as its use by humans. The terms Land Use Change (LUC) and Land Use and Land Cover Change (LUCC) are often used interchangeably to refer to the conversion of one type of land (e.g. forest) to another (e.g. agriculture). However, LUCC is more typically used for the analyses that view land use change dynamics as a complex socio-ecological system. I, therefore, will generally refer to LUCC to describe the process of change – emphasising its nature as a complex socio-ecological system. As a shorthand for LUCC within the local study area, I will use the term "landscape transition". The term "landscape" refers to the geographically bounded area of the local socio-ecological land use and land cover system. The term "landscape" is adopted from the field of "landscape approaches", or "integrated landscape approaches" – a policy approach for managing trade-offs between social, economic and environmental objectives (Sayer et al., 2013; Reed et al., 2020, 2021)[M].

Historically, socio-ecological transitions occurring in forested areas have often been situated within the context of a forest transition curve (see Appendix D.3). However, while forest transition curves provide a reasonable generalised view of forest transitions, they fail to recognise complex processes of socio-ecological feedback (Lambin and Meyfroidt, 2010) and thus are inadequate for the analysis of complex relationships, such as those between landscape change and food systems. To analyse such relationships, an explicit systems approach is needed.

Among the first to systematise the study of land use change as a complex system consisting of an interplay between biophysical, economic, demographic, social and political forces was Lambin et al. (2001, 2003) who describe five high-level causes of LUCC: (1) Resource scarcity and pressure on productive resources; (2) Changing opportunities driven by market changes; (3) Policy interventions; (4) Increased vulnerability and loss of adaptive capacity and; (5) Attitudes and access to resources. Each of these five forces may operate at different speeds at different times and interact with one another in unique, complex, unpredictable and non-linear ways. As such, land use change can be considered an "emergent property of complex adaptive systems" (Lambin et al., 2003), displaying the recognisable characteristics of such systems discussed in Section 4.2.

My analysis of food systems change in the context of complex socio-ecological transitions in forested landscapes is heavily influenced by the work of Lambin et al. and colleagues. In particular, I draw on Geist and Lambin (2002) in distinguishing between underlying drivers and proximate drivers of change – as well as later authors adopting this approach for the specific purpose of analysing swidden transitions (e.g. VanVliet et al., 2012; Dressler et al., 2015, 2017). Underlying drivers are typically exogenous – i.e. they are not influenced by any part of the system (at the landscape level) and act upon the system as if from outside. Proximate causes of landscape change are those which directly result in LUC and are often endogenous – i.e., they are responding to changes elsewhere in the socio-ecological system. The distinction is vital and often missed in crude analyses of LUCC – mistaking deforestation caused by shifting cultivators for the direct result of shifting cultivation (Ickowitz, 2006; Mukul and Herbohn, 2016).

4.5.2 Pathways Between Land Use Change and Diets

Until recently, the theory of how landscape diversity affects diets and nutrition has received little attention (Sunderland and Rowland, 2019; Ickowitz et al., 2022; Rosenstock et al., 2023). However, the studies demonstrating empirical links between landscape change and dietary outcomes discussed above have led to a more detailed interrogation of the causal mechanism behind such links[4]. One such conceptual framework is the Gergel et al. (2020) presented in Figure 4-4. The figure shows four main pathways between landscape change: (1) Direct Contribution Pathway; (2) Agroecological Pathway; (3) Energy Pathway; and (4) Income Pathways. As this thesis focuses on food choice, this section will focus on the pathways affecting food provision and income. However, an overview of the energy pathway is shown in Appendix D.8.

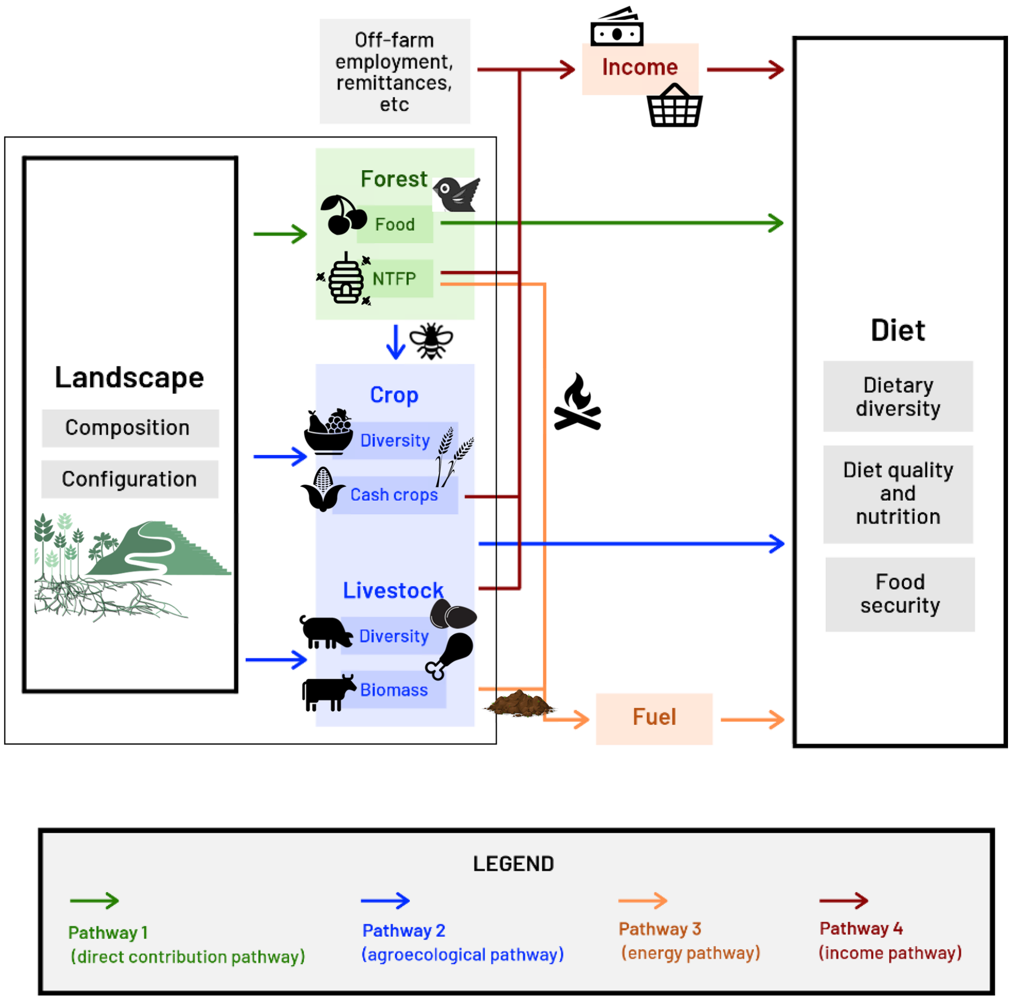
Food-Provisioning Pathways

The most obvious link between landscapes and diets is the direct provision of WFs. Though some foods are clearly "wild", the discrete category of "wild foods" is generally problematic. In fact, there is a spectrum from truly wild foods through managed wild foods, domesticated wild foods and cultivated foods (Bharucha and Pretty, 2010; Powell et al., 2015)[5]. There is extensive research that wild and semi-cultivated foods play a significant – but massively under-reported and underestimated – role in diets

[4] It should be noted that these conceptual frameworks were not available at the time this research project was designed. However, colleagues with whom I collaborated worked using a similar set of assumptions and causal pathways, but which were not published

[5] However, the abbreviation WF will be used in this thesis to refer to both wild and semi-cultivated foods as this is the standard terminology used in the literature

Figure 4-4: Conceptual Pathways Between Forests and Nutrition: Source Gergel et al. (2020)



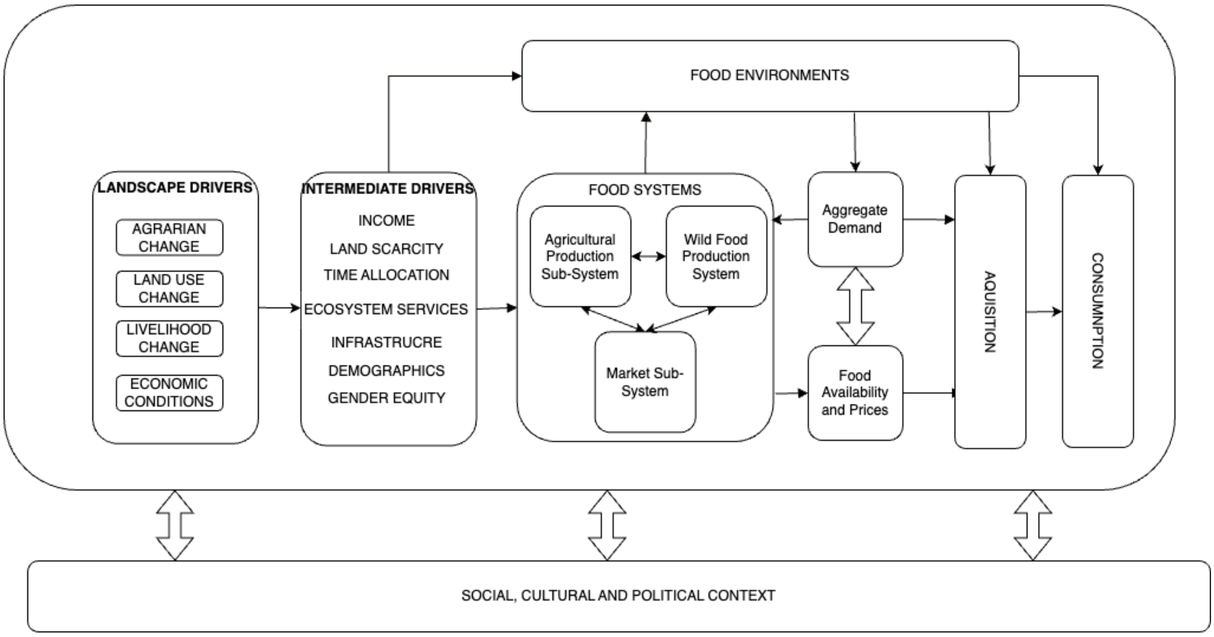
in many populations around the world – especially those living in forested areas (Powell et al., 2015; Ickowitz et al., 2022). A summary of this literature is available in Appendix D.7. In recent years several studies have examined the impacts of landscape transitions on diets with a focus on the loss of wild foods (Broegaard et al., 2017; Rasmussen et al., 2020; Blundo-Canto et al., 2020).

As well as directly, wild and semi-cultivated foods contribute to diets through the diversity at the farm and landscape level via the agro-ecological pathway. Edible species that grow in and around agricultural fields, in fallow fields or the farm environment is known as agrobiodiversity[M] (Scoones et al., 1992; Thrupp, 2002; Powell et al., 2015). Fallows are an especially rich source of agrobiodiversity as they contain "legacy species" previously cultivated crops, now self-perpetuating), plants which have self-propagated from human seeds and fruits discarded by humans after consuming them, as well as Wild Edible Plants (WEPs) which grow as part of fallow regeneration (Wood et al., 2016). Hence, more extensive production systems which incorporate fallow cycles tend to have higher levels of agrobiodiversity. Swidden systems – the focus of this study – have exceptionally high agrobiodiversity as the system incorporates fallow, weeds, natural regeneration and forests into the system – as well as providing a location for hunting and deliberate trapping of animals. As such, swidden must be thought of not as an agricultural practice but as a diverse livelihood that blurs the distinction between "cultivated" and "wild" and incorporates casual and opportunistic use of the forest as part of a wider forest-based livelihood strategy.

As a landscape trend away from diverse, extensive production systems towards specialised and intensified production systems, biodiversity and agrodiversity typically also decline (Phalan et al., 2011; Ickowitz

Figure 4-5: Integrative Conceptual Framework Linking Landscape Change with Dietary Intake

Source: Author



et al., 2019; Gitz et al., 2021; Ickowitz et al., 2022) . Correlations between forest cover and nutrition outcomes (Johnson et al., 2013; Ickowitz et al., 2013) and diverse traditional forest-based agricultural systems and nutrition (Ickowitz et al., 2016) suggest that production systems, in addition to wild food consumption may play a vital and under-researched role in producing healthy and diverse diets (Powell et al., 2013, 2015)

Income Pathways

Forests and biodiverse landscapes provide a wide range of products and services, which can be described as "environmental income" in that households would otherwise have to purchase such goods and services (Angelsen et al., 2014). Environmental income is usually absent from economic analyses of development and socioeconomic surveys (Angelsen et al., 2014) – especially those based on expenditure surveys. Forests also directly provide income in the form of the sale of Non-Timber Forest Products (NTFPs). These sources of income are often vital for household economies but are rarely "a pathway out of poverty" (Wunder, 2001). Many communities rely on the sale of NTFPs as coping mechanisms during times of economic or climatic shocks (Arnold et al., 2011; Shackleton and Shackleton, 2012) – though they may not be the only, or the most common coping strategy (Wunder et al., 2014b). As discussed in Section 4.4 above, greater income does not automatically result in improved nutrition. The effect may be positive in some contexts and negative in others depending on (among other factors) market access and women's empowerment.

4.6 Integrative Conceptual Framework

So far in this Chapter, I have presented a number of different theoretical frameworks which focus on different aspects which relate to my research. However, neither of these conceptual frameworks is sufficient for my purposes – which is a particular context where agrarian, landscape and food-system changes are occurring concurrently. For example, while the framework by Gergel et al. (2020) discussed in Section 4.5 provides a useful way of conceptualising links between landscape diversity and diets in general, it is not designed explicitly with the intention of exploring landscape transitions. Likewise, the Turner et al. (2017) and HLPE (2020) frameworks focusing on food systems and food environment discussed in Section 4.3.1 are essential for understanding the effects of agricultural and food systems changes on dietary intakes – but do not account for the rural biodiverse context in which this research is situated.

There is a need to integrate food systems frameworks from the field of agri-health with frameworks from the study of land use change to conceptualise landscape transition – diet linkages that extend beyond agrarian pathways. The conceptual framework presented below in Figure 4-5 is the working conceptual framework for my research. The framework does two things. Firstly, it expands on the Gergel et al. (2020) framework to make the focus on transitions more explicit. Secondly, it incorporates landscape pathways with pathways from agri-health to show more explicitly the different agriculture-nutrition linkages.

Building on the work of Lambin et al. on complex socio-ecological systems of Land Use and Land Cover Change (LUCC) discussed above, I separate underlying drivers from proximate drivers (see Table 4.3). The framework shows four landscape drivers (agrarian, land use, livelihood, and economic changes[VII]) as semi-autonomous sub-systems with their internal own-system dynamics – but which crucially interact with one another to form a larger complex system of landscape change[6]. Landscape drivers influence food systems and food environments[VIII] via the intermediate drivers, which include changes in livelihoods, household economics, as well physical aspects of landscape and land use. Changes in the food system and food environment then influence changes in food acquisition and consumption by influencing food choice through changing priorities, preferences, or by increasing or decreasing constraints and friction.

The food system is explicitly shown as being comprised of sub-systems – illustrating that the food system is an emergent property of interconnected sub-systems. Unlike other frameworks, I include the wild food production system as separate from the agricultural production system as they interact with the agricultural production sub-system but are affected in different ways by different landscapes and intermediate divers. I also have chosen not to include food processing and packaging sub-systems here as they tend not to occur locally in rural contexts[7]. I make the deliberate choice to emphasise the importance of supply and demand dynamics in this framework, as the absence of such is a gap in existing food environments theory (see 4.3). The phrase "aggregate demand" is used to emphasise the effect of market responses to community-level demand (e.g. income levels, availability of locally produced foods). In keeping with systems theory, these may exhibit non-linear behaviours triggered by demand reaching thresholds and tipping points[8].

4.7 Research Matrix and Research Questions

In this section, I present the overall research framework. Table 4.4 summarises the theoretical, methodological and evidential gaps identified in this chapter and the literature review and shows where my thesis aims to contribute towards addressing them.

My research questions are as follows:

[6]As discussed in section 4.5. While Lambin et al. (2003) uses the term LUCC to describe a socio-ecological system, I prefer to use landscape change to describe the overall system as it differentiates itself from the common use of both "land use" and "land cover" change which are commonly referred to in the literature solely in terms of spatial configurations of land use and land cover

[7]Note, I have chosen not to include food processing and packaging sub-systems commonly included in such frameworks (e.g. Global Panel, 2016; Grace, 2016) as these do not generally occur locally rural contexts of LMICs.

[8]E.g. if a community begins producing less food locally but producing more income. At a certain threshold of demand, a tipping point is reached, and outside vendors respond to this demand by providing food to sell.

Table 4.3: Landscape and Intermediate Drivers

Driver	Description
Landscape Drivers (Underlying)	
Agrarian Change	The location, extent and type of crop and livestock production
Land Use Change	Changes in the spatial pattern and configuration of land cover and land use and associated ecological functions. Includes forest loss & fragmentation as well as infrastructure development
Livelihood Change	Changes in the overall livelihood strategy including household and intra-household allocation of time and labour, sources of income and food
Socio-Cultural Change	Changes in social and cultural norms
Political Ecology	Legal, regulatory, and governance context
Intermediate Drivers (Proximate)	
Household Income	Change in household and intra-household allocation, including cash income as well as environmental income
Gender Dynamics	Intra-household gender equity including gender roles, control over income, expenditure and decision making. Social and cultural gender equity including women's social status and participation in community decision making
Ecosystem Services	Function of ecosystems and the supply of provisioning, regulating and socio-cultural ecosystem services
Infrastructure	Physical infrastructure (e.g. bridges & roads) as well transport infrastructure (e.g. public transportation) and market access
Demographic	Changes in population structure including immigration, emigration, temporary workers. Changes in the population distribution of age, cultural, religious characteristics

Table 4.4: Intended Contributions of Thesis

Intended Contributions Towards Adressing Gaps in Theory, Evidence and Methods

Gap	Thesis Contribution
Theoretical Gaps	
Existing food systems and food environment frameworks do not fully integrate the role of wild foods, and agrobiodiversity	Explicitly integrate the role of wild foods both in terms of contributions to food environments and wider role within local food systems
Food environment frameworks do not fully account for supply and demand dynamics, leading to issues of endogeneity.	Focus on the role of local market systems in adapting to changes in demand.
Evidence Gaps	
Lack of research on dietary effects of swidden-oil palm transitions. Previous studies of oil palm-nutrition pathways based upon commercialised rubber farmers adopting independent oil palm.	Examine pathways between oil palm adoption and dietary intake pathways among formerly swidden farmers. Contribute evidence of the effect of oil palm adoption on activity spaces, food systems, external food environments and personal food environments.
Modifying Effect of women's empowerment upon food choice and diet under-researched	Oil palm's effect on changing gender roles; time and labour allocation; and impacts on food choice.
Lack of research on food environments in biodiverse rural contexts in LMICs	Study food environments in biodiverse rural contexts in LMICs
Effect of women's time and labour allocation in smallholder oil palm and potential impacts upon nutrition	Investigate the effect of women's time and labour allocation on smallholder oil palm and potential impacts on nutrition.
Methodological Gaps	
Lack of activity-space approaches to food environments	Develop and apply activity-space approaches to study food environments.
Lack of tools measuring production diversity which incorporate wild and semi-cultivated foods	Develop tools to measure production diversity that incorporate wild and semi-cultivated foods.
Most food environment survey tools designed for HIC settings	Develop an overall approach for investigating food environments in biodiverse rural settings in LMICs.
Lack of mixed-methods approaches in oil palm studies	Use of concurrent mixed-method design, integrating mixed methods throughout and provide reflections on approach.

RQ 1: How does oil palm adoption by smallholder swidden farmers affect the intra-household allocation of time?

RQ 2: What effects does community-wide adoption of oil palm have on local food systems?

RQ 3: How do changes in food systems and time use impact food choice decisions?

This thesis addresses these research questions in the following way: **Chapter 6**, I outline the main landscape and livelihood trajectories in each set of villages. Chapter 8 focuses on how these changes described in Chapter 6 affect village-level food availability and prices via changes in the agricultural, wild food and market food sub-systems. Chapter 7 focuses on the transitions described in Chapter 6 on the gendered allocation of labour and time – and also shows how intra-household time allocation is a partial driver of these changes. In Chapter 9, I focus on the nature of food choice in each set of villages. While the chapter covers all aspects of food choice, I narrow in on those aspects of food choice influenced by changes in food systems and time allocation discussed in Chapters 8 and 7.

Endnotes for Chapter 4

[I] Fanzo and Davis (2021) describe these concepts thus:

> A "food systems approach" is a departure from traditional approaches, which tend to be sectoral with a narrowly defined focus and scope. Instead, a food systems approach uses a holistic, comprehensive view of the entire system. This approach includes the actors within the food supply chain and governance mechanisms that shape their roles. A food systems approach requires "food systems thinking," which identifies and describes the influences, or "drivers," and relationships in the systems. Food systems thinking also considers how these influences intersect with each other in both positive and negative ways

[II] As stated by Ahmed et al. (2021):

> Regardless of the place of the personal domain, it is critical to understand the dimensions of the personal domain because these notably influence healthy diets, nutrition, and health

[III] People may be more active in choosing their food environments than is commonly consumed (Ver Ploeg and Wilde, 2018). In many locations, individuals may have multiple options providing the same goods and services (e.g. traditional markets, supermarkets, malls). The decision of which to visit may be, partially at least, influenced by an individual seeking out a particular food environment. Excluding situations of extreme market failures, in general, the external food environment may partly reflect the market's response to aggregate consumer demand within this area. Put another way – a particular food environment may contain lots of fast food outlets because it is frequented by people who desire fast food. The causal exposure-outcome model does not take into account the mental decision-making process of individuals. Individuals making food choice decisions simultaneously weigh trade-offs across multiple food environment dimensions (e.g. cost and convenience). Thus, interactions with food environments often reflect household priorities given a set of external conditions. Where possible, within the constraints of the food environment, households will make decisions based upon maximising those properties which are most important or by balancing competing priorities (GCRF AASH, 2021; Cooper et al., 2023)

[IV] Rural development policies over the past few decades have often assumed poverty reduction and reducing gender inequality go hand in hand – with reducing gender inequality driving poverty reduction and poverty reduction reducing gender inequality. Such approaches have been labelled as the 'feminization of poverty alleviation' – the treatment of gender inequality as a 'silver bullet', leading to an overemphasis on female-controlled income and lack of emphasis on female labour (Chant, 2008). There is an entire body of literature critiquing this approach. Amongst the many criticisms levelled is a: lack of accounting for differences amongst women, overlooking the effects of different socio-economic conditions and household dynamics, neglecting male-female power dynamics, and placing the 'burden of poverty reduction' on women – in addition to their other time and labour constraints (Molyneux, 2006; Chant, 2008). Feminist critiques have introduced two vital components previously missing; first, the importance of power dimensions between men and women, and second, the central role of reproductive labour.

[V] While "landscape approaches" evolved as a policy approach to conflicting priorities and objectives, the "landscape transition" has increasingly been adopted as a unit of analysis for research (Reed et al., 2015) though has also received some criticism. The concept of landscapes and landscape transitions have received substantial criticism. Firstly, while conceptually, the idea is coherent, translating landscapes into a single geographical area with boundaries is a challenge. Deciding what is inside and what is outside of a landscape is not easy given the inherent properties that "landscape are multi-actored, multi-purpose, and multi-nested scaled, and usually an assumption of poly-centrism" (McCall, 2016). Secondly, while landscape approaches are supposed to be inherently inclusive, in reality, they often fail to account for power asymmetries – especially between indigenous people (Kusters, 2015). Thirdly, landscape approaches may be "more readily marketed than implemented" (Reed et al., 2020) and, while popular in policy discussions, there is little evidence that they are in reality, being implemented. Criticisms of the "landscape approach" notwithstanding, I use the term "landscape" in this thesis specifically to draw attention to the poly-centrism, overlapping spatial scales, governance, and the complex, non-linear interconnections of these actors and forces.

[VI] Agrobiodiversity is defined as "the biological variety exhibited among crops, animals and other organisms used for food and agriculture, as well as the web of relationships that bind these forms of life at the ecosystem, species, and genetic levels. It includes not only crops and livestock directly relevant to agriculture but also many other organisms that have indirect effects on agriculture, such as soil fauna, weeds, pollinators, pests and predators." (Fanzo et al., 2013).

Agrodiversity also has broader effects on nutrition than can be detected in studies based around farm surveys – for instance, in protecting and restoring ecosystem services to agriculture and creating agricultural systems that are more resilient to climatic and economic shocks (Thrupp, 2002; Kahane et al., 2013; Vansant et al., 2022).

[VII] Agrarian change here is defined as the location, extent and type of crop and livestock production and also refers to the overall strategy of farming. The reason for this is that swidden livelihoods have their own cycle around which other forms of agricultural production are orientated. Swidden is far more than a method of agricultural production – it is a system of agrarian livelihood which comprises part of a wider diversified on-farm and off-farm strategy (Dove, 2011a). Among swidden changes are wider changes in livelihoods including, including on-farm and off-farm labour waged labour, business and other economic activities and forest-based livelihood activities. LUC is presented as a sub-system here as – while it influences and is influenced by the agrarian change and livelihood sub-systems, it also behaves as an independent complex system (as described in 4.2)

[VIII] I make the choice in Figure 4-5 to separate the food system from the food environment. This is based upon the conceptualisation of food environments in the Turner et al. (2017) framework, which places food environments as the "interface between food systems and individual consumption". This also allows me to distinguish between two pathways which affect food environments. Food environments are influenced by changes in the food system itself (i.e. the changes in availability, food prices, convenience and desirability of foods), as well as changes in livelihoods and personal circumstances of individuals (e.g. changes in time allocation, time pressure, activity spaces, income).

Chapter 5: Methodological Approach and Study Design

Contents

5.1 Introduction

This project is interdisciplinary in nature and uses a mixed-methods research strategy. It takes as its conceptual framework work conducted in the fields of agri-health and public health nutrition, as well as drawing on debates from environmental science and agrarian studies. It uses methods from a variety of disciplines, in particular agricultural and environmental economics, ethnobotany, anthropology, sociology and development studies. The study aimed to compare and contrast oil palm-adopting communities with those of non-oil-palm-adopting communities.

Study villages were selected based on a multi-stage qualitative matching procedure, which aimed to identify communities with similar historical characteristics but which have subsequently diverged as a result of oil palm adoption/non-adoption. Primary fieldwork was conducted over eight months, led by the author, with the assistance of a small team of locally recruited enumerators. To achieve a balance between depth and breadth of research, quantitative survey questionnaires were administered with randomly selected respondents across 26 villages (13 oil palm adopting, 13 non-oil palm adopting). A subset of ten villages (5 oil palm-adopting and 5 non-oil palm-adopting) were selected for in-depth qualitative research consisting of semi-structured and open-ended interviews and focus group discussions incorporating participatory ranking, pile-sorting and mapping techniques. A visual representation of the study design is shown in Figure 5-1.

5.1.1 Chapter Structure

This chapter introduces the methodological approach, data and methods used in the subsequent empirical chapters. **Section 5.2** outlines the interdisciplinary mixed-methods approach I adopt, as well as the need for novel methods and approaches.**Section 5.3** describes the selection of the study villages and respondents and gives a brief overview of their characteristics. **Section 5.4** describes the process of fieldwork itself, including the formative research and design, team training, pilot survey and steps taken to test the reliability and validity of instruments used as well as the quantitative questionnaire survey data (5.4.3) and qualitative and participatory research (5.4.4). **Section 5.5** describes the primary and secondary data and analytical approaches. Finally, in **Sections 5.6 and (a)**, I discuss steps undertaken to mitigate potential sources of bias and endogeneity as well as to ensure that research was as ethical as possible. I outline the measures taken to mitigate any potentially negative impacts, obtain consent and ensure respondent confidentiality. I also provide a reflexive account of the fieldwork, providing my reflections on both the ethical dilemmas which arose during the research, as well as on broader methodological issues.

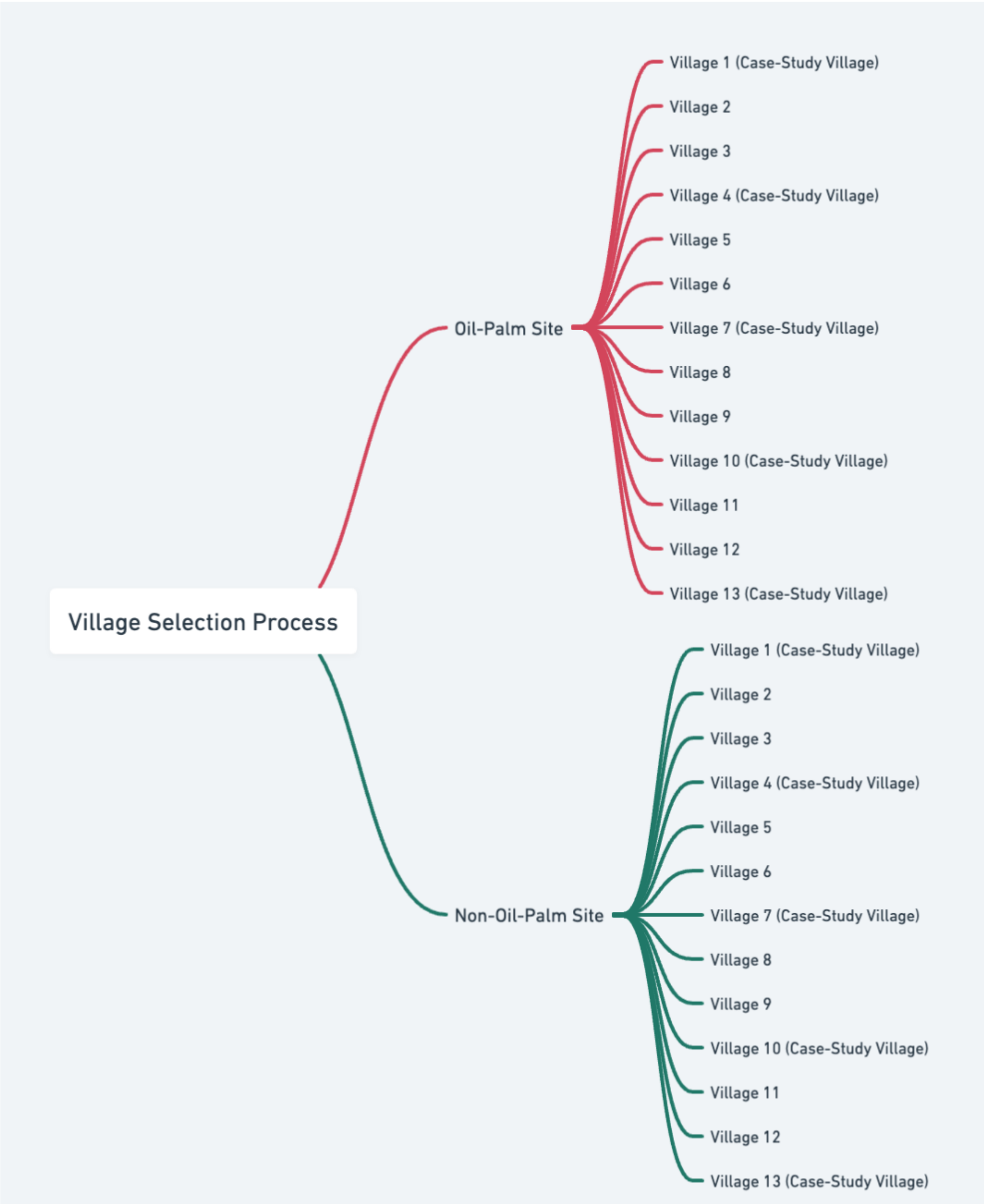
5.2 Methodological Approach

5.2.1 Interdisciplinarity

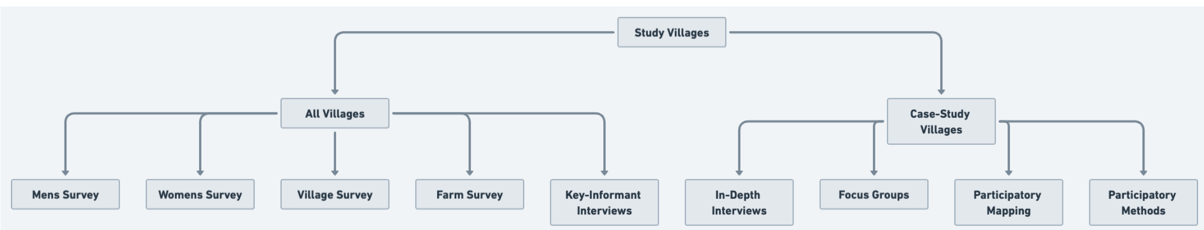
Over the past decade, there have been widespread calls for a “new global research agenda for food” (Haddad et al., 2016) requiring new multidisciplinary and interdisciplinary approaches (Dangour et al., 2012; Foran et al., 2014; Horton et al., 2017; Picchioni et al., 2017; Waage, 2022). This study is intrinsically interdisciplinary. Firstly, it is method-agnostic and mixed-methods – selecting the methods, or

Figure 5-1: Study Design

(a) Study Villages



(b) Research Activities Carried Out



combination of methods best able to produce a holistic view of the research problem. Secondly, while my research is independent, it is part of a much broader, multidisciplinary collaboration between nutritionists, economists, anthropologists and sociologists (both Indonesian and foreign). Finally, it aims to analyse a complex system as a whole without reducing the analysis to relationships between individual components.

This thesis focuses on a topic which is both theoretically and methodologically underdeveloped. I, therefore, took an abductive approach to both the qualitative and quantitative research. Abductive approaches are a pragmatic solution to the extremes of induction and deduction by allowing literature and theory to guide open-ended research questions while allowing data and findings to influence the theoretical framework (Dubois and Gadde, 2002; Tavory and Timmermans, 2014). Abductive approaches are suitable for situations where the aim is to create new hypotheses and theories from the data while incorporating and reflecting on existing theories and literature. The research questions posed in Chapter 4 (Section 4.7) are guided by theory past literature and are thus deductive approaches. Both qualitative and quantitative data contribute towards answering these research questions. However, our qualitative study primarily consisted of inductive inquiry by seeking open-ended responses to topics.

5.2.2 Mixed-Methods

Table 5.1 shows the types of data collected as part of this research. Data consist of traditional quantitative (e.g. survey questionnaires, market inventories etc.) and qualitative data (e.g. interviews and focus groups) as well as participatory approaches that are predominantly qualitative (e.g. participatory cooking) and participatory approaches which are primarily quantitative (e.g. ranking exercises). A final category (represented by arrows) is participatory data, which is originally qualitative in nature but which can be transformed into quantitative data (as described by Chambers, 2007, discussed below). This category includes free-listing data, which can be tabulated to create quantitative indices, or village walks and participatory maps, which can be combined with other sources of data to create quantitative measures of village characteristics.

Table 5.1: Types of Qualitative, Quantitative and Participatory Research Methods Used

Qualitative, Quantitative and Participatory Research

			Participatory	
Methods	**Quant**	**Qual.**	**Quant.**	**Qual.**
Pile Sorting			✓	✓
Ranking Exercises			✓	✓
Village Walks			✓	→
Participatory Mapping			✓	→
Participatory Cooking			✓	
Photo-Elicitation			✓	
Key Informant Interviews (KIs)		✓		
In-Depth Interviews (IDIs)		✓		
Focus Group Discussions		✓		
Free-listing			✓	→
Village Shop Inventories	✓			
Market Surveys	✓			
Men's Survey	✓			
Women's Survey	✓			

Note: → Indicates that data is transformed from qualitative to quantitative

The tension between qualitative "precision of meaning" and quantitative "accuracy in measurement" (Van der Riet, 2008) is present in many research designs. In order to strike a balance between breadth and depth of research, quantitative surveys were conducted in numerous villages covering a wide geographical area, while a much smaller subset of case-study villages were selected for more intensive qualitative research. This approach has several advantages (as well as challenges). The approach allowed quantitative data can be collected from a random sample of households across a wide range of villages, ensuring sample sizes are sufficient for quantitative analysis without sacrificing the in-depth qualitative approach necessary for understanding the context and developing the critical perspective for interpreting qualitative results.

I adopted a mixed-methods approach for two main reasons: Firstly, I believe that neither qualitative nor quantitative approaches are sufficient in themselves to give a complete picture of this research topic. As shown in the literature and background Chapters (2 and 3), the lack of mixed-methods research in the research on the topic of welfare outcomes of oil palm adoption has led to disciplinary and methodological silos. Secondly, by collecting concurrent quantitative and qualitative data, it is possible to overcome methodological weaknesses in individual approaches (Anastario and Schmalzbauer, 2008; Jagoe et al., 2020). Food systems research is a relatively new field. As such, there are few validated survey instruments for LMICs, especially in rural contexts[1].

Mixed-methods approaches cover a wide range of ways of integrating quantitative and qualitative data. I opted for a concurrent triangulation[2] strategy whereby different sets of qualitative and qualitative data are collected simultaneously and given equal importance in the analysis (Creswell, 2017). Triangulation methods include convergence (increasing validity and credibility of results), complementarity (using different methodological strengths and weaknesses to answer different parts of a research question), and divergence approaches (comparing and exploring differences between results generated by each method) (Fetters and Molina-Azorin, 2017; Morgan, 2019). This study uses elements of all three of the approaches. However, the primary goal was a complementary approach, in that qualitative data was collected to capture aspects not captured in qualitative data and vice versa.

The primary mixed-method approach I adopted was that of complementarity – i.e.ủsing different methods to answer different parts of the research question. However, there are also parts of the research where qualitative and quantitative data approaches aim to measure the same underlying aspect. In these cases, data either support each other or are divergent in their findings. When such cases arise, I explicitly analyse the resulting congruence or incongruence of the data and, in the case of the latter, offer a potential explanatory hypothesis as to the discrepancy.

This study borrows from a wide range of methods from different disciplines. Questionnaires borrowed heavily from existing methodologies in socio-economic surveys such as the Demographic Health Surveys (DHS) and Living Standards Measurements Studies (Grosh et al., 2000) as well as past research conducted at the interface of tropical forests and agriculture such as CIFOR's 10-year long Poverty and Environment Network (PEN) (Angelsen et al., 2014; CIFOR, 2014). In addition, many methods have been borrowed from the fields of agriculture and nutrition – especially elements of gender research within this field such as the Women's Empowerment in Agriculture Index (WEAI) – which themselves draw upon a long history of gender research with their own methodologies (Alkire et al., 2013b). Finally, this study also draws from ethnobotanical research. Ethnobotanists have long paid attention to the importance of wild and semi-cultivated plants in diets and have devised a wide range of anthropological and participatory research tools to assess knowledge, preference and significance of wild foods and animals (Alexiades and Sheldon, 1996; Cunningham, 2001).

A core component of the research approach is the use of participatory methods to obtain what Chambers

[1]See Chapter 4 (Section 4.3.2). Since this study was designed, several more tools have been produced – but these were not available at the time of designing and implementing this research. Despite some methodological development, there are still few validated methods and approaches for LMIC contexts

[2]Fetters and Molina-Azorin (2017) and Morgan (2019) propose abandoning the use of the term "Triangulation". However, since the three approaches described in this section have emerged from triangulation approaches. I use the term as a catch-all for the collective approaches of convergence, complementarity and divergence.

(2007) calls "participatory numbers". The participatory approaches in this study are drawn from a combination of Participatory Rural Appraisal (PRA) and ethnobotany. Ethnobotany research, in general, has developed sophisticated ways of transforming qualitative and participatory data into quantitative data for statistical analysis or visual representation (Martin, 2004; Höft et al., 1999; Cunningham, 2001; Vogl et al., 2004), and there is significant scope for methods for borrowing and adapting such methods for the study of food systems and food environments. This is discussed in more detail in the methodological reflections in the discussion (10.3).

5.3 Site Selection and Respondent Recruitment

In total, 26 villages (13 oil palm adopting, 13 non-oil palm adopting) villages were included in the study. A subset of ten villages (five oil palm adopting, five non-oil palm adopting) was selected to carry out more extensive qualitative research (see Figure 5-2). In each study villages, a short questionnaire was also administered to the village head or village secretary about general village characteristics and a rapid participatory map was created with key-informants which showed the general village characteristics. In the selected case study, villages focus groups and in-depth interviews were conducted out as well as participatory exercises.

This approach was chosen as it struck a balance between the need for both purposive and probability-based sampling methods – a constant challenge in mixed-methods research (see Appendix E.8) and provided a suitable framework for investigating my research questions. Several of the research questions require large sample sizes and randomised participant selection so as to generate research findings which are externally valid (i.e. replicable) and representative of oil palm or non-oil palm adoption within this particular context. On the other hand, the depth of information required for many aspects of the research was unfeasible at this scale. The combination of a wider quantitative survey and sub-set of case-study villages thus allowed me to integrate quantitative and qualitative findings and strike a balance between breadth and depth of research. Table 5.2 shows the types of sampling strategies for each research component.

Table 5.2: Sampling Strategy

Method	Sampling Strategy	Selection Criteria
All Villages		
Women's Questionnaire	Random-sub-sample[1]	Mothers of children aged 12mths-5yrs
Men's Questionnaire	Random-sub-sample	Husbands of women in survey
Village Questionnaire	Purposive	Village Head (or similar)
Rapid Participatory Mapping[1]	Convenience	Knowledgeable about area
Rapid Participatory Mapping[1]	Convenience	Knowledgeable about area
Women Only FGD	Purposive	SHF or PPP
Case-Study Villages		
Mixed FGD	Purposive	SHF or PPP
Key-Informant Interviews	Purposive	SHF or PPP
Participatory Mapping	Purposive	SHF or PPP
Participatory Walks	Purposive	Women SHF or PPP
Participatory Cooking / Participant Observation	Purposive	Women of children aged 12mths-5yrs

Notes: SHF= Smallholder Farmer; PPP = Plasma Scheme Participant [1] With small groups of 2-3 participants (often including key informants)

Figure 5-2: Activities Carried out in Study Villages and Case Study Villages

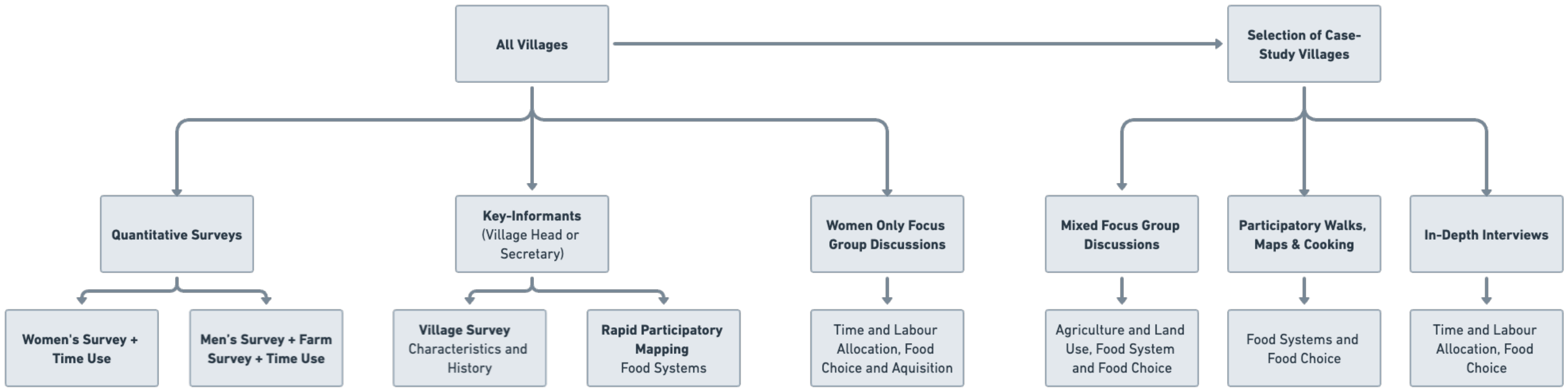
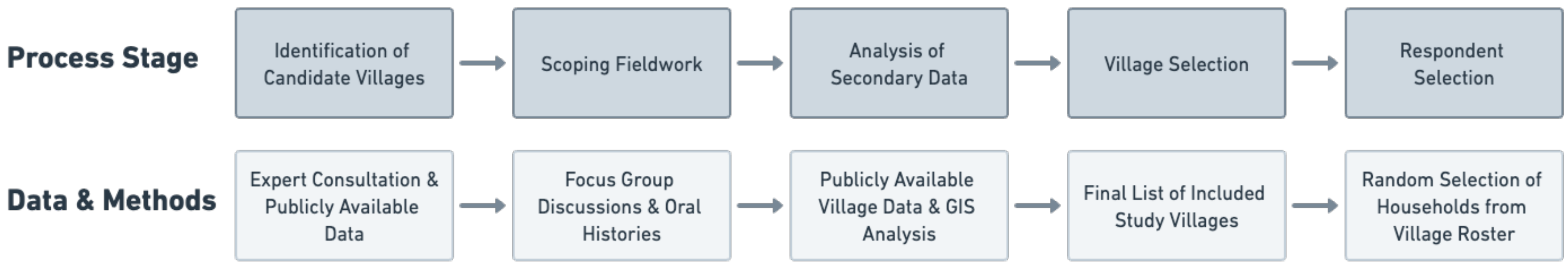


Figure 5-3: Village and Participant Selection Process



Notes: A list of potential villages was selected from all villages within Kapuas Hulu Regency using expert consultation and public data. Focus groups and key-informant interviews were then carried out in each potential village, focusing on historical (pre-year 2000) livelihoods, demographics, economic conditions and land use change to identify villages that best shared a common historical baseline. Where secondary data was available, we used this to confirm the historical baselines we obtained from the FGDs (see Appendix E.6), while GIS analysis of satellite imagery confirmed the shared historical baselines of forest-cover (Appendix E.7).

5.3.1 Selection of Study Villages

This research was conducted in collaboration with a larger multidisciplinary research project (Drivers of Food Choice[3]) led by CIFOR, which aimed to describe and understand how oil palm adoption impacts nutrition and health (see Appendix A.1). This project[4] used the main sampling framework of the DFC study – but only sampled a subsample of respondents in each village. The study uses a multi-level sampling approach with respondents nested in villages, nested in sub-districts, and within sites (Figure 5-1). An important consideration of the DFC study was to capture a broad range of smallholder plasma oil palm and non-oil palm livelihoods while matching villages so that they shared similar historical baselines. As such, the sampling frame aimed to cover a diverse range of oil palm-based livelihoods in different areas with different histories of oil palm development. As a result, the study villages covered a wide geographical area across four sub-districts (two oil palm, two non-oil palm).

The selection of study villages was carried out using a multi-stage process, including consultation with experts and boundary partners, preliminary scoping field research and the analysis of publicly available data and satellite imagery (see Figure 5-3). Multiple criteria were used for identifying candidate villages for inclusion in the study, the most important of which are shown in Table 5.3. The aim was to select oil palm and non-oil palm villages which shared a similar historical baseline (i.e. before oil palm development began in the region in the 2000s) but which have subsequently diverged as a result of oil palm adoption/non-adoption (see Box 5.1).

The approach taken means comparisons can be made between randomly selected households within oil palm-adopting and non-oil palm-adopting villages. This approach has a number of advantages over the alternative (randomly selecting households and later assigning them an adopter status based on land ownership/income) and avoids common sources of endogeneity and selection bias, which are discussed in Appendix E.1. The main advantage is that it reflects how plasma communities adopt oil palm. For plasma agreements, consent is granted by village authorities on behalf of village residents and dividends, compensation and other forms of payments are collectively bargained (Andrianto et al., 2019b; Yuliani et al., 2020). Additionally, my study is focused on food system and food environment changes. These occur as a result of mass or aggregate shifts in livelihoods, economies and food systems. The purpose was to investigate the effects of mass oil palm adoption, not the individual effects on households adopting oil palm in an otherwise unchanged environment. Another advantage is that farmers who have adopted oil palm but who have subsequently sold their plasma holding are included in the adopting group – a significant source of selection bias in alternative approaches which, by definition, sample only those smallholder farmers who are successful (see 2.3).

Selection of Case-Study Villages

Ten villages (five oil palm-adopting adopting five non-oil palm adopting) were selected as case-study villages for more in-depth qualitative research. The selection of model villages was done by examining maps of village locations. Based upon the rationale that villages in close proximity to one another had more shared characteristics, I first identified groups of 2 (occasionally 3) villages which were located extremely close to one another and selected only one from village from the group to designate a model-village. The aim was to ensure an even spread of model villages across the sites to ensure that conclusions generated from them could be generalised to some extent to be reflective of the diversity of experiences within the site.

[3]Hereafter referred to as the DFC study. Full title: From Growing Food to Growing Cash: Understanding the Drivers of Food Choice in the Context of Rapid Agrarian Change in Indonesia

[4]The CIFOR DFC study produced the original study design. While I am a co-investigator of this project, this high-level project design was predominantly done by the principal investigator along with the nutrition team and focused on the core dietary intake research.

Box 5.1: Divergent Outcomes from a Shared Historical Baseline

Comparisons between oil-palm adopting and non-oil-palm adopting communities are a form of space-for-time substitution (see Appendix E.2). However, I explicitly reject the idea that forest villages in this site represent a "pre-oil palm" state of the oil palm villages. Non-oil palm villages have also continued to change, responding to new and changing environments and economic contexts. Thus, the two sites represent divergent trajectories – one towards oil palm, and one maintaining swidden cultivation as the central livelihood, while also adopting more rubber cultivation and more off-farm labour sources into livelihood strategies.

The sites represent different outcomes of a larger swidden transition occurring throughout the regency of Kapuas Hulu. It is my assertion that the livelihoods in the forest village – while not necessarily representing a "pre-oil palm" livelihoods in the oil palm sites – are realistic alternative livelihoods that villages in the oil palm site could have adopted had they had not adopted oil palm. Likewise, there are few endogenous reasons why forest villages could not have resembled oil palm villages had they adopted oil palm around the same time (See ection 5.6.1).

It is also important to consider that swidden transitions in both sites are continuing to evolve and that this study is merely a snapshot of a larger swidden transition which has been occurring for decades before it, and will continue for many years after it. Thus, comparisons between sites are not only comparisons of a single variable (oil palm vs no oil palm) but comparisons of two sets of transitioning landscapes and livelihoods – one if which has been modified and accelerated by oil palm development.

5.3.2 Description of Sub-Districts and Villages

In all selected villages, food production was produced via subsistence agriculture, primarily slash-and-burn rotational swidden rice cultivation. Livelihoods at the baseline period consisted of swidden agriculture combined with small-scale rubber agroforestry and forest-based activities such as hunting, fishing, collection of other NTFPs as well as. No villages with extensive participation in logging or mining activities were included. Land tenure in all villages was historically based upon customary land ownership. In addition to these inclusion requirements, oil palm villages were required to have extensive community-wide participation in oil palm plasma schemes. Respondents within each village were selected at random from a household roster acquired from village health authorities. Map 5-4 shows the location of the study sites within the context of Kapuas Hulu Regency. All respondents in all villages were indigenous Dayaks who historically practised swidden rice cultivation combined hunting, fishing, and collecting wild edible plants and other NTFPs. In the oil palm villages, the agricultural practices were identical to those carried out in the forest sites prior to the arrival of oil palm.

Characteristics of the study sites were analysed using publicly available GIS and village-level data and satellite to obtain further information on the historical livelihood and land use trajectories (Appendix E). Secondary village-level data reveals few differences between the study villages at the baseline period (Appendix E.6). The sites show clear differences in land use trajectories since the introduction of oil palm to Kapuas Hulu in the 2000s (Figure E-3). Figure 5-5 shows an overview of the recent oil palm expansion in the selected sub-districts. The overwhelming majority of oil palm planted has been done by companies, with only very small areas planted by smallholders. On average, just under 40% of the oil palm expansion has come at the expense of forest lands, though this varies by village and sub-district (Figures E-1 and E-2).

Table 5.3: Essential village selection criteria

Criteria	Characteristics
All Villages	
Ethnicity	Indigenous Dayak Populations
Land Tenure	Historically Customary
Livelihoods	Historically Swidden-centric livelihoods, small-scale rubber agroforestry, NTFPs
Economic History	No large-scale logging or mining activities
Oil Palm Villages	
Plasma Participation	Community-wide Participation in Oil Palm Plasma Scheme
Harvesting	No villages in the temporary stage between initial planting and first harvest

Notes: At the historical baseline set (the year 2000), all of the candidate villages – both oil palm and non-oil palm – had to have (1) Populations comprised of mainly or entirely indigenous Dayak communities; (2) Forest-based agricultural and forest-based livelihoods; (3) Comparable access to market and infrastructure; (3) Livelihoods primarily based around swidden cultivation combined with rubber, hunting-fishing and the collection of the NTFPs. Villages were excluded if they had large-scale logging activities within the boundaries in recent history. Additionally, oil palm villages had to have given community-level consent to oil palm development, resulting in wide-spread enrollment in smallholder plasma oil palm schemes.

Figure 5-4: Sub-Districts Included in Study

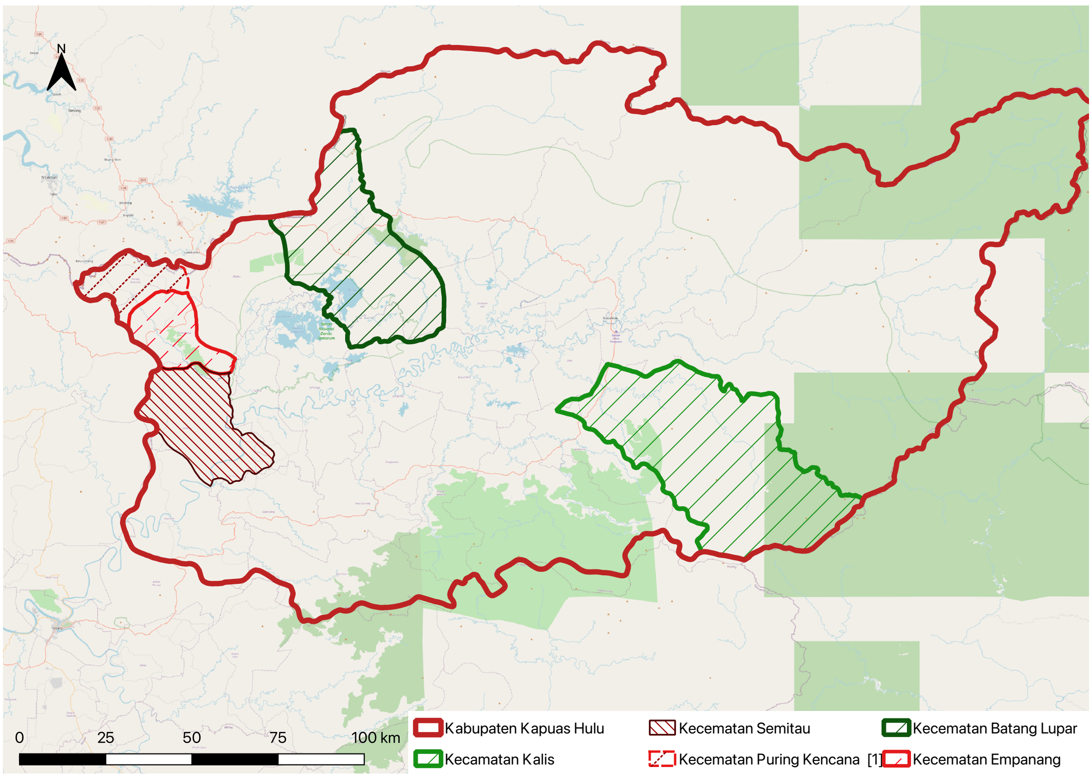
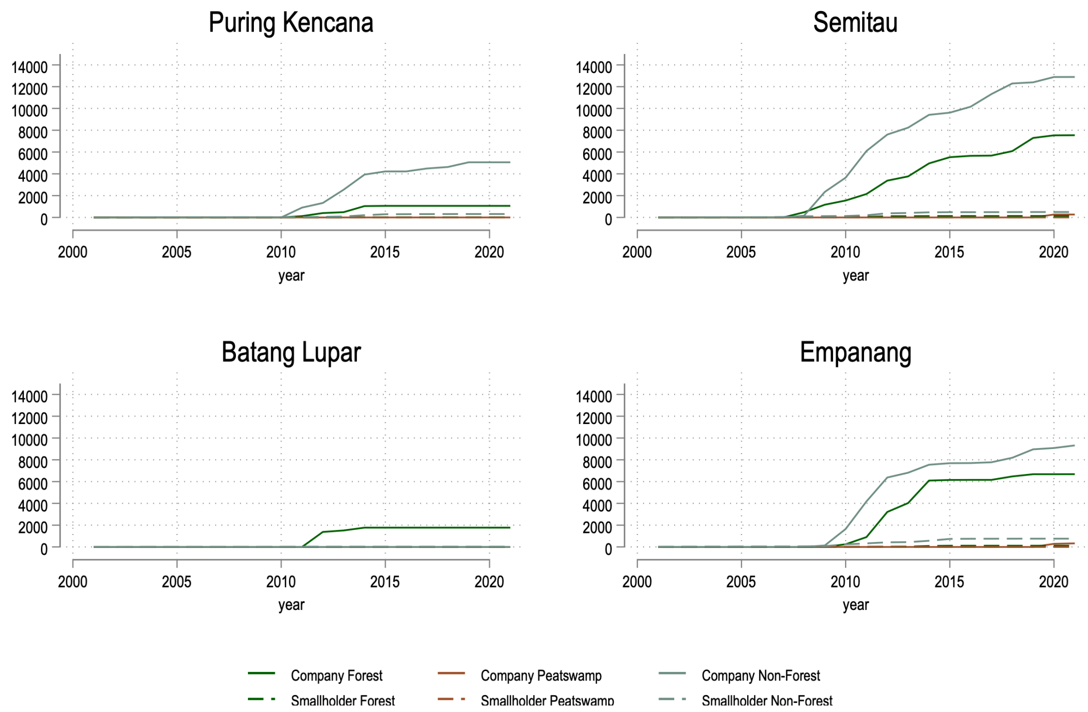


Figure 5-5: Cumulative Oil Palm Expansion by Sub-District



Data source: Nusantara Atlas (2023).

5.3.3 Selection of Study Participants

Study participants were a sub-set participants in the wider DFC study. The DFC study had randomly selected participants from village rosters provided by health authorities. While the DFC study was conducted exclusively with mothers with children between the ages of twelve months and five years, we also conducted surveys with their husbands. A small proportion of women were not available to survey, and a few more were excluded from the survey because they were pregnant[5]. I do not believe there is any systematic selection bias in respondent availability of female participants. However, men who worked in specific livelihoods – in particular, those engaged in circular migration – were systematically less likely to be available and thus less likely to be included in the sample (see Section 5.6). This is a clear source of potential selection bias for some outcomes, which should be considered when interpreting results.

5.3.4 Defining Household Membership

Questionnaire surveys were designed to collect data on all members of the household, including children, adolescents, young adults and elderly relatives or non-relatives. We used a slightly modified definition of the household taken from the Demographic Health Survey (DHS) which defines a household as "group of related or unrelated persons who live together in the same dwelling unit(s), who share the same housekeeping arrangements and who are considered a single unit" (Croft et al., 2018). This approach, considered standard within socio-economic surveys in both Indonesia and LMICs generally, has also received criticism for failing to account for the "complexity and fluidity of household arrangements" (Kreager and Schröder-Butterfill, 2008), resource use, units of production and consumption, rights and power dynamics.

Several authors have argued that widely used household definitions may lead to biased or misleading

[5]Which may affect food choice behaviours, as well as time and labour allocation and other livelihood activities.

results by, for example, not considering extended family structures, non-resident household members and multifamily households found in many Sub-Saharan Africa, Asian and Southeast Asian contexts (Randall et al., 2011; Beaman and Dillon, 2012; Randall and Coast, 2017). Use of this simplified definition may result in biased or inaccurate results in societies where the production and consumption of goods and resources are either fully or partially carried out collectively or in extended kin networks (Guyer and Peters, 1987; Kriel et al., 2014). Additionally, critics argue that the reductionist view of the household leads to assumptions of "household-level decision making" which glosses over intra-household gendered and generational power dynamics (Agarwal, 1997; Doss, 2013). The ways in which these issues relate specifically to Indonesian and Dayak societies are discussed in Box 5.2.

Despite these valid criticisms, and while recognising its drawbacks, we use this definition for the quantitative component of the research for several reasons. Firstly, as discussed in Box 5.2, while extended kin and mutual support networks are important in Dayak societies, the household is, in fact, a well-defined and understood unit within Dayak societies and map reasonably well onto this definition. For example, despite the existence of extra-household sharing, exchange and use of resources and labour, many Dayak households have clear boundaries in terms of household membership centred around participation in production activities and rights over the goods produced (Dove, 1985). Secondly, it is not clear what the alternative approach would be – at least for the quantitative survey component. While the qualitative investigation was not bounded by household definitions and was able to explore multiple facets of communal/reciprocal production, consumption and decision-making, some inclusion/exclusion criteria are necessary for the survey. Broader definitions are likely to not be applicable to all households, as each community has subtle differences in arrangements. Indeed, this is one of the reasons why more complex definitions of households also introduce substantial bias into quantitative analyses (Beaman and Dillon, 2012). Finally, the primary focus of this study is on food systems and food choice. As such, the focus is primarily on the activities and behaviours which affect the production, acquisition and consumption of food. While no doubt some food and income is generated by household members outside our definition of the household, the overwhelming majority of this food and income will come from household members included in this definition. While acknowledging the potential complexities and limitations of this definition, I therefore believe that it is an appropriate and necessary simplification for the research questions in this study. Further reflections on the definition and potential limitations and caveats to the study findings are discussed in the Discussion Chapter (Section 10.3).

Box 5.2: Household Definitions: Complexity and Criticism

Extra-Household Production and Consumption in Indonesia

Mutual aid and reciprocal labour exchange is a common feature of many agricultural livelihoods in Indonesia. Many different ethnic and social groups have different familial and customary traditions relating to collective management, participation and governance of production and consumption (Hüsken and Koning, 2006). Such collective mutual assistance customs (known as *gotong royong*) have become an important part of Indonesian self-identity as well as ethnic identity. Bowen (1986) argues that while they correspond to "genuinely indigenous notions of moral obligation and generalized reciprocity", this diverse range of distinct local customary traditions have been "reworked by the state", merged and submerged to inculcate a unified national identity as well as used as "as a cultural-ideological instrument for the mobilization of village labour".

Household Structures and Extra-Household Support in Indonesia

While nuclear/bilateral household structure is arguably not the dominant arrangement in much of Asia (Randall et al., 2011; Randall and Coast, 2017), Kreager and Schröder-Butterfill (2008) argue that it is, in fact, the prevailing norm for most Indonesians (especially in Java where the majority of the population lives). Additionally, the authors argue that such ties are becoming more widespread due to various social, demographic, and economic factors. However, they also note the great diversity of social family norms and support arrangements which extend beyond this household definition. Different communities have different patterns of "support flows" between family members, generations, extended kin and community and ethnic relations, and many different models may co-exist within communities.

Such support flows may include the provision of time and labour to support a household's productive and reproductive activities (such as helping with farm activities or assisting with childcare). Another common form of support are remittances from family members who are economic migrants – either temporary/-circular (e.g. in oil palm) or settled (e.g. factory labour) (Elmhirst, 2002). Such individuals would be missed by existing definitions of household membership as they do not reside in the same dwelling but are often essential parts of household budgets and strategies (indeed decisions to send workers to pursue such activities may be made by other household members for the benefit of the wider household). Additionally, such relationships are not always immediately apparent, as remittances fluctuate depending on economic circumstances and serve as a safety-net for smoothing income during periods of crisis (Frankenberg et al., 2003; Elmhirst, 2002).

Household Structures in Dayak Communities

Dayak household structures are somewhat heterogeneous between groups and regions. The issue is complicated by the historical transition from customary living arrangements (i.e. multi-family longhouses) and labour regimes, and accelerated ongoing swidden transitions and government development programs which give primacy to male decision-making as the household head (Colfer, 2008b). In some respects there appear to be clear divisions between household and community – exemplified by the "inner" private space and "outer" communal spaces of traditional longhouses (Helliwell, 1993; Sather, 1993). However, as Helliwell (1993) argues, this "fixed-dichotomy" overlooks the "complex and shifting balance achieved between household rights and community rights". While it is clear that "household units" are clearly defined within many Dayak societies, it is also clear that many roles, responsibilities, rights and resources are shared between extended kin networks with complex and shifting inter-generational and multi-family support structures.

An excellent account of the boundaries of the household unit and its interaction with broader kin and community networks is provided by Dove (1985) in the context of Kantu Dayaks in West Kalimantan, where longhouses were divided into quarters between families. The account details four key characteristics of the household – they are a unit of production, a unit of consumption, a ritual unit and a unit of land appropriation. Of these, the first, production, is considered the most important with the majority of swidden agricultural activities carried out as household units (except for planting and carrying which are carried out with extra-household labour with reciprocal labour-exchange). The second, consumption, defines the boundary of the household, as all goods and resources "must be shared and consumed within the household with absolute equality regardless of which members of the household were directly responsible for producing them". Indeed, Dove notes that even when multiple households share the same living and cooking quarters, rice is still cooked and consumed separately. The third characteristic, ritual, relates to the ways in which customary and spiritual mandates, prohibitions, sanctions and ceremonies apply only to members of an individual's household and not other members of the shared living quarters. Finally, swiddens opened from forest land are the sole property of the household and forfeited by older siblings upon marriage to other households, or divided between different households upon death in a manner proportional to their investment of labour into the land. The latter, however, is not universal for all Dayak societies, with different groups and sub-groups exhibiting complex and changing patterns of inheritance (Eghenter, 1999; Peluso, 2005a). Additionally, such rules only apply to in-use swiddens with a diverse set of complex customary rules applying to former swiddens and other types of land (Cramb, 2007).

Figure 5-6: Fieldwork Stages

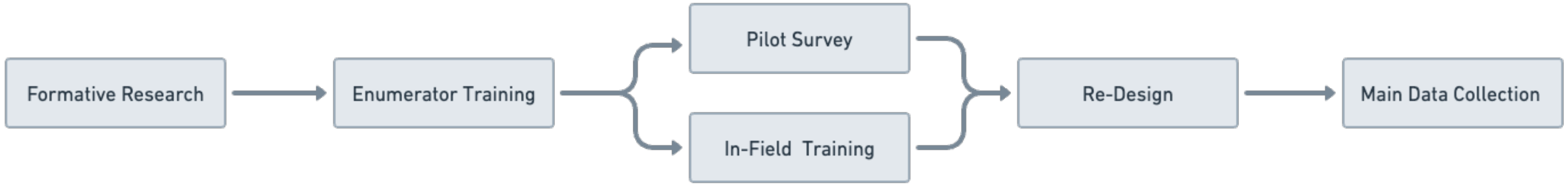
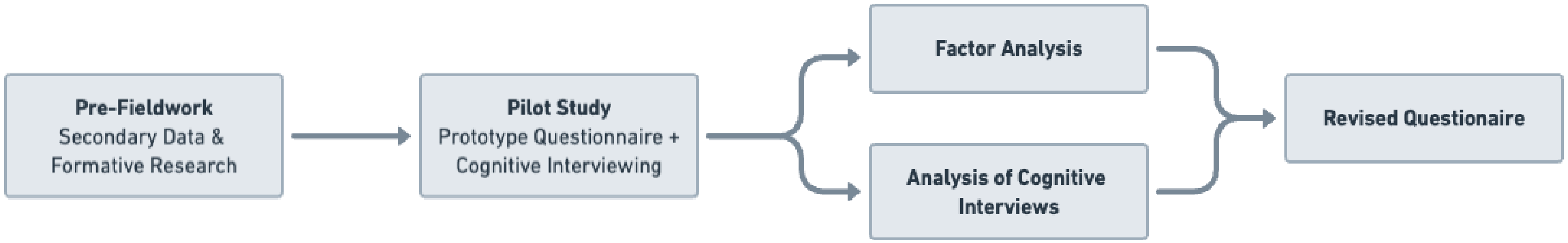


Figure 5-7: Questionnaire Design Process



5.4 Data Collection

Primary fieldwork was conducted over eight months in 2018, led by the author in collaboration with a locally recruited field assistant and a team of four local enumerators who underwent extensive pre-field and in-field training (see Appendix for details). Most of the team members were Dayaks, although two were Malay[6]. An overview of the fieldwork process is shown in Figure 5-6. The main stages of the fieldwork were: (1) Formative research and enumerator training; (2) Pilot survey and testing; (3) Redesign of survey and approach and; (4) Main data collection period.

5.4.1 Design and Piloting of Methods

Prior to the main survey, a rapid one-month pilot survey and in-field enumerator training was conducted (Figure 5-6). Initially, I had hoped that one of the outcomes of the project would be the development of several validated scales for rapid evaluation of certain constructs of food choice and time allocation[7]. However, this was later abandoned when I realised that it was over-ambitious, and it was likely to detract focus from main research objectives. However, as a result, the pilot survey was more extensive and rigorous than was perhaps necessary and involved a multi-stage process of validity and reliability testing. The full procedure is discussed in Appendix E.13, but a simplified version is shown in Figure 5-7.

The process began with formative research and familiarisation with the study context using secondary data provided by the DFC study[8]. Construct validity (does the method theoretically test the intended construct?) was assessed through expert consultation, and face validity (does the method make sense in the context?) was assessed through discussions with boundary partners and within research team training sessions. The pilot study was designed to test and validate methods as well as to conduct cognitive interviewing to improve question phrasing and approaches. To prevent bias and respondent fatigue, the pilot study was conducted in a different village from those in the main survey and was selected based on convenience (i.e. proximity from Putussibau plus knowledge and connections in the village by team members).

[6]The term Malay (*Melayu*) refers to indigenous residents, formally Dayak, who have subsequently converted to Islam. This is the most commonly understood definition of Malay in Kalimantan. Definitions in other parts of Indonesia vary. A more detailed explanation of the Malay and Dayak ethnicities is provided in Section 6.2

[7]I initially set out to create a set of new scales which could be used to measure certain aspects of the respondent's lives. These aspects (e.g. time pressure) are latent constructs – i.e. unobservable characteristics whose presence is inferred by other observable characteristics. Developing scales for measuring latent constructs is a widely used process in disciplines such as psychology, where the characteristic of interest to the researcher cannot be measured directly. The design of these instruments followed standard scale-development protocols (e.g. DeVilles, 2011) and consisted of three phases: (1) Face value validity testing; (2) Cognitive interviewing and data collection; (3) Statistical and qualitative evaluation of pilot data; (4) Item reduction and redesign of survey instruments. Further details are available in Appendix E.13.

[8]By the time I received my research permit, researchers from the DFC study had already conducted research in all the study villages, and I had access to preliminary findings. Additionally, I had already read transcripts of FGDs and interviews carried out by CIFOR researchers during the study-village selection process. I was also already familiar with the broader context of Kapuas Hulu, having participated in several CIFOR research projects located in the area during 2014-2015, including co-authoring a taxonomy of land use change dynamics (Leonald and Rowland, 2016). During this period, I spent considerable time scoping potential study sites for another CIFOR project, which required travelling extensively with my research partner by motorcycle across much of the District. I was also familiar with Kalimantan more broadly, having worked and conducted research in Central Kalimantan intermittently since 2008.

Certain aspects of the research were prioritised for piloting. Firstly, FGDs were carried out which sought data required to inform the survey design – for instance, local terms and definitions (including the different meanings of words describing types of land use, forest, wild habitats, and fallow lands, as well as the various meanings of units of products) as well as locally used categories and classifications (including wild foods, agricultural production systems and land ownership and tenure). Secondly, the pilot phase was used to create and test parts of the survey where no existing validated methods were available – in particular, questions relating to food choice and time allocation.

5.4.2 Fieldwork Process

Having a small team, large sample size, and significant geographical distances to travel meant that the fieldwork process would take many months. The questionnaire surveys alone would take months, but factoring qualitative studies in case-study villages (and the time taken to socialise and integrate into these communities beforehand) meant my fieldwork would inevitably span several seasons and crucially – different parts of the swidden seasonal calendar. The issue is compounded by the fact that OP and FOR villages are geographically clustered – thus using the most efficient sequence of villages (in terms of travel) would mean that OP and FOR villages would be sampled in different seasons. The two obvious solutions to this problem were splitting into two teams or randomising villages. However, the former was not desirable as I would not be present for data collection in some villages, and the latter would have been logistically impractical and required an excessive amount of time spent travelling between villages.

Ideally, households would be surveyed and resurveyed at multiple points throughout a year. However, doing so is highly expensive and logistically complex. Given this, an alternative approach suggested by the Inter-Agency and Expert Group on Food Security, Agricultural and Rural Statistics (IAEG) is to randomise village clusters in such a way that the time during which a survey is conducted in a particular village does not overly bias the outcomes of interest (IAEG-AG, 2018; Bell et al., 2019). This is (more or less) the approach I took[9] in that I alternated between OP and FOR villages (albeit in a non-randomised fashion[10]).

Primary field research took place over eight months between February and September 2018

We alternated (as much as logistically possible) between oil palm and non-oil palm villages so that for every month that surveys were conducted, there were both oil palm and non-oil palm villages included – this meant that surveys would be conducted at different locations during different seasons and stages of the farming cycle[11]. During field research, I spent the majority of my time conducting qualitative research in the form of in-depth interviews alongside my research assistant, while the team of enumerators

[9] The recommendations cited above had not been published at the time that I conducted fieldwork
[10] a compromise based upon logistical constraints
[11] With a small team, but a large sample of villages and respondents, This approach at least ensured that oil palm and non-oil palm-adopting villages were not surveyed during different parts of the agricultural calendar and that there was sufficient heterogeneity to control for seasonal effects in regression analyses. Reflections on the implications of this approach are provided in Section 10.2

Table 5.4: Research Questions and Methods

Variable	**RQ1 (Time Use)**	**RQ2 (Food Systems)**	**RQ3 (Food Choice)**
Women's Survey	✓	✓	✓
Farm Survey	✓		
Men's Survey	✓	✓	
Village Survey		✓	
Participatory Cooks*		✓	✓
Participatory Walks		✓	✓
Photovoice*		✓	✓
Free-Listing		✓	✓
Pile Sorting		✓	✓
Participatory Mapping		✓	
Ranking (Individual)			✓
Ranking (Group)			✓
Market Inventory		✓	
Qual.KI & FGD	✓	✓	✓

Notes: *Participatory cooks were not particularly effective. A decision was made part-way through the research to replace this with photovoice which elicited much better responses. **Research Questions: (RQ1)** How does oil palm adoption by smallholder swidden farmers affect the intra-household allocation of time?; **(RQ2)** What effects does community-wide adoption of oil palm have on local food systems?; **(RQ3)** How do changes in food systems and time use impact food choice decisions?

conducted the questionnaire surveys (overseen by myself and my research assistant). Focus groups were led by myself and my research assistant with input from all team members – especially when groups broke out into subgroups for participatory exercises.

Table 5.5: Source of Surveys Data

	Measure/Units	Disaggregated By	Recall	DFC	Men's	Women's
Farm Characteristics						
Land Ownership	ha	Type of Ownership	Current	(✓)	✓	✓
Field Types and Farm System:						
Distance	Mins	Field			✓	
Production Methods (e.g. inputs)	Value	Field			✓	
Cultivated Crops	Counts, Value	Species, Field, Use	12 months	(✓)	✓	
Agrobiodiversity	Counts, Value	Species, Field, Use	12 months		✓	
Own-Consumption/Sale	Quantity, Value	Species, Field, Use	12 months		✓	
Livestock	Countes, Value	Species, Field, Use	Current		✓	
Time and Labour Allocation						
Time Allocation	15-minute blocks	Primary & Secondary Activities	24-hours		✓	✓
Time Scarcity	Likert	-				✓
Off-Farm Labour	Person-Hours	Household Member, Activity	30-days		✓	✓
On-Farm Labour	Person-Hours	Household member, Field, livestock	3-months, 12 months		✓	✓
Hired Labour	Person-Hours	Field, Livestock			✓	
Activity Spaces	Ocassions,Days	Location, Food-Group	7-days, 30-days		✓	
Food Choice						
Food Choice and Time Scarcity	Likert, Time	-	7-days, 30-days			✓
Food Choice and Preferences	Likert	Food Group, Food Source	-			✓
Food Choice and Affordability	Likert, Value	-	30-days			✓
Household Characteristics						
Wealth	Assets	-	Current	✓		
Age	-	Household Member	Current		✓	
Education	-	Household Member	Current		✓	
Ethnicity	-	Household Member	Current		✓	
Employment Status, Business	Value	Household Member, Activity	30-days		✓	
Wild and Environmental Resource Use					**x**	
Inedible NTFPs	kg, Value	Location, Species	30-days			
Wild edible foods:						
Hunting	kg, Value	Location, Species, Opportunism	30-days		(✓)	✓
Fishing	kg, Value	Location, Species, Opportunism	30-days		(✓)	✓
WEPs	kg, Value	Location, Species, Opportunism	24-hr, 7-days, 30-days	✓	✓	

Notes: (✓) Indicates that some data is collected but the main source of this data are the other surveys

5.4.3 Questionnaire Surveys

Table 5.4 summarises the different research methods and their contributions towards each of the research questions. The table also shows the secondary data used from the DFC study survey – some of which was used to simply triangulate or cross-check my data, but some components (e.g. wealth assets) were used from this source so as to reduce the length of my survey and mitigate against respondent fatigue[!]. Further details of the methods and data used in each chapter are provided in the relevant sections. Here, I outline the main survey instruments and approaches taken, as well as describe some of the challenges and trade-offs encountered and the rationale behind certain decisions made.

The primary survey instruments were the men's survey and the women's survey. Each of these contained an identical time-allocation survey module (described in Chapter 7) and food acquisition behaviour recall (though slightly differing versions). While both surveys covered similar topics including participation in on-farm activities and off-farm labour, use and acquisition of environmental resources, the surveys had different emphases. The women's survey had an emphasis on food choice and contained questions relating to time scarcity, food preferences, food budgets and decision-making[12]. The men's survey was more focused on household-level data (although also contained individual environmental resource acquisition questions focused on hunting and fishing). There were two reasons for focusing on household-level data in men's survey. Firstly, it substantially reduced the time needed for the women's survey – allowing a greater focus on time allocation and food choice and reducing respondent fatigue. Secondly, many of the household questions focused on land ownership and agricultural practices – of which women were familiar but which men were more enthusiastic about answering. In addition to the men's and women's survey, a rapid questionnaire survey was administered to village representatives or other key informants in each village. This survey contained basic characteristics about the village including village facilities, any active or recent NGO or government development activities, and the accessibility of the village from other villages, towns and markets. Additionally, the respondents were asked to list the places (and mobile vendors) from which certain foods could be obtained. This latter data was triangulated with the same information collected from multiple other sources.

Challenges and Limitations of Income Data

I initially set out to measure household incomes in all forms including cash income from employment and casual labour, household business activities, sale of agricultural and forest products as well as "environmental income" in the form of the use of non-cultivated resources consumed (e.g. food, fuel). Measuring cash income was done primarily through the household survey administered to men which covered income generated from all household activities by all household members within the preceding three months. For each member of the household roster, all sources of waged agricultural labour (both oil palm and non-oil palm), and non-agricultural employment income (e.g. teachers, local government positions, company

[12] Additionally, a participatory food preference ranking exercise was initially included but dropped after it became clear that there was minimal variation in the results between respondents and that focus groups could obtain the same data more efficiently.

jobs in offices) were estimated as well as income from secondary and casual employment. Additionally, household enterprises such as small business activities (e.g. handicrafts, shops etc.) and the sale of agricultural products were estimated. Recognising that standard socio-economic surveys have been shown to neglect many dimensions of environmental resource use (Vedeld et al., 2007; Angelsen et al., 2014), and that conventional farm surveys under-estimate the contributions of wild and semi-cultivated foods and crops (Scoones et al., 1992; Powell et al., 2015), I also obtained data on all environmental resources collected (for own consumption or sale) during the three-month recall period based upon a modified survey approach from previous CIFOR studies methods[ll].

The approach outlined above allowed exhaustive household data on all activities and sources of income and food, including from typically overlooked casual and informal parts of the economy, as well as from wild and semi-cultivated environments. While essential for the analyses within this thesis, I decided not to use the data to calculate estimates of total household income. There are several reasons for this decision. Firstly, for the purposes of statistical analysis, including the regression models in Chapter 7, it is preferable to use measures of wealth rather than measures of income (Bollen et al., 2002; Sahn and Stifel, 2003). Wealth indices constructed through principal component analysis of asset ownership have been shown to be more reliable indicators of household financial status than measures of household income, as they reflect the long-term economic status of a household (Filmer and Pritchett, 2001; Vyas and Kumaranayake, 2006). They are also less prone to reporting bias and more likely to capture informal and casual economic activities, while also avoiding the need to distinguish between the often-blurred definitions of income and investment in household enterprises.

Secondly, complex household structures (see 5.3.4) make estimating the total levels of household more challenging. This is particularly the case for non-resident household members (e.g. those involved in circular migration for oil palm work) for environmental income provided by extended family and kinship networks. The latter is borne out by the data which reveals a significant role of "gift-giving" for agricultural, wild and semi-cultivated foods. Thirdly, calculating environmental income is complicated by the fact that a significant proportion of wild and forest resources are not traded locally. As such, it is necessary to calculate the "shadow price" from crude approximations of farm-gate prices, retail prices, or opportunity costs of time[13] (Cavendish, 2000; Angelsen et al., 2014; Wunder et al., 2014a). Fourthly, recall periods were selected to maximise the accuracy of data (see below). For many sources of environmental income – especially those pursued sporadically, opportunistically, or whose probability of success is highly variable[14] – longer recall periods are highly inaccurate and introduce systematic under-reporting

[13] In the absence of price data, estimates must be made using approximations such as equivalent market prices (the price of similar goods sold in local markets), equivalent farm-gate prices (farm gate prices for equivalent products or equivalent market prices minus transaction costs), or replacement costs (how much an alternative would cost) (Cavendish, 2000; Angelsen et al., 2014; Wunder et al., 2014a). Such prices and costs are often challenging to obtain, fluctuate over time, and vary dramatically from village to village. Furthermore, prices do not necessarily reflect the value to the household themselves or their willingness to pay for them. For many households in this sample, the cost of wild or semi-cultivated foods is probably best valued as the opportunity cost of time spent collecting it – but this results in different prices for different households and assumes that time spent collecting wild resources is easily substitutable with time spent in cash-generating activities as well as the calculation of a "shadow wage" from a suite of different income and employment opportunities – engagement with which often fluctuates seasonally.

[14] An extreme example of this is *Gaharu* (Agarwood) seeking, which is a high-risk, high-reward pursuit often involving forest expeditions lasting multiple weeks. The dark resin found inside Gaharu trees infected with a particular fungus is highly valued, with higher grades used as a component of perfumes (sometimes known as oud), while lower grades are used for incense and carving. Successful expeditions can yield income on a scale that vastly exceeds any other potential source

bias. Given the extent to which households shift between different formal, informal, and environmental income-generating activities (both seasonally and in response to current household needs), producing accurate yearly estimates of income would require repeated waves throughout the year – preferably quarterly or monthly (Angelsen et al., 2012; Jagger et al., 2012). As such, income estimates produced from my data would likely not accurately reflect the long-term economic health of households and would lead to a misleading level of confidence in what would most likely be crude estimates containing systematic bias.

A Note on Recall Periods

Throughout the design of primary survey questionnaires, it was necessary to decide upon recall periods. Recall-based surveys introduce a number of potential biases such as “telescoping”, “heaping” and “recall decay” (Beegle et al., 2012)[111]. In general, shorter recall periods are considered more accurate than ones. However, information is also lost with shorter recall periods – particularly when weekly, monthly or seasonal variation is high and sample sizes are so large that a survey takes a long time to conduct (Bell et al., 2019). A lengthier discussion of this problem and recommendations from experts to mitigate these issues are provided in Appendix E.14.

Studies have shown that the optimum recall period depends on the nature of the event, and that combining different recall periods within one survey can be the best way to minimise trade-offs (Huttenlocher et al., 1990). For the environmental resource use data – based upon the general principle that rarer and more memorable events are less likely to be under-reported than routine events – I used recall periods ranging from 7-days to 12-months. At the shorter end of the range were easily forgettable events such as the opportunistic collection of wild plants while carrying out other activities. At the other end of the range were events such as hunting expeditions, which were less likely to be overlooked by respondents. The shortest recall period (24-hours), was used for collecting time allocation data. While it would be ideal to obtain labour-time allocation data covering a longer period to allow analysis of changes over seasons, longer recall periods have been shown to systematically under-report some types of labour more than others (e.g. domestic and care duties)(Juster and Stafford, 1991; Juster et al., 2003; Te Braak et al., 2023). As my focus was on estimating labour time spent in all activities, with a specific interest in gendered time allocation, I chose to adopt the gold-standard 24-hour recall approach.

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of income. In rare cases (but one I have witnessed) a single successful expedition can provide sufficient income equivalent to several years' worth of regular household expenditure. Such extreme rewards are rare, but not unheard of, though decreasing in probability as gaharu becomes over-exploited and more difficult to find. Typically, income from gaharu is much lower, but it is still not uncommon for a single expedition to produce income equivalent to several weeks' or months' worth of household expenditure. However, nor is it uncommon for expeditions to yield little to no success, even occasionally pushing households into debt to repay those who provided the capital to fund the expedition.

5.4.4 Qualitative and Participatory Research

Focus Groups, Free-Listing, Pile-Sorting and Ranking

General focus groups were carried out with women in each of the study villages. Focus groups consisted of between 10–12 individuals and covered a broad spectrum of different ages and primary livelihoods. Additional mixed-gender and male-only focus groups were carried out in the 10 case-study villages, split evenly between the forest and oil palm villages. Focus group discussion covered a wide range of topics, including agricultural practices, forest use, land use and land use change, time allocation, and household decision-making. Each focus group also featured discussions around time allocation and strategies employed to increase time efficiency and coping strategies to manage time pressure. Focus groups with women had an emphasis on time allocation and labour, including many aspects of reproductive labour such as food acquisition, cooking, childcare and other domestic activities. In addition, we also obtained seasonal calendars of livelihood activities and perceived availability of foods.

Focus group discussions included multiple free-listing exercises of foods, food sources and land use types. Free-listing in ethnobotany is a technique in which the respondent is asked to name as many items in a given category as they can (often within a time limit) and is a type of inventory method (Vogl et al., 2004). Free-listing began with local sources of foods (including market, agricultural and wild foods), which were then used as the basis of free-listing exercises to identify foods available from these sources. Information on each food was obtained, including market prices, farm-gate prices, acquisition practices and behaviours, and gender-roles in collecting. This approach was also to analyse participants knowledge and awareness of type of: wild edible products such as WEP, bushmeat, traditional medicines using wild plants and animals and cultural/ceremonial uses of edible products; sources of information on health and nutrition, exposure to food advertising and marketing, access to health care; and types of convenience foods.

Free-listing exercises were followed by pile-sorting and ranking exercises. Locally identified food sources were written on cards and classified by respondents by pile sorting. Respondents were asked to sort the cards into groups based upon local categories as well as according to various characteristics and properties relating to food choice (including frequency of visitation, distance or difficulty of acquiring). More general qualitative perspectives were also sought at this point on how both women and men perceived and utilised these sources. Each category was then listed on cards, and women arranged cards in rank order from most to least important according to numerous criteria. Photographs of the rankings were taken, with the data later transformed into quantitative estimates. A similar process was carried out for women's food choice priorities.

Qualitative Interviews

We conducted semi-structured interviews with 42 men and 39 women, which consisted of a mix of Key-Informant Interviews (KIIs) and In-depth Interviews (IDIs)[IV]. IDIs with women were split between general interviews focusing on women's livelihoods and time allocation and more detailed interviews focusing on reproductive labour. Preliminary research in both sets of villages indicated that women were the primary agents of food choice decisions but that men (especially in the FOR villages) also engaged in food acquisition, which affected household food consumption. Thus, while the primary focus of the investigation was on women's food choice decisions, men were also interviewed about food acquisition events and motivations for them, as well as included in mixed focus group discussions around food choice and food acquisition. Additionally, IDIs with men, which were conducted on a range of topics relating to agricultural practices and wild resource use, also included a focus on food choice and food acquisition decisions.

Other Methods

In addition to the activities described above, we carried out a number of other participatory techniques – not all of which proved useful in generating good data. One such method was participatory cooking, which I believed would be a good entry point into understanding women's choices and priorities in food choice decisions. However, data from this method were not particularly useful – often because women were focused on cooking, making it a far-from ideal context to elicit reflective and expansive answers. I therefore, quickly decided to abandon this approach, as it was both time-consuming for us and often inconvenient for the respondent. I later trialled using photovoice using photos taken of food sources, field types and wild locations taken during the research – this was a highly effective technique and elicited detailed and reflective responses and would be among my first choices of methods if carrying out similar research in future. Several other recent food-choice investigations have found it similarly effective (Spires et al., 2020; Turner et al., 2022; Wanjohi et al., 2022).

We also used a rapid version of participatory mapping (Braslow et al., 2016). While detailed participatory mapping is best suited to FGDs, due to logistical and time constraints, full-scale participatory was not carried out. However, we conducted rapid participatory maps with small groups of 2-3 key informants in each village to quickly identify the main types and locations of foods and food sources, which informed the rest of our investigation. Participatory mapping has a long history in social and environmental research in biodiverse landscapes, including Kapuas Hulu and has been used both a research tool and an advocacy tool (Peluso, 1995; Radjawali and Pye, 2015). More recently, it has become used as a way of identifying and quantifying the perceived flow of ecosystem services within landscapes in Kapuas Hulu (Mathys et al., 2023; Sutherland et al., 2023; Ahammad et al., 2024). Mapping was a quick and effective approach of generating a useful visualisation of the food environment, which could be used to form the basis of subsequent research. However, it was always considered an additional data source to supplement others in subsequent triangulation, not a data-source in its own right.

A final source of data used for triangulation were village walks, which were conducted during the research opportunistically. Key-informants were encouraged to participate in village walks following key-informant interviews. While these yielded good data about food sources in the village surroundings, many food sources were located some distance from the village. In these cases, participant observation would have been a better approach but was logistically incompatible with this study. However, we did also conduct farm walks opportunistically with women as part of the validation of the time use instrument in the forest sites and were replicated in the oil palm villages.

5.5 Data Analysis

5.5.1 Indicators and Metrics

Most studies of oil palm, diets and food systems rely on indicators of dietary quality or food availability from markets or agriculture, which calculate diversity scores by summing foods across food groups. The use (and some argue misuse) of these measures is a topic of some debate – especially when adapted or used for invalidated purposes. Critics argue that, while at the population level, they are reasonable indicators, at the individual level, their correlation with final nutritional outcomes is weak (Ruel et al., 2018). Another issue is that both the direction and magnitude of effects may vary depending on the choice of metric (e.g. Islam et al., 2018). The widespread use of household food security metrics as proxies of individual dietary adequacy has been objected to by some nutrition-focused researchers (e.g. Verger et al., 2017; Nurhasan et al., 2020a); for example, Household Dietary Diversity Score (HDDS) created from household level 7-day recall data and the share of food expenditure (as a percentage of total expenditure) – both of which are widely accepted measures of food security, but which have not been validated to measure dietary quality. To a certain extent, this debate is rooted in different disciplinary traditions and interpretations. Within nutrition communities, there is a strong belief that "not all dietary diversity scores can legitimately be interpreted as proxies of diet quality" (Verger et al., 2017). In contrast, economists have tended to adopt a more pragmatic approach – arguing that no metrics are perfect and citing correlations between household and individual measures of dietary diversity (Fongar et al., 2019; Sibhatu, 2020) (see Chapter 3, Section 3.1.4). However, different food groups respond differently to agricultural and landscape change (Nandi and Nedumaran, 2022). By relying on such indicators, researchers overlook the effects oil palm development may have on the consumption of unhealthy food groups and the potential implications of dietary changes on diseases of over-nutrition[15] – arguably a greater risk to health than undernutrition in many middle-income contexts (Murray, 2020). In this thesis, I use these indicators for their intended purpose – to be population-level indicators of outcomes such as general market food availability or production diversity. I do not use them as individual outcomes for which they are not validated. In some cases, where no existing validated methods exist, I have adapted methods or used existing methods differently. In such cases, I explicitly describe my reasoning and include multiple measures to test the robustness of the findings.

[15] As discussed in Chapter 3 (Section 3.1.4), this is especially frustrating given that many of the data sets analysed contain data on all food expenditure and calculating these impacts would be relatively straightforward.

5.5.2 Analysis of Quantitative Data

The analysis of quantitative data varies by research question and is discussed in the relevant sections of each chapter. The time allocation data was analysed using fractional-multinomial logit regression using an approach developed by Mullahy (2015) and used by Picchioni et al. (2020) in the context of time-use studies, to model the shares of time spent in different activities (see 7.3.2). The model was estimated in Stata with the package FMLOGIT (Buis, 2008). The estimations control for autocorrelation among the outcome variables, heteroscedasticity, and non-linearities. Standard errors throughout are clustered at the household level. I also used regression analysis of time allocation data to provide quantitative estimates of activity spaces – i.e. time spent in different locations, but this method suffered from weaknesses in the underlying data (discussed in Chapter 9, Section 9.2.1). Therefore, I employ this analysis solely for supplementary confirmation when triangulating data on activity spaces – along with the 7-day and 30-day recall data, and qualitative information (see Appendix H.1)

Throughout the thesis, I frequently use classical tests of hypotheses, such as independent two-sample t-tests for comparisons of means and z-tests of proportions to compare between sites or sexes. Where appropriate, I employ the Welch's t-test variant (Welch, 1947) in instances where data violated of the assumption of equal variances. It is important to adjust for the Family Wise Error Rate (FWER) when conducting multiple comparisons. I therefore use the Bonferroni correction when simultaneously multiple variable. This is likely overly conservative in places, resulting in type-II errors (false non-significant results) (Dunn, 1961). However, I use this approach because (a) it is the most widely used correction in this sort of literature and (b) by minimising false discoveries, I ensure that my research presents a conservative analysis and do not over-state findings. For a comparison of this method with alternative methods using a worked example from my data, see Appendix E.16.

5.5.3 Analysis of Qualitative Data

Transcripts of interviews and focus group discussions were translated from Indonesian to English, and a subset were back-translated to Indonesian to validate the translation process. Coding of qualitative data was carried out in NVivo 12. This thesis uses qualitative data in three main ways:

1. To depict specific contextual factors, activities, processes, etc., in a manner that illustrates and enriches the description of the characteristics of a particular site or procedure.

2. As part of a *triangulation* approach to mixed-methods research – i.e. to compare and contrast with findings from the quantitative data

3. In an interpretive way using reflexive TA to identify themes within respondent interviews and focus groups.

The first of these is straightforward; throughout the subsequent chapters, quotes will be presented, where qualitative data can help present a clearer understanding to the reader of what is being discussed. This is intended to present the reader with a description of the context and subject matter in the words of the respondents themselves. I have also tried to ensure that women's voices are presented as much as possible. The second use of qualitative data – mixed-method triangulation – has already been discussed in Section 5.2.2. Here the aim is to use the qualitative data alongside the quantitative data to find areas of agreement, disagreement and expansion to produce an integrated mixed-methods interpretation of a particular topic or research question. The third way in which qualitative data is used – reflexive TA – differs from the other two in that it is inherently exploratory and narrative driven.

Reflexive TA differs from the other two uses of qualitative data because it is inherently "story-telling" and tends to use longer descriptions. Braun and Clarke (2021) define Thematic Analysis (TA):

> The purpose of TA is to develop patterns of meaning ('themes') across a dataset that address a research question. Patterns are generated by the researcher through a rigorous process of data familiarisation, data coding, and theme development and revision. The method can be and is applied in lots of different ways, to lots of different datasets, to address lots of different research questions, and within a range of theoretical frameworks... TA is not a singular method – TA is best thought of as an umbrella term for a set or family of approaches for analysing qualitative data that share a focus on developing themes (patterns of meaning) from qualitative data.

Braun and Clarke emphases the difference between "semantic" and "latent" themes – the former being focused on "surface meanings", the later interpretive (Braun and Clarke, 2006). The latter should also not be confused with "domain summaries" or "topic summaries" (also known as "bucket themes")[16]. The two types of themes (semantic and latent) are not however mutually exclusive – both can be coded in the data simultaneously (and even double-coded) and used for separate purposes so long as neither are prioritised over the other (Byrne, 2022).

The form of TA I used was an abductive approach (Lipscomb, 2012; Thompson, 2022) to reflexive thematic analysis (Braun and Clarke, 2012, 2021). Development of themes followed a multi-phase process as described by (Nowell et al., 2017). An abductive approach was chosen as it integrates both inductive and deductive reasoning. Thus, it allows the researcher to embed the study in the specific data while simultaneously critically examining, refining and expanding on existing theory. The abductive approach enabled thematic analysis to be situated within existing theories of food choice, food systems, and food environments while also keeping the analysis open to uncovering novel dimensions and aspects of food choice. This is particularly important given the nascent state of food choice and food environments research, particularly in biodiverse rural contexts in LMICs(Sparling et al., 2021; Toure et al., 2021).

[16] e.g. "Description of field type and crops grown" or "Reasons for visiting particular food source".

Table 5.6: Sources of Potential Bias and Steps Taken to Mitigate Them

Bias Type	Description	Risk	Example of Possible Bias	Steps to mitigate
Selection	Introducing bias through choice of respondents	Low	Key informants are often of higher social status	Stratified random sampling
Question Order	Influencing later answers due to line of questioning	Medium	Asking about government/company followed by customary land rights	Contentious questions left until end of survey/questionnaire/FGD
Gender	Women answering differently to male interviewees	Very high	Awkward topics such as childbirth, menstruation	Female research assistant recruited
Cultural	Ethnocentrism of research	High	Over-emphasising wild foods because of pre-conceived notion of importance	Research assistant from local area, reflexivity, base upon DFC data
Acquiescence	Tendency of respondent to agree with interviewer	Low	If interviewer declares interest in forest foods, respondent overemphasises importance	Clear explanation of role of researcher, starting research after socialisation period
Recall	Some events more memorable than others, declines with increasing time between event and recall	High	Memorable events such as agricultural work more likely to be remembered than less memorable work such as child care	Short recall periods (24-hours, 7 days) with maximum recall period 1 month. Prompting and structured recall.
Social Desirability	Respondent answers questions in a way as to please the respondent	Very high	Respondent assumes that foreigner has a hidden agenda – potentially from an anti-palm oil NGO and/or aligned with companies/village elites	Socialisation period and village meeting, reconfirmation of neutrality of researcher at start of survey/interview/FGD
Interviewer bias	Respondents reply different to different interviewers	Very high	Interviewer responds different to female of local interviewer than foreigner	Post hoc testing

5.6 Mitigating Bias and Endogeneity

Before fieldwork, I outlined the potential sources of bias as well as the precautions required to mitigate them. The full list is available in Appendix E.3. Here, I outline only the key steps which are referred to in the discussions of the following empirical chapters. Additionally, where possible, I piloted data as described in Section 5.4.1, and tested statistically for signs of potential bias (see Appendix E.5).

In the context of oil palm-related controversies and contexts, and in areas with a long-held justified suspicion of outsider "researchers" operating on behalf of various actors (see Eilenberg, 2012), one of the biggest challenges was building up trust and legitimacy.

Building Trust, Hidden Agendas and Foreign Researchers

Crucial to reducing bias was the recruitment of the research assistants locally. I worked alongside my sponsor and university counterparts from Politeknik Kesehatan Kementerian Kesehatan (POLTEKKES) Pontianak to recruit local students and recent graduates for this purpose. In particular, I ensured a mix of men and women as well as predominantly those of Dayak ethnicity (with one Malay[17] assistant from and living in Kapuas Hulu). All research was conducted exclusively in Indonesian and my research assistants did not speak English. While I already had a relatively good working knowledge of Indonesian and had conducted household surveys before, I underwent an intensive one-month immersive language program at a language academy in Yogyakarta, where I focused on topics relating to my fieldwork prior

[17] The term Malay refers to indigenous residents, formally Dayak, who have subsequently converted to Islam. This is the most commonly understood definition of Malay in Kalimantan. A further description the Malay and Dayak ethnicities is provided in Appendix A.2

to the start of the fieldwork.

A major problem with conducting research in oil palm (or potential oil palm) villages is that visiting researchers are most often associated with working for a government official, a company or NGO with and agenda (or which is a front for special interests). In the case of a foreigner such as myself, the assumption is usually that the researcher would be from an environmental NGO with an anti-oil palm agenda. I was acutely aware that people would naturally assume that I was opposed to oil palm plantations or opposed to companies. To mitigate this and many other sources of bias, several days of socialisation were carried out before starting research., including meeting village meetings and meetings with village elders. In the model villages where more in-depth qualitative research was being carried out, the socialisation period was even longer, typically around one week. I also observed during piloting that better responses were obtained from interviewees and survey respondents if focus groups had been conducted first, allowing an informal setting for questions and answers and an understanding of who we were and what research we were carrying out. Respondents were also reassured before starting research that all responses would be anonymous and stripped of names and identifiable characteristics. This was part of the consent process discussed in Section 5.7.1.

Presumed Alliance with Village Elites

A problem it was not always entirely possible to mitigate was the issue of influence of village elites. Several studies have shown how village and local elites may be used by companies seeking permission for oil palm expansion and, in so doing, co-opt processes of land use change and licensing, capturing the benefits (e.g. Yuliani et al., 2020). For visiting researchers, this presents a problem as it is necessary as obtaining their permission and consent to stay and do research in a village is essential, and it is typical (and usually expected), in these circumstances, to stay in the house of the village head. This automatically creates an environment of perceived alliance between the researcher and the village leaders. Compounding the issue is that village leaders – often solely out of kindness and support – try to arrange for participants to attend researcher's focus groups. The outside researcher cannot be sure to what extent those selected are allies of the village leaders and to what extent they feel free to express their views.

While it was not possible to entirely mitigate this issue, I did take steps to ensure that our team did not suffer from too much bias in this regard. Firstly, we made it absolutely clear to both the village leaders and to all respondents and participants that we were not asking about oil palm contracts and agreements, companies, land rights and other contentious issues and that our main focus was on health, nutrition and well-being. Further implications of this are discussed in Section 10.2. Secondly, we made use of the fact that Indonesia has an extensive network of community health centres, with every village having at least a village-level health post and many having health centres and/or midwives. We thus tried to, as far as was feasible, use those staffing or volunteering at community health posts as the base of our research, asking village heads to introduce us to the staff and volunteers at the health post and then continuing to organise activities such as obtaining village rosters or organising meetings from there. Where possible, we also slept on the floor of the health posts themselves or with staff or volunteer members who offered us accommodation.

5.6.1 Mitigating Endogeneity

While comparisons between oil palm-adopting and non-oil palm-adopting villages eliminate some sources of endogeneity at the household level, there still remain many potential sources of endogeneity which must be addressed. This study was an exploration of pathways between oil palm adoption and food choice and was not an attempt to draw causal inference between oil palm adoption and diets. As such, the issue of endogeneity in the research are less severe than they might otherwise be. However, it has to be acknowledged that the decision or opportunity (or lack thereof) to adopt oil palm is not random and that the underlying reasons for differences in these decisions may also affect other outcome variables of interest. I identified five potential reasons why oil palm may not have been developed in a particular village;

(1) A community may have been approached by an oil palm company but rejected the company offer and terms;
(2) The area is unsuited to oil palm cultivation due to poor soils or steep slopes;
(3) It is not commercially viable to grow oil palm in the area due to poor infrastructure and market access;
(4) Government permits cannot be obtained to grow oil palm in the area due to land use zoning as conservation forest, national park, or as being allocated to other oil palm land uses (e.g. forestry);
(5) A village is situated too far away from existing oil palm plantations and mills.

Each of these factors introduces potential sources of endogeneity if differences between oil palm and swidden villages in these characteristics also affect outcome variables of interest. I identified five categories of potential endogeneity which were used to create study site selection criteria: cultural, geographical, economic and political endogeneity. A description of each is provided in Appendix E.4, while the steps to address each potential source in the section criteria are shown in Appendix Table E.2.

5.7 Research Ethics and Personal Reflexivity

5.7.1 Research Ethics

The collection of data from individuals in this context raised a range of ethical concerns. Not only did common research issues around anonymity, data storage and collection, the sensitivity of the topic, and the potential for consequences for study participants had to be considered. A summary of these concerns and actions taken are shown in Table 5.7. This section briefly discusses a few of the most pressing ethical issues, while more detailed explanations are provided in Appendix E.9 along with the details of internal and external ethics reviews and research permits.

Throughout this research, I have tried to adhere to the principles of Free Prior Informed Consent (FPIC) (see Appendix E.9). Recognising the risk of solely using consent forms to "operationalise consent" (Xu et al., 2020), there is a need for researchers to implement pragmatic, context-specific and reflexive forms of "dynamic" informed (Hyder and Wali, 2006; Montenegro Surís and Monreal Agüero, 2008; Xu et al., 2020; Brear, 2020). In this context – where signatures of meeting attendance are routinely falsely presented as evidence of consent[18]. I believed, therefore, it would be both disingenuous and counter-productive to use consent forms for most interviews[19], opting for "dymanic verbal consent" (Tauginienė et al., 2021). More details are available in Appendix E.9.

This research touches on several topics which may cause difficulties for those in abusive relationships or those who, for any reason, need or desire to keep certain information secret from partners. Two topics in particular are of particular concern: (1) Individual-level time allocation data and (2) Data on intra-household decision-making and control of income and expenditure. In both of these cases, there are immediately apparent reasons why data should not only be anonymised but that all efforts should be made to ensure confidentiality within the research setting. However, researchers themselves are not always aware of the reasons why data could pose a risk to respondents (Kaiser, 2009). Thus, all interviews and all data were treated with the same strict standards of confidentiality discussed in Appendix E.9. Challenges which arose in doing so (especially for women-only FGDs) are discussed alongside other reflections on the methods and ethical approach in Section (a) below.

Ensuring respondent's data was anonymous was central to mitigating multiple ethical concerns. Oil palm is a highly contentious issue, frequently causing intra- and inter-village conflict as well as conflicts between companies and communities[20]. It is vitally important, therefore, to mitigate the potential effect of my research on sparking or exacerbating local conflicts.

Two approaches were taken to reduce the risk of conflict between parties and actors. Firstly, it was decided that specific information would not be deliberately sought out about contractual arrangements between individuals, households, communities, and companies, as well as agreements or disputes with the government. While this was of interest, it was not a key focus of our research. Further to the ethical considerations, it would also likely bias other research findings (see Section 5.6)—secondly, data needed to be anonymous not only at the individual level but also at the village level. While the list of villages surveyed is publicly available, all data, quotes have been anonymised using village codes throughout the thesis.

[18] Author's perspective based upon (confidential, non-academic) work reviewing and evaluating oil palm company documents relating to social and environmental remediation procedures. Similar criticisms have been made elsewhere about the coercive nature of attendance at meetings by those corralled to join by others who stand to benefit from the implied consent it confers (e.g. Yuliani et al., 2020; Berenschot et al., 2021; Gecko Project, 2022a). For instance Gecko Project (2022a) quote one company's defence against accusations of miss/under-informing plasma farmers as saying "everything is stated in these meetings, and we report it transparently".

[19] However, where required, consent forms were used in addition to verbal dynamic consent (see Appendix E.9)

[20] Conflict between and within companies, various levels of government, workers and communities are common – as are reports of retaliatory action for raising issues. For a general overview of the issue, see Levang et al. (2016); Meijaard and Sheil (2019); Dadi (2021), while for a more detailed systematic, comparative and econometric analyses, see Barreiro et al. (2016); Abram et al. (2017); Berenschot et al. (2021); Kenny et al. (2022); Berenschot et al. (2021); Grasse (2022)

Table 5.7: Ethical and actions taken

Ethical Consideration	**Details**	**Actions Taken**
Retaliation by companies, officials etc.	Potential retaliation by companies, elites and other actors for expressing opinions relating oil palm development and adverse impacts and/or contractual arrangements	Ensure FPIC is clear about use of data and quotes. Avoid asking direct questions about contractual arrangements. Anonymisation of quotes at both individual and village level. Participatory mapping avoids boundary mapping.
Intra-Village Conflict	Potential to raise issues which spark intra-village conflict through topics and questions (e.g. relating to oil palm plasma dividends) or participatory mapping (e.g. boundary disputes)	Income and benefits from oil palm generalised in questions, participatory mapping avoids boundary mapping
Inter-Village Conflict	Potential to raise conflicts between villages over land tenure / boundaries	Participatory mapping avoids boundary mapping.
Intra-Household Disputes	Personal data or information– especially about where individuals spend time – may exacerbate issues such domestic violence	Sensitive parts of questionnaires (esp. time allocation survey) conducted in the absence of partner. Never share any data about individuals without others.
Data Privacy and Protection	Personal data about individuals should be protected from abuse or collection from third parties	Private data secured on encrypted hard-drives. Use of cloud services only for fully anonymised data.
Compensation for Time	Time consuming surveys and participation in interviews and focus groups should be compensated for without biasing results.	Small compensation in the form of modest gifts.
Complaints Procedure	Respondents should have a way of seeking clarification, raising and issue or dispute about the researcher.	All respondents given a copy of consent form with contact details of staff members at CIFOR, stating that complaints will be treated anonymously.
Dissemination of results and findings	Research findings should in some way benefit communities and researcher should be made aware of how the research findings are used – and have the ability to withdraw consent if necessary.	CIFOR led dissemination of nutritional findings to communities and local governments

5.7.2 Post-Fieldwork Reflections

(a) Reflections on Fieldwork

Conducting research of this nature in this region introduces a number of challenges. The people of Kapuas Hulu are well-studied[21]. However, it is still relatively unusual to see foreigners[22]. The challenge is exacerbated by Kapuas Hulu's long history of illicit activities (e.g. smuggling, illegal logging), a legacy of military and corporate surveillance, and more conflicts between communities and oil palm companies – in which NGOs, posing as researchers or using research as an advocacy instrument are often involved. This history has, in the words of Michael Eilenberg, reporting on his research studying the border regions of Kapuas Hulu in the early to mid-2000s, resulted in a situation where:

> "Many unspoken grievances from this recent past remain concealed.... A healthy suspicion towards outside authorities and prying researchers is part of the survival strategy of the border population"
>
> Eilenberg (2012)

A reflexive account of my experience as a foreign researcher is provided in Appendix E.11. The account discusses the difficulties and challenges of fieldwork I encountered some of the approaches (both successful and unsuccessful) I took to navigate them and some of the unavoidable aspects of bias introduced. Section E.11 discusses the inherent tension between adherence to the legal process of being a foreign researcher, demonstrating courtesy towards local elders, village and customary elites and maintaining the perception that one is an unallied independent researcher. I also provide a frank account (Section E.11) of the difficulty I experienced when initially trying to socially integrate into the life of the villages in which I was conducting qualitative research – and the deficiency of my techniques developed during years of mixed-methods research in Kalimantan in contexts where village residents are short of time.

The account also discusses the strengths and weaknesses of the strategies to resolve some challenges. For instance, Sections E.11 and E.11 discuss the merits and pitfalls of attempting to avoid the most likely topics of oil palm-related controversies (i.e. contractual and land ownership disputes), as well as general approach of framing the research outside the context of oil palm specificity – for instance, by using the village health centres and staff/volunteers as a base of operations in each village. I also discuss the critical importance of my team of research assistants/enumerators, including the advantages of their local identities and their ability to speak a variety of Dayak languages – as well the drawbacks of this, given that I cannot (Section E.11). Finally, in Section E.11, I discuss a few of the ways in which I tested to see if I could detect bias in quantitative surveys, while reflecting on the fact that, despite my efforts, it is inconceivable that my presence as a foreign male researcher did not have some effect on the responses

[21] The district has been a hotbed of research since the arrival of oil palm in the early 2000s. Before that, the Iban had been studied extensively by anthropologists, and while most of it is situated in the Malaysian province of Sarawak, many Iban groups span both sides of the border region.

[22] See Eilenberg (2012) for a full account from 10 years ago, when he was the only foreigner in the region. Today one or two international organisations have a permanent presence in the region, GIZ and WWF. The former has only 2–3 foreigners living in the district, while the latter of which is almost entirely staffed by Indonesians but may occasionally have visits from foreigners. As a foreigner, I was often assumed to be German working for the GIZ.

and the quality of the research. I also discuss the issue of confirmation bias and the treacherous lure of the novel, exciting or publishable finding.

(b) Ethical Reflections

While broadly, I feel the steps taken outlined above to mitigate potentially adverse impacts were appropriate, thinking reflexively following the research, it is possible to identify a number of issues which bear consideration. A lengthier reflexive account of the ethical challenges and dilemmas faced in my research is provided in Appendix E.15. The account describes my unease that by ensuring I do not violate my promises that neither respondents nor their villages will be identifiable in any outputs, I am unable to report local anger and resentment against a particular company for violating agreements made with the community. I am aware that doing so "may have implications for maintaining or perpetuating troubling power dynamics" (Lancaster, 2017). In this particular case, however, I believe my original decision is correct. Most importantly, I do not want to violate the trust and promises I made to respondents. I was neither asked to raise attention, seek clarification or help resolve the issue. In fact, those who discussed the matter with me were resigned to the issue and did not believe any change could happen[23]. I am also working entirely from anecdotal evidence from one side of the dispute. Fully understanding the issue would require extensive research and triangulation. Not only does this fall well outside the scope of my study (and would be detrimental to it), but as a foreign outsider, I am also ill-suited to this type of investigation.

[23]It should be noted, however, that while angry and disappointed at the company in question, the overall view of oil palm in this particular case was generally positive. Many respondents frequently cited the benefits oil palm had brought, despite it not living up to expectations and promises (see Chapter 6, Section 6.9)

Endnotes for Methods Chapter 5

[I] The DFC study contained data about the basic characteristics of the household, including taking a household roster which include the ages, occupation, ethnic and religious identity, education level. The survey also included an asset inventory with which wealth indices could be calculated. The DFC study also collected farm and field data, including foods which had been consumed from these sources. While these data were not complete for my purposes, some of the variables were used in my analysis, and the data were useful to validate my findings where there was some overlap.

[II] Many aspects of the surveys involved collecting data on environmental resource use (for example, wild foods acquisition). These surveys were designed by adapting surveys from previous CIFOR studies methods specifically designed to capture off-farm resource use both in terms of “forest income” and “environmental income”. The modified survey tools were based primarily on the CIFOR-led Poverty and Environment Network (PEN) (CIFOR, 2014; Angelsen et al., 2014) and Agrarian Change in Tropical Landscapes Project (ACTL) surveys (Deakin et al., 2016). The former surveys use recall methods to quantify the consumption of environmental resources and use local prices to generate value. The latter project used detailed farm surveys which explicitly examined off-farm resource use such as fallows. The survey was modified to shift the focus away from the economic value of off-farm resource consumption and trade towards the acquisition of foods from off-farm areas (though non-food data was also collected) as well as on behavioural activities, as well as changing the recall periods depending on activities. This approach was taken because*standard socio-economic surveys have been shown to neglect many dimensions of environmental resource use as they deal primarily with resources that are easily monetised or purchased through markets (Vedeld et al., 2007; Angelsen et al., 2014).* In addition, conventional agricultural surveys are constrained to cultivated crops within field boundaries and do not account for agrodiversity and wild foods (Scoones et al., 1992; Powell et al., 2015).

[III] *Telescoping* is the process whereby respondents may incorrectly identify the time in which an activity occurred, moving it (either forwards or backwards) in time so that it falls in or out of the recall period. *Heaping* is the process whereby respondents may incorrectly aggregate several activities as occurring around the same time (e.g. respondents may answer questions relating to “around six-months ago” by including answers from several months before and after). *Recall delay* is the process by which more recent events are more likely to be remembered than events further in the past. This not only affects the accuracy of responses using longer-recall periods but also introduces biases in terms of study timings – for example, if some respondent clusters or village clusters are surveyed more recently after an event of interest than others (Bell et al., 2019). The degree to which *recall decay* is significant depends on the activity in question. For example, the recall of rare but important and memorable activities (such as hiring agricultural labour) are likely to still be highly accurate long after the event and are less of a concern (Dex, 1995; Beegle et al., 2012). Other potential sources of errors with longer recall periods are the under-reporting (forgetting) of routine activities, as well as recency bias (extrapolation) and rounding errors – which are more common with larger numbers (Huttenlocher et al., 1990; Clarke et al., 2008).

[IV] Of these interviews, some may be considered key-informant interviews – i.e. they were interviews with specialists aimed at gathering information and data (for example, obtaining information about hunting from known hunters). This was particularly the case for men, for whom this type accounted for two-thirds of the interviews. For women, the majority of interviews were in-depth interviews (i.e. focused more on personal perspectives and experiences) though some key-informant interviews were also conducted. Though we used semi-structured interview guides, many interviews were free-ranging and covered topics from one or more guides. Therefore, It is difficult to estimate the exact numbers of interviews that fall into each category.

Chapter 6: Study Context: Oil Palm–Swidden Transitions in Kapuas Hulu

Contents

6.1 Introduction

This chapter presents an overview of livelihoods in the study sites, situating them in the context of ongoing regional swidden and livelihood transitions. The chapter is divided into two parts. Part A focuses on the broader historical context of Kapuas Hulu Regency, historical shifts in livelihoods and land use and general dynamics of land use transitions. Part B then presents an overview of the key agrarian and livelihood transitions occurring in the study sites using primary qualitative and quantitative data.

PART A: HISTORICAL CONTEXT AND LANDSCAPE CHANGE DYNAMICS

6.2 Introducing Kapuas Hulu

This study was carried out in Kapuas Hulu Regency, situated in the far northwest of West Kalimantan province. The region is considered one of the frontiers of oil palm development. Until recently, the region has been considered remote and inaccessible. However, the region has opened up in recent decades as a result of infrastructure development and commercial oil palm expansion. The district is also highly forested and contains two major national parks. As such, a focal point of tension between environmental and economic development objectives (Potter, 2009; Yuliani et al., 2022).

The forests and wetlands of Kapuas Hulu Regency form the main basin for the Kapuas River, the longest river in Borneo. They also contain some of the most biodiverse habitats on earth (Jeanes and Meijaard, 2000). Topographically, the region can be divided into upland forested landscapes and peat wetland areas centred around the Danau Sentarum National Park. Despite experiencing a boom in logging and oil palm development, Kapuas Hulu remains heavily forested (see Appendix E.7). Economically, Kapuas Hulu is estimated to be twice as dependent on forestry as other provinces in Kalimantan (Eilenberg, 2022). Recent figures show that the Agriculture, Forestry and Fisheries Sectors make up around a quarter of the District's Gross Regional Domestic Product (22.9%) (BPS, 2021).

Two main ethnic groups make up the majority of the population of Kapuas Hulu: Malays and Dayaks. Dayak is a term which covers "dozens – indeed hundreds – of ethnic groups, each of them distinctive in culture, social organisation, and language"[1] (Sellato, 1994), while the term Malay refers to Muslim converts of Dayak backgrounds[2].

[1]The diversity of groups and subgroups of Dayak ethnicities across Borneo is astounding. Some estimates suggest there may be more than twenty Dayak subgroup populations living in Kapuas Hulu – largest being the Iban (Alloy et al., 2008). Other well-represented groups are the Embaloh and Kantuk, particularly in upstream areas (Eilenberg, 2012; Anandi et al., 2020). Detailed linguistic studies combined with oral histories suggest complex histories of migrations and displacements, resulting in merging and diverging groups and subgroups (Smith, 2017). The construction of a unified "Dayak" identity is relatively recent (König, 2016; Sillander and Alexander, 2016; Widen, 2017), but a key interest is still maintained in the linguistic and cultural similarities between groups, with many Dayaks in Kalimantan speaking multiple different Dayak languages and dialects. In extremely broad terms, Dayak groups are often divided by historical livelihoods into two groups: those who historically were nomadic or semi-nomadic and were forest-product specialists (hunter-gathers) who practised little to no agriculture (Penan and Punan), and those who practised subsistence swidden cultivation combined with market-orientated NTFPs extraction (Dove, 2011b).

[2]Malay (or *Melayu*) has multiple meanings. In many parts of Kalimantan, the term has historically been used to distinguish between upstream swiddening Dayaks and Muslim residents in coastal areas. In Kapuas Hulu, it generally refers to Dayaks who have adopted Islam (the majority of whom in Kapuas Hulu still carry out traditional swidden cultivation). Converts were said to have "*masuk Melayu*", ("entered Malaydom" or "become Malay") (Chalmers, 2006). Note, the term is not used in Kalimantan to refer to the modern nation of Malaysia, though many Dayaks living in the Malaysian provinces of Sabah and Sarawak on Borneo are Malaysian by nationality and historically many groups, such as the Iban, moved between national borders fluidly.

While by no means universal, typically within Kapuas Hulu, Malay population centres, often focused on fishing, are found closer downstream near the Danau Sentarum National Park (DSNP), while Iban and other Dayak groups are concentrated in hillier, upstream areas with livelihoods orientated around swidden, rubber and forest products (Colfer et al., 2000; Anandi et al., 2020).

6.2.1 Historical Context

Two key characteristics of Kapuas Hulu help situate it within the historical, social, cultural and geopolitical context of Borneo. The first is that it *upstream* (*hulu*) of the Kapuas River – a factor which has significant historical and practical importance. The second is that it has key properties of being a "borderland" (Eilenberg, 2012) – forming part of the land border with Malaysia with historical security and commercial importance[3].

Upriver Down River Axis

The coastal regions of Borneo have been integrated into global markets since pre-industrial times. Coastal communities were both staging posts on trade routes to and from China, as well as centres of trade themselves, exporting gold, diamonds, camphor, and NTFPs including tortoise shells, hornbill ivory, rhinoceros horn, birds nests, and spices among many others (Broek, 1962). Evidence for trade in some NTFPs dates back as early as the first century CE, with trading networks extending as far as China, India and The Persian Gulf (Sellato, 2002). Archaeological evidence suggests Chinese and Indian-influenced centres of trade date back to as early as the 6th Century (Broek, 1962). However, historically, *upriver* groups remained practically autonomous, even if theoretically ruled by coastal sultanates, while those furthest upstream were exempt even from paying tribute (Sellato, 2001). Likewise, the numerous kingdoms and empires which claimed control over parts of Borneo[4] tended exert control only over the coastal populations who operated as middle-men for tradable resources from the interior[i].

The interior of Borneo has often been beyond the effective political control of coastal kingdoms and sultanates, and even latterly, colonial powers (Wadley, 2001). Indeed, prior to the establishment of the Raj of Sarawak[5] in 1841, Dutch maps of the interior were lacking basic geographical information (Irwin, 1955). Upriver communities in the interior of Borneo had largely been ignored by Dutch colonialists until 1846. Irwin (1955) describes how the Dutch maintained control through vassal kingdoms and sultanates, maintaining power without direct control by setting different groups and regimes against one another. Only two Dutch expeditions had ever ventured up the Kapuas River, and there was no Dutch presence anywhere as far upstream at Kapuas Hulu[6], until the late 1850s and 1860s (Wadley, 2001).

[3]More detailed descriptions of these two characteristics are available in Appendix F.1 and F.2, respectively. This section provides an overview of these two concepts, positioning Kapuas Hulu within the wider regional historical context.

[4]Pre-Dutch colonialism, numerous kingdoms and sultanates have controlled parts or all of the coastal areas of Borneo, often with local kingdoms acting as vassal states for larger empires, including the Hindu-Buddhist Majapahit Empire (centred around Java), the Chinese Ming Dynasty and the pre-Islamic Sulu empire (centred around modern-day Philippines).

[5]Also known as the Brooke State or State of Sarawak, this independent state was run independently from the British Empire until 1946 by the British Brooke family following land concessions obtained from the Sultan of Brunei for mercenary aid in suppressing a local rebellion. The origins and history of this regime are complex but fascinating. Wadley (2001), based upon personal communication with historical John Walker, states that the Raja or Sarawak should be considered a colonial power despite it clearly not resembling the colonial model prevalent elsewhere at the time. While it was a dynastic monarchy, it integrated a greater level of local participation than other colonial powers and (arguably) existed with a greater (if only partial) degree of local consent than other colonial powers. This is a highly contentious and complex issue. For further reading see Runciman (2011) and Walker (2001, 2020). Additionally, for an earlier (extremely dated but fascinating) overview of the period, see Irwin (1955).

[6]Wadley (2001) draws a wide range of source material including primary material from Dutch archives showing that prior to 1841 only two Dutch expeditions had been sent up the Kapuas River (1822 & 1823) and that Dutch maps were based entirely on these. A post existed for a brief period in Sintang, but was withdrawn by 1826. There is little evidence of long-term contact further upstream until after the establishment of the Brooke State, after which the Dutch sent representatives upstream in 1847, 1854 and 1855 to renew contracts with local kingdoms (created in 1823).

History of the "borderland"

The contemporary land border between Indonesia and Malaysia that separates Kapuas Hulu from the Malaysian province of Sarawak originates from these conflicts' attempts to entrench colonial power in Borneo (Wadley and Eilenberg, 2005). Following the establishment of the Raj of Sarawak, Dutch Colonial authorities began to dedicate more resources and attention to the area and ensure control of local kingdoms, which had previously operated with almost complete autonomy (Wadley, 2001). Wadley (2001) provides an excellent account of the relations and tensions between Dutch colonialists, the newly formed Raj of Sarawak, and the founder of the Raj of Sarawak, James Brooke, during the period 1841-1886. The account describes how the founding of the Raj of Sarawak threatened Dutch colonialists in multiple ways: militarily (through potential territorial expansion, supporting local uprising, and/or selling of firearms), economically (through stimulating cross-border trade, facilitating smuggling and/or undercutting Dutch prices via Malay trading settlements across the border).

The border became a source of frustration to colonial powers due to the movement of the local Iban population across the border while refusing to pay taxes and end headhunting practices[7] (Wadley, 2001). A major stated aim of the Brooke State was to end the practice of headhunting while simultaneously offering protection (in return for taxes) for other local groups from Iban raids (Walker, 2001, 2020; Runciman, 2011). Lack of effective political control also meant that the Iban had evaded paying taxes to the Dutch and Raj authorities[8] which considered the area as their possession (Wadley, 2001; Pringle, 2010). While they had different approaches[9]; both sides used violent means to subjugate border populations and bring them under the control of the state.

The borders solidified by the Dutch and Brooke colonial regimes re-emerged as sites of conflict following Indonesian independence in 1949 and the incorporation of the State of Sarawak into the Federation of Malaya (leading to the establishment of Malaysia) in 1963. During the 1960s, President Sukarno embarked upon armed conflict with the newly formed state of Malaysia (known as *Konfrontasi*) over the incorporation of Sarawak into Malaysia. These conflicts were exacerbated by cold-war tensions, with Sukarno (known to have increasing associations with communist organisations and countries) directly supporting and training communist volunteer rebels who were fighting against the British state, as well as implicitly allowing them sanctuary over the border in West Kalimantan[10] (Fowler, 2006; Eilenberg, 2012).

Following the ousting of Sukarno and establishing the New Order Regime, geopolitical tensions were eased due to President Suharto's more pro-western stance. However, the border remained heavily militarised. As part of the new regime's anti-communist stance, the Indonesian military targeted communist rebels in West Kalimantan, as well as locals supporting them were targeted by the Indonesian military. While most local Iban remained neutral, some locals aided the military in purging communists and communist sympathisers from the areas. A "select few" leaders of these groups were later rewarded with forest concessions by the military to *form the base of the border elite* (Eilenberg, 2012), which dominates today. The New Order regime pursued the twin objectives of increasing economic and national security controls in the border area. In 1967, on the grounds of *national security considerations* an Indonesian military-owned company (PT Yamaker) was granted logging rights to a concession covering over one million hectares along the Indonesia-Malaysia border (HWC, 2006; Obidzinski et al., 2007). The

[7] In fact, the Brooke State ultimately explicitly sanctioned headhunting by Iban mercenaries against other Iban

[8] as well as to the Sultanate of Brunei

[9] Wadley (2001) describes how the Dutch used local "auxiliary" troops consisting of non-Iban groups with historical grievances with the Iban, such as Kantu Dayaks and Kapuas Malays commanded by Dutch officers (rotated so as to ensure distancing from populations). The Brooke State had a policy that "only Dayaks can kill Dayaks" and used Iban mercenaries, both to control and punish resisting Iban groups, but also to provide a "sanctioned" outlet for headhunting, raiding and plunder. The Dutch established border posts and territorial control over the border more effectively and earlier than the Brooke State, which aimed to control the area politically but was less concerned about physically occupying border territory

[10] Requiring Commonwealth forces to make territorial incursions into Indonesia in order to pursue rebels.

military, however, lacked both the capital and technical knowledge to conduct logging operations, so it relied instead on wealthy investors and contractors, including Chinese businessmen from Pontianak and Malaysian Timber companies (despite having a publicly facing anti-Chinese and anti-Malaysian stance) (Wadley and Eilenberg, 2005).

During the *Reformasi* (reform era) which followed the fall of Suharto, significant powers were decentralised, allowing provincial and district governments new powers, among them, the power to issue logging concessions (Moeliono and Limberg, 2012). In Kapuas Hulu, *Bupati* (heads of District Government[11]) primarily used their new powers to issue licences to local co-operatives, working in collaboration with Malaysian timber entrepreneurs (Wadley and Eilenberg, 2005). Connections with Malaysian timber entrepreneurs *(tukei)* , as well as infrastructure and logistics, resulted in vast quantities of timber – both legal and illegal – being transported across the Border to Sarawak through a vast network of small roads (Obidzinski et al., 2007).

The increasing dominance of Malaysian entrepreneurs in the timber industry in Kapuas Hulu led to concerns at the national level of undue Malaysian influence over the region, leading to increased national-level state control over the industry (Eilenberg, 2012; Hasudungan, 2018). Additionally, the rapid expansion of oil palm estates in Malaysia during the 1990s led to concerns among officials that the relative under-development of Kapuas Hulu relative to Sarawak could eventually lead to Malaysian expansion (Hasudungan, 2018), as well as large numbers of Indonesians working illegally as oil palm labourers in Malaysia (Potter, 2009).

National policymakers, therefore, saw the need to for rapid economic development along the border region, able to secure the border, raise living standards for border communities and absorb the labour of returning migrants from Sarawak (Cramb, 2007; Hasudungan, 2018). In the early-to-mid 2000s, the national government announced a number of strategies and plans for the border regions, re-defining them as the nation's front yard (*halaman depand*) (Eilenberg, 2012). The plans involved the creation of a new *plantation corridor* along the entire 200km border with Malaysia, justified partially on border security grounds (despite involving Malaysian investors as some of the main investors) (Potter, 2009; Eilenberg, 2012).

Despite the national strategy to use oil palm plantations along the border, conflict between branches and levels of government, as well as opposition from local and transnational NGOs as well as some local groups, delayed oil palm development (Potter, 2009). The earliest oil palm development in Kapuas Hulu began in 2001 in Silat Hilir. Large-scale oil palm development began in 2001 in Silat hilir, partiality in response to security concerns (Shantiko et al., 2013) – but was considered too far from the border by local government officials (Hasudungan, 2018). Additionally, vast areas of forest were cleared (logged) with the justification of oil palm development, which failed to materialise (Potter, 2009). In 2011, Kapuas Hulu was included as one of eight regions included in the *Grand Design* (Bappenas, 2011), a 15-year plan for economic development along the border. This coincided with presidential regulation aiming to scale up economic growth in border regions, driven in large part by the development of agricultural plantation (Eilenberg, 2014)

[11]The term *bupati* originates from Dutch colonial times. The literal translation is, but are analogous to a mayor. The *bupati* is a directly elected political position with wide-ranging executive powers.

6.3 Landscape and Land Use Change in Kapuas Hulu and West Kalimantan

Between 2001 and 2019, West Kalimantan lost 2.4 Mha of forest, accounting for 13% of Indonesia's deforestation during this period and the second-highest forest loss of any province in Indonesia (GFW, 2019). Around one-third of industrial oil palm plantations in Kalimantan are found in West Kalimantan (Sharma et al., 2019). Industrial-scale oil palm development began later than in many other parts of Indonesia. The majority of the oil palm development in West Kalimantan has occurred since the year 2000. Between the years 2000-2016, the area of West Kalimantan under oil palm plantations almost quadrupled from 0.4 Mha to 1.57 Mha, expanding at 73,282 ha yr-1 and now covers 16% of the land area of the province (Sharma et al., 2019). Of this expansion, 42% occurred in previously forested land (15% intact forest, 26% logged, 1% regrowth). Some estimates state that, under business-as-usual scenarios, the area under palm oil is estimated to more than triple again by 2035 to 4.8 Mha (Sharma et al., 2019). However, there is also evidence to suggest that – while forest loss in West Kalimantan remains substantial, the rate of forest loss in Indonesian Borneo may have peaked between 2009 and 2012, and has been declining year-on-year since (Gaveau et al., 2019)[12].

Direct conversion of forests to oil palm is rare and makes up a small proportion of oil palm expansion. Advocates for oil palm often point out that the overwhelming majority of plantations are planted on degraded land[13]. However, this does not mean that oil palm is not a driver of forest loss, as complex land use change dynamics result in indirect forest loss (Carlson et al., 2012; Austin et al., 2019). Rather than the direct replacement of forests with plantations, a more commonly found mechanism is that of "sequential conversion" (Yuliani et al., 2022), where forests are converted to other land uses – either by logging (legal or illegal), agricultural expansion of other types (e.g. swidden expansion), or fire (accidental or deliberate)[ii].

6.3.1 Dynamics of Swidden Transitions

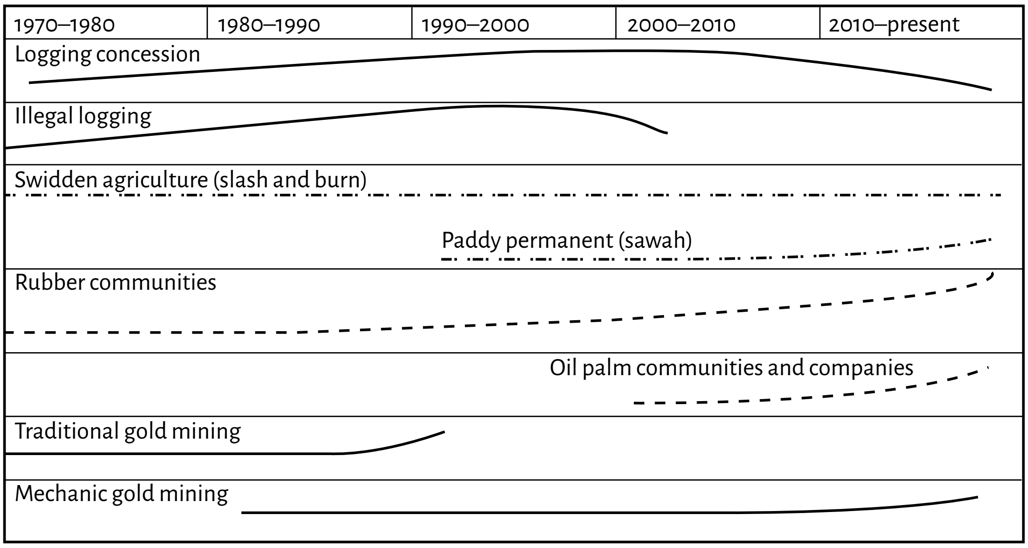
Oil palm expansion in Kapuas Hulu cannot be separated from broader transitions in swidden agricultural production. Like similar swidden transitions across Southeast Asia, swidden transitions in Kapuas Hulu are influenced by a combination of demographic, market and governance forces (Padoch et al., 2007; Fox et al., 2009). Swidden transitions often share certain characteristics such as the intensification of agriculture, a move from collective to individual land tenure, relocation of cultivation to less upland areas, changes in crops cultivated, market integration, official banning and/or controlling of traditional practices, and restricted land access (Dressler et al., 2015, 2017). These transitions often result in shorter fallow times, replacement of swidden with permanent, perennial crops and/or annual monocrops, loss of customary land tenure and the enclosure of former swidden land either by expanding plantations or conservation programmes (Mertz et al., 2009; Dressler et al., 2018). While local swidden transitions vary dramatically by ethnic group, location and local ecological, economic and political contexts, changes to swidden cultivation often share common characteristics. One common characteristic is a general reduction

[12] The cause of this decline in the rate of deforestation is uncertain, though it is probable that it has little to do with sustainability schemes and voluntary standards (Carlson et al., 2018).

[13] While this is true, there here are several mechanisms through which forests can be converted to palm oil while not registering in official statistics. For example, forest land can be reclassified as productive or degraded land, upon which there are no restrictions for planting palm oil. While this is technically forbidden by the central government, the authority to classify land usually resides with the district government, not the central government. One (now dated) estimate for a region in West Kalimantan suggested that 50% of the area of forest converted to palm oil followed this pathway – first being classified as productive forest (for selective logging), then as degraded land (which can be clear felled), followed by land for agricultural development (Carlson et al., 2012). Another mechanism is that growers can illegally expand beyond their official concession (often with tacit or explicit agreement from local authorities) For instance, in Riau Province, Sumatra, 28% of palm oil land is technically outside legal concession boundaries (Gaveau et al., 2017).

Figure 6-1: Agrarian Change Dynamics in Kapuas Hulu

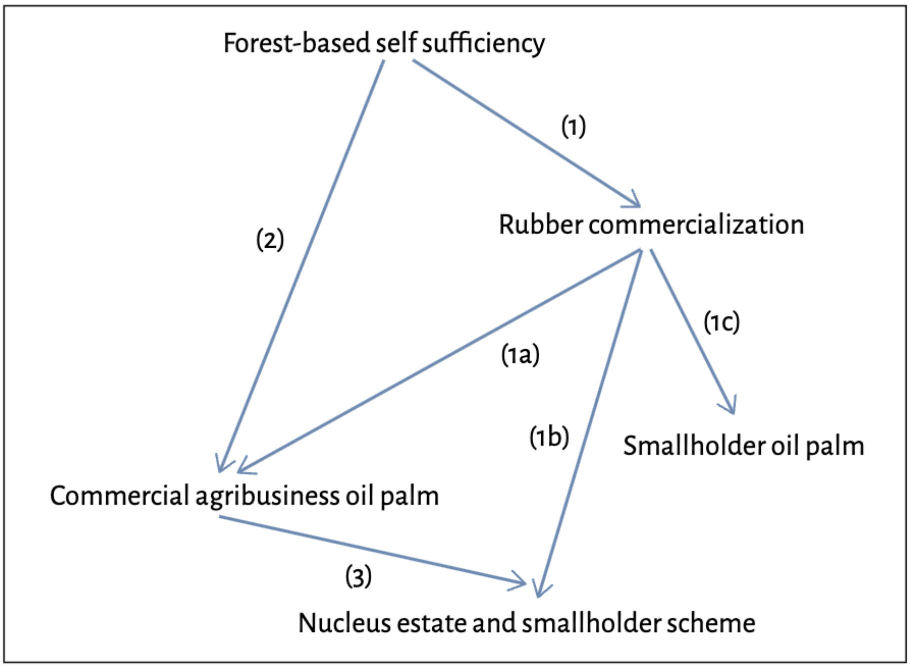
Source: Leonald and Rowland (2016)



Notes: Y-axis shows relative increase/ decrease in activity. Figure taken from Leonald and Rowland (2016) based upon research conducted jointly between author and CIFOR colleagues.

Figure 6-2: Pathways to Oil Palm in Kapuas Hulu

Source: Leonald and Rowland (2016)



"Scenario 1 represents land-use change scenarios where rubber agroforestry is an intermediate stage between smallholder oil palm (1c), nuclear estate and smallholder schemes (1b), and commercial agribusiness (1a). Scenario 2 is the direct expansion of oil palm estates into forests. Scenario 3 represents the expansion of commercial oil palm into smallholder land through the use of nuclear estate and smallholder schemes" (Leonald and Rowland, 2016).

in plot size and fallow length. For example, one longitudinal study carried out over more than 20 years showed that the average swidden size was more than halved while fallow lengths were reduced by around one-third Wadley (1997, 2002). Changes in swiddening patterns have also been observed, for example, shifts from *pioneer swiddens* associated with nomadic livelihoods to *rotational swiddens* associated with permanent settlements (Potter, 2011), or the adoption of rain-fed wet rice systems of *sawah* cultivation in response to population pressure and land scarcity (Padoch et al., 1998).

Major changes in swiddening activities may be temporary – carried out in response to market forces such as price fluctuations, labour opportunities, or government-driven economic incentives. For example, changes in swidden cultivation have been observed in response to temporary spikes in pepper prices and economic crises Wadley and Mertz (2005); Wadley and Eilenberg (2005) as well as government incentives and subsidies to grow high-yield varieties of rubber (Cramb et al., 2009). In West Kalimantan and Kapuas Hulu, economic incentives and opportunities have undergone rapid changes in the decades prior to oil palm's arrival in the 2000s. As well as booms in rubber production, Kalimantan has experienced a number of other booms (Shantiko et al., 2013; Leonald and Rowland, 2016; Hasudungan, 2018; Anandi et al., 2020). These include the emergence (and subsequent decline) of the logging sector throughout the 1970s, 1980s and 1990s (Wadley and Mertz, 2005; Heri et al., 2010; Purwanto, 2018) economic activities including agarwood *(gaharu)* collection (Paoli et al., 2001) and artisanal mining (Shantiko et al., 2013). Each of these changes in the local economy and landscape has led to changes in swidden production – both through the emergence of new technologies, changes in labour-force dynamics through opportunities for off-farm work, immigration and transmigration.

6.3.2 Agrarian Change in Kapuas Hulu

As part of a collaborative research project conducted just prior to the start of this PhD, I participated in producing a generalised typology of land-use change dynamics in Kapuas Hulu[14]. Parts of the resulting typology are shown in Figures 6-1 and 6-2, which show the historical land use and agrarian change dynamics and smallholder pathways to adopting oil palm, respectively. As is shown in the diagram, oil palm development is a relatively recent driver of agrarian change and is simply the latest in a series of booms which have affected the landscape – including logging (both legal and illegal) and rubber.

Figure 6-2 shows the *theoretical* pathways by which land owned by local farmers may become planted with oil palm. In reality, pathways 1C (conversion of rubber to palm oil) and (2) are rare. Far more common are pathways 1A (companies purchasing or incorporating smallholder land) or the exchange of land as part of a smallholder plasma scheme (1b). It is this latter model which is increasingly common in Kapuas Hulu. The dominant form of plasma scheme in West Kalimantan is likely to be company-managed partnership smallholder schemes where 'smallholder farmers' do not farm their own oil palm plasma plots (Gillespie, 2016). As discussed in Chapter 2, smallholder oil palm in West Kalimantan generally, and Kapuas Hulu specifically, is dominated by smallholder plasma schemes. Increasingly, these schemes take the form of "sharedolder" or "partnership" models as companies aim to move away from the inefficiencies of out-grower systems and centralise management of plantations (Zen et al., 2016; Hasudungan, 2018). Increasingly even farmers with existing outgrower contractual arrangements are being pushed towards shareholder models even where different prior agreements exist, enabled by legal loopholes and a government preference for direct compensation negotiations between affected communities (Gillespie, 2011; Purwanto et al., 2020).

[14]Research was conducted for Center for International Forestry Research (CIFOR) Agrarian Change in Tropical Landscapes project.

PART B: LIVELIHOODS AND SWIDDEN TRANSITIONS

This section provides a summary of the main livelihood strategies and trajectories in the FOR and OP villages, emphasizing the crucial aspects of livelihood and agrarian transitions essential for understanding the subsequent empirical chapters. The data presented are descriptive and comparative statistics drawn from the men's and women's survey questionnaires, integrated with qualitative findings from focus groups and interviews. Supplementary data on livelihoods and household characteristics are available in Appendix F.

6.4 Village and Household Characteristics

Village survey data were used to compare and contrast village attributes such as physical infrastructure and assets (Table 6.1). Villages did not differ greatly between sets of villages in terms of access to credit and health facilities. On average, both sets of villages have similar levels of market access in terms of time to reach towns and wholesale shops. However, road quality was variable and seasonal – especially in the FOR villages. Three types of roads exist in the region – asphalt roads (highest quality), compressed earth and/or rock (lowest quality) and oil palm roads, which are engineered to higher standards than compressed earth roads in remote areas but are lower quality than asphalt roads[15]. Surprisingly, a greater proportion of FOR villages were accessible by asphalt roads compared with the OP villages, which were served by oil palm roads. A frequent complaint in OP villages was that, though oil palm company-built roads had improved road access in general, frequent use by heavy trucks laden with oil palm FFBs resulted in degrading road quality, quickly leading to impassable areas of mud and dangerous slippery surfaces during the wet season, and high levels of dust in villages during the dry season. This is reflected in residents' perceptions of road quality, with 40% reporting it as difficult or very difficult to access via road during the wet season in the FOR villages, compared with 100% of OP villages[16].

The attributes of surveyed households in the study sites are shown in Table 6.2 (note that surveys are not necessarily representative of the whole village population due to survey design[17]. Sampled households in the OP villages were significantly wealthier than households in the FOR villages, but women were less highly educated. In both sets of villages, the majority of households are primarily dependent on own production of staple foods (rice) – though more so in the FOR villages than OP villages (FOR=96.8%, OP=84.2%, p=0.00). However, on average, households in the OP villages produced smaller quantities of rice, producing sufficient rice for around half the year, compared with around ten months of the year in the FOR villages (p=0.00). In terms of food security, the sites appear to be comparable over the period immediately prior to the survey. No significant differences were found in food security levels using the Coping Strategy Index. Despite this, there were significant differences between sets of villages in the proportion of households who had borrowed cash to buy food or obtained food in credit in the preceding seven days (FOR=32.6%, OP=60.5%, p=0.00).

[15] Oil palm roads and logging roads (most often built by companies rather than governments) are visually redder than compressed earth roads and have a distinctive look. Such roads are made of compressed earth, but with greater engineering input and a higher degree of compression, and capable of withstanding higher traffic and heavier vehicles.

[16] This figure in fact hides significant variation in accessibility in the FOR villages – while respondents rated accessibility by road more similarly in the OP villages, the degree of variation in accessibility by road was far greater in the OP villages. All respondents across both sets of villages rated accessibility by road to be easy or very easy for most of the year. All respondents in OP villages rated roads as difficult to pass in the wet season, whereas 20% in the FOR villages rated it difficult, and 20% very difficult. See Appendix F.6 for survey results.

[17] Surveys were conducted on a randomised subsample of village populations focusing on households with young children and in the case of oil palm villages – households enrolled in smallholder plasma schemes (see 5.3)

Table 6.1: Village Characteristics

Variable	FOR	sd/se	OP	sd/se	p-value
Infrastructure (% villages)					
Asphalt Road	26.7	11.00	0.0	0.00	0.027
Compressed Earth or Rock Road	73.3	11.00	50.0	13.00	0.183
Oil-Palm Road	0.0	0.00	50.0	13.00	0.001 **
Perceived Road Quality (Diff. or V.Diff.)	40.0	13.00	100.0	0.00	0.000***
Market Access (Mins†)					
Closest Town	58.3	3726.00	65.9	3997.00	0.589
Large Shop	0.3	62.00	0.5	82.00	0.529
Village Facilities (% villages)					
Bank or Credit Union	6.7	6.00	18.8	10.00	0.316
Health Center	66.7	12.00	87.5	8.00	0.166
Midwife	100.0	0.00	87.5	8.00	0.157
Nurse	53.3	13.00	50.0	13.00	0.853
Institutional Support (% villages)					
Environmental NGO(s)	26.7	11.00	0.0	0.00	0.027
Social NGO(s)	33.3	12.00	6.2	6.00	0.056
Government Programmes:					
Agricultural	20.0	10.00	6.2	6.00	0.254
Health (KIP)	80.0	10.00	68.8	12.00	0.474
Education (KIS)	86.7	9.00	75.0	11.00	0.411
Conditional Cash-Transfer (PKH)	93.3	6.00	43.8	12.00	0.003**

Notes: Data originates from village-level survey conducted with village representatives (village head or similar), triangulated with data from key-informant interviews and focus groups. For continuous variables, differences are reported as t-tests with standard deviations. For binary variables, differences are reported as Z-tests of proportions with standard errors. † Minutes by motorcycle. KIP, KIS and PKH are educational, health and conditional transfer programmes, respectively (see Appendix F.5)

Table 6.2: Household Characteristics*

Variable	FOR	(sd/se)	OP	(sd/se)	p-value
Demographics					
Age (Woman)	30.4	5.85	29.2	6.60	0.085
Age (Man)	11.63	8.99	11.93	10.36	0.815
No. Children ≤ 14 years	2.39	1.19	2.04	1.16	0.006**
No. Children $15 \leq x \leq 18$ years	1.16	0.39	1.29	0.63	0.022**
Female Education (years)	8.18	2.62	6.75	3.69	0.000***
Financial Wellbeing					
Wealth (asset index)	0.60	1.40	0.69	1.74	0.000***
Gov. Welfare Recipients†(% hhs)	2.60	0.01	1.60	0.01	0.546
Food Security and Nutrition					
Coping Strategies Index (CSI)	9.56	0.99	10.0	0.93	0.583
WMDD (%)	44.8	3.20	53.8	2.88	0.04
Months Self Sufficient in Rice	9.84	2.50	6.19	2.22	0.000***
Own-production Staples (1st source)	96.8	0.01	84.2	0.03	0.000***
Borrowed/ purchased food on credit ◇(% hhs)	32.6	0.04	60.5	0.34	0.00***

Notes: † = Comparison of days borrowing food/ obtaining a loan for food among those who engaged in such practices; † = Households with self-reported net debt (debt minus savings) of over 1 million IDR ◇ = % of HHs who have borrowed food of obtained formal or informal credit for the specific purpose of buying food within the preceeding 7 days

6.5 Access to Income and Financial Wellbeing

The wealth indices reported above, clearly show higher asset ownership in the OP villages than the FOR villages, indicating that cash incomes are likely to be higher over the long term. However, while asset ownership reflects long term financial status, food choices are influenced by more short-term financial status and are highly dependent on fluctuations in cash-flow, gendered access and control over income and expenditure. Given the absence of reliable comprehensive cash income data (see 5.4.3), this section aims to describe the main differences between sets of villages in terms of opportunities and access to income generating activities and the ways in which households combine different sources of income within the overall household strategy. Several key differences in income patterns emerge between the OP and FOR villages. First, households in OP have greater access to a broader range of (generally more lucrative) income sources. Second, while FOR households combine multiple income streams to create diverse livelihood portfolios, OP households tend to specialise, obtaining most income from one or two main sources. Finally, while access to income is greater in the OP villages, there are distinct signs of financial precarity, including high levels of debt and clear evidence of periodic shortfalls in cash flow.

Sources of Cash Income

Table 6.3 shows the most important sources of income for households in both sets of villages. Significance tests between common sources of income types are shown in Table 6.4. Average estimates of the returns from different sources of income-generating activities are shown in Table 6.5. The clearest difference between sets of villages is the extent to which households in the OP villages depend on waged oil palm plantation labour for their most important source of income. While rubber is the most important source of income in the FOR villages (with 68% of households counting it as one of their top-three sources of income, and 50% of households counting it as their most important source of income), in the OP villages, oil-palm-related income was by far the most important source of income, with over 93% of the sample counting some form of oil palm income among their top-three sources of household income.

The dependency on oil palm in the OP villages is not surprising – the sample was restricted only to those households enrolled in oil palm plasma smallholder schemes (see 5.3). However, the main *type* of oil-palm-related income was indeed surprising. Despite all households in the OP villages being theoretically “smallholder oil palm farmers” – at least by the standards of official statistics[18] – for the overwhelming majority, waged oil palm plantation labour, not oil palm farming, provides the majority of their income. Within this sample of farmers enrolled in oil palm plasma schemes, 88% of households considered waged labour on company oil palm plantations as their primary source of household income – almost all of whom (98%) considered this source to be the most important source of household income. Likewise, only 3% of households received important income from independently grown oil palm. Of the dozen or so households who did cite plasma revenues as one of their top three sources of household income, just three households cited it as their most important source of income, while over half (53%) of the plasma households cited waged plantation labour as their primary source of household income. While in many ways it may be surprising that so-called “oil palm smallholder plasma farmers” may receive so little of their income from smallholder oil palm, this observation is not unique and corroborates other accounts from plasma oil palm in the region (Li, 2015; Gecko Project, 2022b).

[18]See 2.3 for a discussion of the classification of smallholder oil palm farmers.

Table 6.3: Sources of Incomes in FOR and OP Villages

Rank	FOR				OP			
	Most Important	**%**	**Top 3**	**%**	**Most Important**	**%**	**Top 3**	**%**
1	Rubber	50.0	Rubber	68.1	OP Labour[4]	87.0	OP Labour[4]	88.5
2	Ag. Labour[1]	12.1	Ag. Products	39.4	Independent OP	2.6	Ag. Products	20.8
3	Tradesperson	9.4	Ag. Labour[1]	29.4	Tradesperson	2.1	Ag. Labour[1]	26.0
4	Agarwood[2]	5.4	Tradesperson	18.1	Plasma	1.6	Rubber	23.4
5	Civil Servant	5.4	Civil Servant	8.8	Ag. Labour[1]	1.6	Plasma	6.8
6	Ag. Products	5.4	Timber	8.8	Civil Servant	1.0	Tradesperson	6.3
7	Timber	4.0	Agarwood[2]	6.3	Rubber	1.0	Independent OP	3.1
8	Trade/Retail	2.7	Trade/Retail	5.7	Trade/Retail	1.6	Trade/Retail	2.6
9	Non-OP Company	2.7	Handicrafts	2.5	Timber	0.5	Civil Servant	2.1
10	OP Labour	2.0	Gold Mining[3]	1.9	Non-OP Company	0.5	Non-OP Company	2.1

Notes:[1] Non-oil palm casual agricultural labour, typically hired labour for swidden in peak swidden seasons; [2] *Gaharu* (Agarwood) is typically collected during long, difficult (and often dangerous) forest-expeditions lasting between a few days and few months (but averaging a few weeks). However, it can also be cultivated – typically in small monoculture plots in ex-fallows; [3] Artisanal gold mining – typically small-scale alluvial mining (often utilizing locally built rafts) or gold-panning; [4] Waged oil-palm plantation labour for oil palm companies.

Table 6.4: Prevalence of Income Sources in OP and FOR Villages

Proportion of Households Obtaining Significant[1] Income

Income Type	**FOR**	**SE**	**OP**	**SE**	**p-value**
Oil Palm Wage	0.02	0.01	0.89	0.01	0.000***
Plasma Scheme	0.00	0.00	0.06	0.00	0.001**
Independent Palm Oil	0.01	0.01	0.04	0.01	0.059
Sale of Ag. Products (Food)	0.39	0.04	0.21	0.04	0.000***
Agricultural Labour (Casual)	0.30	0.04	0.27	0.04	0.533
Company Employee (non-oil-palm)	0.06	0.02	0.02	0.02	0.045
Business	0.06	0.02	0.03	0.02	0.145
Rubber	0.68	0.04	0.23	0.04	0.000***
Cash crop (other)	0.11	0.03	0.00	0.03	0.000***
Timber	0.09	0.02	0.01	0.02	0.001**
Handicrafts	0.03	0.01	0.03	0.01	0.958
Garahu *(Agarwood)*	0.09	0.02	0.01	0.02	0.000***
Other NTFP(s)	0.21	0.03	0.06	0.03	0.000***
Civil Servant/ Pension	0.06	0.02	0.02	0.02	0.045
Government Assistance	0.03	0.01	0.00	0.01	0.027
Other	0.20	0.03	0.07	0.03	0.000***

Notes:[1]In the top three sources of household income. Differences are reported as Z-tests of proportions with standard errors. Significance levels have been corrected for multiple comparisons using Bonferroni correction.

Table 6.5: Example Incomes

Typical Income and Wages by Activity (1000s IDR)

Activity	Men	Women
FOR Villages		
Gaharu	*Variable*	-
Rubber[1]	60[2]	60[2]
Agricultural Labour	50	50-60
Tradesperson[3]	75 - 180	-
Selling Vegetables	-	100
Selling Cakes	-	30-100
Handicrafts	-	50-150
Village Official (*monthly*)	2000-3000	-
Logging	150	-
OP Villages		
Plantation Labourer	93-110	85-100
Plantation Foreman/Supervisor	302	*Rare*
Office Worker, Oil Palm (*monthly*)	1500-2500	*Rare*
Tradesperson[3]	75 - 180	-
Handicrafts	-	50-150
Government Employee (*monthly*)	2000-3000	-
Truck Driving	-	$\geq$ 110
Security Guard	-	90-150

Notes: Income is reported as daily income unless otherwise specified [1] If share-cropping 40/60% split; [2] Based upon 60,000 IDR for a two-person man and woman team; [3] E.g. Mechanic, carpenter

Diversity and Combinations of Income Sources

As well as differences in the types of off-farm income, there were differences between sets of villages in terms of the diversity and combination of off-farm labour. Figure 6-3 shows the combinations of different sources of income in each village type. A striking difference between the two sets of villages is the extent to which households in the OP villages have specialised. A significantly higher proportion of households in the OP villages have only one main source of income (OP=31%, FOR=10%, p=0.00) – almost all of whom (93%) are waged oil palm plantation labourers. Similarly, 64% of households in the FOR villages had three or more sources of household income, compared with only 34% in the OP villages (p=0.00). Figure 6-3 also highlights the flexibility of rubber as an income source – with it being possible to combine rubber (either as a primary or secondary activity). Those cultivating rubber most often combined this source of income with the sale of agricultural products (usually vegetables). In contrast, for oil palm waged labour, for those who had additional sources of income, they were primarily in the form of additional waged labour (primarily overtime work as security guards or driving trucks for oil palm companies) or the sale of agricultural productions (predominantly pepper). While rubber was combined with oil palm labour at the household level for a few families – this is mainly explained by harvesting of rubber by older members of the household who did not work on oil palm plantations.

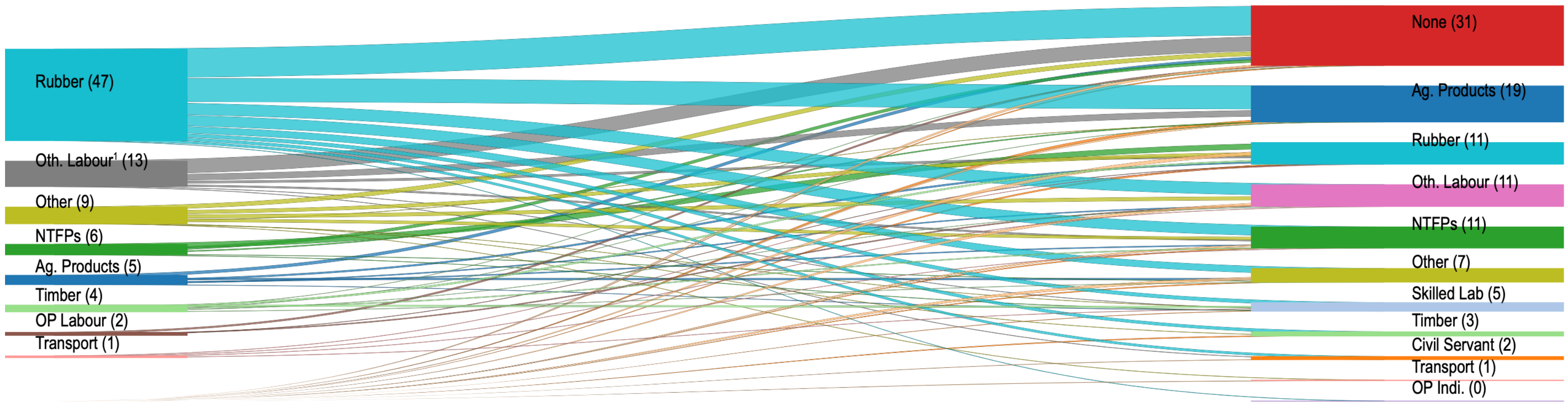
Indicators of Financial Precarity

Despite greater asset ownership and higher cash incomes, there are some indications that households in the OP villages may have greater financial precarity. One indication is the extent to which households are reliant on cash loans and credit to purchase food (Table 6.2). Salaries from oil palm plantation labour are theoretically paid monthly, but few households have the resources to last a month between pay-checks.

Figure 6-3: Combinations of Primary and Supplementary Income Sources

Primary sources of household income (left) and their supplementary sources of incomes (right)

(a) FOR



(b) OP

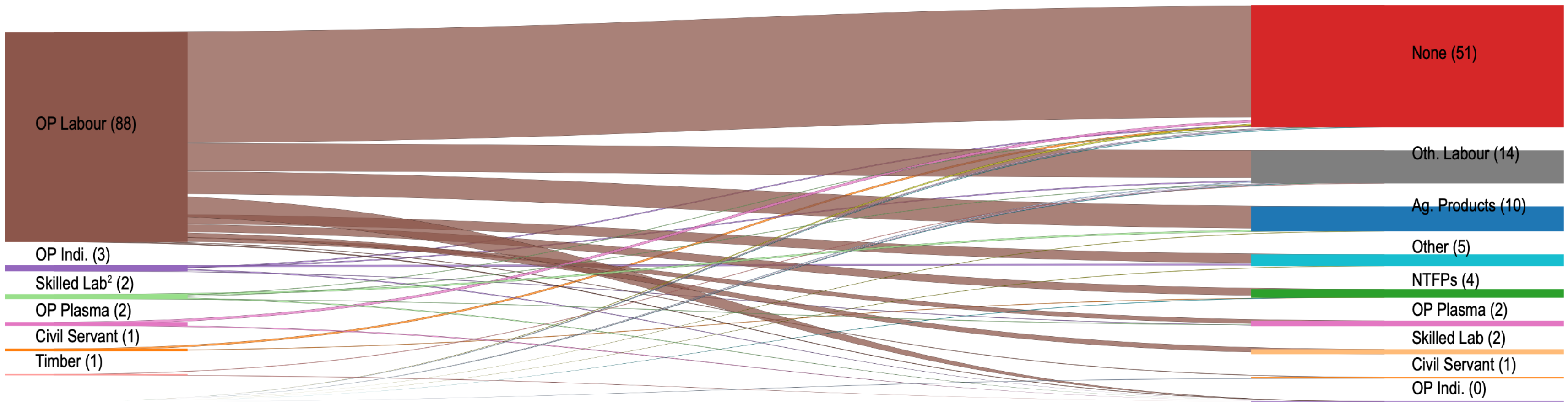


Figure Notes: Sankey diagram[a] showing the relationship between primary (most important) sources of household income (left) and supplemental forms of household income (right) in each village type. Numbers in brackets represent the percentage of households who obtain income from each source. The size of flows represent the relative number of households who have this combination of income sources. [1] *Other Labour* refers to casual and informal waged labour. In the FOR villages this is primarily waged agricultural labour. In the OP villages this is primarily off-farm labour associated with oil palm, for instance, security guarding or truck driving; [2] *Ag. Products* here refers to both food and cash-crops other than rubber. In the FOR villages there are a mix of commercial agricultural products dominated by edible products (especially vegetables) but also *Kratom* and *Gaharu*. In the OP villages agricultural products sold are almost exclusively cash crops and predominantly pepper.; [3] *Skilled Labour* here refers primarily to skilled trades (carpenters, mechanics) predominately operating locally as self-employed individuals.

[a]Created using open-source "SANKEY" package for STATA (Naqvi, 2023)

As such, companies offer cash-advances midway through the month. These cash advances are considered a routine and institutionalised process with wage advances and monthly salaries considered the "little pay-day" and "big pay-day" respectively.

> *"There is a difference: there is a little two-week payday and there is a big one-month payday. But the two-week one – that is a loan, the loan is just 200 [thousand]."*
>
> **Quote 6-1:** (FOR_Vill_FGD3_F)

The differences in cash availability before and after pay-days was so significant that it was regularly reported as one of the most pertinent factors behind food choice decisions – in particular in terms of the consumption of meat and other purchased protein foods. The role that cash-flow cycles and credit and debt play in food choice decisions is addressed specifically in Chapter 9. The indications are, however, that respondent households in the OP villages were sufficiently financially precarious that they were highly dependent on pay-cycles for basic household expenditures and had little financial reserves.

6.6 Livelihood Strategies and Trajectories

Table 6.6 summarises the livelihood strategies in both sets of villages, while Table 6.7 summarises the major livelihood transitions. There is considerable overlap between the strategies employed in both sets of villages. In many respects, differences between the sets of villages are a matter of degree rather than qualitative differences. both sets of villages, for instance, deploy a modified version of swidden agriculture – but swiddens are more heavily modified in the OP villages. Likewise, both sets of villages engage in rubber tapping, hunting, fishing and collection of NTFPs. The main difference between sets of villages is the degree to which households have specialised income-generating activities – primarily rubber in the FOR villages (as well as circular oil palm migration) and oil palm waged labour in the OP villages. What is noticeable, however, is that while livelihoods are more diverse in the FOR villages (see Appendix F.7), livelihoods in the OP villages are still diverse to some extent. Enrolment in oil palm plasma schemes has not led the majority of households to abandon food production – indeed, households in the OP villages continue to grow the majority of their own food (Table H.6). Nor has income from oil palm obviated other types of supplemental income. While rubber is used less as an income source in the OP villages, oil palm households still continue to cultivate cash crops (primarily pepper)

The general trends can be classified into five categories of livelihood trajectories: (1) A swidden transition from traditional upland rotational swidden towards more sedentary, low-land rice with shorter fallows; (2) A farm configuration transition away from farming systems incorporating a diverse assemblage of extensive field types towards fewer and more intensified field types; (3) A cash-crop transition from high-labour, low-capital input crops (rubber) towards low-labour, high-capital input crops (pepper); (4) An off-farm labour transition as households respond to labour opportunities created by oil palm development (both in the region and across the border in Malaysia); (5) A forest-use transition whereby reliance on bushmeat hunting, fishing and NTFPsare gradually reduced.

Table 6.6: Livelihood Strategies

Strategy	**FOR**	**OP**
Subsistence Agriculture		
Traditional upland swidden	+	-
Modified* swidden	++	+
Heavily modified* swidden	+	++
Rain-fed sawah	+	+
Other Subsistence Cultivation:		
Homegardens	+	++
Mixed agroforestry	++	+
Forest-gardens	++	+
Commercialised Agriculture		
Rubber	++	+
Pepper	–	+
Indi./co-op or plasma oil-palm†	-	+
Other (e.g. *kratom*, chilli, cocoa)	+	–
Wild and Forest-based activities		
Hunting	++	+
Fishing	++	+
Wild edible plants	++	+
Gaharu (*Agarwood*) seeking	+	-
Employment and waged labour		
Migratory oil-palm labour	+	-
Local waged oil palm labour	-	++
Casual waged agricultural labour	+	–
Other oil-palm related off-farm labour‡	–	+
Supplemental Income		
Handicrafts	++	++
Home-business (e.g. shop)	++	++
Plasma scheme revenue	-	+
Artisanal mining (e.g. gold, sand etc.)	+	-

Key for Table 6.6: ++ indicates a widespread practice + indicates practised by occasional/few individuals − indicates rare/not practised; **Swidden modification***: Traditional, modified and heavily modified swidden are distinguished as follows: Traditional = upland long-fallow on forested slopes; modified = shorter fallows and partial relocation; heavily modified = very short fallows and extensive relocation + use of chemical inputs.

Table 6.7: Livelihood Trajectories Pre- and Post-Oil Palm∗

	FOR		**OP**	
Trajectory	**Pre-**	**Post-**	**Pre-**	**Post-**
Swidden Transition				
- Remote upland swidden	↓	↓	↓	↓↓↓
- Fallow lengths	↓	↓	↓	↓↓↓
- Reliance of chemical inputs	-	-	-	↑↑↑
- Months self-sufficient in rice	→	→	→	↓
Farm Specialisation and Intensification				
- Extensive field types[1].	→	→	→	↓↓↓
- Farm system diversity[2]	→	→	→	↓↓↓
Cash-Crop Transitions				
- Rubber cultivation	⇆	⇆	⇆	↓↓↓
- Pepper cultivation	-	-	-	↑↑↑
- Alternative cash-crops (e.g. kratom)	-	↑	-	-
Off-farm Labour Transitions				
- Temporary migratory oil-palm labour	⇆↑	⇆↑	⇆↑	↓↓↓
- Engagement in local off-farm labour	⇆↑	⇆↑	⇆↑	↑↑↑
Forest-Use Transitions				
- Bushmeat hunting	↓	↓	↓	↓↓↓
- Fishing	→	→	→	↓
- Commercial NTFPs (e.g. *gaharu*)	↑↓	⇆↓	↑↓	-

Table Notes: ∗In the OP villages, "Pre-" and "Post-Oil Palm" refer to the periods before and after the arrival of oil palm in the study villages. In the FOR villages, these terms denote the time before oil palm development began in the region. **Key for Table 6.7:** ↓ = Decreasing; ↓ ↓ ↓ = Greatly Decreasing; ↑ = Increasing; ↑↑↑ = Greatly Increasing; → = No change; ⇆ = Fluctuating (stable); ⇆↑ Fluctuating (overall increase); ⇆↓ = Fluctuating (overall decrease); ↑↓ = Increase followed by decrease (boom and bust).

6.7 Swidden Transitions in Study sites

6.7.1 Modification of Swidden Rice Cultivation

> *"The first difference is ladangs are getting smaller, the second is that chemicals are used like fertilizer, herbicides, pesticides. It is changing now, before if it was more natural then, now we use herbicides, pesticides."*
>
> **Quote 6-2:** (OP_Vill3_KI_F)

Quote 6-2 illustrates in the words of one key informant in the OP villages some of the changes to rice production since the adoption of oil palm. In general, rice farmers tended to farm smaller plots located closer to villages and roads and rely more heavily on chemical inputs. Additionally, farmers were more likely to rotate swiddens less frequently with shorter fallow lengths, as well as use hired labour, less likely to use customary reciprocal labour exchange arrangements and rely on legal rather than customary land tenure. A similar, although less dramatic, transition has occurred in the FOR villages. Here, too, there has been a relocation of fields away from upland slopes and closer to the village – although the speed of this relocation has not been as rapid, and a smaller proportion of households have relocated.

The qualitative evidence is confirmed by the quantitative data. Table 6.9 provides more data to support this finding. The table shows that rice fields are closer (as measured by walking time) to villages in the OP villages compared with the FOR villages (FOR=22.8 mins, OP=14, p=0.00). However, there was no statistical difference in the size of fields nor in the number of non-rice food crops grown in the same field. Rice farming households in the OP villages were more likely to use fertilisers but not other forms of chemical inputs. Figure 6-4, provides more details of the contemporary differences in swidden rice production in the two sets of villages. The figures indicate significantly shorter periods of fallow regeneration in the OP villages as well as a greater degree of relocation towards villages and roads. While there was no significant difference in the proportion of farmers reporting their current rice fields were fertile, over twice as many farmers in the OP villages reported their current swiddens to have poor soil fertility.

One of the main reasons respondents cited was the advantages of relocating in terms of reducing the distance and time taken to reach these fields. Historically, in both sets of villages, the time taken to reach fields was lessened by the building of wooden huts (*pondok*) close to far away fields, allowing households to live next to the field for times of high-labour demand such as clearing/burning, planting and harvest. This practice was also far less common in both sets of villages today, with residents preferring instead to farm closer to the village.

In both sets of villages, respondents stated that they no longer opened fields in distant upland slopes. There are multiple interacting factors driving this transition. While in the FOR villages, swiddens very far from the village had been abandoned, rice was still primarily cultivated some distance from villages on upland forested slopes accessible only by walking. Rice fields in the OP villages were located far closer to villages, with favoured locations being those near to roads. On average, it took just 14 minutes to walk to respondent rice fields in the OP villages, compared with 22 minutes in the FOR villages. These figures are likely to be an underestimate of the difference in the time it takes to reach fields as many, if not most, farmers in the OP villages travelled to and from rice fields by motorbike, which was not possible in the FOR villages.

Table 6.8: Characterisation of Swidden Rice Production in Study Villages

	FOR	OP
Modification	Partially Modified	Heavily Modified
Rice Varieties	Local Indigenous Rice	Local Indigenous Rice
Location	Upland forested slopes	Near roads and villages
Accessibility	Walking only	Walking or motorcycle
Land Clearing	Slash and Burn	Slash and Burn + Herbicides
Land Availability	Widely available. Existing inherited fallows and land available for opening new fields.	Limited availability of suitable rice farms in desirable lowland locations.
Land Tenure	Customary	Customary and Formal
Land Markets	None/Informal	Present/Formal
Land Availability	Abundant	Prime locations scarce
Planting Cycles[2]	1-2	Most 2-5, some permanent
Fallow Length	Most 2-4 years, Some >5years	Most 1-2 years, some permanent
Labour Arrangements	Traditional reciprocal labour exchange	Household only + hired labour
Pesticide Use	As needed	As needed
Herbicide Use	Extremely rare	Common
Fertilizer use	Extremely rare	Extremely Common
Months Rice Produced	10-12 months	Approx.. 6 months

Notes: Characterisations are rough approximations based upon qualitative research, triangulated with quantitative data (see Chapter 8); [1] Average number of times a field is replanted before moving fields.

Table 6.9: Characteristics of Rice Farms

Variable	FOR	SD/SE[1]	OP	SD/SE[1]	p-value
Prep. of HHs in Sample:					
Rice Cultivation	0.99	0.01	0.80	0.03	0.000***
Rice Farm Characteristics[2]:					
Distance to Rice Field (mins)	22.80	21.60	13.70	16.50	0.000***
Rice Field Area (ha)	0.90	0.95	0.72	1.24	0.057
No. Other Food Crops (#)	4.11	2.61	3.73	2.21	0.295
Proportion Rice Farmers[3]:					
Hired labor	0.15	0.03	0.07	0.02	0.024*
Any Chemical Inputs	0.49	0.04	0.38	0.04	0.049
Fertilizer	0.00	0.07	0.20	0.41	0.002**
Pesticides	0.13	0.34	0.24	0.43	0.506
Herbicides	0.12	0.33	0.13	0.34	0.496

Notes: Table shows differences between sites among households who own farm land, which is a sub-set of all households. [1]For continuous variables, differences are reported as t-tests with standard deviations. For binary variables, differences are reported as Z-tests of proportions with standard errors. Significance levels have been corrected for multiple comparisons using Bonferroni correction. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. [2]For farming households growing rice. [3]Used on rice growing fields.

6.7.2 Changes to Off-Farm Labour

In both sets of villages, historical participation in off-farm labour has fluctuated in response to the ebb and flow of economic opportunities. During periods of economic booms caused by logging activities (both legal and illegal) men often sought employment in logging or related activities. Similarly, spikes in the prices of *gaharu* in the late 1990s and early 2000s led to widespread participation in this high-risk/high-reward activity. The *garahu* boom, however, has faded somewhat as over-harvesting has led to increased scarcity and, thus, lower rewards and higher risks from every expedition. Likewise, the logging boom has been and gone and now operates only at a relatively low level. Today, most young men wishing to engage in short periods of reasonably paid (relative to other options) labour sought employment on plantations in Malaysia or, latterly, elsewhere in Kapuas Hulu. Oil palm development has, therefore, brought access to sources of income not easily available (Quote 6-3) and has rapidly become the main livelihood occupation (Quote 6-4).

> *"Before it was not easy to get money, it's different now."*
>
> **Quote 6-3:** (OP_Vill_KI_F)

While households may have had aspirations of becoming smallholder oil palm farmers, the reality is that oil palm income is primarily derived from waged plantation labour. Oil palm labour now dominates livelihoods to the exclusion of farming and other sources of income, which have become side-activities which supplement and support plantation labour (Quote 6-4).

> *"now since around 4-5 years, oil palm is the main work. [Swidden] farming is already a side [activity]. For the left-over [time] after returning from oil palm farming... Come home from oil palm and then straight to the vegetable gardens... that's how it is now."*
>
> **Quote 6-4:** (OP_Vill_KI_F)

Participation in off-farm labour in the FOR villages was limited by lack of opportunities. Obtaining regular salaried off-farm work generally requires migrating, at least temporarily, away from forest villages. Previously, most migratory work was carried out as oil palm labour across the border in Malaysia, although it was now also possible to carry out this work in Kapuas Hulu (although salaries were lower). Migratory work or extended periods away seeking *gaharu* is only possible due to the low-labour demands of swidden agriculture throughout much of the year. Those seeking income outside the village could either return home for cutting, burning, planting and harvest periods – or pay others to work in the fields if this was not possible (Quote 6-5. While requiring long periods away, such work was seen as a pathway to improve household income and living standards.

> *"Before you go to Malaysia [to work on oil palm], or before you go looking for gaharu, usually the wife and the husband will coordinate first about how long they will go there for, can they be right back when the season is cutting [land clearing and burning] and so on. There are two alternatives... either you leave money so that you can pay other people to work in the [swidden farm], or you go home to help mothers work."*
>
> **Quote 6-5:** (FOR_Vill1_FGD_F)

For households not engaged in migratory labour or *gaharu* seeking, the periods of low labour demand from swidden were used to increase the extent of rubber tapping or to grow vegetables for sale in local markets (Quote 6-6).

> *"Here, there are a few months where we do not have to work on agricultural land – we have to wait. So usually when we wait, we [farm in the] vegetable garden, we grow crops like that."*
>
> **Quote 6-6:** (FOR_Vill2_KI_M)

6.7.3 Cash-Crop Transitions

In the FOR villages, over the past few decades, household dependence on rubber as a primary income source has increased overall – driven partially by access to higher-yielding varieties provided by government agricultural extension services – but also due to the lack of alternative sources of income. While rubber cultivation has increased in general over this period, dependence upon it has fluctuated according to both the price of rubber and other off-farm labour opportunities available. Very few households in the FOR villages cultivate pepper due to its high capital costs and need for chemical inputs. In the OP villages, however, pepper is favoured over rubber as the latter is incompatible with the time demands of waged plantation labour, and households have better access to chemical inputs. Pepper is also favoured because it does not compete for land with oil palm.

At the time I conducted fieldwork, there was a buzz about a potential boom in *Kratom*[19] (*puri*), which respondents in the FOR villages saw as a lucrative cash crop and a potential alternative pathway to wealth without the negative impacts associated with oil palm. A major appeal of the crop was the ease with which it grew, requiring minimal chemical or labour inputs and could be grown entirely independently by smallholders anywhere from ex-fallow land to homegardens beside the house. Only uncertainly over the crop's legal status was holding back many households from entering or expanding their production. I was frequently asked whether, as an outsider, I knew whether it was legal or not or was urged to help find out. Unfortunately, for these aspiring *kratom* farmers, the legal situation is now much more clear with a ban having been implemented (albeit with a delayed implementation period).

6.8 Drivers, Enablers and Outcomes of Swidden Transitions

6.8.1 Flexibility or Inflexibility of Labour

A theme from qualitative research was the degree of flexibility or inflexibility of income-generating activities. In the FOR villages, time spent in income-generating activities could be increased or decreased in response to short-term household needs and seasonal swidden cycles. While access to off-farm waged

[19] Kratom *(Mitragyna speciosa)* leaves produce opioid-like and stimulant-like effects. At the time of conducting fieldwork, the legality of Kratom as a crop and as a drug for sale and export was ambiguous. Numerous farmers expressed to me a desire for clarity, seeing clearly the economic benefits to those who grew it but feared that the crop may be banned in the future and were unwilling to invest significantly in its production. Few farmers had extensive gardens, but many households owned one or more trees and local factories for processing leaves existed in the region. Global demand for Kratom had increased dramatically following widely shared social media posts and comments by influences concerning its possible benefits in treating opioid withdrawal symptoms. A public health debate about potential risks and benefits of the drug was ongoing at the time of fieldwork, but in 2021 a World Health Organisation (WHO) advised against a critical review but recommended that its use and effects be kept under surveillance (WHO, 2021). The crop is scheduled to be made illegal in Indonesia in 2024, intended to give time to farmers to switch crops (Tambun, 2021). In the author's opinion and personal observation, Kratom production in Kapuas Hulu is/was a potentially lucrative export crop which, with minimal capital and labour requirements and few barriers to entry which – if grown responsibly in agroforestry configurations – could bring significant economic benefits to the region without many of the downsides associated with oil palm expansion.

labour was limited, income could always be obtained by allocating more time to rubber collection or the collection and sale of NTFPs[20]. Likewise, both these activities could be reduced or paused without consequences such as reduced yields[21] or losing a job. In contrast, the primary source of income in the OP villages, waged plantation labour, required fixed shifts of 4–7 hours per day, six days a week, at a set time of the day. Rubber cultivation was seen as incompatible with oil palm labour both for the time it required to collect and due to conflicting schedules[22]. As a result, households switched from rubber to pepper cultivation – a which has lower labour, but higher capital requirements. Other income-generating activities, such as hunting or collecting NTFPs, were also considered too time-consuming to be compatible with oil palm labour.

6.8.2 Opportunity Costs of Farm Labour

Different levels of access to off-farm labour create different opportunity costs of on-farm labour. The opportunity costs of agricultural labour in the FOR villages were relatively low as off-farm labour opportunities were limited and rubber cultivation provided consistent, reliable, but small levels of cash income. In contrast, the opportunity costs of agricultural labour in the OP villages were significantly higher due to the easy availability of plantation labour – and the easy availability of overtime labour. At the time of fieldwork, rubber collection as a livelihood produced around 50,000 IDR for a morning's labour[23] (for two people), while a waged daily labourer on an oil palm estate would receive around 100 rupiah for a full-days[24] work. In both sets of villages, this creates an incentive to reduce time spent in swidden agriculture – but the greater opportunity cost in the OP villages, creates a greater incentive than in the FOR villages. Likewise, in the OP villages, the greater opportunity cost of on-farm labour incentivised households to reduce time spent in agricultural production, and households had ceased to cultivate rubber, switching to the less time-intensive but more capital-intensive pepper.

> *"It [fields] used to be far because we walked. Now it feels close for us because we use a motorbike. Now people think they don't want to have a field far away because it takes time. Now people think, because they are busy working, they will farm closer to their homes so they are easy to maintain, easy to monitor."*
>
> **Quote 6-7:** (OP_Vill5_KI_F)

The different opportunity costs of on-farm subsistence labour result in different strategies to manage trade-offs between income-generating activities and food-producing activities. Results from focus group discussions surrounding household priorities show that households in the OP villages aim to maximise income by spending as much time as possible in off-farm labour while also producing sufficient food to meet the bulk of their needs. As oil palm labour was more profitable than competing income-generating activities, households aimed to maximise time spent in this activity by reducing time spent in on-farm labour. The use of chemicals in the OP villages was seen as worthwhile, as the labour allowed households to carry out plantation labour and overtime work. In contrast, in the FOR villages, the use of chemical inputs in swidden cultivation was viewed as an inefficient use of income when the same results could be achieved through time slash-and-burn labour (Quote 6-8).

[20]Collection of rubber us is not limited to the area of rubber land gardens owned by households due to a well-established and standardised system of profit sharing whereby households may collect rubber on land owned by others

[21]Rubber yields are not reduced from less frequent harvesting.

[22]Both activities require labour in the early mornings. Rubber yields were said to be greatest when temperatures were cooler, while oil palm companies began labour early in the morning to reduce the heat under which labourers must work.

[23]Calculated using averages from data collected from FGDs. Average morning rubber collection (for two people) was said to produce around 5 kg of sap at a farm-gate price of 10,000 IDR.

[24]A full day would start very early in the morning and finish around mid-afternoon, see Chapter 7

"You do not need fertilizer. If you move, is it fertile, you get enough rice. You do not need to buy rice or chemicals, so the money you get from rubber can be saved in the future."

Quote 6-8: (FOR_Vill4_KI_F)

6.8.3 Time Scarcity and Time and Labour-Saving Adaptations

As a result of combining waged plantation agriculture with self-production activities (as well as domestic and reproductive labour for women). Households and individuals (both men and women) experienced significant time scarcity and time pressure. The extent of this tome pressure is quantified in Chapter 7. Time scarcity was considered a major – often the primary – reason why respondents in OP villages stated that their agricultural practices had changed since the adoption of oil palm. A lack of time (combined with the opportunity costs of time discussed above) was the major reason why, for instance, households no longer cultivated food crops for sale (Quote 6-9).

"We are too busy. There is no time to grow vegetables or garden vegetables for sale."

Quote 6-9: (OP_Vill7_KI_F)

While traditional swidden was considered too time-consuming to be compatible with oil palm labour, most respondents felt unable to abandon food crop production and rely solely on income from oil palm labour. Thus, changes to swidden cultivation were required to reduce the time and labour invested in it. The main incompatibilities were the time required to travel to and from fields located far from the village, which was unfeasible combined with plantation labour, as well as the seasonal labour requirements around harvest season and land-clearing and burning seasons. By relocating fields away from steep slopes to more accessible locations close to villages or roads, households were able to reduce the time spent walking to and from rice fields. This also meant that motorbikes could be used to access fields quickly, as well as transport heavy goods. In some villages, swidden cycles had been lost entirely, with households switching to permanent *ladang sawah*However, most households had not abandoned swidden cycles altogether; many households simply reduced the frequency of field rotation and reduced the length of fallow periods. This transition reduced the labour required annually to prepare fallows for planting by cutting, clearing and burning.

"For example, if we do it manually, traditionally, it takes one month. But now we use herbicides, with that it is much faster. For example, 2 weeks becomes two days."

Quote 6-10: (OP_Vill9_KI_M)

The move away from traditional swidden systems was made possible using income from oil palm labour to purchase chemical inputs[25], as well as increased access, knowledge and experience using chemicals acquired from oil palm labour. Respondents frequently cited declining soil fertility and increased pests after abandoning fallow systems. The use of chemicals allowed households to overcome these barriers. Chemical inputs also, in combination with reduced fallow length, reduced the need for certain types of labour, including cutting, burning and clearing land (due to younger forest regrowth), thus reducing the

[25] While this is generally the case, I frequently encountered cryptic comments about being "given" chemicals from the palm oil companies. I did not pursue this line of research further as I did not want to risk making respondents uncomfortable (see Chapter 5, Section 5.6). However, it is possible/likely that these chemicals were taken from the plantations without consent – described vividly by Li (2018).

labour required during peak swidden seasons. Income from plantation labour also enabled labour to be hired during peak periods. This practice was also common in the FOR villages – but often took the form of reciprocal labour exchanges between households and kin (gotong royong). This practice, though common before, had died out in the OP villages as it required taking off workdays in plantation labour. For daily labourers, contractual terms allowed both men and women to take unpaid time off as required. However, women were more likely than men to take this time off during peak rice labour seasons. For men, the option of hiring outside labour was seen as preferable to taking time off if daily plantation wages were greater than the cost of hiring labour.

6.9 Discussion and Conclusion

From the outset of the project, I made an explicit decision not to investigate contractual arrangements with oil palm companies due to the risk of biasing other results (see 5.6). In general, however, I found a high degree of ambiguity surrounding the legal tenure, rights and responsibilities of plasma land[iii]. It is impossible to ignore that, although classified as plasma smallholder farmers by official statistics, the livelihoods of respondents more closely resemble that of waged plantation labourers than smallholder farmers. Participants received almost all their income from and spent almost all their income-generating time in waged plantation labour for oil palm companies. Similar findings have been found by multiple other studies, which show that large company deductions of costs and loans result in relatively minor plasma payments to farmers and a dependency on waged plantation labour (Julia and White, 2012; Bissonnette, 2013; McCarthy and Robinson, 2016; Elmhirst et al., 2017; Zen and Nibulan, 2018). Complaints about profit-sharing plasma schemes are common (e.g. Gecko Project, 2022a). In one recent analysis, Berenschot et al. (2021) estimate that they are a contributing cause in around 57% of all oil palm-related conflicts across Indonesia (66% in West Kalimantan).

The pursuit of oil palm-based income opportunities has required abandoning traditional forms of swidden agriculture and a change in farm configuration in both sets of villages. While communities continue to practice swidden cultivation, neither of the village types does swidden resemble the traditional system of upland cultivation with which Dayaks have long been associated. The extent to which swidden cultivation has been modified differs greatly between sets of villages. While swidden has been relocated and fallows shortened in both sets of villages, they have been shortened to a far greater extent in the OP villages – compensated for through the use of chemical inputs. The changes in swidden cultivation in both sets of villages are highly characteristic of swidden transitions across Southeast Asia. As has been noted by Cramb et al. (2009), almost all swidden systems found today are "'partial', in the sense of being supplementary to other livelihood activities". As livelihoods have become more specialised (though still highly diverse), some forms of extensive agricultural production, such as mixed-agroforestry, have been abandoned, resulting in a farm configuration transition away from farming systems incorporating a diverse assemblage of extensive field types towards fewer and more intensified field types. Cash crops, too, have undergone changes. While rubber provides a flexible source of income and a reliable safety net in the FOR villages, it is considered too time-consuming in the OP villages to be combined with waged plantation labour on company oil palm estates.

A major finding is the centrality that time allocation and time scarcity play in swidden and other agricultural transitions. In both sets of villages, households went to significant lengths to reduce the amount of time spent on food production. Households moved away from traditional rotational upland swidden, gradually relocating agriculture closer to roads, shortening fallow periods or skipping fallow periods entirely. Additionally, the substitution of rubber for pepper as a cash crop, and the loss of more extensive fields and fallows is connected with a shift in livelihood strategy underpinned by changes in the opportunity costs of time. The effects of agrarian and livelihood changes on food production are discussed in Chapter 8. The next chapter focuses on the intra-household allocation of labour and time and its relationship to agrarian and livelihood change. Chapter 8 also analyses the feedback loops between the relocation of fields and localised land scarcity, which accelerates a transition away from customary land tenure towards formal legal title and land markets. The next chapter explores the time and labour dynamics of these transitions in more detail, with a particular focus on the intra-household allocation of time.

Endnotes for Chapter 6

[I] Dove (2011b) explains the importance of such coastal kingdoms thus:

> *The historic power of native, coastal kingdoms like Banjar was explicitly based on their ability to veil the wealth of the interior from the eyes of outsiders, thus enabling them to act as middlemen in the trade of everything from pepper to bird-of-paradise feathers.* Dove (2011b, p35)

Citing Alfred Russel Wallace's accounts (1869) of his *difficulties* of collecting specimens directly from those living in the interior of Borneo, Dove explains:

> *Such contact would have undermined the long-established authority of the coastal natives, which was based on ensuring that no one but them had such access to the interior peoples.* Dove (2011b, p262)

[II] The relationship between oil palm and forest fires is controversial – both in the political sphere and academic literature. Working out the root cause of an individual fire is especially difficult when there are long-running grievance narratives in the local landscape. On one occasion, official Ministry of Environment and Forestry investigators were even kidnapped and held hostage (Jakarta Post, 2016). Although an extreme (and only) example, the incident illustrates the highly politicised nature of fires in Indonesia. Forest fires are frequently used as a tool during land disputes between smallholders and companies; they can be used to convert 'forest land' to 'degraded land' (and thus circumvent legal restrictions); or they can be accidental, resulting from poor management or escaping slash-and-burn fires. The latter is also often used as a way of locals blaming immigrants who are viewed as not having the traditional knowledge required to slash-and-burn or who are practising swidden on unsuitable land. Amongst a wide range of politicised narratives are two extremes: first, that fires are caused by palm oil companies, originate in concessions and escape into forests, and second, that fires are caused by swidden farmers. Probably neither is entirely true. The former is not backed up by the limited evidence available. For example, in one study of peatlands in Central Kalimantan, 17-19% of fires appeared to originate in palm oil concessions, but 98% of these fires did not escape the concession boundaries (Cattau et al., 2016). To complicate matters draining of wet peatlands, which creates the conditions for fires in the first place, can be caused by plantations, timber concessions and state infrastructure. The carbon emissions resulting from deforestation and degradation have led to a suite of governance and policy reforms – some of which may have inadvertently increased the rate of deforestation (Enrici and Hubacek, 2016). The 2015 fires – the worst since the 1997/8 fires – burned 2.6 million hectares of forest land and accounted for 97% of all CO2 emissions in southeast Asia for that year (Huijnen et al., 2016). As such, increasing attention is being paid once more to the question of forest fires in Indonesia and the contributions of oil palm and other industries, as well as local agricultural practices, degraded land and poor forest governance. Some authors argue there are landscape configurations that can minimise trade-offs between forest loss and poverty reduction (Law et al., 2015), yet for now; there is a significant tension between forests, biodiversity and GHG emission reduction on the one hand, and economic development through oil palm on the other.

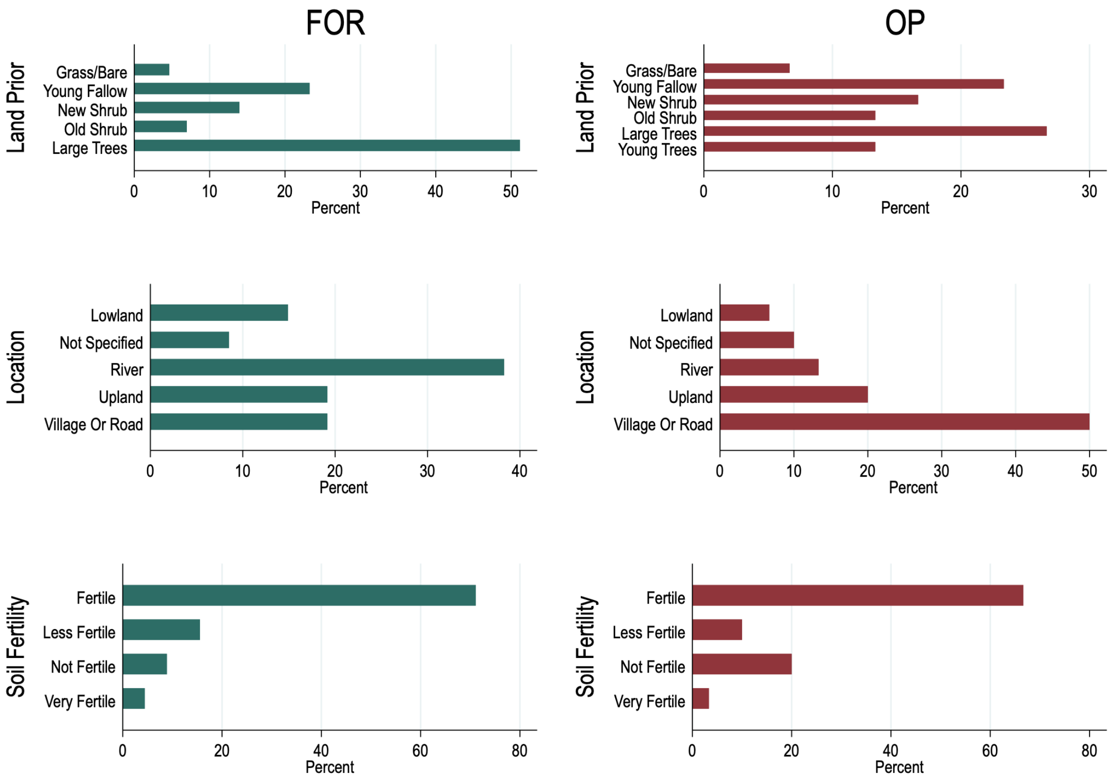
[III] Some participants knew they owned land but did not know the exact location and had never been involved in the planting, management or harvesting of this land. These findings are corroborated by other studies which show how arbitrary definitions, lack of certification and legal title, wide-spread investment and speculation and overlapping and contradictory laws create confusion and ambiguity over true ownership of so-called smallholder lands (McCarthy, 2004; Naylor et al., 2019). Some plasma participants had sold the land directly back to the companies, while others sold their land to other farmers who acted as intermediaries, often selling the land back to the companies at a higher price. Other farmers may have expanded their plasma land by accumulating land from those desperate to sell

> *"When the company first entered the company had explained about the plasma system to the community... also when the company entered many people who sold their land at a cheap price to the compan.y"*

Quote 6-11: (OP_Vill3_FGD_F)

This process, whereby plasma schemes translate into the accumulation of land and wealth by a few, creating a class of landless waged labourers has been widely documented (McCarthy, 2010; McCarthy et al., 2012; Schoneveld et al., 2019b). Complaints that the money received for selling the land was too little were common, though many respondents were glad to have had the cash to invest in improving their homes or starting businesses. Others knew they had been part of a scheme but were unaware that land had been given to them, having instead received improved housing, or believed that company investments in village amenities such as building schools and clinics were the compensation. The mismatch between promises and expectations during the process of obtaining community consent has been termed "cruel optimism" (Elmhirst et al., 2017). Several accounts have explored the gap between promises made and the reality for communities consenting to oil palm. For example, in a systematic comparison of promises made and the realities that manifested, Yuliani et al. (2020) showed that companies leveraged local elites to persuade communities to consent to oil palm, resulting in widespread dissatisfaction when promises were not realised. Similar findings were also found by Hasudungan (2018); Hasudungan and Neilson (2020), who documented the role that customary elites played in mediating land tenure claims that resulted in the dispossession of customary land. Again, this is not the topic of my study, but I frequently encountered similar complaints. Dissatisfaction was in no way universal, and negative views were often simultaneously held with more positive ones. I have tried to reflect in my choice of quotes in this chapter how respondents are often conflicted and hold complex views about the impact of oil palm adoption. I have also attempted to emphasise how people's view of oil palm is typically viewed through the lens of comparisons with people's views over the realistic alternatives to adoption. From this point of view, respondents felt oil palm adoption was, in many ways, an improvement in mass engagement, in particular (often illegal) migration to work as oil palm workers on Malaysian oil palm plantations, which had become, for many, the primary occupation. However, this view is compatible with simultaneously being disappointed that oil palm is under-delivering relative to expectations/promises and farmers being misled either intentionally or unintentionally to expect unrealistic outcomes.

Figure 6-4: Characteristics of Current Swidden Plots



Notes: Self-reported current rice field characteristics from farm survey data. The land use prior to planting indicates the degree of regeneration fallow fields undergo before being re-used, with large trees indicating long periods of fallow regrowth, and bare land/grass indicating the least regeneration.

Chapter 7:
Situating Time Use in Swidden – Oil Palm Transitions

Contents

Chapter Abstract

Background: Time allocation is an important determinant of well-being as well as maternal and child nutrition and an indicator of women's empowerment and gender equality. Previous studies have shown how oil palm adoption alters intra-household labour allocation and gender roles and responsibilities. However, no previous study has attempted to quantify gendered dimensions of labour allocation across all aspects of daily life. To do so requires the deployment of specialised time-use methods able to capture the complexities of concurrent activities as well as accurately record time spent in neglected categories of labour including domestic labour and caregiving, alongside rest and leisure activities.

Methods and Approach: Time allocation data were collected from both men and women using a validated 24-hour time allocation survey. Time allocation data was modelled using a fractional multinomial logistic regression of data to models the shares of times spent in different activities. Findings were integrated with data from qualitative research on the subjective experience of time allocation, as well as the causes, consequences, and coping strategies to manage trade-offs in time allocation.

Results and Conclusion: We find that relative to non-oil palm adopting swidden farmers, participation in oil palm plasma schemes is associated with more time spent in productive labour for both men and women, driven by off-farm labour on oil palm plantations. For women, increased time comes at the cost of reduced time spent in rest, leisure, and sleep. Increased time spent in off-farm labour drives households to adapt agricultural production methods, changing cash crop production as well as accelerating swidden transitions. These changes alter gender dynamics and responsibilities within the household.

Significance and Implications: Our results suggest that changes in time allocation may have significant consequences for women's well-being and gender equity. Women in the OP villages experienced greater stress over time scarcity and employed coping strategies more frequently. Our findings indicate that time allocation could be used as an indicator of the effects of oil palm expansion and adoption on well-being and that potential effects of time scarcity on well-being, gender equity, and maternal and child nutrition should be considered by policymakers when making land use decisions.

7.1 Introduction

In Chapter 4, I described how the literature on agriculture-nutrition linkages is increasingly focused on how contextual factors modify the links between changes in agriculture, diets and nutrition. Women's time allocation is known to be a critical modifier of such relationships (Ruel et al., 2018), influencing nutritional outcomes directly via food choice and women's energy expenditure as well as indirectly through impacts on gender equality and women's empowerment (Johnston et al., 2015, 2018; Stevano et al., 2019). This thesis focuses primarily on the food choice pathway – which is the subject of Chapter 9. This chapter aims simply to analyse the ways in which smallholder plasma oil palm adoption changes gendered time and labour allocation. It aims to answer one of the three main research questions of this thesis:

RQ 1: How does oil palm adoption by smallholder swidden farmers affect the intra-household allocation of time?

7.2 Overview of Gendered Impacts of Oil Palm Adoption

Only a handful of studies have explicitly explored gendered impacts of oil palm expansion and adoption (Li, 2015). The paucity of studies is partially explained by the lack of available gendered-disaggregated data. Li (2015) has argued that lack of gender-disaggregation is part of a broader assumption within development policy in Indonesia "that women and men benefit equally from development schemes through their membership in households". This assumption, however, is contradicted by a considerable body of (primarily qualitative) research showing adverse impacts on women. Among the many gendered effects highlighted through qualitative and descriptive studies are: women's dispossession from land, and the returns of land and labour, women's exclusion from decision-making concerning oil palm and livelihoods, the "feminization" of smallholder agriculture, and gendered effects of contractual arrangements with oil palm companies. This section provides a rapid overview of some of these effects. I begin with an overview of the literature on women's exclusion from negotiations from consent and management decisions and how they manifest themselves in unequal employment opportunities and terms, as well as their dispossession of land. Next, I examine the handful of studies which have explicitly examined the gendered allocation of labour and show how the deployment of specialised time-use methods is needed to capture the complexities of concurrent activities as well as accurately record time spent in neglected categories of labour (including domestic labour and caregiving, alongside rest and leisure activities.

7.2.1 Women's Exclusion and Dispossession

Oil palm development often involves a transition from customary land tenure to formal, legal land tenure. Due to a lack of legal clarity concerning customary tenure, a workaround has emerged in which companies are required to obtain community consent for oil palm development. These negotiations are, in reality, more akin to negotiations over terms between companies and communities and are often influenced by elites who represent village residents in negotiations (Semedi, 2014; de Vos, 2016; Yuliani et al., 2020). Several studies have shown how women are typically excluded from the decision-making process and ongoing management negotiations (Elmhirst et al., 2015; Morgan, 2017), which can result in the exclusion from, or exploitation of, plantation labour dispossessed of their land (Julia and White, 2012; Elmhirst et al., 2015; de Vos, 2016).

Dispossession of Land

Several studies have shown how the adoption of oil palm excludes women from inheriting customarily owned land as well as from processes which govern it. Customary land tenure among most Dayak groups in Kalimantan share common features. Forest land opened from for the purposes of swidden fields (ladangs) or forest-gardens (*tembawang*) is assumed to belong jointly to the married couple whose labour opened the plot. Rights are established through labour, maintained through use and management, and marked by the planting of fruit trees which remain as a marker of location long after fallows have regenerated into secondary forest (Peluso, 2005b). The land opened by a married couple passes to all future descendants – male and female – upon death. Although ownership can be transferred to children upon them leaving home to become married through gifting, the new ownership must be reinforced through the working of land and the planting of trees. Such arrangements are complex and can lead to multiple claims. Subtle differences in rules exist between communities. Ownership is tracked and monitored by customary (*adat*) leaders and disputes settled through *adat* meetings – at which women are able to attend (Tsing, 1990; Colfer, 2008a). The boundaries of collectively owned land are determined by the sites of old villages, longhouses or burial grounds of ancestors, marked by the presence of planted durian trees (which can live to >150 years).

Even in the absence of oil palm, there has been a trend towards increasing individualisation of land rights – primarily through the planting of rubber gardens (often on old fallows), which can remain productive assets for up to 40 years. Unlike rubber, however, which is largely still regulated through customary laws and systems, oil palm, whether smallholder or commercial, requires permits and licences from the state. Such licences are issued at the household level, and the man – as the de facto head of the family – becomes the legal owner. Even in cases where land is inherited through the woman's family, land must be registered under the male name (Julia and White, 2012). This transfer of ownership is far from symbolic. Legal land tenure means men can sell the land without the woman's consent, collect revenue directly from oil palm companies or co-ops, and use the land as collateral to access credit (Fortin, 2011; Julia and White, 2012). It also means that women lose rights in the case of divorce or becoming widowed.

Participation in Management Negotiations

As well as stewarding the village-level consent to oil palm, local male elites can dominate the ongoing management of oil palm within a village. A common feature of oil palm, especially plasma models, is giving up land ownership in return for a share of profits, dividends, or other rewards from oil palm companies. These negotiations also typically include collectively bargained wages and guaranteed hiring terms and work hours for plantation labour on the oil palm estate. Such labour is especially important during the first few years between planting and the first harvest.

Companies often use village "co-operatives" or "community task forces" as an interface for negotiations between the company and the community. In smallholder schemes and partnership models, cooperatives buy inputs, collectively sell harvests, manage payments and remittances as well as settle disputes. Cooperatives are also used to manage labour on behalf of the company – deciding who works on what jobs and arbitrating in pay disputes and negotiations (Feintrenie et al., 2010a). Membership of the cooperative is mandatory for participants in schemes and partnerships (Colchester and Jiwan, 2006) but is reserved for those whose registered identity card is associated with the land – disproportionately men (Li, 2015; Elmhirst et al., 2017). Only cooperative members can vote in co-op elections, stand for leadership positions and attend meetings (Li, 2015; Elmhirst et al., 2017). Cooperatives are managed by a board, who also tend to be local male elites most likely to benefit from oil palm development, (Elmhirst et al., 2017) while in some instances, members are paid by the companies for the role (Julia and White, 2012). Thus, women are excluded from the management of the land, including decisions overinvestment, debt, and disputes with companies.

Women's Access to Income and Labour Opportunities

Different studies have found different contractual terms for women, reflecting the heterogeneity of locally negotiated contractual terms between communities and companies. Several gendered studies of oil palm have noted different contractual terms for men and women in oil palm labour. Women's pay is almost always lower than that of men – supposedly reflecting less physically demanding work – and women tend to work fewer hours than men (Julia and White, 2012; Elmhirst et al., 2015, 2016; Li, 2015; de Vos, 2016; Toumbourou and Dressler, 2020). In some villages, women are only allowed to work certain, less physically demanding tasks, and then only between the age of 35 and 55 years, while men were allowed to work for a longer period of life (de Vos, 2016). Women also do not have access to the range of off-farm employment opportunities that accompany oil palm development, such as drivers, office workers, and officials.

While much of the oil palm labour force is increasingly casualised (Li, 2017), women are more likely to be working on casualised contracts (Julia and White, 2012; Bissonnette, 2013; Li, 2015) which do not offer benefits, job security, overtime, opportunities for promotion, health insurance, or access to loans (Clerc and Others, 2012; Julia and White, 2012; Li, 2015). In some cases, the casualisation of women's labour is a product of household requirements to meet seasonal demand for labour. By not having formal contracts, women can absorb peaks in labour demand during harvest and planting (Bissonnette, 2013; Maharani et al., 2019). Likewise, the fewer work hours offered to women are often justified by the 'need' for women to take care of their 'primary responsibilities' – subsistence agriculture and caregiving (Elmhirst et al., 2015). However, casualisation is also used as a cost-cutting measure by companies. Recruitment of casual labourers is often not done by companies themselves, but rather done by field supervisors who keep no records and who can hire based upon any criteria (Li, 2015; Lindquist, 2017). Field supervisors have been reported to preferentially hire women in casual contracts, rather than permanent contracts to avoid having to pay for menstrual leave[1] (Rossi and Lambrou, 2009; Fortin, 2011). It should also be noted however that, in the context of plasma agreements – the nature and terms of these contracts are often the result of negotiations between companies and communities (which, as discussed above, tend to be dominated by male elites).

The casualisation of women's contracts leaves them vulnerable to exploitation, extraction and to sudden changes in circumstances. For example, Li (2018) reports that supervisors routinely deduct 10% of women's monthly pay – considered the "normal" rate. Another form of casualisation is shadow labour, driven by bonus systems designed to incentivise production. Men are paid a standard daily rate but are offered bonuses for meeting certain targets. Several reports have identified cases of widespread illicit subcontracting (with the tacit support of supervisors) of labour to women, children and migrants, children as a direct consequence of bonus systems paid per kilogram harvested (Pye et al., 2012; Bissonnette, 2013; Li, 2015; Lindquist, 2017).

[1] Menstrual leave has existed in Indonesia since Japanese occupation towards the end of WWII (Nakayama, 2007) as part of a package of "several motherhood protectionist employment policies" (King, 2021) and were subsequently adopted by the Indonesian government upon independence. While often misunderstood as an employee benefit, the law has been associated with widespread discrimination and abuse, including human rights abuses in multinational sweatshops (Keady and Kretzu, 2000). For an excellent account of the history and controversy, see King (2021).

7.2.2 Studies of Oil Palm Adoption and Household Labour Dynamics

Studies Among Commercialised Independent Smallholders in Sumatra

One set of studies has focused on labour impacts of oil palm adoption amongst cash crop farmers in Sumatra, using econometric approaches applied to panel survey data (Kubitza and Gehrke, 2018; Kubitza et al., 2019; Chrisendo et al., 2020). All studies come from a particular context where former cash crop farmers in Sumatra adopting oil palm as independent smallholders[2]. In this context, oil palm's superior labour efficiency (compared with rubber) is seen as "freeing up" up time for households. This time can be allocated instead to off-farm labour, or to expanding farm sizes (Krishna et al., 2017; Kubitza and Gehrke, 2018; Chrisendo et al., 2020). Indeed, it is farm expansion and off-farm labour (rather than increased profitability) are the main mechanisms through which oil palm can improve farmers financial well-being (Euler et al., 2016, 2017; Krishna et al., 2017).

While it is clear in this context that independent smallholder oil palm adoption does free up labour (relative to farming rubber), the effects on gendered time and labour allocation are less clear. Most studies do not use time-research methods but rather rely on partial recalls of labour-time spent over 12-month periods[3]. Two recent studies from this cluster have explicitly addressed gender intra-household labour dynamics (Chrisendo et al., 2020; Mehraban et al., 2022), but inferences concerning time allocation are limited by methods[4]. Chrisendo et al. (2020) found that while oil palm adoption reduced on-farm labour time for men and women, it increased participation in off-farm labour only for men. This indicates that women either do not have access to, do not want to, or are somehow prevented from participating in off-farm labour. While the study did not explicitly investigate the cause of this, it attributes this finding to pre-existing culturally pervasive gender roles. The study also does not measure women's time allocated to domestic and reproductive labour – thus is unable to determine the net effect on women's overall time burdens. In a more recent study, Mehraban et al. (2022) does measure all aspects of women's time allocation[5], finding that women in households only growing oil palm on average one hour less in on-farm labour but spent more time in both reproductive labour and in leisure and rest activities. Regression models showed that the share of the farm under oil palm cultivation was significantly negatively associated with time spent on farm, as well as time, spent resting and sleeping. However, it was positively associated with time spent in reproductive labour and leisure activities[6].

In both of the above studies, the explanation provided for women's reduced time in off-farm labour under oil palm cultivation is attributed to women's social and cultural forces. Mehraban et al. (2022) states that "human capital and cultural constraints" in the local context mean women do not participate in off-farm labour "especially when there is no immediate economic need to do so". Plainly put, this somewhat euphemistic explanation, implies that culturally women do not work when there is no financial need to do so. While neither study is combined with any qualitative research into gender roles, this supposition

[2]In fact, both studies use similar data taken from the same larger data set as the other papers described in Chapter 3. As I argue in both Chapters 2 and 3, this context is relatively unique within the broader landscape of Indonesian oil palm. As such, I agree with Santika et al. (2019a) that these studies have "limited transferability" to other contexts.

[3]While these are sufficient to measure general patterns of labour, these methods are extremely poor at capturing time allocation (see Section 7.3.1)

[4]Chrisendo et al. (2020) relies on a mix of measures of participation in certain categories of labour in the form of binary variables alongside labour-input questionnaires and self-reported hours worked in certain other categories of labour, with over recall periods ranging from 30 days to one year. Mehraban et al. (2022) uses better quality data – based upon a 24-hour recall – but with one-hour, rather than 15-minute, time blocks rather and without measuring concurrent activities. While these approaches can capture broad patterns of labour allocation, they are inaccurate in the measurement of more fine-grained labour allocation (Seymour et al., 2020). Furthermore, such methods tend to systematically under-report many types of labour – especially women's domestic and reproductive labour (White, 1984; Seymour et al., 2017, 2020).

[5]Though, as stated above, without concurrent activities and using one-hour recall blocks, so likely under-estimates time spent in reproductive labour.

[6]The apparent contradiction between increased time spent in leisure but decreased time in rest and sleeping is difficult to explain.

does appear to be supported by the data – with fewer women from wealthier households participating in off-farm labour than women from poorer households. However, it is not clear what the mechanisms are which keep women from participating in off-farm labour.

Studies Among Swiddening Communities in Kalimantan

In contrast to studies among former market-orientated rubber farmers in Sumatra, studies of oil palm adoption among subsistence farmers in Kalimantan suggest that oil palm livelihoods may increase the overall burden of productive labour as households continue to manage diverse portfolio livelihoods and continue to self-produce the majority of their household's food – at least in the short term (Julia and White, 2012; Li, 2015). Some studies in this context indicate that oil palm shifts some of the responsibility of subsistence food production onto women so as to free up time for men's oil palm labour (Julia and White, 2012). Several studies have documented how, following the introduction of oil palm, men have become the primary source of household income (both because of higher wages and longer more regular hours) while women become the primary food producers (Fortin, 2011; Julia and White, 2012; Elmhirst et al., 2015, 2017; Li, 2015; Maharani et al., 2019; Toumbourou and Dressler, 2020).

Drivers of this shift appear to be interactions between access to waged employment and their contractual terms, and existing social and cultural norms. As discussed above, women's pay is almost always lower than that of men and are more likely to be on casualised contracts without benefits such as job security, opportunities for overtime, health insurance or access to credit. This results in an increased importance of men's oil palm labour. For example, Julia and White (2012) find that women are structurally excluded from many oil palm labour jobs (especially the higher paying jobs), leading women to become mainly responsible for subsistence agriculture and any income generated by women to be considered supplemental to the main source of household income generated by men. These underlying economic incentives interact with existing social and cultural norms – especially surrounding women's "obligation" (Elmhirst et al., 2015) in subsistence farming and childcare.

7.2.3 The Need for Time Use Studies

While the studies above are able to describe general patterns of intra-household allocation, they are able to capture the full extent of gendered impacts. To do so requires the deployment of specialised time-use methods able to capture the complexities of concurrent activities as well as accurately record time spent in neglected categories of labour including domestic labour and caregiving, alongside rest and leisure activities. The measurement of time use is vital in understanding hidden dimensions of intra-household labour-allocation – especially in providing evidence of the 'invisible' role of women's labour in agricultural livelihoods as well as the routinely underestimated burden of reproductive labour (domestic work and caregiving) (Doss et al., 2011). It also provides insights into a range of other social and well-being outcomes. Time use is increasingly used as a measure of women's well-being and empowerment (Alkire et al., 2013b,a; Williams et al., 2016). Time allocation can also negatively affect a multitude of health and nutrition outcomes of women and their dependants (Strazdins et al., 2011; Johnston et al., 2015; Williams et al., 2016). This study is the first to explore time allocation in the context of Indonesian oil palm using validated time use research methods. Our quantitative analysis is coupled with results from qualitative research, collected over a period of seven months, which contextualises findings and offers an understanding of the potential pathways through which households reorientate labour towards oil palm-based livelihoods. We aim to answer the following research questions:

7.3 Methods and Data

This time-use research was one component of a larger investigation into landscape, livelihood and food system changes. The overall approach, study design and general research methods are described in Chapter 5. This section describes the methods only those parts of the research which related exclusively to time allocation.

7.3.1 Time-Use Survey

Accurately measuring time-use is notoriously difficult, and many widely used measures have poor accuracy, reliability and validity (UNSD, 2005; Seymour et al., 2017; Johnston et al., 2018). I employed a time-use recall survey included in the Women's Empowerment in Agriculture Index (WEAI), which has been validated in several rural contexts in LMICs (Alkire et al., 2013b). The survey instrument was adapted to include locally relevant activities such as hunting, fishing, and collecting NTFPs as well as a free text option for 'other' activities. The survey tool is a "full-accounting method" using a 24-hour recall period and records up to two concurrent activities for each 15-minute block of time in the preceding day. This approach is considered to be the 'gold standard' of time-use methods, and is significantly more accurate than other methods (e.g. time diaries or respondent estimations of time allocation), particularly over longer recall periods[7]. To further reduce recall bias, enumerators used the Day Reconstruction Method (DRM) (Kahneman et al., 2004), to first outline the main events in the respondents' previous day. The DRM aims to reduce inaccuracies by including a 'first-pass' recall that reconstructs the major events of the day, stimulating memory and reducing the cognitive burden, prior to data collection (Seymour et al., 2017). Where concurrent activities are recorded, with enumerators classify activities as primary or secondary. Primary activities are the activities which were the objective of the time-block, while secondary activities are those which were done concurrently with the primary activity. The inclusion of secondary activities is essential as significant burdens of labour – especially reproductive labour such as childcare – can be missed when this is not considered (UNSD, 2005; Seymour et al., 2017; Stevano et al., 2019).

The time-use survey module was added to an existing socio-economic and livelihoods survey administered to the male household head and an existing questionnaire focused on diets and food environments given to their spouse. Formative research indicated that only Sundays were taken off from formal work, and that routines were similar on the other six days. As the survey focused on activities in the preceding 24 hours, surveys were not administered on Mondays. The implications of this are discussed in Section 10.2. Following enumerator training, a pre-pilot test was conducted using cognitive interviews to improve question phrasing and technique. In addition, the time-use recall survey was compared against findings from a small sample of participants, follows with women in the FOR villages to check recall accuracy and recall bias. Enumerators accompanied women from early morning until before women went to bed, with a different enumerator conducting the recall survey the following day. Despite a small sample size, the validation exercise indicated good overall recall accuracy using relatively broad activity categories and no systematic under or over-reporting of any category.

The focus on male-female pairs is the standard approach for measuring time allocation in agrarian settings (Alkire et al., 2013b; Johnson et al., 2017; Malapit et al., 2015, 2019). In most, but not all contexts, this typically means a husband-wife pairing[8]. By focusing on both the men's and women's

[7] Methods using longer recall periods which have been shown to have extremely poor accuracy and introduce systematic bias in terms of which activities are recalled and which are forgotten (see 5.4.3).

[8] To avoid bias due to complex household structures, the WEAI recommends allowing households to self-identify as the primary economic and social decision makers within the household (Malapit et al., 2020). In our case, however, as the focus is on mothers of small children, we focus on the male partner in household decisions of the wife included in the maternal and child-focused nutrition focused DFC project

time, researchers are able to identify gender disparities in time allocation and examine the relative burdens of time experienced by household members (Stevano, 2019). As such, this approach represents an explicit rejection of the "unitary model of the household" (Alkire et al., 2013a; Malapit et al., 2019, 2020).

While the male-female dyad approach allows for gendered comparisons, it is relatively time-consuming and resource intensive to conduct. Additionally, it omits other household members who may contribute time towards a variety of household labour, both productive and reproductive. The approach cannot therefore be used to calculate *total* time and labour allocated at the household level to various activities. However, the dyadic approach excels at identifying *relative* gender disparities as well as the absolute times for individuals of interest (in this case mothers of small children) (Alkire et al., 2013a; Malapit et al., 2019, 2020). Conducting time-allocation surveys with all household members is highly time and resource intensive, and in most cases is impractical (Seymour et al., 2017; Malapit et al., 2020). However, the dyad of the primary male and female decision makers within any particular household is a reasonable approximation of intra-household dynamics in many agrarian settings (Alkire et al., 2013a; Malapit et al., 2019, 2020). While a simplification, it is a practical compromise which is still a vast improvement on crude approximations provided by other approaches (Quisumbing et al., 2014; Malapit et al., 2019). It should also be noted that household structure is controlled for within the regression analysis. The potential impacts of ignoring the time and labour allocated by other household members – especially grandparents and adolescent and young-adult (typically unmarried) children is discussed in 10.2.

7.3.2 Fractional Multinomial Logit Regression Model

Rather than modelling absolute times spent in different activities, I elected to model the share of times allocated to activities. This approach is preferable to modelling absolute times as it reflects the inherent trade-offs between activities. I tailored a Fractional Multinomial Logit (FML) model developed by Mullahy (2015) and used by Picchioni et al. (2020) in the context of time-use studies with covariates relevant to the local context. The methodology allows for the calculation of marginal effects that can be interpreted as trade-offs between time allocated in activities, keeping the daily allocation of time constrained to 24-hour in a day. The econometric specification is:

$$\begin{cases} y_t^o & = \beta_0 + \beta_1 \textbf{OIL PALM} \times \textbf{SEX} + \beta_2 \textbf{IND} + \beta_3 \textbf{HH} + \beta_4 \textbf{CONTROLS} + \epsilon \\ y_t^a & = \beta_0 + \beta_1 \textbf{OIL PALM} \times \textbf{SEX} + \beta_2 \textbf{IND} + \beta_3 \textbf{HH} + \beta_4 \textbf{CONTROLS} + \epsilon \\ y_t^r & = \beta_0 + \beta_1 \textbf{OIL PALM} \times \textbf{SEX} + \beta_2 \textbf{IND} + \beta_3 \textbf{HH} + \beta_4 \textbf{CONTROLS} + \epsilon \\ y^p & = \beta_0 + \beta_1 \textbf{OIL PALM} \times \textbf{SEX} + \beta_2 \textbf{IND} + \beta_3 \textbf{HH} + \beta_4 \textbf{CONTROLS} + \epsilon \\ y_t^s & = \beta_0 + \beta_1 \textbf{OIL PALM} \times \textbf{SEX} + \beta_2 \textbf{IND} + \beta_3 \textbf{HH} + \beta_4 \textbf{CONTROLS} + \epsilon \end{cases} \tag{7.1}$$

Where $\mathrm{y_t}$ represents the ratios of time allocated in a day in off-farm activities, agriculture and forest work, reproductive labour, leisure activities and sleep and rest (yo = to , ya = ta , yr = tr , yp = tp) and yt = 1440 respectively, being the sum of time spent in the different activities (to, ta, tr, tp,ts) equal to 1440 min (24 h). As the primary outcome of interest is the share of time spent in different activities, I weighted secondary activities and primary activities. In time blocks with both a primary and secondary activity, the primary activity was allocated 80% of the time (12 min) and the secondary activity was allocated 20% of the time (3 min). A sensitivity analysis was conducted to compare different proportions (Appendix G.1).

Off-farm activities ($\mathrm{t_o}$) are defined as all income generating activities which do not take place on the respondents' household farm, for which they receive financial remuneration. While this category consists primarily of waged agricultural labour (both oil palm and non-oil palm), it also includes non-agricultural salaried positions (e.g. teachers, civil servants, corporate office jobs) as well as independent and household business activities (e.g. shops or handicrafts). Agricultural and forest-based activities (t_a) is defined as time spent in labour relating to a household's farm production – whether for self-consumption or for sale – and includes both swidden agriculture and cash crops such as rubber or pepper. This category also includes all collection of forest products including non-timber forest productions (NTFPs) such as wild foods both for own-consumption and sale. Reproductive labour (t_r) includes domestic labour in the home (cooking, cleaning, household chores) and outside the home (food shopping) as well as caregiving activities. Finally, leisure and personal time (t_p) is time engaged in recreational and leisure activities as well as time taken for personal care (e.g. washing, personal hygiene). Based upon standard methodology from the International Classification of Activities for Time-Use Statistics (ICATUS) (UNSD, 2005), time travelling to an activity is included within time allocated to that activity.

The focus in the estimation of (7.1), is on the vector that includes the full factorial interactions between sex (male and female) and a dummy variable capturing whether the village is in the forest or oil palm plasma group. The vector includes individual characteristics (age and education), while the household characteristics are captured in the vector . These include household composition, wealth, and whether the spouse had wage work. Finally, control variables (vector) include farm characteristics (land size, farm diversity, use of inputs). While no surveys were conducted while households were engaged in peak-labour demand swidden activities (planting, harvesting, slash and burning) a dummy variable was included if the survey was conducted during a month when such activities are common in the swidden cycle.

The model was estimated in Stata with the module FMLOGIT (Buis, 2008). The estimations control for autocorrelation among the outcome variables, heteroscedasticity, and non-linearities. We clustered standard errors at the household level to account for data clustering and correlations between individuals in the same households. However, as the data is hierarchical (individuals nested within households, nested in villages) it is possible that clustering at the village level may have some effect. Following Abadie et al. (2023) and Cameron and Miller (2015) the cluster level was selected based upon the data structure and sampling design. Additionally, sensitivity analyses using alternative specifications were conducted which indicated that the findings were robust across different model specifications[9]

[9]Correlation analysis between villages and key dependent and independent variables did not reveal village level to be a major source of clustering. However, it is still possible that some unknown village-level factor leads to omitted variable bias. The standard approaches to addressing this however (e.g. clustering standard errors at multiple levels or running a mixed-effects model) are not currently possible with a fractional multinomial regression model in Stata. We therefore decided to focus on the primary source of clustering in the data — that of the household. The justification for choosing household level clustering of standard errors is primarily theoretical, rooted in the data structure, sampling design and the outcomes of interest. Firstly, in observational studies (particularly with cross-sectional designs), the appropriate level of clustering depends on the source of variation in the independent variables, rather than simply selecting the highest level of aggregation (Abadie et al., 2023). In our case, the dependent variables, and almost all the independent variables are highly correlated at the household level (for instance, farms are shared between household members). Secondly, the appropriate level of clustering depends heavily on the study design – particularly in randomised controlled trials where interventions may occur at individual, household or cluster-levels (Cameron and Miller, 2015; Abadie et al., 2023). In our study design, while household sampling was random, village selection was not. Indeed, villages were purposely selected to minimise variation between villages. The qualitative village matching process (described in 5.3.1) aimed to find villages which were as similar as possible — focusing on villages with similar contemporary and historical agrarian and livelihood trajectories. Thus, villages are far more similar to each other within the set than they would be if villages were simply randomly selected from a list of villages in the district and any unobserved village-level effects are also likely to be smaller.

While the decision to take this approach was taken for theoretical reasons, for the sake of comparison, alternative approaches have been compared in Appendix G.3. The comparison with alternative approaches indicates that the model fit of the selected model is as good as clustering standard errors at the village level, and better than alternative fixed-effects approaches (see Appendix G.3). Additionally, a sensitivity analysis (Appendix G.3) indicates that findings are highly robust between models, and thus do not affect the overall interpretation of the analysis.

7.3.3 Definitions of Time Poverty and Time Scarcity

Time scarcity can be defined as having "relatively low levels of discretionary time or relatively high levels of necessary and committed time" (Williams et al., 2016). A time-scarce individual or household therefore has far fewer options and far less flexibility in how they allocate their time. A household or individual is said to be in time poverty when time spent in certain activities exceeds a threshold or discretionary time falls below a threshold. Time scarcity, therefore, is analogous to having a low income, while time poverty is analogous to being classified as "poor".

Multiple definitions of time poverty have been proposed (Williams et al., 2016; Seymour et al., 2017). Like material poverty, such definitions fall into absolute thresholds (numbers of hours spent in particular activities) and relative thresholds (defined as differences from median population values). Depending on the context, relative thresholds of time poverty may over or underestimate the burden of time scarcity compared with absolute thresholds (Martey et al., 2021). Given this, I use the widely accepted definition used by the WEAI (Alkire et al., 2013b). The WEAI classes and individuals as time-poor if they spent 10.5 hours or more in paid and unpaid work. This indicator has been validated for women's and men's work in a number of rural agricultural settings in LMICs around the world (Lesotho Bureau of Statistics, 2003; Bardasi and Wodon, 2006; Gammage, 2010).

7.3.4 Qualitative Data and Analysis

Qualitative data collection on time-use formed part of a wider qualitative investigation strategy consisting of women-only, and mixed-genderFocus Group Discussions (FGDs), Key-Informant Interviews (KIIs) and In-depth Interviews (IDIs) (see Chapter 5, Section 5.4.4). Women-only FGDs were carried out in each of the 26 study villages, with additional FGDs carried out in model villages (see 5.3). General FGDs covered a wide range of topics including agricultural practices, forest use, land use and land use change, time allocation and household decision-making. The time allocation and household decision-making component focused on the subjective experience of time allocation and household approaches to managing time and making time-related decisions, including household-level and individual-level coping strategies[10].

The qualitative investigation aimed to understand how the adoption of oil palm-based livelihoods affected men and women's time-use differently. Time-use was explored not only in terms when and where men and women spend their time, but also aimed to describe the subjective experience of time allocation and understand how households manage time and make time-use decisions. Household decision-making over time and labour allocation was explored through a broad lens of landscape scale drivers consisting of economic, agrarian and land use change forces.The general approach to the analysis of qualitative data in this thesis is an abductive approach to reflexive thematic analysis (described in Chapter 5, Section 5.5.3). For the time-use data specifically, development of themes followed a multiphase process as described by Nowell et al. (2017) beginning with coding in Nvivo based on codes generated from broad a priori themes (relating to time allocation, intra-household allocation of time, time-saving strategies and technologies), but with codes modified, developed and new codes added inductively from the data throughout the analysis.

[10]Coping strategies for managing trade-offs in time and labour were collected after other topics so as not to influence responses. Coping strategies are discussed in this chapter but are focused on in more detail in chapter 9.

7.4 Quantitative Results

The final data set consisted of 603 individuals comprised of 200 household pairs (where data were available for both men and women from the same household) as well as 65 individual men and 138 individual women. Descriptive statistics are shown in Appendix Tables G.2 and G.3 for individual and household level characteristics, respectively.

Mean shares of time for each group are reported in Table 7.1. Shares of time are the proportion of a respondent's time engaged in a particular activity over a day (24 hours, 1440 minutes) and can range from 0 (no time spent in activity) to 1 (all the respondent's time spent in activity). On average, men spent most of their awake time in productive activities. In the FOR villages, the productive activities primarily consisted of on-farm labour or collecting forest resources. In the OP villages, wage work was the main type of productive labour and accounted for an average 30% of their time (equal to more than seven hours a day). Men's time in reproductive work, leisure and sleeping was similar in the two sets of villages. This contrasts with the pattern of time-use of women. On average, women in the OP villages worked two hours more than those in the FOR villages and spent 72 minutes less on leisure and personal activities and had 45 minutes less of sleep.

Table 7.1: Allocation of time use, by sex and location.

	Men					**Women**				
	FOR		**OP**			**FOR**		**OP**		
	Mean	**sd**	**Mean**	**sd**	**Diff.**	**Mean**	**sd**	**Mean**	**sd**	**Diff.**
Wage Work	0.12	0.15	0.30	0.10	-0.18***	0.06	0.10	0.25	0.11	-0.19***
Agriculture and Forest	0.20	0.14	0.05	0.07	0.15***	0.13	0.12	0.03	0.06	0.10***
Reproductive Labour	0.07	0.08	0.07	0.06	0.01	0.19	0.09	0.18	0.10	0.02
Personal and Leisure	0.26	0.08	0.25	0.07	0.01	0.26	0.08	0.21	0.05	0.05***
Sleep	0.34	0.04	0.34	0.04	0.01	0.35	0.03	0.33	0.03	0.02***

Notes: Results are reported as mean shares of time. Significance: $p < 0.1$; $p < 0.05$; $p < 0.01$

(a) Regression Results

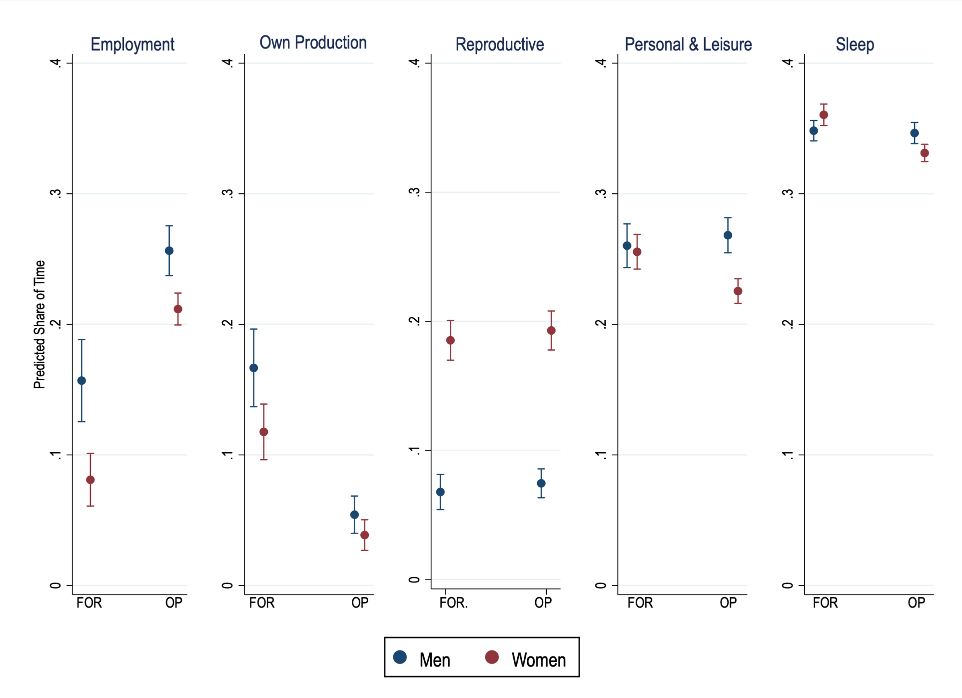
Table 7.2: Predicted Shares of Time in Different Activcities

Statistical difference of predicted shares of time spent in different activities, by sex (within) and site (between)

	Wage Work	**Agriculture and Forest**	**Reproductive Labour**	**Personal and Leisure**	**Sleep**
Male (baseline) vs Female					
Forest	-0.07***	-0.05***	0.12***	-0.00	0.01*
Oil Palm	-0.04***	-0.02*	0.12***	-0.04***	-0.02***
FOR (baseline) vs OP					
Male	0.10***	-0.12***	-0.00	0.01	-0.00
Female	0.13***	-0.08***	0.01	-0.03**	-0.03***

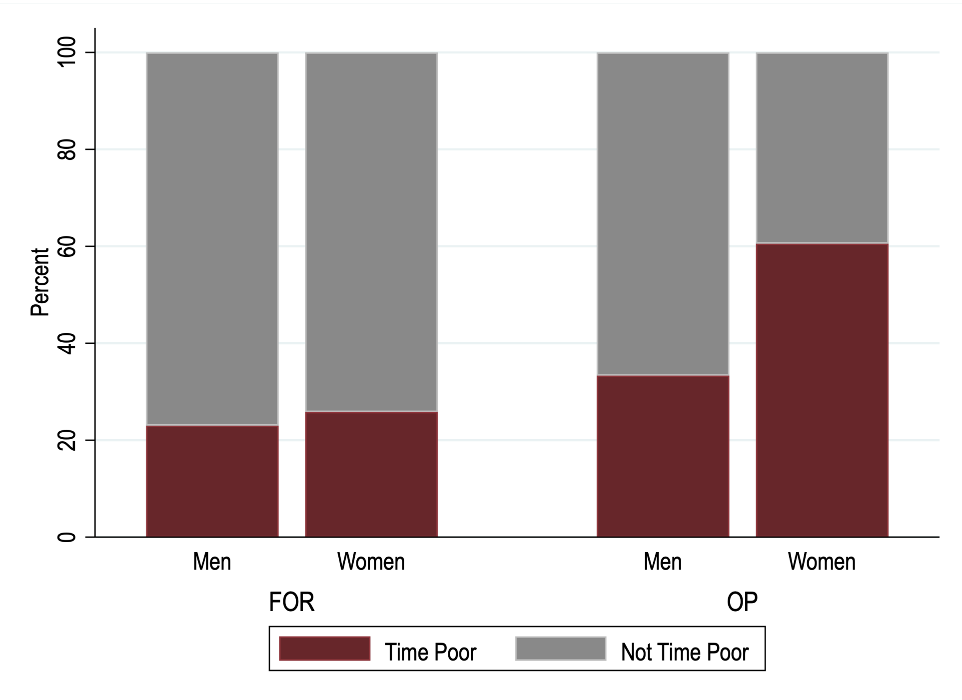
Regression marginal effects are reported in Figure 7-1. Marginal effects of covariates on time shares in activities are reported in Appendix Table G.4. The significance level of the trade-offs by sex (within) and areas (between) of predicted shares of time spent in different activities are reported in Table 7.2. Both men and women in the OP villages spent less time in agricultural and forest activities and significantly more time in off-farm labour compared with the FOR villages. However, the reduction in the share of time spent in agricultural and forest-based activities was greater for men than for women. Women spent

Figure 7-1: Predicted Shares of Time Spent in Different Activities



Note: Plots show mean and 95% confidence intervals of timeshares, predicted from the fractional multinomial logit regression model

Figure 7-2: Proportion of Individuals in Time Poverty



12% more time than men in reproductive work, without any significant difference OP and FOR villages.

The different patterns of activities reflects the substitution of activities in the OP and FOR villages. In the FOR villages, the additional time women engage in reproductive work is compensated by a lower amount of off-farm work compared to men. However, in the OP villages, the amount of work done by women does not compensate for the entire difference and less time is available for leisure and personal activities and sleep compared to men. Compared with the swidden villages, both men and women allocate more of their time to wage work and less of their time to agricultural production. However, for women the additional time that women spend in wage work in the OP villages is associated with a reduction of personal and leisure time.

Time Poverty

A significant proportion of men and women in both sets of villages meet the WEAI threshold of time poverty of spending more than 10.5 hours per day in productive or reproductive labour. The proportion meeting this threshold amongst women in the OP villages is astonishing – 60% of women in the OP villages could be classified as time-poor (Figure 7-2) This compares with just 33% of men in the same villages. For both men and women, the proportion of the population in time poverty was significantly lower in the FOR villages compared with the OP villages. There was no significant difference between men and women in the FOR villages.

7.5 Qualitative Themes

Subjective experience of time

Both men and women reported more severe time pressure in the OP villages, compared with the FOR villages, though the experience of time pressure differed with men reporting physical exhaustion from oil palm labour but women reporting stress and tiredness due to managing competing demands on their time. Quotes 7-1 and 7-2 illustrate the ways in which women in the OP villages

> *"The breaks are not enough, because I come home from work at 2, there is a bit of rest, sometimes, but at 3 o'clock, it must be food preparation, looking for clean water to drink."*
>
> **Quote 7-1:** (OP_Vill5_KI_F)

> *"In the evening working too, working the evening. If you rest when you are tired, it is impossible. We are pushed for time. If you are resting the work is not continuing."*
>
> **Quote 7-2:** (OP_Vill4_KI_F)

The periodicity of time pressure differed OP and FOR villages. Unlike the OP villages, where time pressure was seen as persistent, time pressure in the FOR villages was cyclical, with periods of intense labour almost always followed by periods of low labour combined with rest and recuperation.

> *"Even on Sundays we sometimes go to the fields. There is no rest. . . "*
>
> **Quote 7-3:** (OP_Vill3_KI_F)

A key theme was the importance of breaks and socialising. Women in the OP villages took only one short rest period between returning from the plantation and going out to household fields. During official breaks in plantation labour, women returned home (often against the instructions of supervisors) to begin cooking and carrying out other domestic duties. Women also forwent leisure time in the evenings to begin preparing breakfast for the next day – enabling men to eat immediately after waking and leave quickly for work. The contrast with the FOR villages is clear. In the latter, women and men spend much of the day together and both take breaks between activities and periodic rests during work.

> *"By the evening we are already tired. We are already sleepy. We do not have energy [to socialise] and need to wake up in the morning."*
>
> **Quote 7-4:** (OP_Vill6_KI_F)

Table 7.3: Comparison of qualitative themes between FOR and OP Villages

OP	FOR
Periodicity of labour, rest and time-pressure	
• Time pressure is consistent without periods or rest	• Cyclical periods of intensity followed by rest periods.
Physical and Mental Exhaustion	
• Men experience mainly physical exhaustion • Women experience both physical and mental exhaustion • Women report stress at managing competing demands of carrying for husband and children alongside own-production and waged labour	• Time pressure is experienced as busyness not exhaustion
Social Consequences of time allocation	
• Women perceived few opportunities to socialise with other women outside of festivities and holidays • Men and women do not see each other for much of the day • Socialising for men occurs at sides of road during breaks and following waged labour as well as evenings • Women's evenings are primarily filled with domestic activities e.g. preparing next day's breakfast. • Women carry out domestic duties instead of socialising during plantation breaks.	• Men and women work together all day as household unit • Socialising occurs in later afternoons and evenings • Social time may be constrained for women in evenings due to cooking and cleaning duties
Maximising income via maximising men's time spent in off-farm incom	
• Men and women have access to waged plantation labour, but men offered more hours and higher pay. Higher-paying salaried jobs (e.g. office jobs) exclusively for men. • Overtime and supplementary jobs were mainly available to men. • Aim to maximise men's time spent producing income by shifting on-farm labour to women • Women perceived as insufficiently strong or lacking technical expertise (e.g. mixing chemicals) for certain types of work. • Men's labour needed for cutting and burning reduced by shorter fallows and use of tree-poison herbicides. • Men's labour carrying heavy goods to/from fields reduced through relocation closer to roads allowing motorcycle access.	• Access to off-farm labour limited for both men and women • Local paid agricultural labour often involves men and women • Migratory work arranged around on-farm activities
Women's Roles in Food Acquisition and caregiving	
• Women seen as unable to work longer hours in plantation labour or take on extra work due to care responsibilities	• Women often to leave fields earlier than men to carry out care duties or stay at home when children are young
Coping Strategies	
• Ability to carry out childcare whilst carrying out other tasks is constrained by children not being allowed on oil palm plantations. • Plantations, villages and surroundings are not considered safe for children to play unsupervised or casually supervised. • Reducing time spent acquiring and cooking goods (details discussed in Chapter 9) • Outsourcing childcare to grandparents while in plantation work, or if not available with informal day-care arrangements or with security guards.	• Older children can play casually supervised while carrying out agricultural work or else play unsupervised around the village. • Younger children can be carried on slings during agricultural work. • Reducing time spent acquiring and cooking goods (details discussed in Chapter 9)

Trade-offs in time allocation and coping strategies

Respondents in FGDs and IDIs were asked to free list trade-offs in time and labour allocation. Trade-offs were defined as conflicts between activities such that more time spent on one activity meant less time spent on another. Trade-offs identified were collated and categorised into 'meta' themes. The most common type of trade-off identified by both men and women in both sets of villages concerned trade-offs between time spent in income production and food production. Women in both sets of villages also identified several trade-offs between time spent in productive labour and reproductive duties.

Productive reproductive and leisure time

> *"Yes sometimes, if we are busy. We will skip the rest."*
>
> **Quote 7-5:** (OP_Vill8_KI_F)

Women in both sets of villages reported challenges in managing the competing demands of reproductive labour, such as cooking and childcare, alongside productive labour in on-farm and off-farm labour. Women in both sets of villages reported sacrificing leisure time and sleep to meet the demands of domestic labour and caregiving. Women had similar strategies in both sets of villages for coping with time pressure and time scarcity – but women in the OP villages reported using these strategies more frequently. For example, one strategy was using evenings to cook and prepare meals for the next day. While this was seen as an occasional necessity in the FOR villages, it was a daily practice for many women in the OP villages.

> *"We wake up earlier [than husbands], around 4 we wake up, we prepare breakfast and so on for our husbands... so they will be able to directly eat breakfast and immediately go to work."*
>
> **Quote 7-6:** (OP_Vill4_KI_F)

> *"You don't have time because ... when we come home from work, we work again to take care of our husbands."*
>
> **Quote 7-7:** (OP_Vill7_KI_F)

Other common strategies to cope with time scarcity were reducing the time spent acquiring and cooking food by purchasing food (mainly OP villages), collecting wild foods close to a respondent's activity space (both sets of villages), selecting quicker foods to cook (both sets of villages) or through using faster cooking fuels (OP villages only). Finally, the outsourcing of childcare to other family members, such as grandparents, was common – but considerably more frequent on the OP villages. Some childcare was also outsourced to oil palm company employees when other family members were unavailable in formal or informal company-supplied (but fee-paying) childcare.

Gender roles and intra-household allocation of time and labour

Table 7.4: Gender roles in FOR and OP Villages

		FOR		OP	
		Men	**Women**	**Men**	**Women**
Plantation	Operating machinery	-	-	X	
	Applying chemicals	-	-		X
	Mixing chemicals	-	-	X	
	Harvesting FFB from palms	-	-	X	
	Picking fruits from floors	-	-		X
	Loading trucks and wheelbarrows	-	-	X	
Other off-farm	Company office jobs	-	-	X	
	Oil palm mill work	-	-	X	
	Supervisor positions	-	-	X	
	Village Officials	X	X	X	(x)
	Teachers, nurses, midwives etc.		X		X
	Truck drivers	-	-	X	
Business	Local shop	X	X	X	X
	Trading and transportation	X		X	
	Skilled Trades	X		X	
	Handicrafts		X		X
Own production	Planting	X	X	X	X
	Weeding		X		X
	Harvesting (Rice)	X	X	X	X
	Harvesting (Vegetables)	X	X		X
	Applying Chemicals	-	-	(x)	x
	Building huts and shelters	X		-	-
	Clearing Land	X		X	X
	Carrying and transporting	X		X	X
Cash crop	Rubber tapping	X	X	-	-
	Pepper planting and harvesting	-	-	X	X
	Commercial vegetable gardens	X	X	-	-
	Cash crop weeding and maintenance	X	X		X
	Cash crop harvesting	X	X	X	X
Forest	Hunting	X		X	
	Fishing	X		X	
	Collecting Wild Fruits and Vegetables		X		X
	Sale of NTFPs	X		-	-

Note: Consensus views on gender roles from focus group discussions. X = job normally conducted by men/women; (x) = job occasionally done by men/women; - = NA, activity not generally conducted in this village type.

> *"Men can work in all kinds of jobs for the oil palm company because men are more able and men only work for companies. They do not need to do other work, such as taking care of household activities, farming, etc."*
>
> **Quote 7-8:** (OP_Vill7_KI_F)

Men had access to a wider range of jobs in the oil palm sector, including the best-paying jobs. As daily labourers, men were paid more per hour and worked longer hours than women. Both men and women respondents cited greater knowledge and capacity with machinery as well as more physical tasks as the reason for the pay differential. The pay differential was commonly cited as a reason why men preferred to work long hours. Men had access to overtime work that women did not (such as truck drivers and security guards). It was common for men to combine plantation labour with overtime work leaving little time for other tasks during the day. As a result, women carried out most of the farming during the six-day working week (Quote 7-9). Compared with the FOR villages, women in the OP villages took on a wider range of roles in food-producing agriculture. Table 7.4 shows the consensus views on gender roles from FGDs.

> *"My husband leaves early in the morning and comes back home at night, or late afternoon. Sometimes when he works as a driver he has to work late at night. So*

he doesn't have time to work with me unless there is a day off. It is like this, when men are busy with their work activities, automatically the women do the farming."

Quote 7-9: (OP_Vill6_KI_F)

While most women did not have the option to work longer hours, it was also not seen as desirable (Quote 7-10). Both men and women cited caregiving and domestic duties as reasons why women could not work longer hours. In both sets of villages, women were the primary caregivers and took on the majority of reproductive labour, including cooking and domestic work.

"Mothers work less because they care for their children."

Quote 7-10: (OP_Vill2_FGD_F)

Women were ultimately responsible for day-to-day food acquisition in both sets of villages, but men were more heavily engaged in helping in the FOR villages. Growing vegetables was only carried out by women in the OP villages and was the most frequent reason to visit fields. Growing rice remained a joint household responsibility, although men did not dedicate much time to this task during workdays due to lack of time. Men's labour in rice fields was concentrated on Sundays and holidays. The most common sources of income were jointly produced by FOR households[11]. Rubber was sold to local traders jointly by the household, often against credit for food. NTFPs (excluding gaharu) were also sold by both men and women regardless of who collected them. In contrast, women's income in the OP villages, though important for the household economy, was considered supplementary to men's.

"Both [men and women] try to earn money. Only it is more for the men, the men have to earn money, but she only helps. If she can get money, it is okay. But if she can't get money then she will think – he must go earn money."

Quote 7-11: (OP_Vill3_KI_F)

A noticeable contrast OP and FOR villages was the degree to which households operated as a unit, with members working alongside each other. In the FOR villages, men and women spent most of the working day time working side-by-side – first in rubber fields and then in swidden fields. This was also the pattern in the OP villages before the adoption of oil palm. However, today, men and women do see each other for most of the day, working side-by-side only on Sundays and holidays.

7.6 Analysis

This section integrates the qualitative or quantitative findings. The core difference between the sets of villages is the greater time spent in off-farm labour in the OP villages. Both quantitative and qualitative results show substantially more time allocated to off-farm work in the OP villages compared to the FOR

[11] with the exception of *gaharu* and circular migratory labour (see 6.7.2)

villages for both men and women. This increase is predominantly attributable to wage labour on oil palm plantations. In the OP villages 89.9% of men's and 87.2% of women's time, spent in off-farm labour was spent in oil palm plantation employment. On average, men spent 4.3 hours longer in off-farm employment in the OP villages compared with the FOR villages, while women spent 4.5 hours longer. Time allocated to oil palm labour necessitates reductions in time elsewhere. Both men and women spent substantially less time in on-farm labour in the OP villages (with greater reductions for men than women). In addition, women time spent less time in personal and leisure activities, as well as sleep. Our qualitative results illustrate how differences in gender roles OP and FOR villages derive in part from the changing nature of opportunity costs of labour as well as gendered consequences of time and labour-saving adaptations employed to mitigate time-allocation trade-offs.

7.6.1 Time Pressure, Time Poverty and Time Scarcity

Relative to the FOR villages, both men and women in the OP villages experienced time scarcity and time pressure. For women, this time pressure resulted in women sacrificing time spent in leisure and rest. Compared with the FOR villages, women in the OP villages spent less time in personal and leisure activities, as well as sleep. The regression results suggest that domestic labour, including cooking, cleaning and childcare, is relatively inelastic – i.e., it cannot be reduced to compensate for increases in time spent elsewhere. Our qualitative findings indicate that women may sacrifice rest and leisure time to maintain their ability to care for children and carry out other domestic duties. One striking example is women returning home during breaks in plantation labour (often against the instruction of supervisors) to begin cooking midday meals. Women in the OP villages were also more likely to go to bed after their husbands, sacrificing sleep and leisure time to prepare breakfast, so men could quickly eat before plantation work the next morning. In contrast, while women in the FOR villages were typically able to reduce time spent in on-farm activities to accommodate domestic and caregiving activities. A good example of this is that women were able to leave swidden fields earlier than men to engage in domestic duties such as cooking and looking after children.

Time scarcity was most severe for women in the OP villages. An astonishing 60% of women in the OP villages could be classified as time-poor (Figure 7-2), significantly higher than men in the same villages and women in the FOR villages. These findings corroborate those of the qualitative analysis. Women in the OP villages also spent less time in leisure, and more time in productive activities, and consistently reported the experience of being stressed and exhausted due to lack of time. The qualitative data suggests that women feel intense time pressure in the OP villages, and consistently reported feeling as if they had very little time for leisure activities and less time for leisure than their husbands. In contrast, in the FOR villages, both women and men reported being busy and experiencing temporary periods of time scarcity but did not report suffering from chronic time scarcity.

As well as differences in the prevalence and intensity of time scarcity, there were multiple differences between FOR and OP villages in the nature of time scarcity. Both men and women reported more time pressure having become more severe since adopting oil palm. Complaints about time pressure were heard commonly, though generally differed between men and women – with men reporting physical exhaustion from plantation labour and women reporting stress and tiredness due to managing competing demands on their time.

Another difference OP and FOR villages was the periodicity of time scarcity. In the FOR villages, busyness was reported, but time scarcity tended to be temporary and cyclical. Outside of peak swidden periods (e.g. harvesting and land clearing), both men and women took Sundays off, resting and going to church. In contrast, in the OP villages, Sundays and holidays were used for farming activities as households (especially men) did not have time in the week. These were also the only opportunities for men and women to work side-by-side. The time-use survey deliberately avoided conducting time-use recalls on Mondays (i.e. recording time-use on Sundays). As discussed above, I had not fully appreciated the extent of the difference between the OP and FOR villages in terms of the working week was not during preliminary research. As a result, the time differences OP and FOR villages are likely to be considerably underestimated.

7.6.2 Gendered Allocation of Labour and Time

The two sets of villages displayed different patterns in the allocation of time and labour. Compared with the FOR villages, women in the OP villages took on a greater share of responsibility for household food production. This is reflected both in the relative shares of time spent in own-production for men and women, as well as the wider range of roles carried out in own-production. Likewise, compared with the FOR villages, men in the OP villages took on a greater share of the responsibility of income production. It is important to note the differences between relative shares and absolute times/incomes. In the OP villages, in absolute terms, women spend more time in off-farm labour, less time on-farm, and produce more income compared with the FOR villages. In relative terms, however, labour allocation and income generation are less equal between men and women, with women taking on a greater proportion of the (reduced) on-farm labour and producing a lower share of the (increased) household income. Many of the labour-saving adaptions to swidden employed to allow dual swidden and oil palm livelihoods appear to reduce men's time more than women's or allow women to take on roles formally carried out by men. While men's oil palm labour has clearly shifted even more of the responsibility for food production towards women, it cannot be concluded that food production has become the sole domain of women. Men still commit considerable time and labour to agricultural activities – particularly rice production, which is still largely as a joint household enterprise.

7.6.3 Drivers of Time Scarcity and Gendered Allocation of Time

Participation in off-farm labour in the FOR villages was limited by lack of opportunities. Obtaining regular salaried off-farm work generally requires migrating, at least temporarily, away from forest villages. In contrast, in the OP villages, both men and women had access to greater opportunities for off-farm work in the form of waged plantation labour. However, men's off-farm labour in the OP villages is more accessible (i.e. more types of jobs and longer hours available) and more highly remunerated than women's. Respondents stated that men's plantation labour was more highly remunerated due to the physical nature of the work[12]. Additionally, men in the OP villages had access to overtime work as truck drivers or security guards. Similar gendered pay disparities have been found in multiple other accounts of oil palm labour (Julia and White, 2012; Bissonnette, 2013; Li, 2015; Elmhirst et al., 2015, 2017).

The gendered pay differential creates a gendered difference in the opportunity cost of on-farm labour – resulting in households prioritising men's off-farm labour. Shifting agricultural work away from men towards women to allow men to carry out more off-farm labour is a rational strategy in a context where the opportunity costs of men's on-farm labour is greater than that of women's. As such, households aim to maximise men's time in plantation labour in a joint-utility maximising fashion (Becker, 1965) in order to maximise household income within the constraint of producing sufficient food to feed the family.

While decisions to maximise returns on men's labour appear to be made at the household level, we have little data on intra-household decision-making. Women's agency in such decisions is a vital component of the process missing in this study (see 10.2). Nevertheless, it appears from self-reports alone that women perceive themselves to have a high degree of influence in household decision-making and control of expenditure in both OP and FOR villages. Decision-making occurs in the context of local social and cultural norms and expectations. Women's social and cultural role in reproductive labour, especially as caregivers and cooks, was seen as immutable and a major factor in why women could not work longer hours in productive labour. Likewise, greater pay for men than women in oil palm labour was considered uncontroversial by both men and women with respondents typically cited the more physical nature of men's labour. However, men were also given nearly all the positions of less physically demanding roles as supervisors and office workers. Women were also seen as lacking the knowledge to mix chemical inputs – despite both men and women applying chemical inputs in plantation labour. It should also be noted that contractual arrangements are usually the product of village-level negotiations between local elites and companies – from which women are often excluded (Julia and White, 2012; Elmhirst et al., 2015, 2017; Yuliani et al., 2020). Thus, both levels of pay and access to work are the product of pre-existing cultural and social views on gender roles, filtered through agreements made by village elites on behalf of communities.

Different levels of access to off-farm labour create different opportunity costs of on-farm labour. Results from focus group discussions surrounding household priorities show that households aim to maximise income by spending as much time as possible in off-farm labour while also producing sufficient food to meet the bulk of their needs. As oil palm labour was more profitable than competing income-generating activities, households aimed to maximise time spent in this activity by reducing time spent in on-farm labour. The opportunity costs of on-farm labour, however, are different for men than women. In the OP villages, men are paid at a higher rate, are offered more hours and have access to more types of off-farm labour than women. Similar gendered pay disparities have been found in multiple other accounts

[12]This explanation was near-universally offered by both men and women – despite being inconsistent with the fact that men also took on more highly remunerated non-physical jobs.

Table 7.5: Gendered Effects of Swidden Transitions

Type of Change	Description	Gendered Effect
Labour-Saving Modifications to Rice Cultivation[1]		
Relocation of Fields	• Reduce time spent walking to and from fields & enables access by motorcycle	• Reduced need for men to transport heavy goods to/from fields
Use of tree-poisons	• Reduce need for labour-intensive cutting prior to burning	• Reduces need for male labour during cutting & land preparation
Use of Pesticides and Herbicides	• Reduce time spent on weeding • Enables shorter fallows and consecutive cycles	• Reduces women's time weeding • Reduces need for male labour during cutting & land preparation
Transition from Pepper to Rubber[1]		
Reduced time in rubber cultivation	• Rubber incompatible with oil palm due to time constraints and schedule conflict	• Men and women no longer engaged in shared income generation activities
Opportunities for off-farm labour		
Waged plantation labour	• Men offered more hours than women in plantation labour • Men have access to a wider range of supplementary jobs such as overtime, driving, and security guard positions	• Maximising household income requires maximising time men spend in off-farm work • Where possible, households shift on-farm labour from men to women
Wage Differential & Seniority	• Men paid more than women for plantation labour due to perceived more physical nature of work • Opportunity cost of time spent in farm greater for men than women	• Only men have access to higher-paying positions such as supervisor or office jobs • Households aim to maximise time spent in off-farm labour

[1]Discussed in previous chapter

of oil palm labour (Julia and White, 2012; Bissonnette, 2013; Elmhirst et al., 2015, 2017). As a result, households aim to maximise men's time in plantation labour in a joint-utility-maximising fashion (Becker, 1965) in order to maximise household income within the constraint of producing sufficient food to feed the family. Labour-saving adaptations to swidden cultivation disproportionately reduce men's time, as well as allow women to carry out tasks formerly carried out by men. For example, men's role in transporting heavy goods is reduced through motorbike access to fields near roads, and male labour required for cutting and clearing land is lessened through reduced fallow cycle frequency and/or the use of herbicides. The effect is a shift not only in time allocation but also in household gender roles.

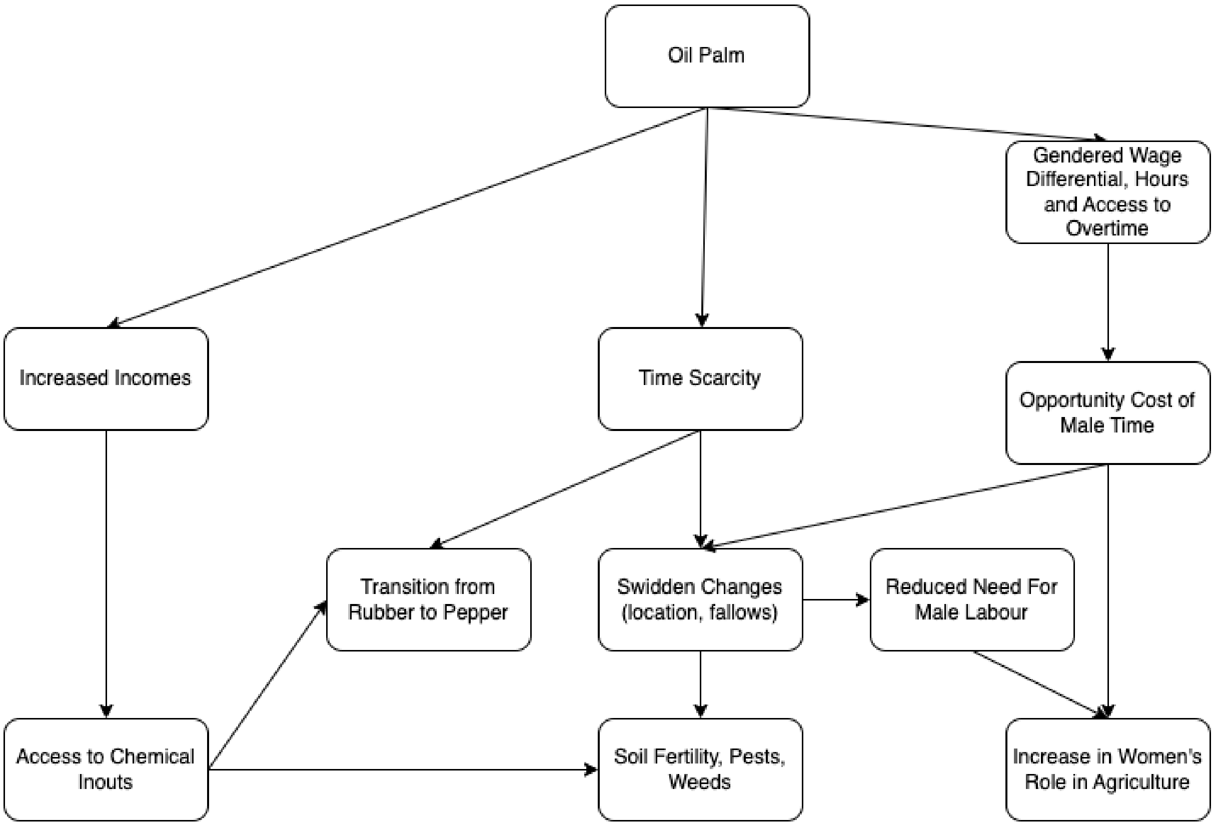
These findings support previous qualitative studies that have shown that swidden-oil palm transitions result in changes in the gendered distribution of labour (Julia and White, 2012; Bissonnette, 2013; Villamor et al., 2014, 2015; Elmhirst et al., 2015, 2017; Maharani et al., 2019). For example, we found near-identical shifts in gendered labour dynamics to Maharani et al. (2019) who showed how changing gender dynamics were driven by labour-saving adaptations such as changes to the farming system (shortening/shipping fallow periods, relocating fields closer to roads), access to technology (use of chemical inputs, motorbikes) which reduced the need for many forms of physical labour which were previously carried out by men.

7.6.4 Gendered Rational and Impacts of Swidden Modifications

Chapter 6 described a number of labour-saving modifications to swidden agriculture and other agricultural changes which occur in direct response to oil palm adoption. Most important among these are the

Figure 7-3: Drivers of Change in Time Allocation and Agrarian Change

Visual Overview of Relationship between Time Allocation and Agrarian Changes



modifications made to swidden rice cultivation (the relocation of fields closer to villages and roads, reduced fallow lengths and less frequent field rotations, and the use of chemical inputs) and the transition away from labour-intensive rubber to capital-intensive pepper. As discussed in Chapter 6, household-level time scarcity is a major driver of these changes as traditional swidden agriculture and rubber cultivation is incompatible with waged oil palm plantation labour – the primary source of income in the OP villages – due to time constraints and conflicting schedules. This chapter has demonstrated that as well as reducing household labour demands of subsistence production, these modifications change the relative amounts of labour allocated to food production between men and women. It should be noted that these gendered changes are not simply a *consequence* of the agrarian transition but also a major *motivator* for making the changes in the first place. In other words, shifting on-farm labour from men to women is not simply a consequence of time-saving adaptations but a key motivator in choosing to employ them. The household-level labour-saving adaptations to swidden cultivation shown in Table 7.5 disproportionately reduce men's time, as well as allow women to carry out tasks formerly carried out by men. For example, men's role in transporting heavy goods is reduced through motorbike access to fields near roads, and male labour required for cutting and clearing land is lessened through reduced fallow cycle frequency and/or the use of herbicides. The effect is a shift not only in time allocation but also in household gender roles. The differences in gender roles shown in Table 7.4 can largely be explained by this process. As with reducing household labour, shifting labour from men to women is enabled by access to income and inputs obtained from oil palm labour.

7.7 Discussion and Conclusion

The main findings of this chapter have been previously published as a journal article (Rowland et al., 2022). This was the first published study to examine the effects of oil palm adoption on gendered time and labour allocation using a validated time use survey instrument. Shortly following the publication of the paper, an additional study (Mehraban et al., 2022, discussed above), in a different oil palm context and using different (non-validated) methods, was published. Together, these studies (which come to opposite conclusions) are, to my knowledge, the only time use studies in any context in rural Indonesia published for several decades[13] and one of only a small handful of studies anywhere in Indonesia[14].

7.7.1 Effects of Oil Palm Adoption on Gendered Labour Allocation

These results highlight the fact that the mechanisms through which oil palm adoption increases participation in off-farm labour may differ by context and smallholder model. Amongst fully independent smallholders who do not engage in subsistence food production, switching from rubber to oil palm may free up time. As discussed above in Section 7.2.2, econometric studies of independent smallholder oil palm adoption by fully commercialised rubber farmers in Sumatra suggest that oil palm adoption can be viewed as a “labour-saving technology” (Kubitza et al., 2019). However, in this study among subsistence farmers whose adoption of oil palm livelihoods is as part of smallholder plasma schemes, participation in off-farm labour is driven not by the labour-efficiency of oil palm, but the insufficiency of income generated via plasma dividends. While this study is the only quantitative study of time and labour allocation in such contexts, it supports the findings of numerous qualitative studies from similar contexts (Julia and White, 2012; Villamor et al., 2014, 2015; Li, 2015; Elmhirst et al., 2017; Maharani et al., 2019). For example, I found near-identical shifts in gendered labour dynamics to Maharani et al. (2019) who showed how changing gender dynamics were driven by labour-saving adaptations such as changes to the farming system (shortening/shipping fallow periods, relocating fields closer to roads), access to technology (use of chemical inputs, motorbikes) which reduced the need for many forms of physical labour which were previously carried out by men. However, by adopting a mixed-method approach, we are better able to

[13]To find studies on gendered time use allocation where both men and women are surveyed, it is necessary to look back to studies published in the 1970s and 1980s which focus on time allocation in rural Java (White, 1984). Though these studies pre-date the use of validated survey instruments for time-use research, they are nevertheless highly detailed studies providing rich insights both into gendered time allocation and time-use research methodology. In one set of studies conducted in 1972-1973, a 24-hour time use recall was used with a sample of 44 Javanese women – each surveyed an astonishing 60 times (White, 1976, 1977; White and Hastuti, 1980). In a separate set of studies in West Java, a combination of 24-hour and 30-day recall methods were used with each member of 120 households across two villages, once a month for a whole year (Sajogyo et al., 1979). Neither set of studies used the now standard time-block approach – where respondents are asked to account for what they were doing in every block of time – instead of reporting the start and stop times of each activity. Additionally, neither set of studies measured concurrent activities – now considered essential for estimating reproductive labour time. However, these studies all used mixed-methods, allowing the researchers confidence in their interpretation of their quantitative findings and adding rich detail to the analysis. Additionally, in the second set of studies, a combination of 24-hour and 30-day recall allowed for the comparison of estimates of recall periods showing (as is now widely known) that long recall periods are highly inaccurate with an underestimation of 40 and 57 per cent of time spent in productive labour for poorer and better off households respectively (White, 1984)

[14]More recent time allocation studies in Indonesia have tended to focus on urban areas (e.g. Dharmowijoyo et al., 2015, 2016). Many studies focusing on time allocation do not record time allocation but labour participation – sometimes combined with time allocation recall for specific activities such as infant care and breastfeeding (Gryboski, 1996) or cattle farming (Nurtini et al., 2019). Likewise, statistics based upon nationally representative surveys tend to focus on macro-level indicators such as hours worked per week and do not contain detailed time-use recall surveys (Gagliardone, 2015).

distinguish between *absolute* changes and *relative* changes in time and labour. Conclusions based on qualitative data alone might have under-emphasized the degree to which women's agricultural labour is lower in the OP villages in absolute terms. Similarly, conclusions based only on the quantitative data would not have detected the complex set of interrelated decision-making processes nor the physical and mental stress of time pressure experienced by women.

7.7.2 Gendered Labour Allocation in the Context of Swidden Transitions

The changing gender dynamics observed in this study are simply the latest development in a long history of gendered transitions within swiddening communities in Kapuas Hulu. Historically, Dayaks practising swidden agriculture have been considered to be "comparatively egalitarian" (Colfer, 2008a) – understood to be a product of low population densities, women's importance in agriculture, bilateral kinship, and geographical isolation from the state (Dove, 1983; Tsing, 1990; Dove, 2011a; Colfer et al., 2015; Elmhirst et al., 2017). The traditional view holds that, while gender differences do occur, for each role or societal function men hold, there is an equally important role for women in a kind of "gender symmetry" (Appell, 1991). These results indicate that the division of labour in the OP villages broadly follows this pattern. While women in the OP villages spend less time on average in productive labour than men (both for off-farm and on-farm and forest activities), men and women spend most of the day working side-by-side in complementary though not identical activities.

In many ways, the gendered effects of oil palm adoption demonstrated in this study (and others) in Kapuas Hulu, resemble earlier studies focused on the logging boom which preceded oil palm development (Elmhirst et al., 2016). Colfer (2008a) documented the effects of a nascent logging industry on gender dynamics amongst swiddening Kenyah Dayaks in East Kalimantan. The parallels with this case study are striking. The new off-farm labour opportunities emerged, which benefited men more than women, leading to men becoming seen as responsible for income generation. At the same time, new technology (such as chainsaws and outboard motors) reduced the workload for men within swidden cultivation but not for women. These changes affected not only the allocation of time and labour but also had lasting effects on intra-household gender dynamics.

7.8 Conclusion

This study suggests that oil palm adoption (in the form of participation in smallholder plasma schemes) amongst former swidden farmers drastically alters the intra-household allocation of time and labour. Oil palm adoption is associated with more time spent in off-farm labour for both men and women – but significantly more so for men than for women. Likewise, oil palm adoption is associated with less time spent in agricultural and forest activities for both men and women – but significantly more so for men than for women. These findings indicate a trade-off between time spent in off-farm labour and time spent in agricultural and forest-based activities. This trade-off is corroborated by the qualitative findings, which indicate that households in the OP villages maximise time spent in off-farm labour and minimise time spent in agricultural and forest-based activities at the household level, shifting as much agricultural labour towards women as possible. This is achieved through a series of changes to agricultural production, which interact in complex, non-linear ways with broader landscape processes of land use and agrarian change.

The increased time women spend in productive labour in the oil palm comes at the cost of personal and leisure time as well as sleep. The qualitative findings confirm that women perceived an overall scarcity of time and that this time pressure manifests itself in the form of mental and physical stress. Time pressure may have significant effects on maternal and child nutrition (Kadiyala et al., 2014; Johnston et al., 2015; Stevano et al., 2019) as well as subjective well-being and women's empowerment.

When faced with insufficient time in the day to carry out all the tasks they need to do, women cope first by sacrificing their own rest, leisure and sleep time. They also deploy coping strategies aimed at reducing the time spent in childcare activities and reducing the time spent acquiring and cooking foods. These coping strategies were deployed more frequently in the OP villages than the FOR villages. However, the total amount of time dedicated to reproductive labour is not statistically different between the two sets of villages. One possible explanation for this is the increased overall burden of reproductive work due to women being unable to take children with them during plantation work and the village environment being considered unsafe for children to engage in unsupervised play. The implications for food choice pathways are the focus of Chapter 9. Additionally, I discuss the non-food mediated pathways through which these time-use effects may affect nutrition in the Discussion Chapter (10). The changes in time allocation are also critical in the provisioning of food from both agricultural and wild sources – which is the focus of the next Chapter.

Chapter 8: A Comparison of Food Systems Between Oil Palm and Non-Oil Palm Villages

Contents

Abstract:

Background and Aims: Research on dietary impacts of oil palm adoption and expansion has largely overlooked structural food-system pathways, focusing predominantly on income-mediated pathways. This chapter aims to explore the ways in which food systems may be modified by oil palm development and identify pathways through which these may affect food availability and prices at the local level.

Methods and Approach: A convergent mixed-methods approach is used to integrate qualitative and quantitative data on food systems in communities which have adopted smallholder plasma oil palm (OP) and with similar communities which have not adopted oil palm (FOR) but have diverged from a similar historical baseline in different ways. The chapter examines each of the three food sub-systems salient in the local context (the agricultural, the wild and the market food sub-systems) in turn before examining the net effect of changes in these sub-systems on village-level food availability and prices.

Results:

Agricultural Sub-System: Overall, the agricultural production sub-system produces a lower diversity of foods in the OP villages compared with the FOR villages. Compared with the FOR villages, fewer households in the OP villages are engaged in extensive forms of agricultural production and own field types high in agrobiodiversity. Farm households in OP are more specialised in rice production and are less likely to produce fruits, vegetables, legumes, nuts and seeds. Additionally, those households who do produce vegetables produce fewer different types in the OP villages.

Wild Food Sub-System: Important wild food environments consisted of forests, agrobiodiversity in agricultural fields and fallows and non-forest wild environments, including village surroundings and paths to and from fields and workplaces. Forests were the most important source of wild meat. However, village surroundings were the most important source of wild fish, as well as Wild Edible Plants (WEPs) (combined with agrobiodiversity in the FOR villages). Compared with the FOR villages, forest food environments were located further away from villages and visiting them required making greater deviations from daily activity spaces. However, paradoxically, they may be easier to access from villages due to improved motorcycle access. Acquisition rates of Wild Foods (WFs) from village surroundings were comparable between sets of villages. However, the acquisition of WFs from all other locations was lower in the FOR villages. While fewer households participated in most types of WFs acquisition, for those who did, there were no significant differences in acquisition frequency (except for other vegetables) or the quantities collected. In neither of the village types was WF abundance considered a significant limiting factor in WF acquisition. Rather, the acquisition was influenced by changing proximity to locations abundant in wild foods due to changing activity spaces, resulting in fewer opportunistic and semi-opportunistic acquisition events. Additionally, time scarcity was seen as a major driver of reduced WF acquisition following the adoption of oil palm livelihoods.

Market Food Sub-System: Overall, the market food systems in each type of villageprovide access to similar food groups, though the diversity of foods within food groups is lower in the OP villages. Prices of most foods from outside-village origin were comparable between sets of villages, but foods produced and sold locally tended to be cheaper than alternatives from outside. Village market food environments found in both sets of villages are village shops selling predominantly non-perishable foods and mobile vendors operating as sole traders on motorcycles selling fresh perishable foods (as well as, less frequently, pre-prepared foods). Additionally, in the FOR villages, there exists an extensive system of hyper-local trade, which is almost entirely absent in the OP villages (although it did exist prior to oil palm development). The hyper-local market food system consists primarily of intra-village peer-to-peer trade, alongside occasional trading between proximate villages. In the OP villages, mobile vendors tend to visit more frequently (though this varies greatly by village according to village connectivity and perceived demand) and residents also make use of temporary markets which spring up around oil palm company offices on pay-days.

Village-Level Availability and Prices: At the food group level, there are no observable differences between food availability at the village level between sets of villages. However, a more diverse range of foods is available in the FOR villages for most food groups. On average, villages in the FOR villages have 2.4 times as many fish varieties, 3.2 times as many fruit varieties and 1.9 times as many Dark-Green Leafy Vegetable (DGLV) varieties, which are commonly available. While market foods of outside origin are comparable between sets of villages, the increased prevalence of cheaper locally produced agricultural and wild foods means that prices of some food groups – especially meat – are cheaper in the FOR villages.

8.1 Introduction

In Chapter 3, I reviewed the current literature on oil palm expansion, diets and nutrition. The review showed a stark contrast between quantitative and qualitative studies. Almost all quantitative studies were situated in a context where markets functioned well and studied oil palm-adopting households who grew little to none of their own food. As such, the studies predominantly focused on the role of income in influencing diets, without considering local production, market-level or food system changes. Several qualitative studies situated in contexts where farmers are subsistence-orientated show that oil palm expansion and adoption may influence food availability through its effects on agriculture and forests. For example, Julia and White (2012) finds that a loss of a local agricultural surplus leads to a lack of fresh food availability after the adoption of oil palm. Likewise, several studies report interactions between forest loss and wild food availability and use (e.g. Orth, 2007; Obidzinski et al., 2012). Market food provision may be altered by oil palm development through a range of mechanisms, including changes in infrastructure, demographics and demand. Oil palm adoption may affect food systems in more subtle ways as well. For instance, Li (2015) notes that the transition from rubber to pepper affects the accessibility of credit for purchasing foods.

While these studies strongly suggest that oil palm expansion can, in some contexts, modify food systems in a way that alters the availability and prices of foods, to date, there has been no systematic attempt to document this. Indeed, most of the qualitative studies reviewed in Chapter 3 were not investigations of foods and food systems at all but uncovered these impacts while focused on other aspects of livelihoods and well-being. To my knowledge, this is the first study to explicitly examine the effect of oil palm production on food systems. This chapter is focused on the facets of the food system which influence the supply of foods at the local level – that is to say the agricultural and wild food production systems and the local market provision of foods. Other less material changes which affect food choice – such as social and cultural preferences are the focus of the next chapter.

The chapter is structured as follows. After a brief overview of methods in **Section 8.2**, I first present a descriptive analysis of survey data in **Section 8.3.1** and an overview of qualitative themes. My analysis is structured around the three food sub-systems outlined in the conceptual framework. **Sections 8.4**, **8.5**, and **8.5** examine oil palm-driven changes in the agricultural, wild, and market food sub-systems respectively. Each section begins with a brief characterisation of the types of food environments within the sub-system before comparing and contrasting their food provision as well as examining recent historical changes. Finally, in **Section 8.7**, I explore the drivers of food system changes as well as the complex interactions and feedback loops between sub-systems.

8.2 Data and Methods

As described in Chapter 5 (Section 5.2.2), this study adopts a convergent mixed-methods approach to integrating quantitative and qualitative data. The qualitative data used in this chapter was part of the general qualitative investigation described in Chapter 5 (Section 5.4.4). Several of the methods used in this chapter require the triangulation of data from multiple sources. Much of the data fall somewhere on the continuum between pure quantitative and pure qualitative data – what Chambers (2007) describes as "participatory numbers". To classify this data, I borrow and adapt a classification used by Nordhagen et al. (2021). I group data into Measured or Observed (MO), Reported (R) and Perceived (P), shown in Table 8.1.

Table 8.1: Types of Data

Classification of Data Based on System Devised by Nordhagen et al. (2021)

	Data Types			
	MO	**R**	**P**	**Source(s)**
Locally Produced Foods:				
Agricultural Production, Ownership, and Diversity	✓			Farm Survey
Wild Food Acquisition Behaviour	✓			Recall Survey
Market Food Prices and Availability				
Mobile Vendors	✓	✓		KII, PM, VS, DO
Peer-to-peer Trade		✓		KII, FGD
Village Shops	✓			DO
Seasonal Availability			✓	PDM

Notes: Measured or Observed (MO) data are measures of objective reality (e.g. numbers of sellers, numbers of crops) either directly observed by myself and/or research colleagues or through questionnaire surveys. Reported evidence are measures of objective reality which are not directly observed but are relayed by key informants (e.g. how often a mobile vendor visits). Perceived data are measures of respondent's subjective assessments of an outcome (e.g. relative fruit availability during different seasons). PDM = Pebble Distribution Method; KII = Key-Informant Interviews; DO = Direct Observation; VS = Village Survey

Data on agricultural production came from the farm survey, which was administered to male household members, while surveys on wild and forest resource use were administered to both men and women as part of their respective surveys. Further details of the questionnaire approaches are discussed in the Methods Chapter (Section 5.4.3). Data on the market food availability and prices, as well as lists of agricultural and wild foods available at the village level, were acquired through triangulating data from multiple sources. I created an "all-source village inventory" by triangulating data from direct observation, shop inventories, free-listing exercises during FGDs and key-informant interviews, participatory walks, and participatory maps. Data were triangulated to cross-verify, identify and interrogate inconsistencies and generate insights. Combining different incomplete sources of data where sources vary in their likely accuracy or reliability requires the use of a "stepwise hierarchical approach" to data collection (Ambikapathi et al., 2018). For transparency, I report my hierarchical approach in Appendix H.1.

The all-source village inventory is an exhaustive list of foods available in the village, irrespective of seasonal fluctuations. While it is representative of food availability at the village level, it misses two crucial sources of food which occur outside the village – temporary markets and pay-day markets. The former, however, is covered by CIFOR DFC data (Appendix H.10). Comparisons between the village inventory and this market data did not reveal any discrepancies in food availability. The latter, I do not have exhaustive data on. However, I do have qualitative data discussing them, as well as my direct observations on a limited number of occasions. I directly observed two pay-day markets but did not implement a full market inventory. This is because one visit was based upon a chance encounter, and the second was a spontaneous visit when it became apparent one was happening nearby. Both visits were brief and spontaneous, and it was not possible to carry out a full inventory at the time, which required more planning and prior training of enumerators. A full inventory was possible without prior planning due to the difficulty of conducting a continual inventory throughout the day, with mobile vendors arriving and leaving constantly. From the researcher's observations, recorded in field notes, the markets were skewed towards non-perishable goods and foods but also contained sellers of fresh perishable foods as well as prepared cooked foods.

Measures and Indicators

I use a wide range of metrics and measures to compare sites and food systems. A full list of quantitative metrics used is available in Appendix H.1. The large number of different metrics in part reflects the lack of standardised methods and ongoing debates over the best indicators to measure aspects of food systems such as agricultural production diversity (Berti, 2015; Sibhatu et al., 2015b; Jones, 2017a; Gupta et al., 2020), market food availability (Turner et al., 2019; Van Der Meulen, 2023) and their links to dietary diversity (Koppmair and Qaim, 2017; Verger et al., 2017, 2019). Additionally, many of the newer "emerging" measures used in the literature have yet to be validated (Data4Diets, 2023). Where possible, therefore, I use multiple indicators to test robustness. A more general discussion of the use of indicators is provided in the Methods Chapter (Section 5.5.1)

For some parts of my analysis, no existing indicators exist. In several cases, therefore, I create novel indicators or adapt existing indicators for a new purpose. For example, to assess food availability at the village level, I create a Village Level Diversity Score (VLDS) by adapting an existing metric of market food availability (the Market-Level Diversity Score) and expanding it to include locally produced wild and agricultural foods. To compare the degree of specialisation between different farm systems, I create a Farm System Diversity Index (FSDI), which counts the number of fields with different cultivation systems within an overall farm system. I produce two variants of this metric: the FSDI, which counts all types of fields and the Farm System Diversity Index for Food Crops (FSDI-F), which counts only those fields which produce edible crops[1]. My reasoning for this was two-fold. Firstly, it has been demonstrated that production diversity indicators which include types of farm systems which are often neglected in farm surveys (for example kitchen gardens) are better than conventional measures at explaining changes in dietary diversity Gupta et al. (2020). Secondly, a significant component of local food production is in the form of wild and semi-cultivated agrobiodiversity, which grows in and around cultivated fields – but is often missed by conventional farm surveys. While my farm survey approach explicitly attempts to capture this, it is still likely to be a significant under-estimate. As different forms of agrobiodiversity are likely to be found in different field types, the number of field types overall is likely to be associated with total farm agrobiodiversity. In addition to measuring the farm system diversity, I measure the relative contribution of fields to the overall production diversity by calculating the diversity of fields relative to the farm-level production diversity. Further details of the construction of these metrics are described in

[1]For instance, a farm consisting of swiddens, rubber agroforestry, and pepper garden would have an FSDI of three and an FSDI-F of two. Full details of the rationale and calculation of the metric are available in Appendix (a).

Appendix (a).

My measures and indicators of Production Diversity (PD) also differ slightly from those often currently used in the literature. Recognising debate over the appropriate metrics to measure PD (e.g. Berti, 2015; Sibhatu et al., 2015b). I use multiple methods of measuring PD including raw counts of food types[2] and desegregated 10-food group count[3]. For the sake of comparison and for robustness, I also include two commonly used sets of food groups, the Household Dietary Diversity Score (HDDS)[4] and the Minimum Dietary Diversity for Women (MDD-W)[5]. While I use the same categories as are standard for each of these in the literature, my approach differs in a crucial aspect: my data contains field-level data on both crop production (i.e. intentionally cultivated) foods and wild and semi-cultivated foods harvested in the preceding 12 months. This approach ensures that no wild or semi-cultivated foods are missed – a major flaw in conventional farm-survey-based measures common in the literature and standard approaches (Powell et al., 2015; Jones, 2017a) – though is still likely to under-estimate the importance of agrobiodiversity[6]. I am therefore able to create and compare both conventional measures of PD alongside this novel measure, which includes agrobiodiversity.

8.3 Descriptive Analysis and Comparative Statistics

This section presents an overview of the quantitative and qualitative data used and a comparative analysis of the data between sets of villages. A description of selected key themes are shown in Table 9.6. The mixed-methods integration of these data is structured by food sub-system in the subsequent chapters.

8.3.1 Farm-Survey Results

Table 8.3 shows differences in the crops produced by farming households. Livestock ownership is reported in Appendix Table H.6. Compared with the FOR villages, where most farming households grew a range of fruits and vegetables, a significantly higher proportion of farming households grew no fruits and no vegetables. These households were primarily focused on rice production[7]. Those who did cultivate fruits and vegetables also tended to produce fewer varieties.

Table 8.2 describes the crop diversity and farm diversity of the farming systems using a variety of metrics. Farms in the FOR villages were more diverse than those in the OP villages in terms of the number of

[2]Species/varieties level measures have issues with taxonomic inflation – but may be more closely related to nutritional outcomes than food group measures (Lachat et al., 2018)

[3]Cereals; Roots and Tubers; Dark-Green Leafy Vegetables; Orange Fruits; Orange Vegetables; Other Fruits; Other Vegetables; Spices and Condiment Vegetables; Legumes; Pulses Nuts and Seeds

[4]Cereals; Roots and Tubers; Pulses/Legumes/Nuts; Milk and Milk Products; Meat; Fish/Seafood; Eggs; Vegetables; Fruits; Oils/Fats; Sweets, Sugar/Honey; Miscellaneous (e.g. Spices/Beverages).

[5]Grains, White Roots, Tubers; Pulses and Legumes; Nuts and Seeds; Dairy; Meat, Poultry and Fish; Eggs; Dark-Green Leafy Vegetables; Vitamin A-Rich Fruits and Vegetables; Other Vegetables; Other Fruits

[6]Foods were included if, and only if, they had been harvested within the past 12 months by households for food (own consumption or sale) based upon a 12-month recall questionnaire. The survey was not an exhaustive list of all wild foods which could be found in a field. Recall surveys of wild foods are likely to suffer from under-estimation due to recall bias– particularly for less memorable events such as the collection of wild edible plants (see Chapter 5, Section 5.4.3 for more detailed discussion of recall bias).

[7]All farming households produced rice

Table 8.2: Farm Production Diversity

Variable	Forest	sd	OP	sd	p-value
Farm Level Diversity (# types):					
All Fields (FSDI)[1]	4.2	1.9	2.9	1.7	0.000 ***
Food Producing (FSDI-F)[2]	2.3	1.2	1.5	0.9	0.000 ***
Production Diversity (Raw Counts, Excl. Livestock)					
Crop Count (# Species)	9.27	10.83	3.67	5.17	0.000 ***
Food Groups† (Max 10)	3.85	1.94	2.58	1.47	0.000 ***
Production Diversity (Metrics, Incl. Livestock)					
Cultivated Foods Only:					
HDDS Food Groups‡	3.33	1.08	2.83	1.30	0.000 ***
MDDW Food Groups†††	3.47	1.16	2.96	1.39	0.000 ***
Including Agro-Biodiversity[3]:					
HDDS Food Groups‡	4.01	1.54	3.08	1.51	0.000 ***
MDD-W Food Groups†††	4.46	1.74	3.36	1.70	0.000 ***

Notes: Table shows comparisons between OP and FOR sites. Comparisons use t-tests for continuous variables and z-tests of proportions for binary variables. Significance levels have been corrected for multiple comparisons using Bonferroni correction: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.; [1,2] **Farm-System Diversity**: Farm System Diversity Index (FSDI) and Farm System Diversity Index-Food Producing(FSDI-F) (See Appendix (a)); [3]**Agrobiodiversity**: Includes semi-cultivated crops and wild foods harvested within field boundaries (does not include other wild foods);

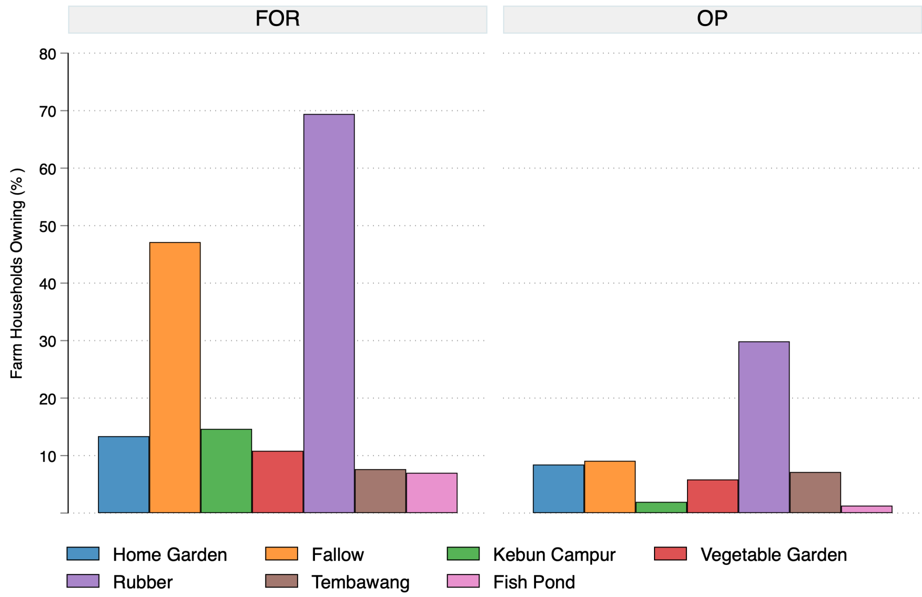
Table 8.3: Food Crops Grown

Variable	Forest	(sd)	OP	(sd)	p-value
Proportion of Farming Households[1]:					
Vegetables(Any)	0.85	0.03	0.64	0.00	0.000 ***
DLGV	0.50	0.04	0.30	0.00	0.000 ***
Orange Vegetables	0.05	0.02	0.00	0.00	0.005
Herbs, Spices etc.	0.32	0.04	0.10	0.00	0.000 ***
Other Vegetables	0.79	0.03	0.56	0.00	0.000 ***
Fruit (Any)	0.44	0.04	0.20	0.00	0.000 ***
Orange Fruits	0.05	0.02	0.00	0.00	0.005
Other Fruits	0.44	0.04	0.20	0.00	0.000 ***
Legumes	0.11	0.03	0.03	0.00	0.002 *
Roots and Shoots	0.17	0.03	0.06	0.00	0.003 *
Nuts and Seeds	0.17	0.03	0.05	0.00	0.001 **
Average Number of Types[2]:					
Livestock	1.42	0.94	1.01	0.94	0.00***
Vegetables(Any)	3.59	3.61	1.96	1.63	0.00***
Other Vegetables	2.67	2.57	1.60	1.30	0.00***
DGLV	1.76	1.36	1.24	0.56	0.01*
Herbs, Spices etc.	1.48	0.71	1.28	0.75	0.31
Fruits (Any)	2.48	1.84	2.08	1.57	0.27
Legumes	1.11	0.32	1.00	0.00	0.38
Roots and Shoots	1.38	0.50	1.31	0.48	0.65
Nuts and Seeds	1.08	0.27	1.00	0.00	0.38

Note: Significance levels have been corrected for multiple comparisons using Bonferroni correction. [1]Farming households are defined as having grown at least one edible crop. For all farming households, rice was grown. Note farming households are a sub-sample of the overall survey population. [2]Average number of species from food group for households growing at least one type of crop from food group.

different arable production systems contained within the overall farm system. On average, farms in the FOR villages had 2.3 different types of food-producing field types, compared with 1.9 types in the OP villages (Table 8.2). Figure 8-1 provides a visual overview of the make-up of farms in each village type. The average number of varieties of different food groups found in each field is presented in Figure 8-2, while Figure 8-3 shows the relative diversity of each field type in terms of each food group.

Figure 8-1: Field Ownership for Farm-Owning Households



Farming households in the FOR villages were significantly more likely to own agrobiodiverse fields such as rubber gardens, mixed gardens and food-producing fallow fields (Table 8.4). Fallows were also older on average, and more likely to have had food acquired from them within the preceding 30 days (Table 8.5)

8.3.2 Wild Food Acquisition Recall Surveys

Table 8.6 shows household-level participation in wild food acquisition in forest and OP villages using 30-day recall data. Some kind of wild food acquisition was a near-universal practice in both sets of villages. While unsurprising in the FOR villages, the high degree of acquisition, even after the adoption of oil palm in the OP villages, is unexpected. The high prevalence of wild food acquisition is predominantly explained by the widespread practice of Wild Edible Plant (WEP) collection by women in both sets of villages (Table 8.7). While there were no statistically significant differences in the proportion of surveyed men who engaged in hunting and fishing in the prior 30-day period, those who did engage in hunting did so almost twice as often (4.5 out of 30 days in the FOR villages, compared with 2.4 days in the OP villages, p=0.00).

Figure 8-2: Crops Grown in Different Field Types

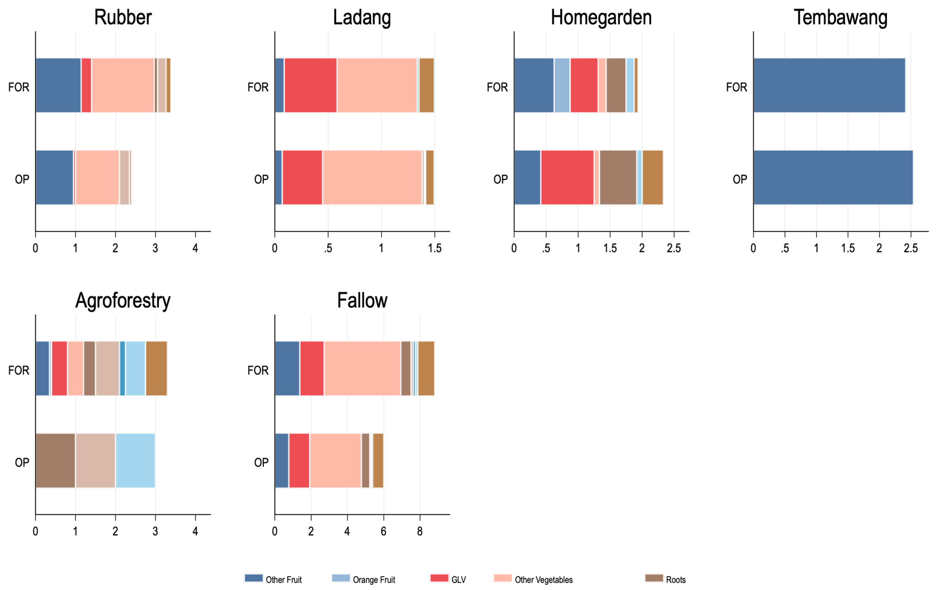
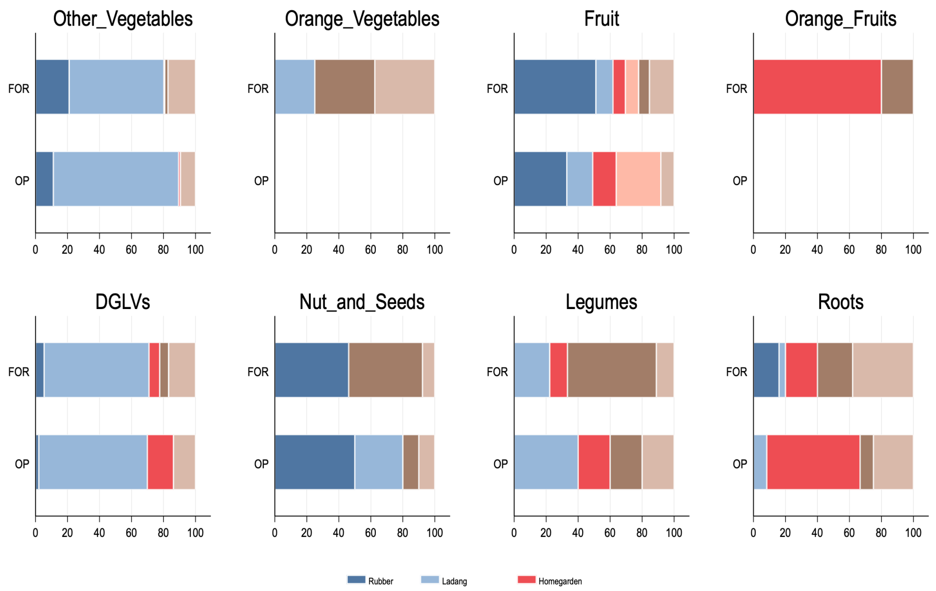


Figure 8-3: Contributions of Different Field Types to Food Diversity



Notes: *Graph 8-3 indicates the average *relative* diversity of different field types. Food species varieties can be counted more than once (e.g. if the same variety is found in multiple fields). The relative diversity for a food group FG in field i is given by: Relative Diversity$_{i,FG} = \left(\frac{v_{i,FG}}{V_{FG}}\right) \times 100$ where $v_{i,FG}$ is the average number of varieties of the food group FG in field i, and V_{FG} is the sum of average varieties of the food group FG across all fields.

Table 8.4: Ownership of Field Types with High Agrobiodiversity

Percentage of Households Owning Field Types

Variable	**FOR**	**se**	**OP**	**se**	**p-value**
Fallow (food-producing)[1]	47	39.5	7.3	1.8	0.000***
Mixed-Agroforestry	14	2.7	1.6	0.1	0.000***
Forest Garden	7	0.0	7	0.0	0.941
Rubber	69.8	3.6	28.6	3.3	0.000***

Table shows ownership of fields high in agro-biodiversity. Significance levels have been corrected for multiple comparisons using Bonferroni correction. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. [1] Fallows reported as having crops harvested in the farm survey. Fallows where wild foods were only occasionally harvested are likely not to be included.

Table 8.5: Fallow Field Characteristics

Variable	FOR	sd	OP	sd	p-value
Fallow Age (yrs.)	2.2	0.5	2.8	0.8	0.001 ***
Fallow Area (ha)	4.0	10.2	0.9	1.7	0.130
Distance (Mins. walking)	38.2	20.3	27.7	12.6	0.026
Value Consumed (30d, 1000 IDR)	177.9	155.3	170.0	133.8	0.836
Value Sold 30d (1000 IDR)	519.4	106.7	107.4	214.8	0.058
Foods Obtained (30d, y/n)	45	0.06	92	0.05	0.000 ***
Food Groups Planted[2] (#)	2.56	0.22	2.17	0.27	0.26

Table shows differences between sites among households who own fallow land, which is a sub-set of farming households. Significance levels have been corrected for multiple comparisons using Bonferroni correction. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. [1] For continuous variables, differences are reported as t-tests with standard deviations. For binary variables, differences are reported as Z-tests of proportions with standard errors. [2] Average number of food groups planted as crops (i.e. excluding wild foods) on fallow land (for households who plant at least one crop on fallow land).

Table 8.6: Household Level Participation in Wild Food Acquisition

Acquisition of wild foods by households in 30-day period prior to survey

	Forest	sd/se	OP	sd/se	p-value
Food Groups, Days Collected (days)†					
Meat	4.43	0.49	2.45	0.21	0.000***
Fish	6.26	0.62	4.26	0.35	0.006**
Fruits	3.00	1.51	2.00	1.51	0.08
DGLVs	4.3	1.46	2.22	0.25	0.08
Roots and Shoots	2.86	1.62	2.11	1.62	0.02
Other Veg.	2.50	1.73	1.00	1.73	0.00***
Food Groups, Quantity Collected (kg)†:					
Meat	4.16	0.97	1.52	0.16	0.001***
Fish	2.09	0.62	0.80	0,13	0.044
Fruits	2.50	2.38	3.00	2.38	0.07
DGLVs	2.2	2.12	1.30	2.12	0.02
Roots and Shoots	8.89	19.09	5.13	19.09	0.37
Other Veg.	4.50	3.98	1.00	3.98	0.09

Notes Data from men's and women's surveys, reported at the household level. For continuous variables, differences are reported as t-tests with standard deviations. For binary variables, differences are reported as Z-tests of proportions with standard errors. † For households who collected at least one wild food during the preceding 30 days. [1] E.g. village surroundings, roadsides, rivers, shrubland etc.

Table 8.7: Gendered Disaggregated Participation in WF Acquisition

	FOR	se	OP	se	p-value
Women:					
Any	94.8	1.5	96.5	1.2	0.403
Fish	48.7	3.9	40.1	3.5	0.103
DGLV	82.3	2.6	85.8	2.3	0.313
Other Veg.	24.7	2.9	6.6	1.7	0.000***
Fruit	27.2	3.1	46.0	3.3	0.000***
Roots & Shoots	23.5	2.9	6.2	1.6	0.000***
Meat	5.8	1.5	7.5	1.8	0.411
Fish	28.2	3.1	33.6	3.1	0.216
Men:					
Meat	30.0	3.8	21.9	3.0	0.08
Fish	55.3	3.9	40.1	3.5	0.004
DGLV	40.9	3.9	22.9	3.9	0.00
Roots & Shoots	27.7	3.5	21.4	3.5	0.17
Fruit	6.9	2.0	2.1	2.0	0.03
Vegetables	28.3	3.6	17.7	3.6	0.02

Locations of Wild Food Acquisitions

The 30-day recall of wild food acquisition included in both the men's and women's surveys also noted the location for each acquisition event[8]. Figure 8-4 shows the proportion of acquisition events occurring in different locations. Three aspects of the figures are worth highlighting. Firstly, in both sets of villages, the village surroundings are highly important as sources of wild foods, accounting for 40% of WEP acquisition events. Additionally, the overwhelming majority of fishing events occur in the river in or near to the home village. Secondly, while forests are the location for the majority of hunting episodes, they contribute a much smaller share for WEPs, accounting for only around 15-20% of acquisition events. Thirdly, the importance of agrobiodiversity is revealed by comparing the graphs with and without agrobiodiversity. Together, sources of agrobiodiversity (in rubber fields, fallow lands and other fields) account for around 26% of wild food acquisitions in the FOR villages[9]. The contribution of agrobiodiversity in the OP villages is substantially lower (10.1%) – but still substantial. The main explanatory factor in the difference in the share of WEPs coming from agrobiodiversity was the absence of acquisition of wild and semi-cultivated foods from rubber gardens in the OP villages (which accounted for 12% of acquisitions in the FOR villages – a practice largely discontinued in the OP villages as rubber tapping was no longer a primary occupation for most households. Finally, a surprising finding is the extent to which forest fragments in and around oil palm plantations make, with 25% of WEP acquisition events occurring in these locations.

Opportunistic Wild Food Acquisition

For each wild food acquisition event recorded, respondents were asked whether the foods collected were done so opportunistically or whether they had set out with the intention of collecting wild foods (Figure 8-5). For women, the majority of food acquisition events of all types were opportunistic, with one exception – wild fruit acquisition in the OP villages. A higher proportion of fruit acquisition was deliberate for both men and women in the OP villages.

Locally Produced Foods in the Market System

Figure 8-8 shows the proportion of wild foods acquired in the 30-day recall period consumed by the respondent's household, sold, or gifted. The majority of wild foods that were acquired were consumed by the respondent household. Of those that were sold, almost all (with the rare exception of some fruits[10]) were sold within the village, directly via peer-to-peer trade, exchange or reciprocal gift-giving. Given

[8]Note: Acquisition events are defined as episodes of wild food collection (i.e. occasions) at the food subgroup level. For instance, if multiple different fern species were obtained from the same place at the same time, it is recorded as a single acquisition event. This choice was made to avoid the danger of inflation due to multiple or overlapping names for different species, which is often exacerbated if dealing with local names for species and varieties (as my survey does).

[9]Note: This is likely to be a substantial under-estimate as I took a conservative approach to aggregating foods from cultivated fields. Where foods could be either cultivated or wild or semi-cultivated, they were not classified as wild foods. Additionally, much older fallows (particularly those no longer incorporated into swidden cycles or belonging to other households) are likely to have been classified as "Other Wild" as they would not necessarily be identified as fallows by respondents

[10]While most wild fruits which were sold were traded within the village, some fruits were sold to neighbouring villages (see below), and some highly valuable fruits (esp. Durian) were sold to outside traders.

Figure 8-4: Locations of Wild Food Acquisitions

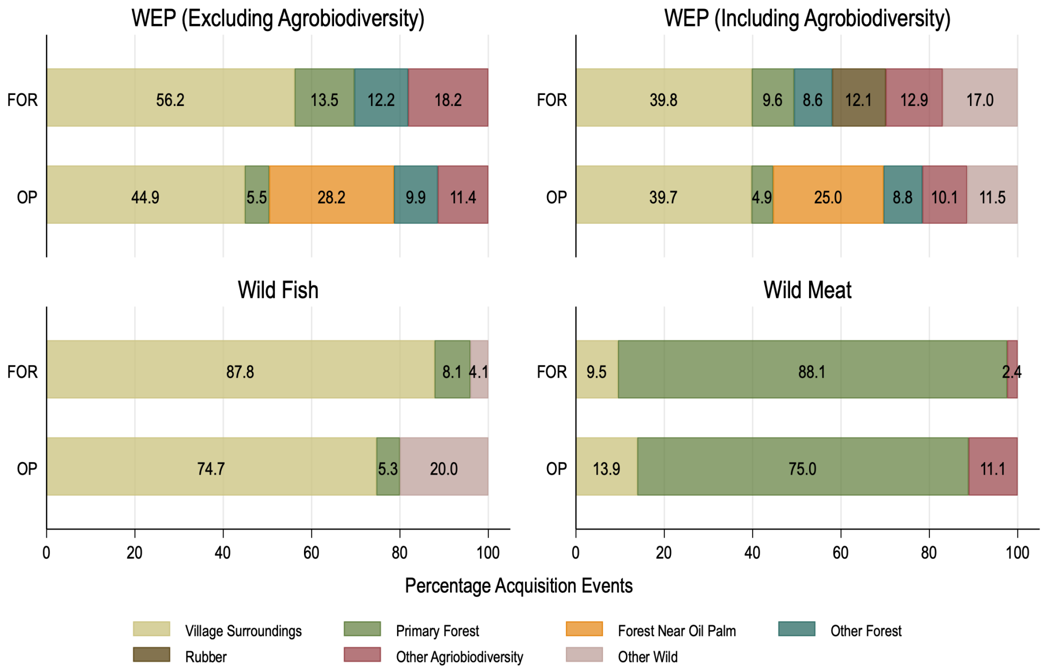


Figure 8-5: Opportunistic and Intentional Wild Food Acquisition

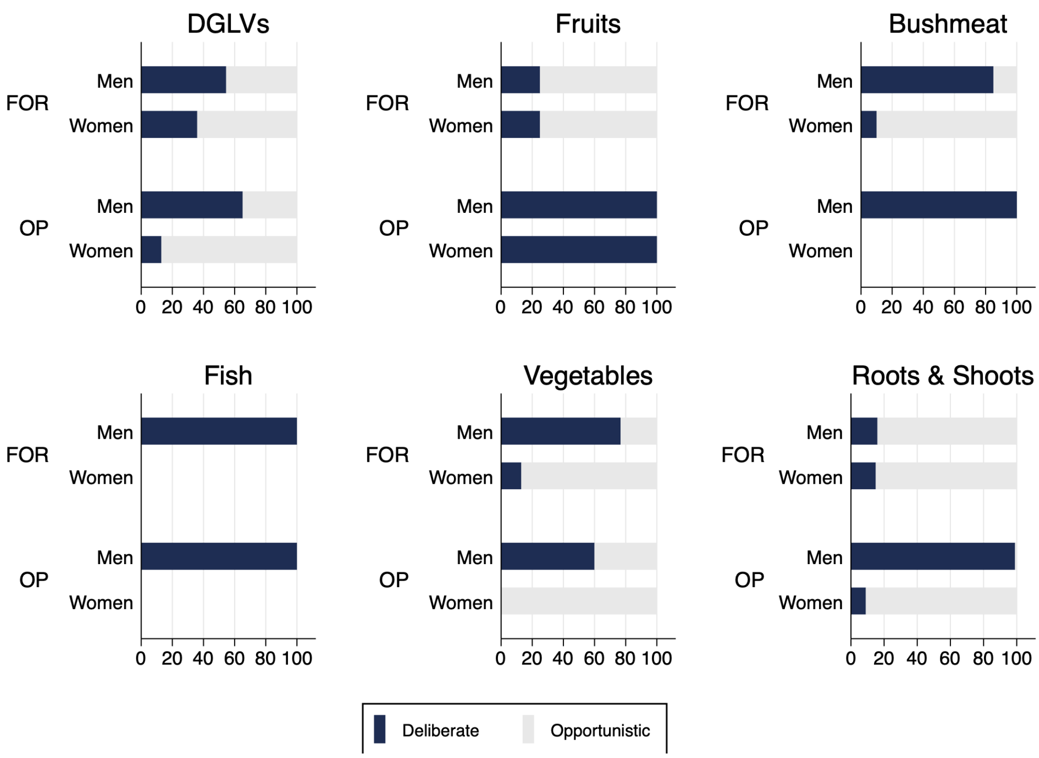


Figure 8-6: Perceived Change in Hunting Frequency

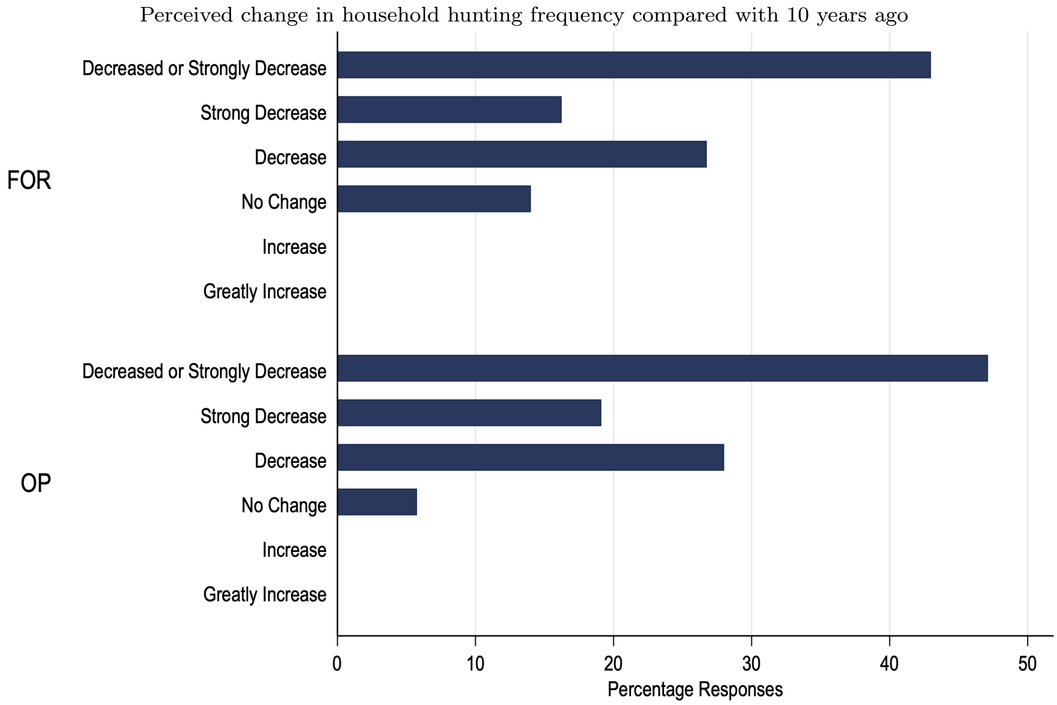
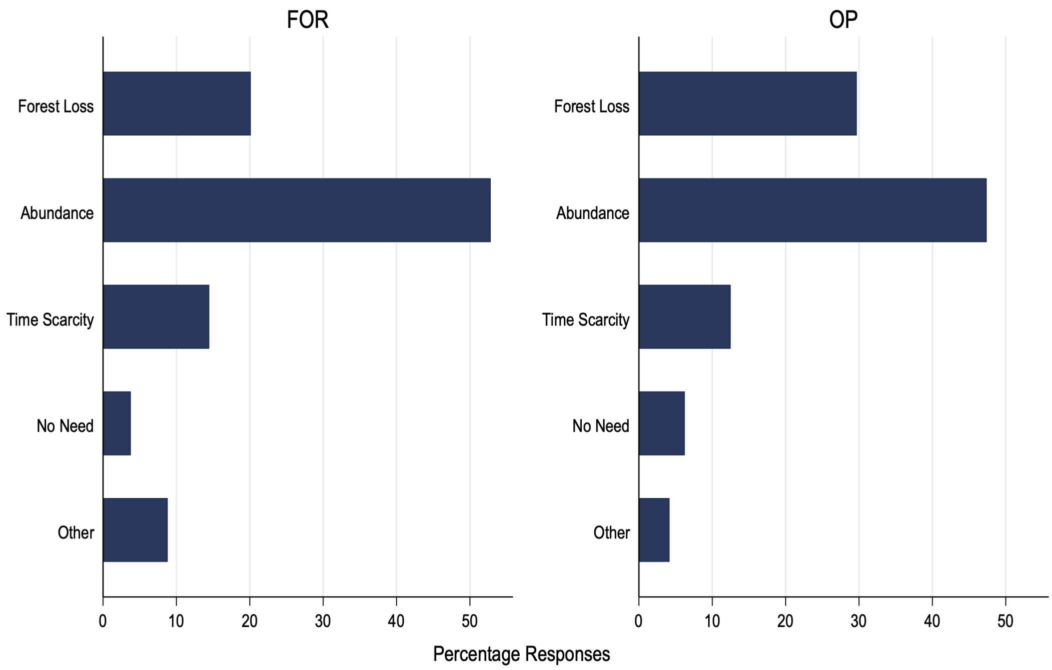


Figure 8-7: Stated Reason Decline in Hunting Frequency



Notes: Reasons given for decline in hunting frequency For men who hunt less frequency than 10 years. Stated reasons for the decline are based on the classification of free-text responses in the questionnaire survey. Categorisations are extremely broad so as to be interpretable.

this, it can be assumed that the vast majority of the foods categorised as "gifted" or "sold" in Figure 8-8 enter the local market food system via peer-to-peer trade.

8.3.3 Food Availability and Prices

(a) Comparisons of Food Availability

Indicators of Market Availability

To compare markets between sets of villages as well as for comparing between subcomponents of market food systems, I use a metric of overall market diversity. While no validated method yet exists for this purpose, the need for such a metric is widely recognised (Pingali and Ricketts, 2014). In recent years, several approaches have been put forward which involve simple checklists of food or good group availability (e.g. Ambikapathi et al., 2018; Zanello et al., 2019). I use the Market-Level Diversity Score (MLDS) – an "emerging" indicator (Data4Diets, 2023) based on the presence or absence of the food groups in the HDDS and increasingly adopted as a general measure of market-food availability and to identify markets lacking in diverse foods (e.g. Gupta et al., 2020; Muthini et al., 2020; Nandi and Nedumaran, 2022). For robustness, I also compare outcomes with other groupings of food groups[11] As well as measuring food availability at the market and submarket levels, I also adapt the metric to measure food availability at the village level by combining sources of foods from both markets and non-market sources to create a Village Level Diversity Score (VLDS). Further discussion and details of the construction of the MLDS and VLDS is discussed in Appendix H.1.

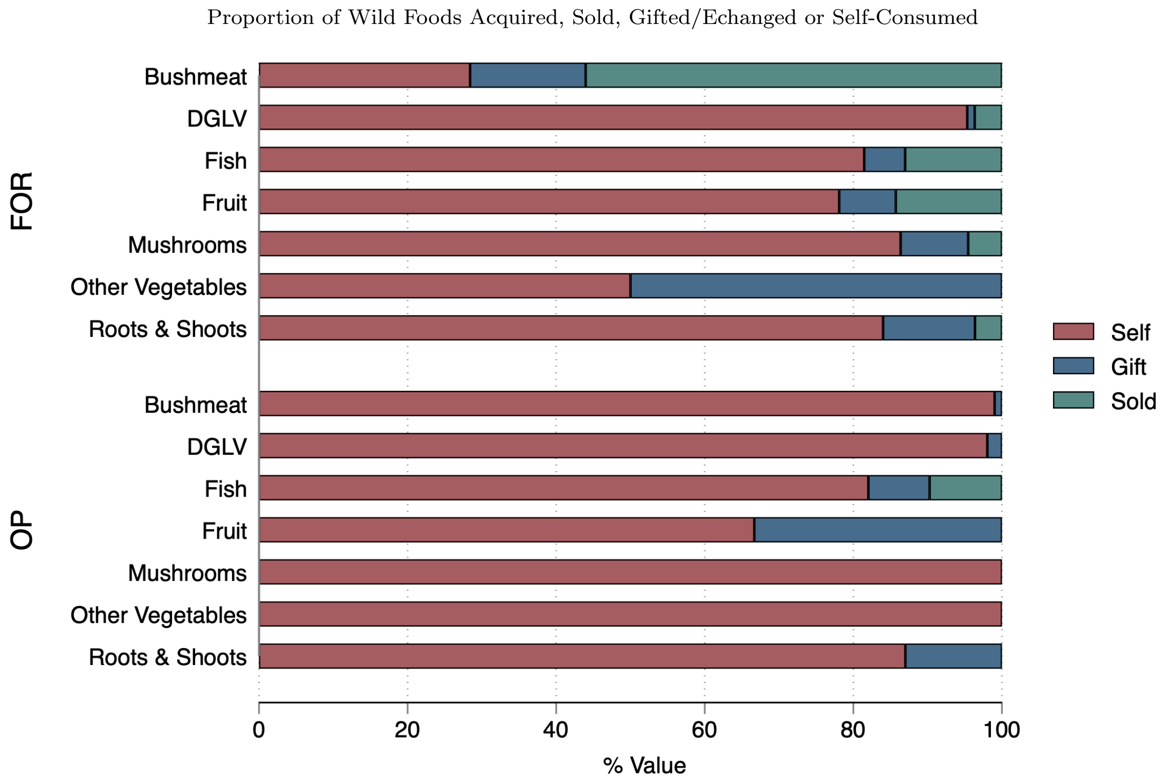
Figure 8-9 shows the MLDS for market source foods (as well as for subcomponents of the market system) and the overall VLDS. At the food group level, the village market food system is comparable between sets of villages – but different subcomponents of the market system contribute in different ways. In the FOR villages, the greatest variety of foods is provided by intra-village peer-to-peer trade, whereas at the OP villages, it is mobile vendors that provide the most types of foods. The diversity of foods provided by intra-village peer-to-peer trade is significantly lower in the OP villages; however, this does not appear to result in lower availability of food groups overall at the village level, partially due to an increase in the diversity of foods offered by mobile vendors.

Raw Food Counts

As well as using food group measures, it is also possible to calculate the food diversity at the village level using species/ food variety counts. Some studies suggest that such metrics may be better correlated with nutritional outcomes than food-group-based metrics (Lachat et al., 2018). However, they also pose a risk of "taxonomic inflation"[AQ I]. Additionally, I used secondary data provided by CIFOR to examine

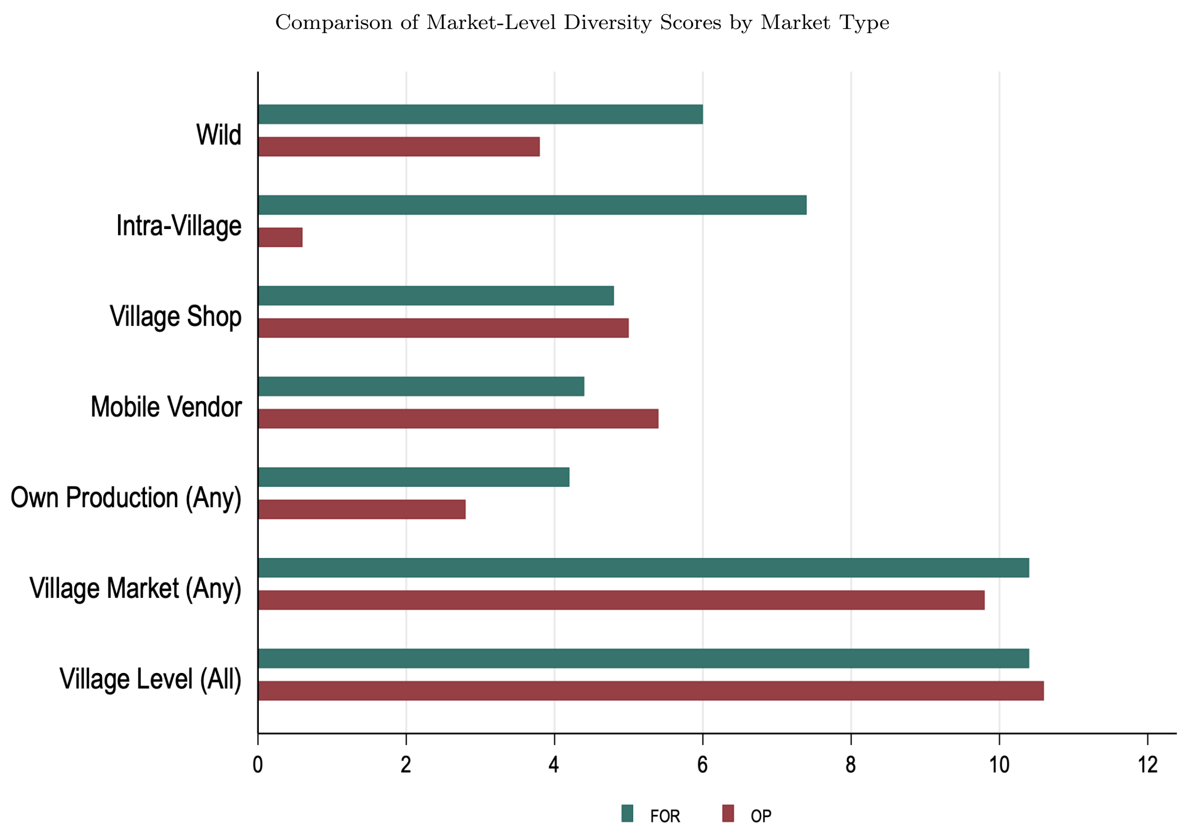
[11]Comparisons are also made using the food groups from the Women's Dietary Diversity Score (WDDS) (as used by Ambikapathi et al., 2018) as well as a self-constructed list of "healthy" food groups (similar to (Sibhatu et al., 2015a). Robustness checks reveal show similar findings regardless of the version of metric used (Appendix H.1)

Figure 8-8: Use of Wild Foods Acquired



Data: Wild food acquisition survey (30-day recall) included in the Men's and Women's Survey. Proportions are calculated based on farm-gate prices.

Figure 8-9: Comparison of Market Level Diversity Scores



Notes: The Market-Level Diversity Score (MSDL) is based on the 12 food groups of the HDDS (see Section 8.2)

Table 8.8: Number of Species/Varieties of Foods

Total Number of Varieties of Foods from All Food Sources Available in Village

Food Group	**FOR**	**sd/sd**	**OP**	**sd/se**	**p-value**
Meat	56.4	6.5	15.4	2.2	0.000 ***
Fish	40.8	17.1	13.6	6.2	0.010
Fruit	42.8	5.0	13.6	4.6	0.000 ***
DGLV	25.6	8.6	13.4	5.0	0.025
Spices, Herbs etc.	21.2	3.6	14.0	3.8	0.015
Roots & Shoots	24.6	4.4	8.4	5.5	0.001 **
Other vegetables	38.2	4.7	9.8	5.4	0.000 ***
Legumes	4.0	0.7	2.4	0.9	0.014

Notes: Data from all-source village inventory, triangulated from multiple sources (see 8.3.3)

a sub-set of commonly consumed food groups (Appendix H.9). Table 8.8 shows the food-level diversity of food groups in each village type. For many healthy food groups, OP villages have on average a far lower number of foods available. On average, villages in the FOR villages have 2.4 times as many fish varieties, 3.2 times as many fruit varieties, 1.9 times as many GLV varieties, and 3.6 times as many fish species.

Availability of Processed Foods

To measure the availability of processed and ultra-processed foods, I used the widely adopted NOVA classification (Monteiro, 2009; Monteiro et al., 2019) of foods to categorise foods available from market sources into four groups: unprocessed and minimally processed foods (group 1); Processed culinary ingredients (group 2); Processed foods (group 3); and Ultra-Processed Foods (group 4). The availability of these foods from different market sources is shown in Figures 8-10- 8-13. A further breakdown of the subgroups of Ultra Processed Foods (UPFs) are shown in Appendix Table H-2.

Figures 8-10- 8-13 show how different subcomponents of the market system contain different types of processed foods, but that these subcomponents do not differ majorly in their provision of these foods between sets of villages. Mini-marts and node-village shops contain the most types of processed foods, followed by village shops. A few processed foods (group 3) are available from mobile vendors and peer-to-peer trade, but these consist mainly of bakery items (such as cakes), which are homemade or made without industrial processing but consist of two or more group-two ingredients. Additionally, some mobile vendors sell pre-cooked food which falls into the same category (e.g. meatballs).

Figure 8-10: NOVA Group 1 (Unprocessed or Minimally Processed)

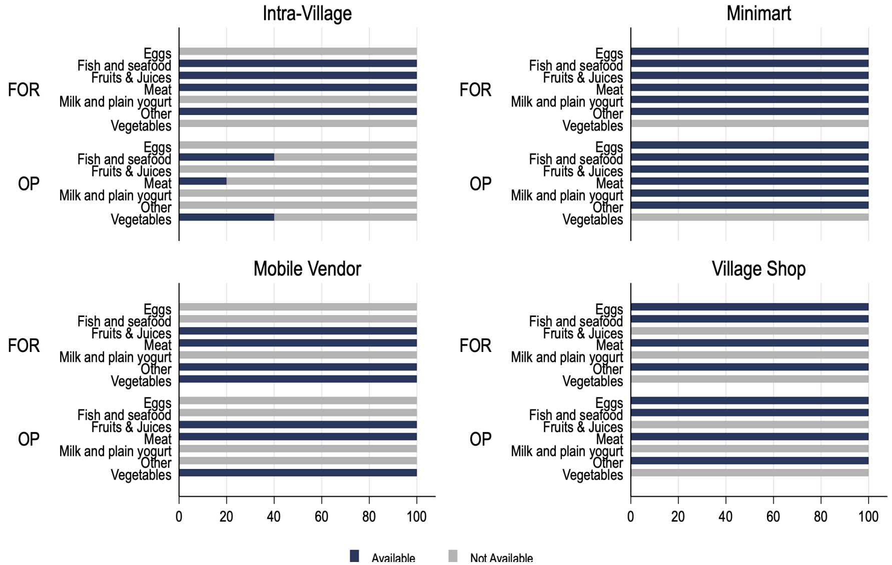


Figure 8-11: NOVA Group 2 (Processed Culinary Ingredients)

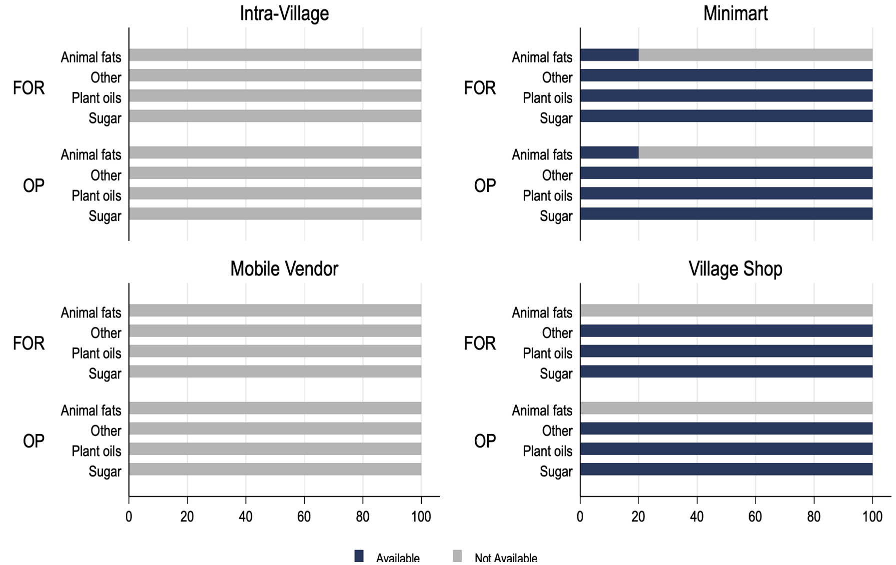


Figure 8-12: NOVA Group 3 (Processed Foods)

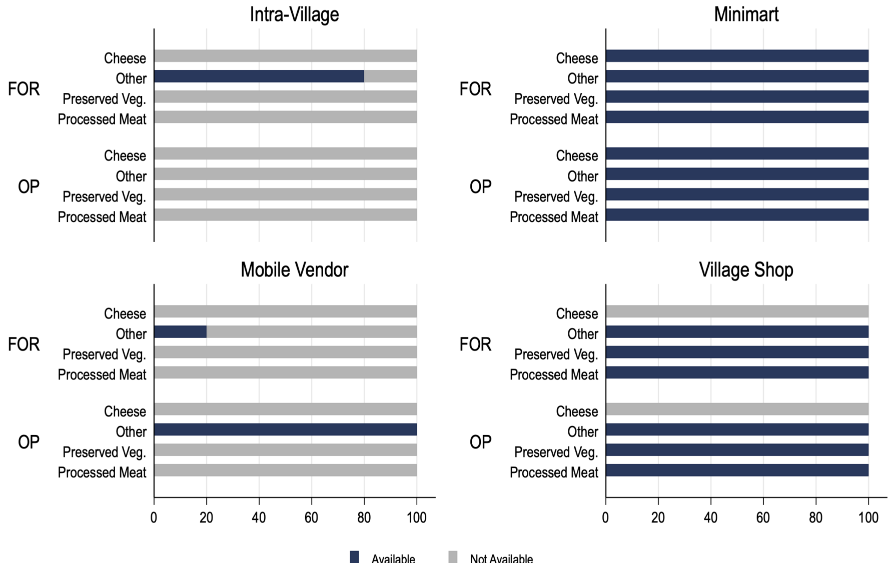
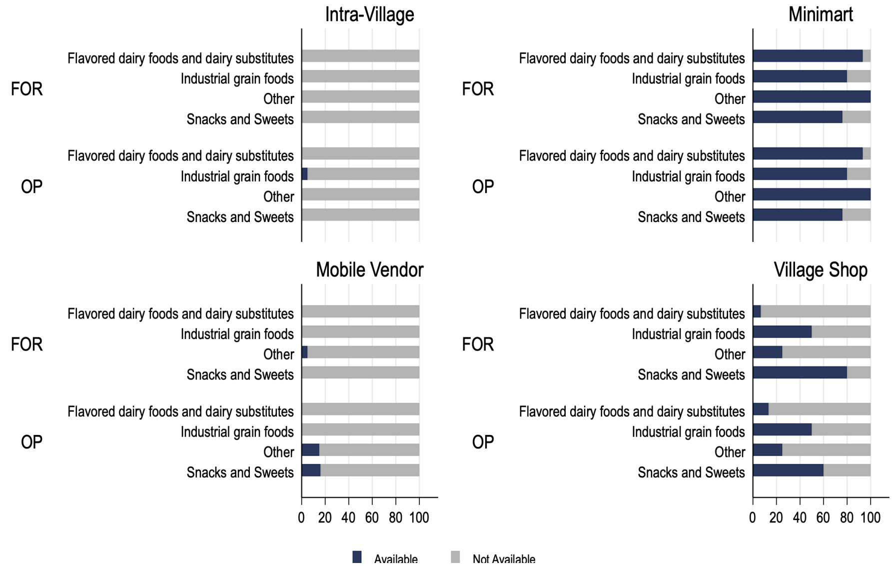


Figure 8-13: NOVA Group 4 (Ultra-Processed Foods)



Notes: Figures 8-10 – 8-13 show the percentage of sampled villages where foods are available from each food group ($\geq$1 food from group) from each food source. Categories of ultra-processed foods are further subdivided and shown in Appendix Figure H-2. Mini-marts were defined as the closest mini-mart or large store in a nearby node settlement.

Availability of Foods From Multiple Sources

The previous analyses have only reported village-level food availability, counting each type only once, even if food is available from multiple sources. However, if food is available from multiple sources (e.g. it can be bought, it can be grown, and it can be found in the wild), it could be considered more available (or more accessible). Figure 8-14 shows the average number of sources it is possible to obtain at least one food from each food group from. The graph indicates that the food system is more diverse in the FOR villages, with foods available from more types of locations – and thus may be more resilient to food system shocks (Hertel et al., 2021).

Perceived Food Availability

As well as using directly observed, measured and reported measures of food availability, I also collected data on local perceptions of food availability. This was done to balance the inventory approach, which produces an exhaustive list but may not reflect the degree to which different foods are available. Perceptions of food availability were obtained by using the Pebble Distribution Method (PDM) and are shown in Figure 8-15. Several noticeable differences between the OP and FOR villages are evident from the figure. In the OP villages, fish from wild sources are considered significantly less available than fish from mobile vendors. Likewise, wild forest meat was perceived as the source with the highest availability of meat in the FOR villages but comprised a tiny fraction of perceived availability in the OP villages, where mobile vendors were seen as the most available source of meat along with agricultural production. Intra-village trade comprised a significant component of perceived availability in the FOR villages, for fish, meat, other fruits and other vegetables. In contrast, in the OP villages, intra-village trade was not seen as an important source of food availability for any food groups except fish (where it was still a minor source of availability).

In addition to these perceptions of general food availability, I explored whether seasonal gaps in availability were present through participatory seasonal calendars in focus groups in case-study villages (Appendix Figure H-9). The chart shows respondents generally perceive few times of year when there is low availability of most food groups – with the slight exception of fruit, which showed greater seasonal variation in both sets of villages – as well as periods of low fruit availability in the OP villages.

8.3.4 Comparisons of Food Prices

A comparison of average prices of available fresh foods is shown in Table 8.9. Note that processed and packaged foods are not included due to the quality of the underlying data[12]. For almost all food groups, there are no significant differences in the average prices. The one exception is meat, which is cheaper

[12]Prices of processed and packaged foods were difficult to compare due to variations in brands, sizes and flavours. I, therefore, constructed a 10-food consumer basket consisting of one or two varieties of specific products and brands. The list focused on commonly found brand names to make comparisons easier. While I found no significant price difference between sets of villages, the limitations of the data prevent making definitive claims, as sample sizes were too small and the variance too great. The full list of foods included in the consumer basket is shown in Appendix Table H.5.

Figure 8-14: Number of Different Food Groups Contributing to Food Group Availability

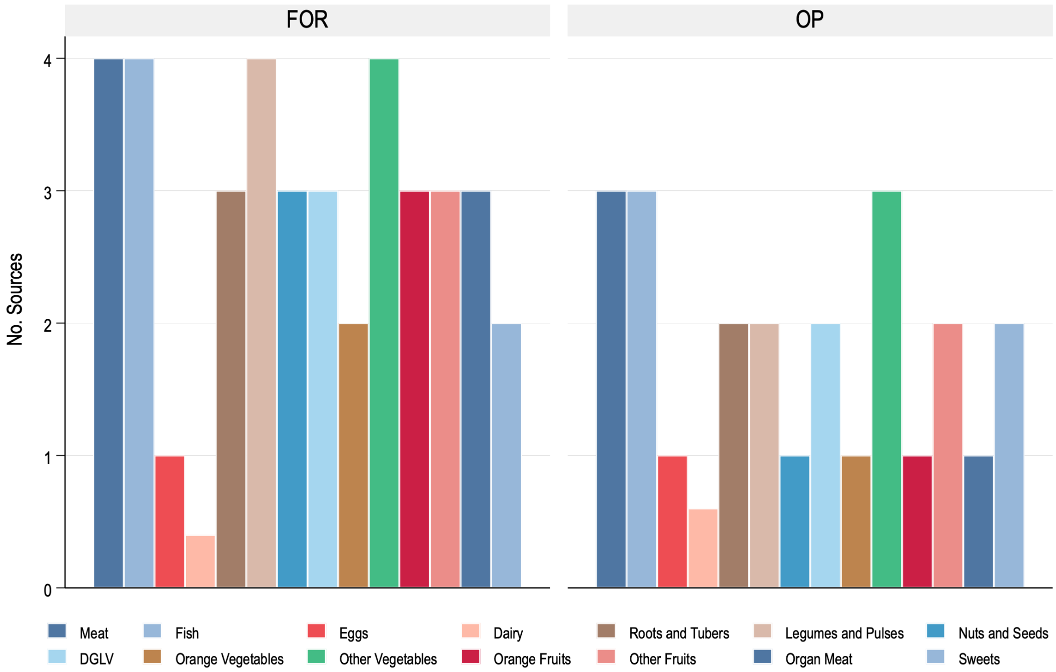


Figure 8-15: Perceived Availability of Foods

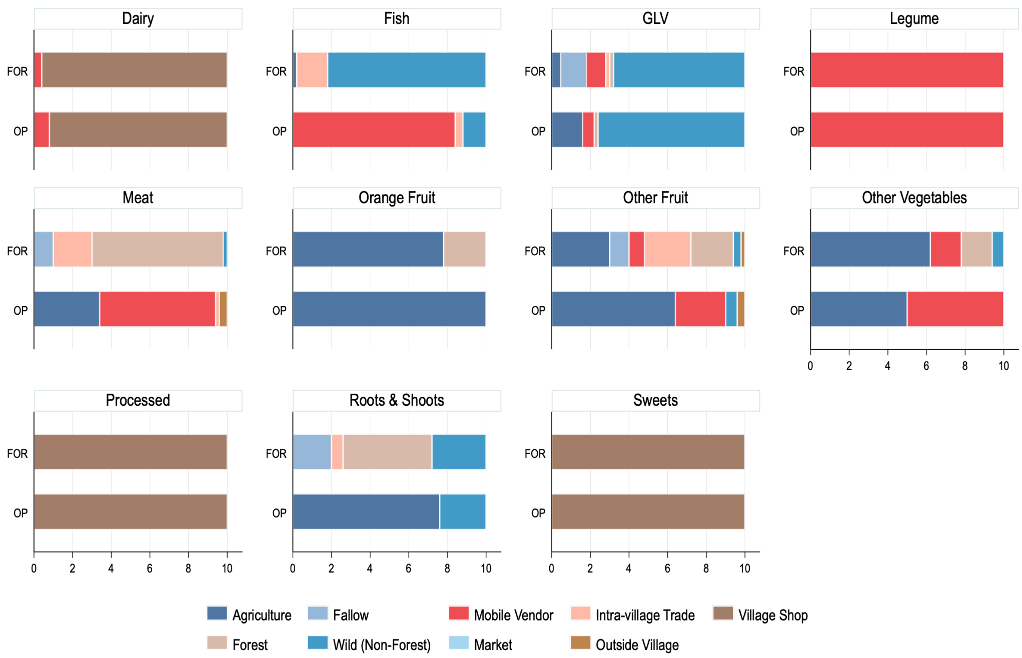


Table 8.9: Differences in Village-Level Food Prices

Food Group	FOR	sd	OP	sd	p-value
Meat	41.24	14.74	61.33	15.06	0.00***
Fish	33.11	6.85	21.67	20.82	0.44
DGLVs	97.35	35.97	64.00	86.12	0.44
Legumes, Nuts and Seeds	86.25	57.35	63.33	32.15	0.53
Vegetables (Other)	47.39	53.38	43.89	43.50	0.85
Vegetables (Orange)	7.86	5.84	9.00	3.61	0.72
Fruits	26.16	12.41	18.33	10.33	0.14

Notes: Prices are given in units of thousands of Indonesian Rupiah (IDR) per kilogram of raw food.
Data Source: All-source village inventory, triangulated from multiple sources (see 8.3.3).

on average in the FOR villages. However, the price of chicken (the main market-origin meat) is similar between the sets of villages[13].

In triangulating data between different sources, I observed a slight discrepancy in prices between market-source foods and foods sold via intra-village trade. I thus decided to analyse this discrepancy formally by comparing like-for-like foods and market-equivalent foods. In exploring the reasons behind the lack of price differences, I decided to compare the price of foods from different market sources with foods sold via intra-village trade (Appendix Table H.3). The results show a wide range of price differences across food groups but, show a consistently lower price of foods obtained via intra-village trade. For instance, vegetables obtained from wild sources but sold via intra-village trade were between 30-100% cheaper than the same or market equivalent product. Likewise, the price of locally produced vegetables via intra-village trade was typically around 50-60% lower than the market equivalent. The greatest difference in prices was for wild meat, which was cheaper than both wild meat of outside village origin[14] and the average price of meat from outside the village origin[15].

8.4 Analysis: Agricultural Food Sub-Systems

This section provides a mixed-method analysis of the effects of these oil palm on agricultural food production at the local level. The section begins with an overview of the types of fields and the foods they produce in Section 8.4.1, before summarizing the main differences and trends between sets of villages and exploring the drivers of change.

[13]This is explained by the wide availability of bushmeat for sale in the FOR villages, but the limited meat available to purchase in the OP villages. The price of chicken (the main market-origin meat) is similar between the sets of villages. Like-for-like bushmeat is much more expensive in the OP villages. However, it is also less available. Inclusion in the average price for meat was done based on the free-listing data. In this case, it probably leads to an artificial inflation of the average price of meat in the OP villages, as in reality, many of the bushmeat species would be difficult to source in the OP.

[14]Though wild meat of outside origin was, in reality, rarely traded in the FOR villages

[15]Mainly chicken – though the average price is raised by some high-value products such as beef which is rarely consumed and treated as a luxury food for special occasions only.

Table 8.10: Selected Themes and Sub-Themes from Thematic Analysis

Sub-System	**Theme**	**Description/Sub-Themes**	**FOR**	**OP**
Market Food Sub-System	Mobile vendors continually optimise	Mobile vendors respond to gaps in supply		x
		Arrival optimised for peak demand days (e.g. after paydays) and times (e.g. mornings/evenings)	x	(x)
		Well-connected villages are passed through on the way to other villages	x	x
		Unpredictability of mobile vendors makes them inconvenient	x	x
	Temporal/seasonal gaps in availability filled by markets	Mobile vendors responsive to changing dynamics of supply and demand	x	(x)
		Diverse livelihoods in village and hyper-local trade ensures seasonal availability	x	
	Availability of non-food goods and services	Node village shops and min-marts used for bulk-purchases and non-food goods and services (e.g. ATMs)	x	
Wild Food Sub-System	WF acquisition limited by time availability	Hunting and fishing constrained by time-availability		x
		Quicker methods of hunting and fishing devised (e.g. traps, nets)		x
		Agrobiodiverse fields and fallows not visited due to time constraints		x
	Declines in wild food/habitat abundance	Declines in animal/habitat abundance affect probability of success	(x)	(x)
		Declines in fish abundance drives lack of fishing		(x)
		Distance to forests increased due to land use changed (but time by motorcycle reduced)		x
	WF acquisition limited by wild food abundance	Reduced Hunting and Fishing Frequency	(x)	x
		Quicker methods of hunting and fishing used		(x)
Agricultural Sub-System	Opportunistic and intentional WF acquisition	Women (primarily) engage in "probabilistic opportunism", selecting travel routes to maximise chance encounters	x	
	Semi-opportunistic collection as part of livelihood strategy	Agrobiodiversity in and around rubber fields	x	
		DGLVs in and around village, roadsides (and plantation edges in OP)	x	x
	Value of low-input, low-output land	Usefulness as source of occasional foods, minimal opportunity costs of land or labour		x
		Opportunity cost of both land (due to emerging market) and labour (due to distance/ time to travel to)	x	
	Role of agrobiodiversity	Agrobiodiversity in and around fallows and mixed-gardens part of "probabilistic opportunism" strategy		x
		Agrobiodiversity in increases with fallow age and decreases with intensification	x	

Notes: x indicates theme present and widespread; (x) indicates theme occasionally present but not widespread.

8.4.1 Types of Fields

Table 8.11 describes the main types of food-producing fields as well as example foods produced by each and whether foods produced are predominantly for own consumption or for sale. A more detailed description of these field types, along with illustrative quotes, are provided in Appendix H.3. The table also illustrates the role of wild and semi-cultivated foods in the food system, discussed below in Section 8.5.1. In terms of food production, the main sources of food in both sets of villages were swidden plots which were centred around rice production, but where vegetables were also grown along the sides of the plots or in adjacent/nearby vegetable gardens[16]. The remaining field types can broadly be categorised into two types: (1) cash crops – noticeably rubber and *kratom* (a narcotic[17]) grown in agroforestry configurations and intercropped with a variety of fruit and nut trees, as well as perennial vegetables and semi-cultivated crops and; (2) extensive production systems which require minimal inputs of labour, yet provide a combination of steady provision of perennial and seasonal foods such as mixed-gardens (*kebun campur*) (usually, though not exclusively agroforests[18]) and traditional forest gardens (*tembawang*) governed by complex customary management and tenure regimes which produce a range of (mostly) fruits.

8.4.2 Differences in Farm Types

Farms in the OP villages are less diverse than those in the FOR villages, both in terms of the crops produced (Table 8.3) and the diversity of farming systems within the food shed (Table 8.2). Farming households in the OP villages were also less likely to grow many nutritionally important food groups, including vegetables and fruits (Table 8.3). Qualitative evidence suggests that farms in the OP villages have experienced a decline in their production diversity since the adoption of oil palm, due to the de-prioritisation of farming within the overall livelihood strategy. Figure 8-16 illustrates how a combination of changes in patterns of field ownership and an intensification of particular field types have driven this loss of production diversity. Most field types are owned by a smaller proportion of farming households and also produce a lower diversity of foods. For instance, the three most diverse field types (in terms of food groups they produce) are fallows, mixed-agroforestry gardens and rubber gardens. Each of these field types is owned by a smaller proportion of farming households in the OP villages but also produces fewer types of foods on average.

[16]The term *kebun sayur* (vegetable garden) covers a range of different field types. While it predominantly refers to subsistence vegetable production, it was also used in the FOR villages as a general term for fully commercialised vegetable gardens (e.g. chilli), or semi-commercialised gardens (i.e. where the surplus is intentionally grown for sale in temporary markets outside the village). Commercial vegetable gardens of this nature were rare, bordering on non-existent, in the OP villages. More details are discussed in Appendix H.3

[17]Kratom *(Mitragyna speciosa)* leaves produce opioid-like and stimulant-like effects. At the time of conducting my fieldwork, the legality of Kratom as a crop and as a drug for sale and export was ambiguous and tolerated by law enforcement. The Indonesian Government has subsequently outlawed the crop – but with some accommodations for existing growers to transition away. Further details are provided in Appendix H.4

[18]Definitions of *kebun campur* vary Martini et al. (2010) defines it as "a garden planted with more than one type of woody plant. Several other types of plants, in the form of annual plants and/or perennial plants that grow alone or planted and left in mixed garden as long as it is not disturbing tree crops."

Figure 8-16: Field Ownership and Field Diversity

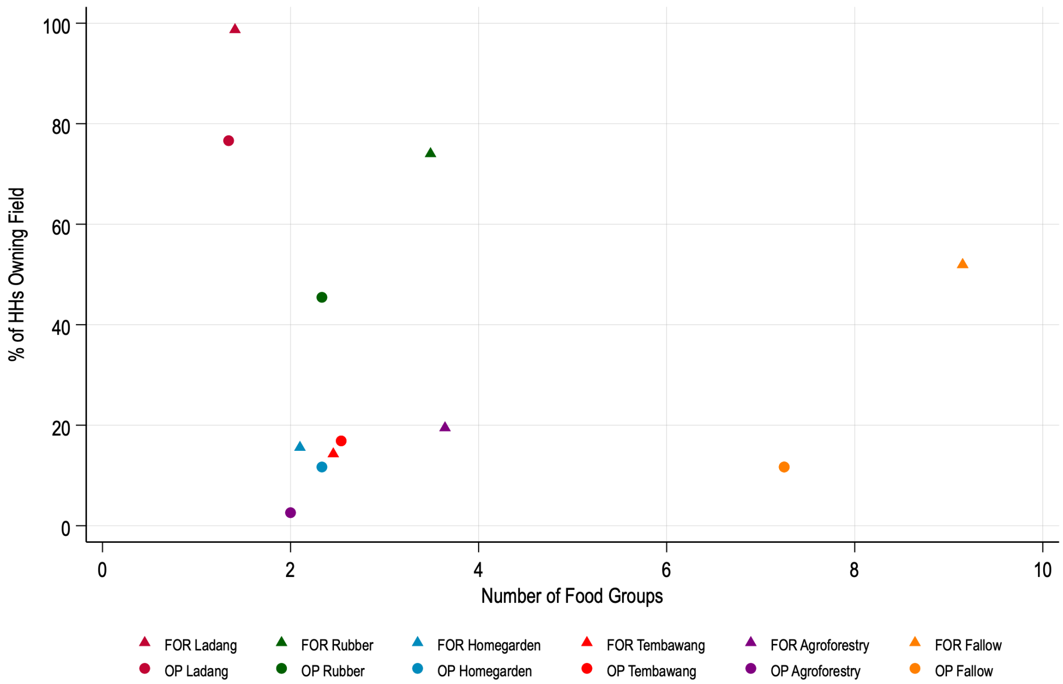


Table 8.11: Types of Fields Producing Food Crops

Land Type	Description	Intensification	PD	Agrobioversity	Example Foods
Swidden (*Ladang*)	Rotational slash-and-burn plot focused primarily on seasonal dry rice production. Swidden plots exist along a spectrum from traditional to heavily modified.	Low*↓	Low	Medium*↓	**Staples** Rice, Corn, Sweet Potato^{EX}, **Vegetables** e.g. green beans^{OC}, cucumber^{OC}, pumpkin^{OC}, aubergine^{OC}
Vegetable Garden (*Kebun Sayur*)	Small garden growing vegetables for household consumption nearby or adjacent to rice field. Can refer to commercial vegetable gardens where vegetables are sold.	High	High	Low	**Vegetables** incl. Chili^{CM}, green beans^{OC}, cucumber^{OC}, pumpkin^{OC}, aubergine^{OC}
Homegarden (*perkarangan*)	Small patch of land growing edible crops close to the home	Medium	High*↑	Low	**Herbs**^{EX}, **Spices**^{EX}, **Condiment Vegetables**^{EX}
Mixed Garden (*Kebun Campuran*)	Semi-cultivated gardens dominated by perennial edible plants, typically arranged in agroforestry configurations. Contain tree-crops and perennial vegetables requiring little to no labor. Can look like wild patches of land to an untrained eye.	Low	High*↓	High	**Fruits** (banana, papaya, rambutan)^{SC}, vegetables (cassava leaves and roots, ferns)^{CT}
Forest Garden (*Tembawang*)	Traditional form of forest garden consisting of a group of fruit trees within a forest.	Low	High*↑	Medium	**Fruits** incl. Durian^{SC}, Langsat^{SC}, Cependak^{SC} **Nuts** e.g. tengkawang$^{CM\ (1)}$
Rubber Garden (*Kebun Karet*)	Rubber gardens can be monoculture plantations but more typically consist of mixed agroforestry with rubber inter-cropped with fruit trees and trees producing nuts and seeds. When chemical inputs are not used or used sparingly and infrequently, they may have a shrub layer also containing edible plants.	Medium	Medium*↓	High	**Fruits** esp. Kundag^{CM}, Rambutan^{OC}, Langsat^{OC}, Mango Plum$^{(2)}$; **Nuts** e.g. Tengkawang$^{CM\ (1)}$, Pinang$^{CM\ (2)}$
Kratom Garden (*Kebun Puri*)	Commercial garden containing Kratom trees (see Appendix H.4). Gardens may be ex-rubber gardens or ex-fallows/swiddens, and they may or may not be inter-cropped with fruit trees.	High	Low	Low	**Fruits**^{CM}

Key: ∗Indicates that differences exist between sites with the arrow representing whether the OP site is higher or lower than the FOR site. CT = Cultivated; SC = Semi-Cultivated; CM = Predominantly Commercialized; OC = Predominantly Own-Consumption but can be sold; EX = Exclusively Own-Consumption
Notes: (1) A.K.A. Illipe Nut (*Shorea spp.*); (2) A.K.A. Mango plum (*Bouea macrophylla*); (3) A.K.A Betel Nut (*Areca catechu*)

8.4.3 Drivers of Agricultural Change

Drivers of Change in Farm Configuration

Reduced farm diversity is primarily driven by reduced ownership of fallows, mixed-agroforestry gardens and rubber gardens (Figure 8-16). Qualitative evidence suggests multiple reasons for the loss of these field varieties and the consequent decline in farm-level diversity. In terms of fallow fields and mixed gardens, the difference in ownership between sets of villages is a product of the different opportunity costs of land, caused by different levels of localised land scarcity (Quote 8-1). Respondents in the FOR villages reported owning and valuing land that they visited infrequently or visited when a certain crop was needed or when certain foods were in season. This was particularly true for production systems abundant with low-maintenance perennial crops, which required little to no labour or chemical inputs, such as follows, mixed gardens, and mixed agroforestry. As land was relatively plentiful (at least further away from the village), there was little opportunity cost of keeping these fields, which provided a source of occasional food, resilience through diversification of food sources with little-to-no cost. The arrival of oil palm expansion in the OP villages dramatically changed this opportunity cost of land which could be used either for oil palm or for rice or vegetable production. Not all land competed with other agricultural uses, but the land which did not was often situated further away – and was undesirable due to the time required to visit it. Using agricultural land that was not in competition for other land uses, situated conveniently close to the village, was seen as a waste of land for low-productivity fields such as mixed gardens or fallows. Increasing land scarcity resulted in the development of an emerging formalised land market – exacerbating the pressure to convert or sell such field types.

> *"If you do not need it, you should sell it... there are many people who are interested in buying fields, many people who have money and are interested"*
>
> **Quote 8-1:** (OP_Vill2_IDI_F)

The supplanting of rubber as the primary crash crop in favour of rubber gardens (which do not produce foods) has already been discussed in Chapter 6, which also noted a preference to retain rubber gardens if possible even if the fields were rarely used as they could be utilised as assets or as sources of work for family members without access to oil palm employment[19]. As discussed already in Chapter 6, in the OP villages cultivation was seen as incompatible with oil palm labour because it was too time-consuming in general – but especially as the highest yields from rubber are obtained in the early mornings (due to lower temperatures and higher sap viscosity) when plantation labour occurs.

[19]Rubber gardens were assets which could be used to secure formal or informal credit (depending on land title). Employment in oil palm was restricted to a narrower working age range than was traditional, leaving many older household members without access to paid employment.

Drivers of Reduced In-Field Diversity

Several field types were less diverse in the OP villages compared with similar fields in the FOR villages. The largest differences are evident for fallow fields and rubber gardens, which tend to produce fewer types of foods in the OP villages. Two types of fields, landings and home gardens, produce a similar diversity of foods in terms of food groups but produce a more diverse range of foods at the species levels. One potential reason for this pattern is that households may be partially compensating to some extent for the loss of diverse field types by growing new types of crops in these fields – in other words, they may be attempting to consolidate their agricultural production in a smaller number of fields (though the overall result is still lower diversity of foods produced).

A major reason for the reduced diversity of fallows is swidden transitions of intensification and relocation, discussed in Chapter 6. Shorter fallows have less time to regenerate and thus produce wild edible plants. Likewise, the relocation of fields results in less natural regeneration of plants from adjacent forest patches. The lower diversity of rubber gardens in the OP villages is primarily explained by the loss of condiment vegetables, DGLVs and other vegetables. In contrast, the diversity of, fruits, nuts and seeds is similar in rubber gardens between sets of villages. There are two potential explanations for this. Firstly, this may indicate that rubber gardens are not used to cultivate annual vegetables – a logical change if rubber gardens are used less frequently. Secondly, it may be possible that rubber gardens in the OP villages still contain a diverse range of vegetables – but these were not mentioned during the farm survey (due to these vegetables being rarely collected).

8.5 Analysis: Wild Food System

This section provides a mixed-method analysis of the effects of this oil palm on the Wild Food (WF) sub-system at the local level. The section begins with an overview of the types of WF environments and the foods they produce in Section 8.5.1, followed by an analysis of WF acquisition behaviours in Section 8.5.2. Finally, in Section 8.5.3, I examine the historical changes in WF availability and use as perceived by local residents in each type of villageand explore the drivers of these changes.

8.5.1 Types of and Wild and Semi-Cultivated Food Environments

Table 8.13 shows the general characterisation of the different locations considered WF environments in each type of villageusing data triangulated from multiple sources. The table has been greatly simplified for the sake of clarity. In reality, there is a vast range of different types of wild and semi-cultivated environments which provide food – the definitions of which vary slightly between locations. A summary of the different types of environments and a more detailed list of foods they provide can be found in Appendix H.5. However, broadly speaking, WF environments can be classified into forest environments, fallow and semi-cultivated environments and village surroundings. Pile sorting exercises in focus groups defined categories of forest according to local custom. While there was no universal agreement, the types of forests were similar between villages. These included wild forest (*rimba*); protected forest (usually *hutan lindung*); secondary forest and (*hutan sekonder*) fallow and semi-cultivated environments including swidden fallows (*bekas ladang*), forest gardens (*tembawang*), rubber gardens (*kebun karet*) as

Table 8.12: Food Environment Prevalence and Recent Historical Trajectories

	FOR		OP	
Food Environment	**Prev.**	**Tradj.**	**Prev.**	**Tradj.**
Agricultural Fields:				
Swidden Plots	●●●	→	◍◍	↓
Vegetable Gardens	◍◍	↑	○	→
Homegardens	◍◍	→	●●●	↑
Mixed-Gardens	◍◍	→	○	↓
Forest Gardens	●●●	→	◍◍	↓
Rubber Gardens	●●●	↑	◍◍	↓
Kratom Gardens†	○	↑↑	-	-
Wild Food environments:				
Forest Environments				
Old growth forest (area)	●●●	↓	○	↓↓
Old growth forest (WF abundance)	●●●	↓	○	↓↓
Secondary/disturbed Forest (area)	●●●	↓	◍◍	↓↓
Secondary/disturbed Forest (WF abundance)	●●●	↓	◍◍	↓↓
Village Surroundings:				
Riverbanks and Tributaries	●●●	→	◍◍	↓
Home and village surroundings	●●●	→	●●●	→
Agrobiodiversity & Semi-Cultivated Foods				
Swidden Fields and Fallows::				
Swidden Fields (food abundance)	●●●	→	○	↓↓
Young Swidden Fallows (ownership)	●●●	→	◍◍	↓↓
Young Swidden Fallows (WF abundance)	●●●	→	◍◍	→
Old Swidden Fallows (ownership)	●●●	↓	○	↓↓
Old Swidden Fallows (WF abundance)	●●●	→	◍◍	→
Other Agrobiodiversity:				
Rubber Gardens (WF abundance)	●●●	→	◍◍	↓
Mixed-Gardens (WF abundance)	◍◍	→	○	↓↓
Forest Gardens (WF abundance)	●●●	→	◍◍	↓
Market Food Environments:				
Village Shop	◍◍	→	◍◍	→
Node Settlements	○	→	●●●	↑↑
Temporary Markets	○	↑	●●●	↑↑
Mini-Marts	○	↑	◍◍	↑↑
Mobile Vendors	○	↑	●●●	↑↑
Intra-Village Trade	●●●	→	○	↓↓

Notes: WF = Wild Foods (Includes both wild and semi-cultivated foods; † At time of fieldwork. The situation regarding kratom production has changed subsequently (see Appendix H.4).
Prevalence: Symbols indicate how widespread food sources are. * In the case of wild food environments the prevalence indicates the availability:
●●●= High Prevalence; ◍◍= Medium Prevalence; ○= Low Prevalence
Trajectories: Symbols represent recent historical trajectories (since oil-palm development or equivalent baseline) ↑= Increasing; ↑↑= Increasing Rapidly; ↓= Decreasing; ↓↓= Decreasing Rapidly

Table 8.13: Types of Wild Food Environments

	Habitat		**Collection**		**Foods Provided**					
Food Environment	**Proximity**	**Wildness**	**Opportunism**	**Gender**	**Meat**	**Fish**	**Fruit**	**Vegetables**	**Pulses & Nuts**†	**Roots & Shoots**
Forest Environments:										
Old-Growth Forest	5	LM	4	M	🌿	🌿	🌿	🌿	-	🌿
Secondary / Disturbed Forest	3-4	DR	D/O	M	🌿	🌿	🌿	🌿	-	🌿
Village Surroundings:										
Riverbanks & Tributaries	1-2	DR	D/O	W	🌿	🌿	🌿 🚜	🌿	-	-
Home & Village Surroundings	1	DR	D/O	W	-	🌿	🌿🌱🚜	🌿	-	🌿
Roadsides	1-2	DR	PO	W	-	-	🌿 🚜	🌿	-	-
Agrobiodiversity:										
Swidden Fields	1-2	DR	D/O	W	🌿	-	🌿 🌱	🌿 🌱 🚜	🌿	🌿
Swidden Fallows (new)	2	PC	D/O	W	-	-	-	🌿 🌱	🌱	🌿 🌱
Swidden Fallows (old)	3	WC	PO	M&E	🌿	-	🌿 🌱	🌿🌿🌱	🌱	🌿 🌱
Rubber Gardens	2	PC	O	W	🌿	-	🌿🌱🚜	🌿🌱	🌿🌱🚜	🌿
Mixed-Gardens	1	DR	D/O	W	-	-	🌿🌱🚜	🌿🌱🚜	-	🌿
Forest Gardens	4	WC	D	M&E	-	-	🌿🌱	🌿 🌱 🚜	🌱 🚜	🌿🌱

Notes: Table presents an overview of data triangulated from multiple sources. Data is mainly obtained from freelisting and pile-sporting exercises in FGDs, cross-referenced with wild food acquisition data from men and women's surveys. **Food Groups:** † Pulses, Nuts and Seeds; △ Roots and Shoots;[a] **Food Codes: x** = Main Food Provided; x = provides food group; (x) = occasionally can provide food group; - = rarely/never provides food group; [b] **Proximity Codes:** 1= Closest to village; 5 = furthest from village [c] **Wildness Codes:** LM = Least Modified; WC = Wild but Curated; DR = Disturbed, Regenerated; PC= Partially Cultivated [d] **Opportunism Codes:** D= (primarily) Deliberate, O= (primarily) Opportunistic, PO = (primarily) Probabilistic Opportunism [e] **Gender Codes:** M= (primarily) Men; W = (primarily) Women; M&W = Equally Men and Women 🌿= Wild Source 🚜= Agricultural 🌱= Semi-Cultivated well as wild and semi-cultivated fruit trees that appear on farms.

Table 8.13 also shows the importance of WFs obtained in agricultural fields (agrobiodiversity). WFs obtained from cultivated fields such as swidden plots primarily consist of WEPs (primarily DGLVs) growing as weeds within fields or around the edges of plots. Semi-cultivated plants consist of foods which were originally agricultural but have survived, spread and continue to flourish without any human intervention (e.g. groundnuts, cassava) as well as plants which have spontaneously grown from seeds dropped while eating (e.g. fruit trees). The three most important sources of agrobiodiversity in the food system are rubber gardens, mixed gardens (typically but not always agroforestry-based) and swidden fallows – all of which may simultaneously contain cultivated, semi-cultivated and wild foods. Swidden fallows were especially important sources of Wild and Semi-Cultivated Foodss (WSCFs) . A local classification of fallow types, along with the types of foods they produce are shown in Appendix Table H.7. Younger fallows provided foods which were semi-cultivated, often previously cultivated foods[AQ II] such as cassava, as well as quickly growing plants such as wild edible ferns. Older fallows contained a larger variety of products, including mushrooms, palm-hearts, bamboo and fruit trees. The latter may be deliberately planted in old fallows[20] or have spontaneously grown from seeds dropped while eating.

There are two main identifiable differences in the WF environments between sets of villages: (1) Differences in the spatial configuration and abundance/ownership of WF habitats and; (2) Differences in the abundance of WFs within these habitats. In the case of the former, households in the FOR were more likely to own those types of fields which are most biodiverse (Table 8.4) such as fallows, mixed agroforestry gardens and rubber gardens. Many WF habitats appear to be located further away from the village in the OP villages. Figure H-4 shows the time it takes to walk from the village to collect WFs in different food groups. Figure H-4a shows average distances across all foods in the food group and uses the village as the starting point. The graph, therefore, shows the approximate relative distance of the most abundant sources of WFs – not necessarily the location of time to collect for the most common, not most convenient WFs and does not account for the respondent's activity space (i.e. if the respondent collects WFs from a location already closer to the source of foods). The average distance, however, may be misleading in contexts where there are large numbers of wild foods, some of which may be collected infrequently. Figure H-4b therefore shows the average minimum time for food groups (averaged across focus groups).

Changes in the time taken to collect WFs are partially a reflection of the changing spatial configuration of WF habitats. There is a paradoxical relationship between the spatial configuration of wild habitats and the time taken to access them. For instance, while fallows are on the whole located closer to villages in the OP villages as result of the relocation of swidden discussed in Section 6, visiting them requires a greater deviation from usual activity spaces[21]. Likewise, the actual distance of forests from villages has increased due to oil palm-driven land-use change – but paradoxically, they may be more accessible now due to improved road access (Quote 8-2).

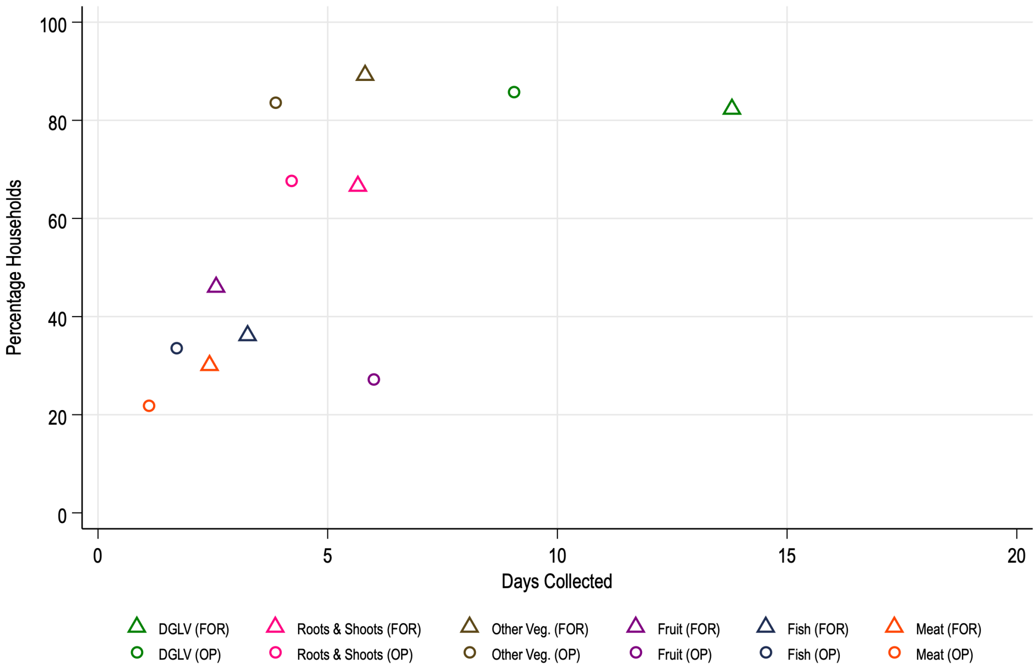
> *"It's [hunting] already difficult now. Actually, although it's [hunting grounds] further away than before, because there's an oil palm road near us, it's easier to use a motorbike"*

Quote 8-2: (OP_Vill4_KI_F)

[20] Historically, this practice was common as a form of territorial land claim under customary tenure rules.
[21] These factors are discussed in the chapter in women's food choice (Chapter 9

Figure 8-17: Prevalence and Frequency of WF Acquisition

% households collecting food group from wild and the average number of collection days*



Notes: *Average number of days collecting ≥ 1 food group by households during the preceding 30-day period for households who collected ≥ 1 WF from that group during this period.

8.5.2 Wild Food Acquisition

The quantitative results indicate that the WF system provisions fewer wild foods in the OP villages – both in terms of diversity (Figure 8-9) and quantities of foods (Table 8.6). The lower diversity of foods produced by the WF system in the OP villages is primarily explained by the lack of wild legumes and pulses, nuts and seeds, which are not available from the WF system in any of the case-study villages. While the WF system produced a less diverse range of foods overall in the OP villages, WF acquisition in general remained high even after the adoption of oil palm, with the overwhelming majority of households having obtained at least one WF themselves within the past 30 days in both sets of villages. Figure 8-17 provides a visual characterisation of WF acquisition practices in each village type. It is striking that the collection of wild foods, particularly vegetables, is a widely prevalent practice at both sets of villages, with a significant majority of households from each location engaging in this activity. For many food groups, acquisition practices appear remarkably similar in the FOR and OP villages, with similar levels of participation in acquisition practices, though at slightly lower frequencies. The proportion of households who had gone hunting in the past 30-days was not statically different between sets of villages, however, those who did go hunting did so for around half the number of days (Table 8.6) in the OP villages. A similar pattern was found for DGLVs, roots and shoots, other vegetables and fish[22].

Locations of Wild Food Acquisition Events

The quantitative findings are confirmed by qualitative findings, which suggest that WF acquisition is still widely practised in the OP villages, but that those WFs found in forests (especially bushmeat) are

[22] Although the differences in fishing frequency were not statistically significant after adjusting for multiple comparisons

collected less often (Quote 8-3).

> *"In this village, it [collecting forest foods] has already gone down. It is a bit rare. Maybe we occasionally eat [forest] vegetables. But if we do, it is only for ourselves to eat – [it is] rarely for sale."*
>
> **Quote 8-3:** (OP_Vill1_KI_F)

Differences in the sources of WF collection explain a substantial part of the observed food group-level differences in acquisition. Figure 8-4 shows how – with the exception of bushmeat – most WFs are not acquired from primary forests in either sets of villages. For most food groups, village surroundings, agrobiodiversity and other non-forest wild environments such as degraded forest fragments are the most common locations for acquisition. Thus, for foods which are abundant and easily available within the village and nearby non-forest WF surroundings, acquisition remains relatively high. This is especially true for WEPs which are available from multiple non-forest sources and the most ubiquitous (such as edible ferns) are even available from the edges of oil palm plantations[AQ III].

The location data also reveals another potential explanation for differences in WF acquisitions, which is the loss of agrobiodiversity within the farm system in the OP villages – driven particularly by the loss of fallows and the reduced availability/use of agrobiodiversity found in rubber gardens. Around one-quarter of WEP acquisitions in the FOR villages come from agrobiodiversity, with 12% coming from rubber gardens alone. As discussed in Section 8.4, fields high in agrobiodiversity (such as fallows and rubber gardens) are owned by a smaller proportion of farming households and contain a less diverse range of food crops. In the case of fallows, this may be due to swidden intensification, leading to shorter fallow regeneration periods and thus a lower abundance of WSCFs . Rubber gardens are not only less likely to contain a diverse range of foods – but are also less frequently visited when owned. Qualitative evidence suggests that the acquisition of WEPs simultaneously while tapping rubber is an intrinsic part of livelihood strategies in the FOR villages – and thus a source of WFs, which is lost when livelihoods switch to oil palm. However, oil palm livelihoods are not incompatible with the collection of WFs in and around villages – especially of WEPs that grow in plantation edges, forest fragments adjacent to oil palm plantations and alongside roads along which women walk to and from plantation labour.

Opportunistic Collection

Survey data suggests that a higher proportion of fruit acquisition was deliberate for both men and women in the OP villages (Figure 8-5). However, this is an artificial binary that does not reflect WF acquisition practices. Qualitative data indicates that WF acquisition exists on a spectrum between purely opportunistic (i.e. chance encounters with no plan to obtain food) and purely intentional (i.e. location is visited where WFs are known to exist). Most opportunistic collections of foods existed somewhere between these two extremes. Both men and women deliberately placed themselves in locations where the opportunistic collection was likely, taking routes to and from fields via forests and fallows likely to have foods which could be collected (Quote 8-4). As such, they maximised the chance of success in collecting WFs opportunistically by altering their activity spaces[23]

> *"Usually, the fallow fields are close to the paths we know. Who knows? Maybe we want to work in the garden and it is close. Who knows? Maybe there is food that is*

[23] I have termed this practice "probabilistic opportunism" and is a major factor in women's food choice behaviour (especially in the FOR villages) – which is the topic of Chapter 9.

> *ripe. So when we pass and if we see that there are vegetables or fruits that are ripe, we can take them"*

Quote 8-4: (OP_Vill3_KI_F)

Despite these limitations with the quantitative data, the survey stills gives an indication of the relative degree of opportunism in WF acquisition for different food groups and between sets of villages. Men's WF acquisition primarily consisted of bushmeat and fish (which are predominantly deliberately acquired[24]) as well as heavier WEPs such as roots, shoots and palm hearts. The latter is primarily acquired opportunistically by men in the FOR villages but deliberately in the OP villages[25]

8.5.3 Drivers of Change in the Wild Food Sub-System

In both sets of villages, respondents reported that the acquisition of WEPs from forest sources had declined compared with historical usage patterns – but that the acquisition of WEPs from village surroundings remained as important as it had been previously. WEP acquisition from other non-forest wild environments outside the village was seen as stable in the FOR villages, but was viewed as having declined dramatically following the introduction of oil palm in the OP villages – primarily because women (the primary acquirers of such foods) spent less time in and around such environments[26]. In both sets of villages, the frequency of hunting and fishing acquisition was deemed to have reduced over the preceding decade – but this opinion was more widely held in the OP villages than the FOR villages (Figure 8-6). Among those who expressed the opinion that hunting had declined, men in both sets of villages cited forest loss and a lower abundance of animals (Figure 8-7). As one respondent in the OP villages stated:

Hunting and fishing constrained by time-availability

Hunting and fishing in the FOR villages blur the line between leisure activity and necessity. While part of an overall livelihood strategy, they are clearly an enjoyable, and in the case of hunting, a social activity. In the OP villages, hunting fishing was seen as less necessary to provide meat and fish and was viewed more as a leisure activity (Quote 8-5), often carried out only when there are public holidays.

> *"Now we don't go to the forest so much, there is enough farming by ourselves so we do not need more food... But going to the forest for hunting, that is different. That is for fun and the meat is better."*

Quote 8-5: (OP_Vill4_KI_M)

Although by no means universal, overall, respondents in most of the OP villages stated that they still had access to forests that could be used as hunting grounds. However, these forests tended to be further away than in the FOR villages, requiring more time to hunt – time which was also less abundant. Men's oil palm contracts also required them to report early in the morning for work in oil palm plantations, limiting the opportunity for nighttime hunting expeditions. Thus, in the OP villages, hunting for bushmeat had become an occupation carried out on days off, particularly holidays, rather than an essential part of an

[24] While most hunting and fishing events are, by their nature, deliberate, men may take firearms with them while carrying out other activities on the off-chance of encountering a suitable animal. This practice was occasionally observed in the FOR villages and may fall into the category of "probabilistic opportunism" discussed in Chapter 9. Additionally, there are other sources of wild meat (e.g. snails, crabs, snakes) which do not require the same methods of hunting.

[25] Some caution should be taken with interpreting this as WEP collection by men in the FOR villages was rare – thus data may be skewed by a handful of instances

[26] The effect of this change in activity space on acquisition behaviour is discussed extensively in Chapter 9.

overall livelihood strategy. For hunters and fishers who still did so to acquire food, many in the OP villages had adapted their methods to increase the time and labour efficiency of the activities. One way was using snare traps instead of hunting with firearms or stationary seine nets in place of line fishing.

> *"Not many people like to go hunting now, they are busy working and do not have much time"*
>
> **Quote 8-6:** (OP_Vill3_KI_M)

> *"It is difficult because our land has been cleared, so the animals are further away in the forest. Because the oil palm has also cleared some of the hutan lindung [protected forest], protected by the government. Not all of them are cleared, especially those at the foot of the hills."*
>
> **Quote 8-7:** (OP_Vill1_KI_F)

Respondents in both sets of villages reported that the time required to reach hunting grounds had increased in recent years. This widely held qualitative perception is confirmed by quantitative estimates provided during free-listing exercises in focus groups, which shows sources of wild meat to be situated closer to villages in the FOR villages (Appendix H.7). Qualitative findings emphasise the importance of time scarcity and the distance needed to reach hunting grounds. In the OP villages, respondents expressly stated that hunting was incompatible with waged oil palm labour as it took too much time, often overnight, and was therefore not compatible with the early mornings required to work on plantations. As such hunting in the OP villages was primarily a leisure activity reserved for holidays and special occasions[27]. This topic is explored in more detail in Chapter 9.

Some respondents in the OP villages reported declining fish stocks as a result of oil palm-related pollution, leading to reduced fishing practices (Quote 8-8). However, it would be misleading to suggest that this is a universal trend – respondents in many villages reported fish abundance had been unaffected by oil palm's introduction. Indeed, the quantitative data shown in Table 8.6 does not suggest significant differences between sets of villages in terms of the proportion of households who fish, nor the frequency of fishing events for those who do[28].

> *"From time to time, but not very much. Because of the oil palm, there are not many fish left"*
>
> **Quote 8-8:** (OP_Vill2_KI_F)

For hunters and fishers who still did so to acquire food, many in the OP villages had adapted their methods to increase the time and labour efficiency of the activities. One way was using snare traps instead of hunting with firearms, or stationary seine nets in place of line fishing. While hunting with snare traps and seine nets is far from a modern innovation – traditional hunting in many Dayak communities involves some use of traps, and stationary fish traps/nets weaved from ratan and other NTFPs (Purwanto, 2018;

[27] While respondents in the OP villages clearly stated that hunting was a leisure activity, the distinction between hunting for necessity and hunting as a leisure activity was not always straightforward in the FOR villages. In particular, when stating their reasons to go hunting, men tended to group a preference for the taste of wild meat over alternatives alongside the leisure and social aspects of hunting. As well as qualitative data on the topic, free-text responses on hunting reasons were collected as part of the WF recall survey with men, the results of which are shown in Figure 8-7. However, for the reasons stated above, this survey approach likely inadequately deals with common situations where men have dual or multiple motivations behind hunting episodes

[28] Data on fishing is much more variable than data on hunting – the lack of significant differences may be driven by greater heterogeneity.

Hendra et al., 2023) – qualitative evidence suggests the deliberate use of these techniques as a time-saving measure in the OP villages[29].

8.6 Analysis: Market Food System

8.6.1 Types of Market Food Environments

An overview of the different types of food vendors is shown in Table 8.14. Lengthier descriptions of each kind of market food source, as well as illustrative photos, are available in Appendix H.8. The main types of vendors present in both sets of villages were small *warungs* (hereafter referred to as village shops), which typically operated as side businesses out front rooms or wooden extensions built onto houses, and mobile vendors who sold produce from the back of motorcycles. Village shops, being only a side business of working households, were restocked infrequently by shop owners who travelled monthly or bi-monthly to resupply. As a result, they sold mainly processed and packaged foods as well as a small selection of essential condiment vegetables with longer shelf-lives (e.g. red onions[30], garlic, ginger etc.). Not all processed and packaged foods are unhealthy. Processed and packaged foods contained a high number of unhealthy UPFs such as biscuits, cakes, sweetened beverages as well as instant noodles[31], they also contain some healthy sources of foods – in particular, canned sardines and dried and/or salted fish. Village shops rarely contained fresh produce in either sets of villages[32]. Unlike village shops, mobile vendors purchased fresh foods in regional markets daily, sourcing foods from regional markets in large towns, or specific villages that specialise in commercial vegetable production.

Intra-village peer-to-peer trade in foods was widespread in the FOR villages and only occasionally practised in the OP villages. Peer-to-peer trade consisted of the sale of foods for cash, as well as exchanges of foods between households and reciprocal gift giving whereby surplus foods (either wild or crops) were given to friends and kin relations with an unspoken expectation of a reciprocal gift (often a different food) for which other households may have an excess at an unspecified time in the future. Which foods are traded depends on whether the foods were produced in sufficient quantities to create a surplus, and how difficult it would be for households to acquire such foods themselves. Foods tended to be traded only when foods produced were surplus to household needs (Quote 8-9). Trade in widely available foods such as edible ferns and other green leafy vegetables was negligible – as it was simply too easy to collect them. Foods such as wild meat, and fish, however, were more difficult to acquire and thus were traded more often. Likewise, WEPs, which were encountered opportunistically but which provided more food than was needed for one family (such as palm hearts), were commonly given away, exchanged or sold to friends or neighbours.

> *"After we return home, usually men bring the results from their searching for vegetables in the forest, their fishing results and sometimes maybe they bring their hunting results, bring game animals. If it is a lot, usually, wives will help their husbands sell the results, but only if there is enough for the family to eat."*

Quote 8-9: (FOR_Vill4_FGD_F)

[29] Traditional trapping of fish was done using rattan, bamboo fibres and other NTFPs and has often been viewed as declining in popularity in many parts of Kalimantan. In a way, the renewed popularity of fish trapping is a revival of this traditional practice – albeit with traditional traps replaced with more modern equivalents made from nylon and steel

[30] Small red shallot-like onions (*Allium cepa L. var. aggregatum*)

[31] Which, though ultra-processed and nutrient-poor, are fortified with some vitamins.

[32] Though in a few villages in the FOR villages, some shops were used as points of intra-village trade occasionally for a small handful of select products. However, the overwhelming majority of intra-village trade consists of peer-to-peer transactions.

Table 8.14: Types of Market Food Environments

Source	FOR Villages	OP Villages
Village Shop	Converted parts of owner's homes or wooden extensions, run as side businesses. Irregular opening hours depending on the owner's livelihood. Small amounts of local produce (esp. condiment vegetables).	Converted parts of owner's homes or wooden extensions, run as side-businesses.
Node Settlements	Nearby larger villages with larger shops or sites of regular temporary markets.	Settlements situated at junctions in well-connected positions catering for passing traffic truck drivers and surrounding villages. Sell a wide range of food and non-food products and services.
Temporary Markets	Weekly or bi-weekly markets consisting of local vendors of agricultural products from surrounding villages (*FOR Only*) and outside vendors.	Same as FOR villages but also, take the form of conglomerations of mobile vendors – primarily motorcycle-based but also pick-up truck-based. Mobile vendors may converge around oil palm company offices on pay days.
Mini-Mart	Typically, local or national chains (but also independent) sell foods in bulk. Range of other services (phone credit, ATMs etc.).	Typically, local or national chains (but also independent) sell foods in bulk. Range of other services (phone credit, ATMs etc.).
Mobile Vendor	Mainly motorcycle-based, independent traders, specialising in one or two types of foods. Able to reach even remote villages at (almost) all times of the year, even when conditions are difficult. Obtain foods primarily from district markets and travel to multiple villages per day. Optimise routes strategically to ensure timing arrival in villages with the greatest demand.	Same as FOR villages, but with slight increase in frequency and variety.
Intra-Village Trade	Trade (for cash, as gifts or exchange) in wild foods and excess agricultural products from non-commercialised farms (i.e. selling or exchange of excess). Differentiating from gifts can be hard due to reciprocal gift-giving.	Practically non-existent, with the exception of high-value foods (e.g. Durian).

In both sets of villages, respondents occasionally purchased food from outside the village. Food sources outside the village consisted of temporary markets, "node settlement"[33] shops and mini-marts. In the FOR villages, the latter were located closer to main towns and served primarily as a means for purchasing in bulk for the owner-operators of village shops. In the OP villages, however, access to mini-marts varied widely. In areas where oil palm was well-developed, mini-marts (including larger local and national chains) could be found within some node villages. However, for most OP villages, accessing mini-marts still required some degree of travel. Temporary markets existed in both sets of villages, but were somewhat different in nature. In the FOR villages, temporary markets (typically weekly) consisted mainly of farmers selling their own produce from surrounding villages, supplemented by a few traders from outside the area. In the OP villages, fewer farmers produced surplus foods for sale. Thus, these markets tended to mainly consist of professional sellers who used four-wheel-drive trucks, operating as large-scale mobile vendors. An additional phenomenon in the OP villages was the existence of pay-day markets which spontaneously formed around oil palm company offices when workers received their salaries. As well as selling fresh produce, these markets would also sell cooked foods as well as non-foods such as household goods.

8.6.2 Differences in Market Food System

Table 8.15 shows the main differences in market food systems in each village type. The OP villages had greater access to market vendors overall[34]. Access to establishments selling food is similar with the exception that around one in three OP villages had access to a node-village shop. Other noticeable differences in food establishments include the greater access to dairy products[35] but lower access to fruits. In terms of mobile vendors, almost all villages were frequented by at least one mobile vendor a week. However, villages in the OP villages were visited on average almost twice as frequently – though the frequency of visitations varied considerably in both sets of villages.

A major difference in market access between the sets of villages was access to the network of intra-village peer-to-peer trade. KIs were asked to name the number of village residents[36] from whom they could "often or usually" obtain different foods from. On average, respondents in forest villages knew more people who acted as informal traders for food and barter, indicating that informal intra-village trade within the forest villages was higher. The results indicate that options to obtain food via intra-village trade are more widespread in the FOR villages compared with the OP villages. In the OP villages, very little intra-village trade occurred – and the small amount that did occur was almost exclusively limited to agricultural products, with very little trade in wild fish or meat.

Taken at the food group level, there are few differences between sets of villages in terms of the market provision of foods, as the market system provides access to most types of foods in both sets of villages (Figure 8-10). However, at the food level, the market food system provides a less diverse range of fruits, vegetables, meat and fish in the OP villages. Access to processed foods within villages themselves is similar (though some OP villages may be frequented more often by sellers of pre-cooked foods). However, the market food system in the OP villages provides access to a much greater range of processed and ultra-processed foods through greater proximity to mini-marts and node settlement shops in the surrounding area (Figures 8-12 and 8-13). While not all OP villages were closer to a node village or mini-mart, for most, such a shop was only a short ride away by motorcycle. Access to these types of shops dramatically increases household access to ultra-processed foods. Similarly, some household members in some OP villages were exposed to other sources of non-village-based food environments which stocked and sold processed and pre-cooked foods – particularly women who passed by oil palm barracks[37] and when mobile vendors targeted locations where men break from plantation labour. While access to these shops

[33] I use the term "node settlements" to reflect their connectivity and their function as serving both passing traffic as well as the surrounding villages as well as the fact that they may not be officially villages but rather a cluster of shops or other buildings which have formed at strategic locations. See Appendix H.8 for more detail.

[34] Significance tests were not carried out due to the low sample size (n=32) of villages.

[35] Note: Ice cream, available in some OP villages and sold by mobile vendors, is not included but is counted as processed food. Also excluded are cans of condensed milk, available in most village shops, which are counted as sweets. This was done to avoid misleading conclusions over the potential dietary and nutritional implications.

[36] i.e. non-professional traders – residents who obtained food for sale, gift, or exchange from their own production or from wild or semi-cultivated sources.

[37] Where migrant oil palm workers are housed

Table 8.15: Market Food Environment - Physical Establishments

Food Source	**FOR**	**OP**
Physical Establishments and Static Locations		
Proximity to establishment (mins[1]):		
Mini-Mart	66.0	48.3
Number of vendors:		
Village Shops	2.3	3.2
Larger shop/Node-Village[2] Shop	0.0	0.3
Temporary Market[3]	0.8	0.8
Establishments[4] Selling:		
Fruits	2.9	1.4
Vegetables	3.7	3.8
Bushmeat	1.3	0.2
Other meat	0.1	1.1
Fish (local wild)	0.0	0.0
Fish (other)	0.0	0.1
Dairy[5]	0.0	0.3
Eggs	1.2	2.0
Mobile Vendors and Peer-to-Peer Trade		
Villages served by mobile vendors[6] (%)		
Raw Foods	93.4%	100%
Cooked/Processed Foods	37.5	81.2
Mobile Vendor Frequency (visits/week):		
Any (raw)	11.9	20.3
Any (cooked)	2.8	4.5
Meat and Fish	4.1	5.3
Vegetables	4.9	5.3
Fruits	0.0	1.2
Processed Foods	1.2	2.8
Number of Intra-Village Traders[7]		
All Foods	6.7	3.3
Wild Meat or Fish	5.5	0.7
Wild Edible Plants	3.1	0.2
Agricultural Products	6.2	3.3

Notes: [1] By motorcycle; [2] Includes crossroads and neighboring villages with built retail environment; [3] Includes weekly "pasar mingu" temporary markets and pay-day markets; [4] Within a 15-minute motorcycle ride; [5] Excludes ice cream and condensed milk; [6] Served is defined as "sometimes" or "regularly" possible to buy food; [7] Average number of people within the same village respondents could name from whom it was "often or usually" possible to buy or exchange food.

is certainly greater – and thus the range of UPFs they stock – it appears that these locations are (for most respondents at least) not regular places of food acquisition. For most, their value lies in the other range of goods and services offered (non-food productions, mobile credit, ATMs and related services) rather than foods – though foods may be bought when visiting these locations for such reasons (Quote 8-10).

> *"Yes that's for sure, every time there is a need to go to the shop to send money and maybe we see various types of food and if there is a lack of food at home – whether it's instant food, sugar, coffee salt, when we go we will buy food there"*
>
> **Quote 8-10:** (OP_Vill1_IDI_F)

8.6.3 Drivers of Differences in Market Food System

Disparities in food provision between sets of villages can be explained by the relative dominance of subcomponents of the market food system in each village type. In particular, the FOR villages and OP villages differ greatly in terms of their day-to-day reliance on mobile vendors and intra-village peer-to-peer trade.

Intra-Village Peer-to-Peer Trade

In the FOR villages, the extensive intra-village peer-to-peer trade system is the primary source of fresh produce within the market system and encompasses virtually all locally produced agricultural and wild foods[38]. In contrast, peer-to-peer trade is infrequent and limited to only a handful of foods[39]. The fact that locally produced foods no longer enter the local food market system is clear from Figure 8-8 which shows the proportion of locally produced wild foods which are sold, gifted or self-consumed[40]. The reason for this is clear: household farms do not produce surplus foods, nor do households collect wild foods in quantities beyond household requirements (Quote 8-11)

> *"If people ask, we will share... but the soil fertility has decreased here... there is barely enough for our own food"*
>
> **Quote 8-11:** (OP_Vill3_KI_F)

Respondents in the OP villages were clear that peer-to-peer trade was important before oil palm adoption[AQ IV] and attributed the loss of this system directly to oil palm-related livelihood changes. These changes, including the reduced diversity and quantity of agricultural and wild foods products produced at the household level, are driven by forces such as the opportunity cost of land and labour discussed above (Quote 8-12)

> *"No, here we don't sell food... here women are busy working in oil palm, and after working in oil palm we have to go to the fields, and we think there is no time to grow*

[38] With a couple of exceptions such as edible ferns (where foods are so ubiquitous, they are not worth trading), any food produced from agriculture or available from the wild can be bought via intra-village trade in the FOR villages.

[39] e.g. domestically reared meat

[40] Gifted in this context, largely means traded in reciprocal gift-giving

> *vegetables or garden vegetables for sale."*
>
> **Quote 8-12:** (OP_Vill4_KI_F)

The loss of intra-village trade in the peer-to-peer trade system coincides with the homogenisation of livelihoods. In the FOR villages, the peer-to-peer system was so useful because different households were engaged in different activities at any one time – visiting different types of fields and locations and engaging in different forest-related activities. Thus at any one time, different households are producing a surplus of different types of foods (Quote 8-13). Peer-to-peer trade thus produced a massively diverse set of foods at any one time. This also contributed to the perception that the system was a dependable source of food (discussed in Chapter 9) and the view that this source of food could bridge any seasonal gaps in food availability. For example, when fruits were ripe and ready for harvest (either wild or agricultural), fruit trees would typically produce more than a household could consume. Excess fruits, therefore, were sold or given to friends and neighbours. In giving gifts or regularly exchanging foods for which a household had excess, households also improved their access to food year-round.

> *"If you have more than enough, sometimes you sell. People can order too. Then, if you want to buy, you let people know and someone who has more than enough will sell to you."*
>
> **Quote 8-13:** (FOR_Vill1_FGD3_KI_F)

As well as direct peer-to-peer trade, another way in which locally produced foods entered the local food system was via temporary markets – which in the OP villages did not tend to have foods produced locally by village residents (Quote 8-14).

> *"Here we don't have [people who sell vegetables]. The people in the village don't sell food at the weekly market because here the women are busy working in the oil palm and after working in the oil palm they have to go to the fields and we think there's no time to plant vegetables or gardening vegetables for sale."*
>
> **Quote 8-14:** (FOR_Vill5_FGD3_KI_F)

Differences in Mobile Vendors

In both sets of villages, respondents perceived there to have been an increase in the availability of foods from mobile vendors compared with historical norms – but far more so in the OP villages where they have become an essential component of the food system since the arrival of oil palm[41]. Infrastructure improvements only partially explain the trend in increased mobile vendor food provision. While road quality was often cited by respondents as a reason why some villages were visited more often than others[AQ V], even the most remote and difficult-to-access villages were occasionally served by mobile vendors. As discussed in Chapter 6, oil palm development did not universally bring improvements to infrastructure and many OP villages were as difficult, or more difficult, to access than many FOR villages. Rather than accessibility, the primary determinant of mobile vendor visitation was an interaction between (a) the connectivity of the village (i.e. whether or not a village was passed through on the way to other villages) and (b) the demand in the village.

[41] Indeed, mobile vendors who travel to multiple villages every day, provide access to types of market foods which could not be sustained by village shops which operate a side business for households who work full-time (usually in oil palm plantations).

Mobile vendors were viewed as adapting to local supply and demand conditions – for example, prioritising villages where there was a shortage of particular foods (Quote 8-15), or when demand was the highest due to residents having been paid recently[AQ VI]. While this market response was viewed as useful by respondents, the continuous changing of routes and schedules also led to a perception of unpredictability and unreliability (discussed in Chapter 9).Thus, rather than changes in infrastructure development, the post-oil palm increase in mobile vendor frequency is likely more a product of changing demand. This demand is driven partly by a change in income levels – meaning households can afford to spend more on food[42], and partly due to necessity as people produced fewer types and quantities of foods and thus demand for market foods was greater.

> *"If, for example, people have been paid recently, they [mobile vendors] know this. They know when people get paid their salary from the company. There will always be more [of them after pay-day]... Also, they know which villages need fish, need fruits... For example, they hear that in this village people want to buy fruit, they will go see."*
>
> **Quote 8-15:** (OP_Vill2_KI_F)

This study draws attention to several types of market systems almost absent from any studies of food environments and food systems. The first is the informal intra-village peer-to-peer trade discussed above consisting of surplus agricultural and wild foods. The second is a distinct but related system of hyper-local inter-village trade which appears to function irregularly[43] but is an integral part of managing seasonal gaps in availability[AQ VII].

8.7 Discussion

This is the first study to measure these food system effects in the context of oil palm development[44]. The outcomes of food system changes and their proximate and underlying drivers are represented visually in Table 8.16.

Households in the OP villages produce a less diverse range of agricultural and wild foods. Underlying both of these changes are the opportunity costs of time discussed in Chapters 6 and 7. It is primarily time – rather than land scarcity – which causes the intensification of fields and the abandonment of more extensive forms of agriculture. This results in a loss of diverse production systems, including fallows, mixed agroforestry gardens and rubber fields[45]. Lack of time, however, interacts with land scarcity. As was discussed in Chapter 3, the relocation of fields to more convenient locations accelerates the transition to formal land tenure regimes and the emergence of land markets, which further drive scarcity of (desirable, local) productive land. Time scarcity also drives changes in wild food acquisition. As a result of the commitments to oil palm plantation labour, hunting and fishing become less core livelihood strategies, and more leisure activities which are carried out on holidays. Changes in time allocation and opportunity costs also affect when and where women encounter wild foods and opportunistically acquire them. These impacts on food choice are discussed in the following chapter.

[42] Qualitative data, discussed in Chapter 9 suggests that market foods were seen as an expensive and unnecessary luxury in the FOR villages when foods could be acquired cheaply and easily from forests. This opinion was not heard in the OP villages, where it was more common to hear of market foods as part of an essential strategy.

[43] Most inter-village trade occurs via temporary markets

[44] Previous studies of oil palm development, diets and nutrition have examined indicators of dietary adequacy and food security as outcomes without considering food-system effects.

[45] Though rubber fields may be retained, but not used.

Table 8.16: Food System Changes and their Proximate and Underlying Drivers in the OP Villages

Visual Overview of Changes and Trends Experienced Following the Adoption of Oil Palm

Sub-System	Outcome	Proximate Drivers	Underlying Drivers
Market	↑ Outside fresh foods	↑ *Mobile Vendor Frequency*	↑ Income ↓ Local production (↑) *Infrastructure/Connectivity*
	↑ Cycles of Availability	↑ Mobile Vendor Responsiveness	↑ Pay-day cycles
		↑ Pay-Day Markets	↑ Pay-day cycles
	↓ Local fresh foods	↓ Intra-Village Trade	↓ Agricultural surplus ↓ Wild Food Acquisition
Agriculture	↓ Production Diversity	↓ Farm-System Diversity	↑ Localised Land Scarcity
		↑ Field Intensification	↑ Localised Land Scarcity ↑ Time Scarcity ↑ Income
	↓ Fruits and Vegetables	↓ Extensive Fields	↑ Localised Land Scarcity
Wild-Foods	(↓) *Bushmeat Availability*	(↓) *Animal Abundance* (↑) *Distance to Forest*	(↑) *Hunting Pressure* ↑ Forest Loss/Fragmentation
	(↓) *Fish Availability*	(↓) *Fish Abundance*	(↑) *Over-Fishing* ↑ *Pollution*

Notes: Table summarising the general changes to food sub-systems and proximate and underlying drivers across multiple villages in the OP site. Increasing and decreasing trends are indicated by ↑ and ↓ respectively. Increasing and decreasing drivers who may be present but are relatively minor drivers are indicated by (↑) and (↓) respectively. Changes and drivers that are highly variable between villages within sites (i.e. present in some but not all villages or varying considerably in importance) indicated by *italics*.

This study demonstrates the complex ways in which markets respond to landscape and agrarian change. As discussed in Chapter 3, it is a common assumption of many studies of agricultural development, that better access to markets brings with it better access to diverse and nutritious food groups. This, however, is not always the case. For instance, in East Kalimantan Reyes-García et al. (2019) finds market integration of forest-centric communities leads to fewer healthy foods and more unhealthy foods being available in the food system. My findings are harder to characterise. On the one hand, access to UPFs is technically greater – but probably not in a meaningful way. At the village level, UPFs are similarly available (and similarly high) both in oil palm-adopting and non-oil palm-adopting villages, and the increased availability in the OP villages was mainly explained by the presence of mini-marts and nearby node-village settlements outside the villages. All indications are that (for the most part) food acquisition from these locations is not routine for women in these study sites villages. It is unlikely, therefore, that lack of access to such foods is a constraint on their consumption in the FOR villages or vice versa. Any differences in consumption, therefore, are likely to be driven by other food choice factors (discussed in Chapter 9).

Much of the econometric literature on agricultural commercialisation focuses on the effects of household-level agrarian changes without considering the aggregate effect on markets of widespread specialisation (Ickowitz et al., 2019). This study shows that widespread oil palm adoption of oil palm results in reduced market diversity of foods due to the loss of a locally produced surplus of agricultural and wild foods. A similar outcome was reported in a qualitative study by Julia and White (2012). The ways in which local production enters the local food system is of significance to studies of food systems and agrarian change and highlight the critical roles played by types of market systems that are almost absent from food system studies. The first is the informal intra-village peer-to-peer trade consisting of surplus agricultural and wild foods. The second is a distinct but related system of hyper-local inter-village trade, which appears to function irregularlybut is an integral part of managing seasonal gaps in availability (at least for fruit).

Locally produced food also enters the local market food system in the FOR villages via temporary markets.

The lack of WEPs in the market system following the adoption of oil palm, is consistent with other studies from Indonesia which suggest that the WEPs which retain market importance tend to be high-value products (often with perceived traditional, cultural or medicinal importance[46]) (Whisnu et al., 2023). However, that bushmeat is not widely traded in the OP villages is in stark contrast to evidence elsewhere in the region showing that markets lead to a commercialised trade in bushmeat (Onibala and Laatung, 2008; Pangau-Adam et al., 2012; Pattiselanno and Nasi, 2015; Pattiselanno et al., 2020). Both quantitative and qualitative data suggest that, while bushmeat is one of the few wild foods that continues to be traded, it is done so infrequently and at high prices which constrain purchases to special occasions (usually connected to customary events). While I believe this finding to be relatively robust, it is also possible that my quantitative data underestimates local trade in bushmeat species as the sampling strategy focuses on indigenous Dayak residents who have adopted oil palm[47].

8.8 Conclusion

Oil palm development creates structural changes in food systems, resulting in changes in food environments and the local availability and prices of foods. Compared with the FOR villages, both the agricultural and wild food sub-systems in the OP villages produce a less diverse range of foods in lower quantities. Oil palm's effects on food systems are both direct and indirect. For instance, oil palm development dramatically alters the opportunity cost of land and labour, which drives changes in agricultural land use and WF acquisition behaviour. Changes in local production have knock-on effects on market food systems. While most households in the FOR villages produce a surplus of agricultural and wild foods which enter the local food system via trade, exchange or gifting, most households in the OP villages do not. The loss of surplus locally produced foods leads to the disappearance of the hyper-local peer-to-peer trade system – which is an integral part of the market provision of healthy food groups in the FOR villages.

The reduced availability of locally produced wild and agricultural foods is partially, though not entirely, compensated for by changes in the market food sub-system, which responds by increasing the supply of certain foods. OP households do not lose access to any food groups as a result of oil palm development – but the diversity of available foods within many food groups is reduced. There is limited evidence that oil palm development increases the supply of unhealthy food groups such as processed and ultra-processed, foods, snacks and beverages within the wider landscape – but the availability of these foods at the village level appears unaffected.

The market response to changes in local production and livelihoods resulting from oil palm development

[46] Other studies have shown that, wild foods – often viewed by non-traditional consumers as foods of the poor – are often not well integrated into markets until they become delicacies in specialised markets (Reyes-García et al., 2015).

[47] The underestimate would only apply to the proportion of meat hunted which is sold/self-consumed and does not affect the results of the village-level inventories which suggest that bushmeat was not commonly available to purchase in most OP villages. However, this finding may reflect general patterns of bushmeat availability and does not account for availability during periods of customary events when demand may be higher. Trade in bushmeat from others outside the village does appear to occur, and appears to coincide with these periods of demand. I have only anecdotal evidence to support this. For instance, on two occasions, while stopping in "node settlements", I met migrant oil palm labourers from other parts of Indonesia who were attempting to sell bushmeat they had personally hunted. They were hoping to sell the meat to local Dayaks in similar villages to my study villages as there was an upcoming traditional ceremony. This aspect of the wild food system is one missing from this current research. This aspect is especially complex since the bushmeat being traded was pig meat (Bearded Pig, *Sus barbatus*) – the hunting and consumption of which is an integral part of Dayak self-identity, but which is *haram* for Muslims. The particular traders I met were Christians from Sulawesi and Flores – but these are likely to be a minority of migrant workers in general. It is not clear how widespread the practice of migrant workers selling foods to indigenous Dayaks is. However, none of my indigenous Dayak respondents reported this as a source of food in any of the interviews focus groups and informal discussions I had.

is driven primarily by mobile vendors, who (on average) visit the more frequently in the OP villages, and who also converge outside palm oil company offices on paydays. This study suggests that mobile vendors are highly responsive to fluctuations in supply and demand due to their mobility, flexibility and lower transaction costs. As discussed in Chapter 4, supply and demand dynamics are largely absent from existing food environments theory, which tends to assume uni-directional "exposure-related" causal pathways. The importance of mobile vendors in mediating supply and demand dynamics in rural contexts such as this are likely under-appreciated in food systems research and is discussed further in Chapter 11.

There is no strong evidence that oil palm adoption either lowers or increases food prices – at least for comparable foods originating from outside the immediate village area. However, better approaches to comparing the prices of processed and packaged foods are needed to confirm this. While like-for-like market foods of outside village origin may not differ greatly in price, it is likely that residents in FOR villages have access to cheaper foods than residents in the OP villages. This is because locally produced agricultural and wild foods which are sold locally via networks of peer-to-peer trade are cheaper than outside alternatives – and these sources of foods are far less available in the OP villages. Food prices, however, are only one part of the equation. Incomes in the OP villages are greater than in the FOR villages (though they lose many sources of environmental income). Perceived affordability and willingness to pay for food is examined in the next chapter. However, this chapter suggests oil palm adopters experience significant cash flow fluctuations throughout the month, affecting the ability and willingness to pay for market foods. The market food system is highly responsive to these fluctuations in cash flow, with mobile vendors visiting more frequently in villages where residents have been paid recently and by the establishment of pay-day markets outside company offices.

This chapter has outlined the major changes in food availability and prices resulting from oil palm-driven changes to food systems. How and why such foods are acquired, however, is mediated through individual food choice – which in turn is affected by individual livelihoods, priorities and preferences. This is the focus of the next chapter.

Endnotes for Chapter 8

[I] **Taxonomic Inflation:** The artificial inflation of the number of species can arise due to how species are delineated. In an ethnobotanical sense, this can occur when there are multiple local names for the same plant (especially common where there are multiple local languages spoken) or where local people distinguish between different types/manifestations of the same biological species. To mitigate this source of error, local key informants familiar with multiple local languages were used to create a list of different local names for the same species/variety. However, without collecting samples and collaborating with botanists, it is not possible to obtain the same resolution as would occur through plant taxonomy. However, this also better reflects the "use value" of the plants. For instance, if two varieties of a vegetable are actually the same species but can be distinguished by locals and are used in different ways or have different properties of value, then they are, from a use-value perspective, different plants – regardless of their taxonomic nomenclature..

[II] For fallow fields that are 5 years old there are still lots of vegetables there that are still taken, because when we farm we also planted vegetables or when we were farming... we have food like fruits we throw near the field, it usually grows and when we are no longer farming there are usually vegetables and fruits that we accidentally planted growing there and so we can take them

[III]

> *"[red leaf fern] is behind the house. But most often, we collect it from the oil palm."*

Quote 8-16: (OP_Vill3_KI_F)

[IV]

> *"Before, we would [trade locally], not so much now. If we have lots, we can sell, but rarely."*

Quote 8-17: (OP_Vill5_FGD_F)

[V]

> *"No there are not often [mobile vendors] here. In [neighbouring village], there are, but there aren't any here... Because it is too difficult for them to get here. The roads are bad, and most people grow products in their gardens."*

Quote 8-18: (FOR_Vill5_KI_F)

[VI]

> *"Well in [village name] it is different. There, the [mobile vendors] come almost every day. But here the road condition is not good. So here they will come only during pay-day. When people get their salary. "*

Quote 8-19: (OP_Vill6_KI_F)

[VII]

> *"We often buy fruits that are sold by outside vendors, such as apples, oranges, but for forest fruits it depends on the season, when the fruits in the forest are in season we take them, but when they are not in season we don't take the fruit and we have to eat fruit from outside [the village]"*

Quote 8-20: (OP_Vill1_IDI_F)

Chapter 9:
Impact of Oil Palm Adoption on Drivers of Food Choice

Contents

Chapter Abstract

Background: Existing research into the effects of smallholder oil palm adoption comes from a limited number of contexts and smallholder oil palm models. Additionally, most analyses have focused solely on income and market access pathways. However, the emerging fields of food choice and food environments have begun to unravel some of the complex inter-related modifying factors which mediate links between livelihood change and dietary intake. Oil palm adoption among former subsistence farmers with swidden and forest-centric livelihoods results in changes to local economic, agrarian, landscape, and context and results in changes in household time allocation, gender relations, and livelihood strategies – many of which will result in changing household food acquisition practices and food choice priorities.

Chapter 8 has shown how a similar set of food groups are available in each village type, but that different parts of the food system predominate in providing these foods. These parts of the food system (retail establishments, mobile vendors, temporary markets, intra-village peer-to-peer trade etc.) each have their own characteristics and similar foods are viewed differently depending on their source.

Aims: This chapter aims to explore the nature and rationale of food choice decisions by women in oil palm-adopting and non-oil palm-adopting contexts. By comparing and contrasting the two samples, as well as exploring recent trends or changes in food choice decisions, the chapter aims to contribute to food choice literature by focusing on a neglected context – biodiverse rural settings with widespread wild food consumption. Additionally, I aim to contribute to the oil palm diet literature by understanding how dietary choices are made in this context – and examine potential dietary pathways which are often overlooked.

Methods: Qualitative data from focus groups and in-depth interviews, as well as quantitative data derived from participatory research, were integrated using a concurrent mixed-methods approach with quantitative survey data from agricultural and livelihood surveys.

Results and Conclusion: A wide variety of mechanisms through which oil palm development may affect dietary intake via food choice pathways were found. Few differences in food preferences were found between the two sets of villages, indicating that individual, cultural and social preferences are (as yet) unmodified by oil palm adoption. However, there are significant differences in women's food choice priorities.

The results indicate that women's food choice priorities are more sensitive to time scarcity in the OP villages – resulting in greater desire for convenience foods. Convenience foods were those which were both quick to cook and quick to acquire. The latter is heavily influenced by activity spaces, which alter the distance women are required to travel to obtain certain foods. As convenience foods contain both healthy and unhealthy varieties, the net nutritional effect of this changing desire is hard to predict. Women's food priorities in the OP villages also fluctuate in a predictable cycle associated with the schedule of salary payments by oil palm companies.

Significance and Implications: The study adds both to the literature on the social and welfare effects of oil palm development on communities in Indonesia as well as to the broader literature on food environments, food systems and food choice. The study suggests a broader range of modifying factors should be considered when examining the dietary effects of smallholder oil palm adoption. The findings of this study may be applicable to other contexts with rapid livelihood changes.

The study highlights the importance of considering the effects of agricultural interventions on time allocation and cycles of affordability. Changes in time allocation may modify diets via two pathways: (1) Generating time scarcity, which increases the desirability of convenience foods which are both quick to acquire and quick to cook and (2) Altering activity spaces, resulting in different opportunities to acquire food as well as the relative convenience of foods within the food system. Cyclical patterns in food availability are driven by payday cycles, and cycles in food availability are driven by payday markets. The perception that diets differed dramatically before and after pay day was so widespread, it warrants careful further study. If confirmed with dietary intake data, it suggests that commonly used approaches to measuring dietary intake should be re-examined.

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9.1 Introduction

In the literature review chapter (3), I summarised existing studies linking oil palm development and food security and nutrition in Indonesia and described how previous studies have tended to explicitly or implicitly focus on one or two causal pathways – primarily income and market-mediated pathways – between oil palm adoption and dietary intake. However, the emerging fields of food choice and food environments have begun to unravel some of the complex inter-related modifying factors which mediate links between livelihood change and dietary intake. To date, this literature has focused overwhelmingly on High-Income Country (HIC) contexts (Turner et al., 2019). Additionally, the small number of studies focusing on Low and Middle Income Country (LMIC) settings have tended to focus on obesogenic environments in urban settings. To date, few food choice studies have been conducted in rural settings in LMICs – particularly in biodiverse contexts where consumption of wild foods comprises a significant part of diets.

In Chapter 6, I showed how this model of smallholder oil palm adoption provided insufficient income to allow farmers to abandon subsistence cultivation. Instead, subsistence cultivation persisted alongside waged plantations on oil palm estates and continued to provide the vast majority (though a reduced share) of the household's food supply. In Chapter 8, I showed how this creates a significant trade-off in the allocation of time and labour, resulting in substantial modification of agricultural practices and livelihoods. One effect of this is shown in Chapter 7 – a significant strain on women's time, resulting in a higher prevalence of time scarcity. Time scarcity is known to drive changes in food acquisition practices, though its effects have been under-explored in rural agricultural settings (Johnston et al., 2015). Time scarcity, however, is only one of many potential avenues through which agrarian and livelihood change may affect food choice. This study explores how oil palm adoption drives changes in food choice. While it focuses significantly on time-related pathways (time scarcity, changes in activity spaces), it also explores changes in other known drivers of food choice, including changes in food affordability, food preferences, and food environments.

9.2 Data and Methods

Both quantitative and qualitative data were collected as part of a broader investigation into land use, agrarian and livelihood change and their consequences for food systems and food choice described in Chapter 5. Individual components of this broader investigation integral to the analysis in this chapter are highlighted in Table 9.1 and discussed below. Focus groups and key-informant and in-depth interviews were carried out as part of the wider study described in Chapter 5 and covered a wide range of topics, including agricultural practices, forest use, land use and land use change, time allocation, and household decision-making. The analysis in this chapter draws most heavily on focus groups with women which had an emphasis food acquisition, cooking, childcare and other domestic activities. In-depth Interviews (IDIs) with women were split between general interviews focusing on women's livelihoods and time allocation and more detailed interviews focusing on reproductive labour. Preliminary research in both sets of villages indicated that women were the primary agents of food choice decisions but that men (especially in the FOR villages) also engaged in food acquisition, which affected household food consumption. Thus, while the primary focus of the investigation was on women's food choice decisions, men were also surveyed about food acquisition events and motivations for them, as well as included in mixed focus group discussions around food choice and food acquisition. Additionally, IDIs with men, which were conducted on a range of topics relating to agricultural practices and wild resource use, also included a focus on food choice and food acquisition decisions.

Qualitative data were analysed using an abductive approach (Lipscomb, 2012; Thompson, 2022) to reflexive thematic analysis (Braun and Clarke, 2012, 2021). An abductive approach was chosen as it integrates both inductive and deductive reasoning. Thus, it allows the researcher to embed the study in the specific data while simultaneously critically examining, refining and expanding on existing theory. The abductive approach enabled thematic analysis to be situated within existing theories of food choice, food systems, and food environments while also keeping the analysis open to uncovering novel dimensions and aspects of food choice. This is particularly important given the nascent state of food choice and food environments research, particularly in biodiverse rural contexts in LMICs.

Table 9.1: Methods and Sources of Data

Method	Details
Qualitative Research	
In-Depth Interviews	Food Choice Priorities, Food Acquisition practices
Focus Group Discussions	Activity Spaces; Daily & Weekly Routines; Food Acquisition Practices
Qual.KI & FGD	Activity Spaces, Wild Food Acquisition
Women's Survey	
Food-Preferences Questionnaire	Time Scarcity; Food Budgets; Food Preferences
Activity Space Recall	Activity spaces visited (7-day & 30-day recall)
Food Acquisition Events	Location specific food acquisition events (7-day & 30-day recall)
Men's Survey	
Wild Food Acquisition	Hunting, Fishing & WEP Acquisition (30 day recall)
Participatory FGDs	
Freelisting, Pile Sorting	Foods, Food Sources, Activity Spaces
Ranking Exercises	Food Choice Priorties
Other Participatory Activities	
Participatory Walks	Food Sources and Food Acquisition Practices; Activity Spaces
Participatory Mapping	Activity Spaces; Food Sources

Notes: Two additional methods were trialed (participatory cooking and individual-level ranking of food choice priorities) but were not included in the analysis (See 9.2.1)

9.2.1 Routines, Activity Spaces and Food Acquisition

A focus on food choice requires an analysis of the ways in which households acquire foods, their exposure to different options, and the influences and constraints on their choices afforded by their immediate environment. It was clear early on in my investigation that both women and men were exposed to significantly different food environments in each village type as a result of different activity spaces throughout the day. Activity spaces – defined as both the temporal and spatial locations in which individuals spend their time – are known to be an important modifier of health exposures, including dietary intake (Perchoux et al., 2013), yet are typically overlooked by traditional food environment and food choice research, which tend to focus on specific geographic contexts such home surroundings, workplaces or schools (Cummins et al., 2017).

When dealing with spatial locations and their uses, reliance on single methods (e.g. solely on participatory mapping) has been shown to overlook important landscape categories and miss important aspects of their use (Wartmann and Purves, 2017). Triangulation of data from multiple sources is therefore necessary. To analyse men's and women's routines and activity spaces, data were triangulated from participatory free-listing, pile-sorting and ranking exercises, as well as participatory walks and maps. The aim was to both identify the spatial locations frequented by women (and the times of day/week/month in which they visited these locations) as well as obtain a contextual understanding of women's activities, motivation and reasoning.

Locally Defined Food Sources and Locations

A list of all locations habitually frequented by men and women, as well as all sources from which foods were or could be acquired (including agricultural, market and wild sources), was obtained through free-listing exercises during FGDs. These locations were then sorted into local categories through pile-sorting exercises (Cunningham, 2001; Martin, 2004; Gerique, 2006). This data was supplemented with data from participatory mapping exercises (see methods section 5.4.4) as well as participatory walks with respondents, which helped to identify any missing or overlooked categories.

Pile-Sorting and Ranking

Locally identified food sources were written on cards and classified by respondents by pile sorting. Respondents were asked to sort according to various characteristics, including frequency of visitation, distance or difficulty of acquiring. More general qualitative perspectives were also sought at this point on how both women and men perceived and utilised these sources. The list of local sources was then used as the basis of free-listing exercises to identify foods available from these sources. All foods in the free lists were also classified (or ranked) by participants according to a number of characteristics, including the ease or difficulty of acquiring, whether women or men (or both equally) were primarily involved in acquiring them, whether they were mainly acquired through opportunism among others.

Qualitative Routines and Activity Spaces

Focus group discussions and in-depth interviews with men and women were conducted on the topic of their daily, weekly and monthly routines, as well as how these routines varied by season. Equipped, with a comprehensive overview of local categories, interviewers were able to probe respondents to be more specific about locations visited, resulting in less general categories[1]. Unfortunately, the time use data, which is the focus of Chapter 7 did not include explicit location data[2] However, it was possible to validate a proportion of qualitative findings against the routine and activity space data[3].

Quantitative Activity Space and Food Acquisition Data

The process of deriving local categories of locations and food sources was also part of the pilot study. These categories were also used as the basis of the quantitative survey on men's and women's food acquisition events and women's activity spaces. For each of the local categories, women were asked to recall the number of occasions in the preceding 7 days they had visited each location and both the number of days and total number of events of food acquisition that had occurred from each. This gave not only a good depiction of the spatial pattern of activity over the preceding week but also the proportion of visitations which resulted in food acquisitions. Additionally, 30-day recall surveys with men and women relating to wild food acquisition (hunting, fishing and WEPs) used locally relevant categories for the location where the events had occurred.

[1]For instance, distinguishing between field types, forest types and types of vendor

[2]The pilot survey showed this to be unfeasible. The extra time required to include these details – especially if using specific location categories – risked introducing intolerable levels of bias and inaccuracy through respondent fatigue.

[3]Some aspects of routines are easily validated (e.g. waking up-times, bed-times, work start times. Additionally, some types of activities are inherently location-specific (for example, time spent in rubber gardens). Other categories, such as "hunting", "fishing" and "own-farm" were not location-specific. Additionally, qualitative data reveals the importance of locations when walking to and from activities, which were not included in the survey.

9.2.2 Food Preferences and Food Choice Priorities

Food Choice Priorities

Focus group discussions on food choice were followed by group pile-sorting exercises to identify and rank women's priorities when making food choice decisions. These exercises involved first identifying the factors considered by women when making food choice decisions through open-ended discussions and free-listing exercises. These exercises were repeated both for general food acquisition as well for specific food groups and food sources. Food choice priorities were then written on cards, and participating women were asked to arrange cards in rank order from most to least important for various categories (e.g. food groups). Photos were taken of these rankings, which were later transformed into quantitative rank data[4].

Food Preference Questionnaire

No existing quantitative methodology exists to measure all aspects of food choice simultaneously, and few tools whatsoever exist which have been validated for biodiverse rural contexts in LMICs. Creating such an instrument would be far beyond the scope of this research. Additionally, due to the concurrent nature of my mixed-methods approach, the qualitative data couldn't guide instrument selection and/or development. I therefore selected two aspects of food choice I thought may be important, based upon formative research I had conducted prior to this study in the research area. These two aspects were preferences for wild foods over alternative sources and the importance of convenience foods and the impact of time scarcity. The scale development process is outlined in Chapter 5, Section 5.4.1.

9.3 Descriptive Analysis

This section presents an overview of the results from the quantitative survey and quantitative data obtained from participatory methods. The thematic analysis of qualitative data is discussed below in Section 9.4 before the mixed-methods results are integrated in Section 9.5.

9.3.1 Differences in Food Acquisition Practices

The previous chapter has described the various sources of foods and the types of foods they provide in each of the two sets of villages, as well as analysed data on wild food acquisition practices. Table 9.2 summarises these sources and locations, the times of day women are present in these locations, and the rough frequency that women encounter these opportunities to acquire food. The table highlights how women encounter different opportunities to acquire food as they go about their daily and weekly/monthly routines. On a daily basis, women in both sets of villages have access to both purchased sources of food such as village shops, mobile vendors (and in the FOR villages, peer-to-peer vendors) as well as access to foods in and around the village surroundings, alongside paths and roads and to homegardens containing cultivated foods near to the home. Other sources of food are available only when these locations are visited deliberately (for instance, agricultural fields or forest locations) or from the locations they work throughout the day (e.g. rubber gardens in the FOR villages, plantation edges in the OP villages). Most

[4]The exercises were also repeated at the individual level with women as part of participatory exercises intended to break up the monotony of women's questionnaires – and thereby reducing respondent boredom and fatigue. However, this particular exercise was abandoned during the fieldwork as it became clear agreement between women was extremely high, resulting in low variation in rankings. Individual level rankings initially obtained before being abandoned confirm the order of these rankings.

Table 9.2: Sources, Locations and Occasions of Food Acquisition

Opportunities to acquire foods at different locations and times of day in OP and FOR Villages

(a) FOR Villages

Source	**Types of Foods**	**Times**	**Frequency***
Rubber Gardens	Vegetables$^{\text{w}}$; Fruits$^{\text{c,w}}$; Nuts$^{\text{c}}$; Seeds$^{\text{c}}$	Early Mornings	$5-6\times \text{week}^{-1}$
Mixed Agroforestry	Fruits$^{\text{c,w}}$; DGLVs$^{\text{w}}$, Oth. Veg.$^{\text{w,c}}$	Afternoon	$0-5\times \text{month}^{-1}$
Rice Fields	Vegetables$^{\text{c,w}}$	Afternoons	$2-5\times \text{week}^{-1}$ †
Fallow	DGLVs$^{\text{w}}$; Oth. Veg.$^{\text{w,c}}$; Fruits$^{\text{c,w}}$	Afternoons	$0-5\times \text{month}^{-1}$
Peer-to-peer trade‡	Bushmeat$^{\text{w}}$; Fish$^{\text{w,c}}$; Fruits$^{\text{w,c}}$; Oth. Veg.$^{\text{c,w}}$	Afternoon/Evening	$2-7\times \text{week}^{-1}$
River	Fish$^{\text{w}}$	Afternoon/Evening	$0-7\times \text{week}^{-1}$
Village shop	Packaged & UPF; Cond. Veg.	Afternoon/Evenings	$2-7\times \text{week}^{-1}$
Village Surroundings	DGLV$^{\text{w}}$; Fruits$^{\text{c,w}}$	Evening	Daily
Homegarden	Spices$^{\text{c}}$; Cond. Veg.$^{\text{c}}$	Evening	Daily
Forest	Bushmeat$^{\text{w}}$	Evening/Night	$0-5\times \text{month}^{-1}$
Path's/Roadsides	DGLV$^{\text{w}}$; Oth. Veg.$^{\text{c,w}}$	Any	Daily
Hyper-local trade§	Fruits$^{\text{c,w}}$; Bushmeat$^{\text{w}}$	Any	$0-5\times \text{month}^{-1}$ †
Mobile Vendors	Fruits$^{\text{c}}$; Oth. veg.$^{\text{c}}$; Meat$^{\text{c}}$; Fish$^{\text{c}}$	Variable††	Daily

(b) OP Villages

Source	**Types of Foods**	**Times**	**Frequency***
Rice Fields	Vegetables$^{\text{c,w}}$	Afternoons	$1-3\times \text{week}^{-1}$ †
Path's/Roadsides	DGLV$^{\text{w}}$; Oth. Veg.$^{\text{c,w}}$	Afternoons	5-7
Pay-Day Markets	Meat$^{\text{c}}$; Fish$^{\text{c}}$; Fruits$^{\text{c}}$; Oth. Veg.$^{\text{c}}$	Afternoons	$1-2\times \text{month}^{-1}$
Temporary Markets	Meat$^{\text{c}}$; Fish$^{\text{c}}$; Fruits$^{\text{c}}$; Oth. Veg.$^{\text{c}}$	Afternoons	$1-3\times \text{month}^{-1}$
River	Fish$^{\text{w}}$	Afternoon/Evening	$0-5\times \text{month}^{-1}$
Forest	Bushmeat$^{\text{w}}$	Evening/Night	$0-1\times \text{month}^{-1}$
Village shop	Packaged & UPF; Cond. Veg.	Afternoon/Evenings	$2-7\times \text{week}^{-1}$
Plantation Edges	DGLVs;	Afternoon	$6\times \text{week}^{-1}$
Village Surroundings	DGLV$^{\text{w}}$; Fruits$^{\text{c,w}}$	Any	Daily
Node-Villages	Meat$^{\text{c (f)}}$; Staples$^{\text{c (b)}}$	Any	$1-3\times \text{month}^{-1}$
Mobile Vendors	Fruits$^{\text{c}}$; Oth. veg.$^{\text{c}}$; Meat$^{\text{c}}$; Fish$^{\text{c}}$	Variable††	Daily

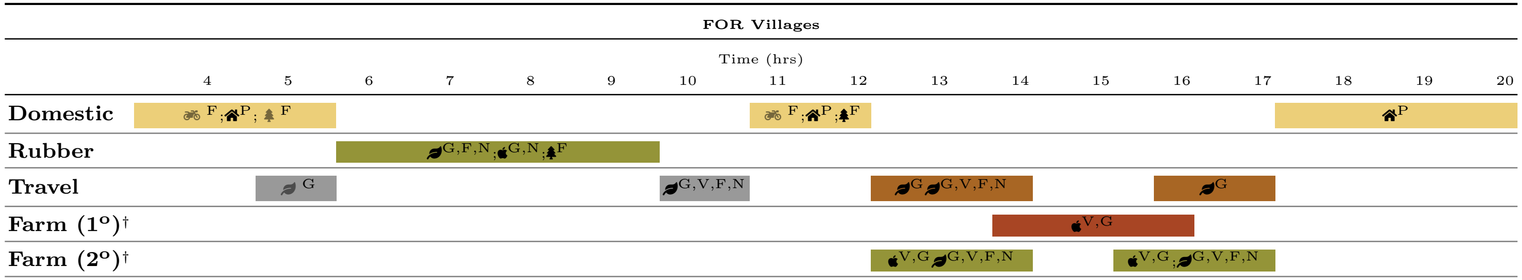
Source data: Triangulation of village surveys, FGDs (free-listing, pile-sorting); participatory mapping, participatory follows and direct observation * Frequency of visitation (not necessarily collection) – indicates opportunities to acquire; Sources are indicated by superscript letters (with order indicating dominance of sources): $^{\text{w}}$= Wild and Semi-Cultivated; $^{\text{c}}$= Cultivated; $^{(f)}$ = Frozen (typically); $^{(b)}$ Purchased in bulk † Highly seasonal; ‡ Includes purchase, gifting, exchange and reciprocal gift-giving; †† Variability depends of village connectivity (i.e. how remote from other villages or if suite en route to multiple other villages as well as the village demand for foods as perceived by mobile vendors food acquisition opportunities are in the afternoons and evenings when women spend time in and around agricultural fields (although some important food sources, such as mobile vendors, may arrive at any time). Evenings are also the peak time for peer-to-peer trade in the FOR villages as men and women returning from various activities and locations sell, trade or gift surplus produce to friends, relatives and neighbours.

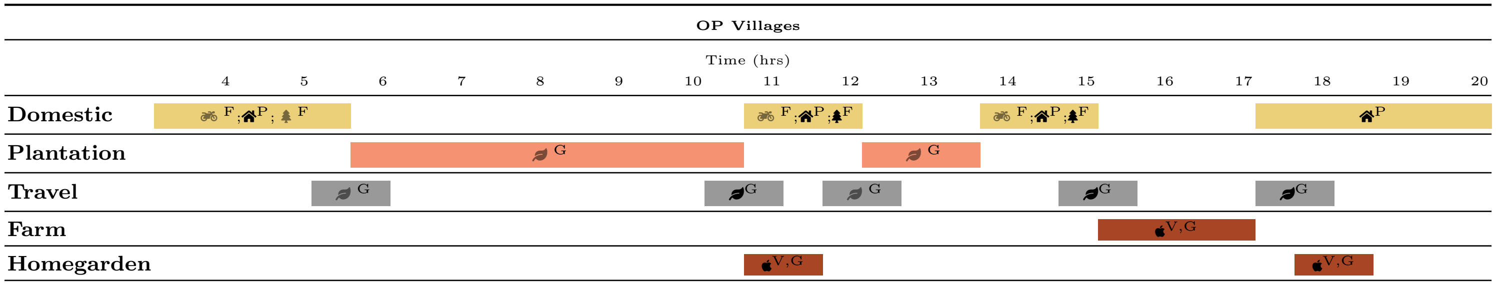
Daily Routines, Activity Spaces and Food Acquisition

Figure 9.3 shows a rough characterisationof men and women's daily routines, showing the locations they spend their time and opportunities to acquire food throughout the day. Both women and men in the oil palm zones had highly structured routines, with little variation between households. For women and men in OP villages, the working week is structured around six days of paid labour on plantations, with set start times and set end times, around which the rest of the day is structured. For men, this involved waged plantation labour between set hours, with breaks taken either on the plantation or nearby. For women, daily oil palm labour was carried out during set times for two slightly shorter periods of time, separated by a break in which women would usually return home. Women finished oil palm work earlier in the day and carried out other productive activities in the afternoon, usually farm labour for self-production. This contrasts with women and men in the FOR villages, who carried out a greater variety of activities.

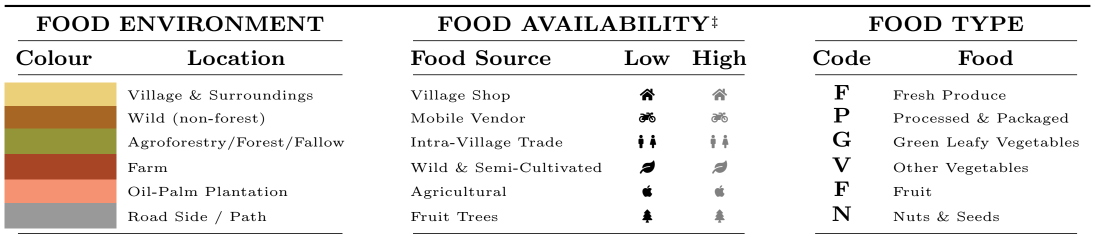
Table 9.3: Food Acquisition Opportunities within Women's Daily Activity Spaces

Visual representation of food environments encountered during a "typical"* daily routine





Legend



Notes: *Typical routines here are a rough characterisation of the general pattern of movements for women based upon descriptions of daily routines collected in focus group discussions (and cross-validated with time use survey). Timings are highly approximate, with significant variations between individuals and villages as well as throughout seasons. Routines here represent workdays (Mon-Sat) when engaged in "usual" activities outside of swidden peak periods of labour (clearing, burning, planting, harvesting etc.).

‡ **Primary and Secondary Farm Types:** Primary farm types are swidden and/or other main field (e.g. commercial vegetable garden), Secondary Farm Types include mixed-agroforestry gardens, fallows, forest gardens etc.

†Low probability: Indicates either fluctuating likelihood of availability (e.g. wild foods may or may not be present, mobile vendors may or may not arrive) or high-availability but low probability of women obtaining food from this source at this time (e.g. wild foods are available but women choose not to collect them at this time and place)

Activities carried out by women in the FOR villages are far more varied than the OP villages. However, the structure of the day is similar regardless of the activity carried out. Both women and men tended to wake up, go to bed, leave the house and return home around the same time regardless of activity (excluding Sundays). Both women and men in the FOR villages typically spent the morning engaged in rubber collection in the morning, when rubber yields were said to be highest, and in the afternoon, a mixture of own agricultural production, hunting, fishing or collecting forest products. Thus, while women in oil palm perform very similar or even identical activities at set times, six days a week, in forests, women often select from a set menu of possible routines. Exceptions to this daily routine were in the case of torrential rain that limited rubber collection or, in the case of men, hunting or *gaharu* (agarwood) expeditions by men.

In both sets of villages, women collected foods opportunistically and as needed (primarily WEPs such as ferns and cassava leaves) while walking to and from various locations. In the FOR villages, walking to and from rubber gardens and swidden fields in the FOR villages involved walking through areas of forest, non-forest wild and fallow fields, or required only slight deviations to do so – which allowed for the collection of wild foods. In contrast, most travel in the OP villages was conducted by road – either walking or by motorbike – either to oil palm plantations or fields which had been relocated away from forested upland slopes closer to roads and villages.

9.3.2 Weekly Activity Spaces and Food Acquisition

Figures 9-1a and 9-1b show the frequency that women visited different locations and the proportion of those days in which visits which resulted in a food acquisition event respectively. On average, women in the FOR villages visited both agricultural wild and semi-cultivated locations far more often than women in the OP villages. A smaller proportion of visits to wild forests and mixed-agroforestry gardens resulted in food acquisition in the OP villages. However, women were equally likely to acquire at least one food when visiting other agricultural and semi-cultivated environments.

9.3.3 Women's Food Choice Priorities

Women-only focus groups in food choice identified several important considerations women take into account when choosing which food to acquire or cook. Table 9.4 shows the most commonly cited food choice priorities across both sets of villages. Note that the categories presented represent my own aggregation of sub-categories. The most important general reasons cited for choosing which foods were cost, current or seasonal abundance, the ease of procuring foods, the time taken to cook the food and the taste of the food.

The top food-choice priorities varied only slightly by food group. A comparison of the top-ranked priorities in each sites for different food groups is shown in Appendix I.1. One aspect of note is the importance of women's perceptions that vegetables were free from chemical contaminants when making food choice decisions, which was ranked as the third most important consideration in both sets of villages. The time food took to cook was a major consideration for women when considering which foods to prepare. However, this appears to be a much greater concern for protein sources than vegetables. For vegetables, the importance of chance encounters is far greater in the FOR villages compared with the OP villages, whereas in the latter, the availability of vegetables from purchased sources is a bigger consideration.

Table 9.4: Women's Food Choice Priorities

Author's aggregation of women's choice priorities derived from FGDs

Category	**Aspect of Food Choice**
Ease of collection	Time required to collect
	Distance required to travel (from routine)
	Available from friends/neighbours
	Abundance/probability of encountering
Time to cook	Cooking time of food
	Foods to be combined with left-overs
Cost, prices & affordability	Cost to purchase
	Labour or cost to grow
	Pay-day cycles of affordability
Taste	Preference of Family member
	Taste preference for wild foods
	Taste preference for local foods
	Personal preference
Food Quality/Safety	Contamination with chemicals
	Adulteration with plastic[1]
	Freshness
	Food origin / trust

Notes: Raw food choice priorities were obtained from FGDs and IDIs. Table shows categorisation of commonly cited priorities surrounding food choice. [1]Rice Only

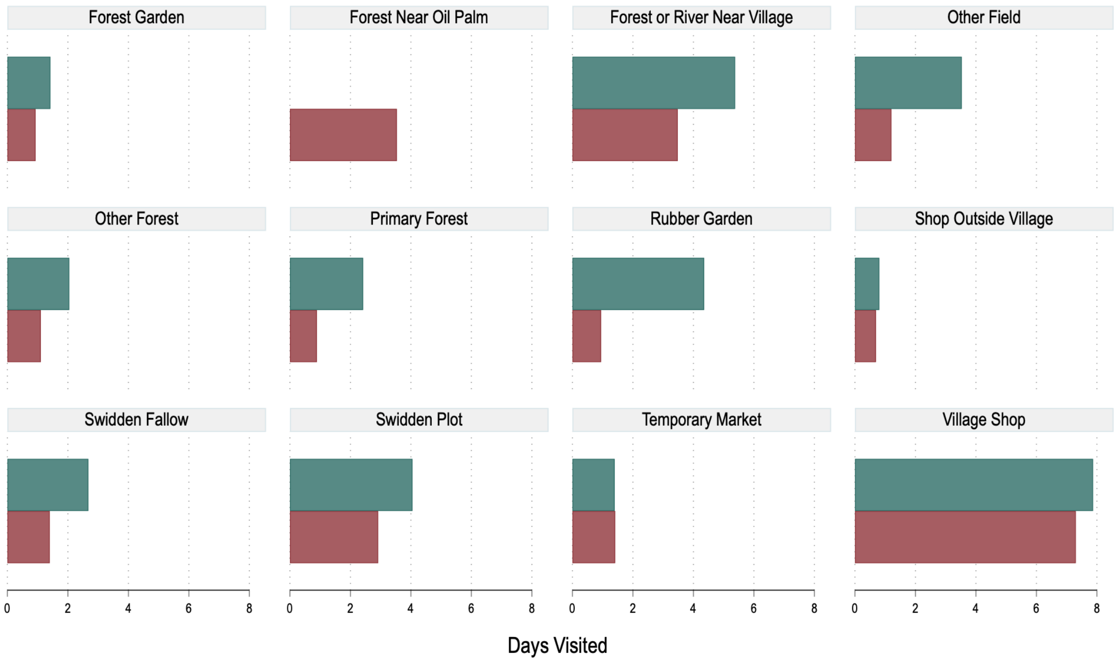
9.3.4 Food Choice Questionnaire

Table 9.5 shows women's responses to Likert-scale statements surrounding the preferences of wild and local foods as well as to the impact of time scarcity on food choice. No statistically significant differences in the responses of women were found between sites in terms of preferences for local and wild foods over their market equivalents – with preferences for local and wild foods extremely high in both sets of villages. In contrast, a significantly higher proportion of respondents in the OP villages agreed with statements indicating that time scarcity had affected food choices. Almost three-quarters of women in the OP villages stated that they would cook different foods if they had more time (73%) compared with just over half in the FOR villages (53%, p=0.00). Additionally, significantly more women in the OP villages reported frequently choosing foods which were easy to cook because they were tired, compared with women in the OP villages (FOR=40%, P=62%, p=0.00).

Figure 9-1: Women's Activity Spaces and Food Acquisition

Weekly patterns of visitation and proportion of visits which result in food acquisition

(a) Women's Visitation (No. days in past 7 days)



(b) Proportion of visits resulting in $\geq$ one food acquired

Table 9.5: Responses to Food Choice Questionnaire

Responses to likert-scale questions (% agree or strongly agree)

Variable	FOR	(SD/SE)†	OP	(SD/SE)†	p-value
Preferences for wild foods:					
Given the choice, I would always choose forest meat over non-forest meat	88	0.0	88	0.0	0.968
If the price was the same, I would rather buy forest meat than non-forest meat	87	0.0	89	0.0	0.527
Given the choice I would rather eat fish from the local river than fish from outside the village	92	0.0	90	0.0	0.407
Impact of time scarcity:					
I feel I do not have enough time to cook	4	0.0	15	0.0	0.000***
I feel that I do not have enough time to shop for food	2	0.0	15	0.0	0.000***
I often choose to cook a foods that are quick because I am short of	15	0.0	44	0.0	0.000***
I often choose to cook foods that are easy because I am tired	40	0.0	62	0.0	0.000***
I often choose to cook foods that are easy to cook because I am short of time	17	0.0	52	0.0	0.000***
If I had more time, I would cook different foods	55	0.0	73	0.0	0.000***

Table shows comparisons between OP and FOR villages. Significance levels have been corrected for multiple comparisons using Bonferroni correction: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. † Comparisons use t-tests for continuous variables and z-tests of proportions for binary variables.

Table 9.6: Themes and Sub-Themes from Thematic Analysis

Meta-theme	Theme	Sub-theme	FOR	OP
Availability	Responsive food choice due to unpredictability of food availability			x
		Unpredictability of mobile vendors makes them inconvenient	x	x
	Food security though diversity	Diverse locations visited from which foods could be obtained	x	
		Reliable and dependable foods are available from multiple sources	x	x
Convenience	Time constraints	Hunting and fishing constrained by time-availability		x
		Quicker methods of hunting and fishing devised		x
		Lack of time for visiting distant fields or forests		x
		Quicker cooking foods when time-scarce	x	x
		Time-saving methods of cooking	x	x
	Proximity & difficulty	Convenient foods those acquired within activity space	x	
		Wild foods as convenience foods	x	x
		Purchasing food as “lower-effort”		x
Affordability and Credit	Pay-day cycles	Pay-day cycles of affordability		x
		Cash-advances of ”little” and ”big” pay-days		x
	Food on credit	Foods obtained on credit from rubber traders	x	
	Safety-net	WEPs consumed when food-insecure	x	x
		Wild fish and meat as safety-net	x	
Livelihood Strategy	Activity Spaces	Wild DGLVs collected as part of daily routine	x	x
		“Probabilistic opportunism” in wild food collection	x	
		Variety of habitat types encountered throughout day	x	
	Dual-livelihoods	Market foods as necessary component		x
		Market foods as optional supplement	x	
		Income from oil palm has enabled more food to be purchased		x
	Opportunistic collection	Decisions over food choice left to chance encounters	x	
Food Preferences	Cultural Preferences	Traditional foods such as bushmeat retain cultural significance		x
		Traditional foods consumed around customary events		x
	Taste preferences	Taste preferences for wild foods	x	x
		Wild foods add diversity to otherwise “boring” diets	x	x
	Trust and food safety	Local foods trusted to be safe and free of harmful chemicals	x	x

9.4 Thematic Analysis

Table 9.6 summarises the themes derived from the thematic analysis of IDIs and FGDs and shows their presence or absence in each of the two sets of villages, while Table 9.7 presents the main similarities and differences between sites in terms of the drivers of food choice. Themes can be grouped into five meta-themes, including availability, convenience, affordability and credit, livelihood strategy and preferences.

9.4.1 Managing Uncertainty

In both sets of villages, women managed considerable uncertainty over what foods they were going to acquire and cook. Women typically started each day not knowing what would be cooked later in the evening and rarely had a plan lasting more than a couple of days. The main reason for this was uncertainty over which foods were going to be available. In the FOR villages, a considerable proportion of foods consumed were acquired either by chance (i.e. opportunistic encounters) or through intra-village peer-to-peer trade. In both cases, while it was not certain which foods would be available – there was little doubt that a range of foods would be available. Women encountered so many opportunities to acquire wild foods while working in and travelling to and from agrobiodiverse fields that it was considered implausible that no food would be found. Also related was the diversity of similar inter-changeable foods (especially for DGLVs) and the abundance of locations in which they could be found. For instance, in the case of ferns, multiple species of ferns available in different locations which could be substituted for one another in many recipes (see below).

In the FOR villages, the diversity of different livelihoods within the village at any one time meant a wide range of wild and agricultural foods were available at any one time to purchase or exchange. As intra-village peer-to-peer trade occurred in the late afternoon evenings, this was generally the point when women decided what to cook for the evening meal (and the next day). In contrast, in the OP villages, intra-village trade could not be relied upon as there is no village-level diversity in livelihoods, as almost all household livelihoods are dominated by plantation labour. Furthermore, as discussed in Chapter 8, households no longer have the time to produce surplus agricultural or wild foods for sale. Thus, women are dependent to a large extent on the arrival of mobile vendors. However, there was a general perception in both sets of villages that mobile vendors were unreliable, with village residents not knowing which vendors would turn up on which days, at which hours and selling which foods. Even in villages where mobile vendors visited frequently, they were not seen as a reliable source of food due to their unpredictable arrival times and even arrival days. As a result of this, women in the OP villages tended to manage this uncertainty by relying on the village shop – which, unlike mobile vendors, stocked predominantly processed and non-perishable foods.

> *"If you wait around for the mobile vendors, if they are still far away, then automatically, it will be slow. If you want it fast, buy it at the shop"*
>
> **Quote 9-1:** (OP_Vill3_KI_F)

9.4.2 Availability

Responsive food choice due to unpredictability of food availability

The degree to which different food sources could be relied upon to provide particular types of foods was a common theme among respondents in both sets of villages. When making food choice decisions, women had to contend with uncertainty about which foods would be available and where. This applied to both wild and semi-cultivated foods, which may, or may not, be present in a particular location as well as to the most important.

Reliability of food sources

Respondents in both sets of villages perceived mobile vendors to be unreliable, and this unreliable made them highly inconvenient. Village shops were perceived as more reliable (particularly those run by stay-at-home mothers), but did not stock fresh produce.

Despite individual sources of food being unreliable and unpredictable, women tended to be highly confident that food could and would be obtained. The main reason for this was that while the availability of each individual source of food may be difficult to predict, the sheer number and diversity of different possible foods and different possible sources meant it was certain that some foods of some kind would be available. For instance, wild edible fern species were seen as being among the most available species since they could be found in many locations, with little effort, and could be depended on being there whenever they were needed. Perceived abundance was also related to the diversity of available foods and the number of substitutes each food had. For instance, in the case of ferns, multiple species of ferns existed – all of which could be cooked with relatively interchangeably – but which had different ecological niches, with some species being found close to riverbanks, others in fallows, others at the sides or roads etc. Thus, at least one type of fern could be obtained from almost any location within a respondent's activity space. Respondents reported feeling that the wide availability of these foods increased the feeling of food security as certain foods could always be relied upon being available. For instance, it was considered inconceivable that it would not be possible to have vegetables to eat because – if all else fails – wild foods were always available from multiple locations. Likewise, the wide range of different possible foods which could be used meant that there were few perceived problems with the seasonal availability of any food groups – especially when considering local trade from neighbouring villages (which, as discussed in the previous chapter, were considered cheaper than market foods from further away).

The existence of peer-to-peer intra-village trade in the FOR villages compounds the benefits of diverse sources and livelihoods. The intra-village trade system is highly extensive and extends to almost all agriculturally produced foods and wild foods available within the sites. With a couple of exceptions (where foods are so ubiquitous, they are not worth trading), any food produced from agriculture or available from the wild can be bought via intra-village trade in the FOR villages. In the OP villages, intra-village trade is limited to only a handful of foods – primarily because local agricultural production systems and wild food production systems do not produce a surplus of food. Thus, to access foods from various different sources, an individual does not necessarily need to participate in those activities themselves – a diversity of livelihoods at the local level ensures that someone within the village will be offering foods which are needed at any one time. For some foods (especially fruits and occasionally bushmeat), this effect extends even beyond the village boundaries to hyper-local trade between neighbouring villages – ensuring that if a food is not available within the village (e.g. due to a seasonal gap), village residents can still generally be confident of obtaining if needed.

Temporal/seasonal gaps in availability filled by markets

both sets of villages highlighted the role of markets in plugging gaps in seasonal availability. In the OP villages, respondents referred to market fruits sold by mobile vendors (Quote 9-2), while respondents in the FOR villages referred to trade in fruits locally between villages – for which prices were said to be lower (Quote 9-3)

> *"We often buy fruits that are sold by outside vendors, such as apples and oranges, but for forest fruits, it depends on the season. When the fruits in the forest are in season, we take them. But when they are not in season, we don't take the fruit, and we have to eat fruit from outside [the village]"*
>
> **Quote 9-2:** (OP_Vill2_KI_F)

> *"Here [fruit] comes from the garden, from people's gardens. Sometimes, the fruit is seasonal here. Sometimes in this village it is in season, in other villages it isn't. So in the villages where there is fruit in season, they sell – only the price is not the same as for fruits from outside, from other areas like [the town of] Sintang, from [the city of] Pontianak. So the fruits which arrive here are usually easy [to afford], and the price is comfortable"*
>
> **Quote 9-3:** (FOR_Vill2_KI_F)

9.4.3 Convenience

Time constraints

In both sets of villages, women cited managing time constraints as a major factor in food choice decisions. In response to time pressure, women selected foods which were quicker to cook and to acquire. Respondents in both sets of villages reported that it was easier to purchase convenience foods than had been the case historically. In both sets of villages, the opportunistic collection is directly linked to activity spaces and the abundance of wild foods. In the FOR villages, respondents covered large distances over the course of any single day, often visiting rubber gardens in the morning and swidden fields in the afternoon, often walking to and from these locations via other fields and fallows and areas of forest

Table 9.7: Comparison of Drivers of Food Choice in OP and FOR Villages

Theme	Similarities and Differences
Reliability of sources	• Both report decline in bushmeat availability, but is not a major factor in hunting frequency • Only OP villages (and only some villages) report declines in fish availability
Security through diversity	• OP villages lacks the diversity of livelihoods and field types on individual level and at village scale and village-cluster scale.
Time constraints	• Both report cooking foods which are quicker to cook when time-scarce, but far more so in OP villages • Some OP villages have developed less time-consuming methods of hunting and fishing • In OP villages, hunting and fishing has largely become leisure activity rather than part of life-style and carried out only during holidays due to lack of time
Proximity and difficulty	• In FOR villages, the most convenient foods are those obtainable without deviating far from activity space • Purchasing foods are seen as easy in both. However, FOR villages have access to diverse range of fresh foods from intra-village trade absent in OP villages
Pay-day-cycles	• Pay-day cycles exist only in OP villages where waged plantation labour is the primary source of income
Obtaining food on credit	• Obtaining food on credit is available in FOR villages (though not heavily relied upon) but not OP villages. Shops where credit is available are those owned by rubber traders. Credit is obtained as food-equivalent advance for rubber.
Safety-net functions	• WEPs especially ferns and cassava leaves used as safety-net in both • Bushmeat and fish used as safety-net only in FOR villages
Activity spaces	• Wild DGLVs (ferns and cassava leaves) collected as part of daily routine within activity space in both • Options for collecting is more limited in OP villages due to fewer locations visited during the day • Women in FOR villages engage in "probabilistic opportunism" whereby different routes are taken to maximise the probability of WF encounters. • "Probabilistic opportunism" is not possible in OP and seen as inefficient use of scarce time
Dual-livelihoods	• In FOR villages, market foods are seen as supplemental luxuries – often seen as an extravagance when forest will provide foods • in OP, insufficient food is produced from own-production and lack of time constrains wild food acquisition. Therefore reliance on market-foods is greater • In FOR villages, income earned is seen as best spent on non-food items, whereas seen as appropriate use of income in OP villages
Opportunistic collection	• Women leave decisions over what to cook much later in the day in FOR villages as open and flexible to chance encounters
Cultural preferences	• Traditional foods are consumed largely around special occasions in OP villages – especially bushmeat. Such foods are frequently consumed in FOR villages. Indeed, special occasions other than customary events may be more likely to result in purchasing perceived luxury foods such as beef.
Taste preferences	• Both have strong taste preferences for wild meats over purchased meat or meat from livestock
Trust and food safety	• In both, there is a suspicion of foods produced outside the local area due to known contamination with chemical inputs (fresh foods) or adulteration (rice) • Chicken purchased from outside the village in OP villages were often (or had been) frozen. The quality and safety of frozen chicken (presumed to be of Malaysian origin) was considered less trustworthy.

and non-forest wild habitats. Each of these locations contained different types of foods, some cultivated, some wild, and some semi-cultivated from

Selecting quicker cooking foods when time-scarce

Women in both sets of villages reported selecting foods which were quicker to cook when under time pressure, or when they were busy (Quote 9-4). In both sets of villages, the foods considered quickest to cook were vegetables, eggs and instant noodles. In contrast, the food considered most time-consuming to cook was meat (especially bushmeat).

> *"If there is a busy day, maybe we cook eggs or fried noodles. It's the most practical and the easiest to get. If it's hard to buy noodles, just eggs. We can cook and eat that right away."*
>
> **Quote 9-4:** (OP_Vill1_KI_F)

Time-saving methods of cooking

Women in both sets of villages reported employing multiple cooking strategies to reduce or manage time. One common strategy was preparing foods either the night before or earlier in the day and or reheating/adapting leftovers[I]. Foods which took longer to cook were less likely to be prepared in the mornings when time scarcity was most pronounced. Additionally, women in the OP villages frequently reported using flavouring packets in lieu of grinding and preparing flavouring from fresh spices and herbs – a strategy rarely proffered by respondents in the FOR villages (Quote 9-26).

> *"at 3 o'clock [AM], we use packets of spices if we had not already ground them last night. For example, if I want the meal to be for the afternoon, it must be prepared [ahead of time]. That's what I've already thought about."*
>
> **Quote 9-5:** (OP_Vill1_KI_F)

As well as selecting faster cooking foods, women in the OP villages reported that cooking on oil and gas stoves had significantly reduced the amount of time required to cook certain foods. However, cooking firewood was still preferred for taste reasons for many foods[II].

Opportunistic collection of wild foods within activity spaces

Convenient foods were those that did not require great deviations from day-to-day activity spaces to acquire. In both sets of villages, this involved wild foods which grew within the areas where women were spending time anyway: the edges of oil palm plantations and roads in the OP villages rubber gardens. Paths to and from fields in the FOR villages. Over the course of one day, women in the FOR villages could visit rubber gardens in the morning, swidden fields in the afternoon, passing by a variety of other fields and fallows and areas of forest and non-forest wild habitats – each location containing a variety of wild foods (Quote 9-6). In the OP villages, however, opportunities were limited to wild foods found along the edges of oil palm plantations and roads between villages and plantations (Quote 9-7).

> *"The point is that we have been looking for [foods] all the way to the forest, when we were working in the landang, while working in the rubber garden we pick it. When we walk anywhere we are also looking, that's why we don't buy things like that"*
>
> **Quote 9-6:** (FOR_Vill3_FGD_)

> *...even while working in oil palm. Sometimes, it grows within the oil palm or at the edge. When we have finished our work, we spend a while looking for it...*
>
> **Quote 9-7:** (OP_Vill3_KI_)

The most ubiquitous of the wild foods available in activity spaces in both sets of villages were wild edible ferns, available in almost all locations, from around the home, by river banks, roadsides, plantation edges, and within fields and fallows. As one respondent put it in the OP villages:

> *"Ferns are easy to collect in this village. Around the village, by the river, usually, there is also lots in the rubber gardens. It is very easy to find it, you can eat it whenever you want. [red leaf fern] is behind the house. But most often, we collect it from the oil palm."*
>
> **Quote 9-8:** (OP_Vill1_FGD_F)

Wild foods as convenience foods

In both sets of villages, some wild foods were seen as convenience foods due to the ease with which they could be acquired opportunistically, while others were seen as difficult to acquire due to the time required to search for them. Women in both sets of villages reported being continually on the lookout for wild foods while travelling to and from the various locations they visited throughout the day. Generally, wild meat and fish were not seen as convenient food to acquire, with respondents stating that meat and fish from purchased sources were more convenient (although purchasing wild meat and fish via intra-village trade in the FOR villages was seen as convenient). In contrast, wild vegetables such as ferns, as well as cassava leaves, were considered highly convenient due to both their reliability and their abundance within women's activity spaces.

Purchasing foods as lower effort

For many respondents in both sets of villages, the first option when needing food in a hurry was to search for wild vegetables around the house, but if time is too scarce even for that, then food could be purchased from the village shop. However, while WEPs were a convenient source of DGLV, for meat, fish, and other protein sources, purchased foods were viewed as more convenient to acquire than both wild and agricultural

> *"If it is already the evening, I can search [for food] near the house... If there is time to search, sure. If there is not time, I buy it from the shop"*
>
> **Quote 9-9:** (FOR_Vill5_KI_F)

> *"...most think just instantaneously. I have money, [so] I buy food here. It is helpful now they don't even have to travel far to find food. Sometimes [mobile vendors] bring the food to the front of their house. Even those that are difficult to reach for [mobile vendors], now they can buy it."*
>
> **Quote 9-10:** (OP_Vill3_KI_F)

9.4.4 Affordability and Credit

Purchasing Food with Credit or Debt

In the FOR villages, rubber traders, who also tended to operate local shops, advanced food in return for future rubber. Sap collected by rubber collectors would be given to local traders on a daily basis after completing each morning's tapping. Local traders would pay collectors when they sold the sap to outside traders (usually on a monthly basis). To smooth income in the meantime, traders operated an ongoing tally – with tappers sometimes in credit and sometimes in deficit. The cost of food advanced during the period between tapping and payment was deducted from the final payment (Quote 9-11).[5]

> *"If you don't have enough money usually at the shop where we sell rubber, we can usually take food first. We can bill it there, take what we need and there at the store. We can record all of it as debt. After one month, we bring the [rubber] sap there and then it will be deducted from the money [we owe]. So people will take food first and pay later like that"*
>
> **Quote 9-11:** (FOR_Vill1_KI_F)

In contrast, in the OP villages, both formal and informal credit almost always took the form of cash – either a cash advance from wages or a temporary financial loan. In fact, borrowing money as a cash advance from plantation companies was so institutionalised in the OP villages that respondents referred to them as the "big payday" and "small payday" (see 6.5).

The differences between sites reflect, to some degree, the social relations between vendors and buyers. Mobile vendors (the primary source of purchased fresh food in the OP villages) visited a wide range of villages, frequently changing routes according to changes in demand (see Chapter 8). A consequence of

[5] As discussed in Chapter 6, the system of credit extended even beyond farmers who directly owned rubber gardens themselves, as non-rubber garden-owning households could always tap rubber in gardens owned by others in return for a share of the profit.

this was the lack of social connections which could establish a credit relationship[III]. In contrast, in the FOR villages, the relationship between the rubber trader (a village resident) and the rubber tappers is much clearer, enabling the advancing of food on credit. In addition to systems of credit based upon advanced payment for rubber, intra-village trade and reciprocal gift-giving can be seen as a form of informal credit system, smoothing periods of scarcity by gifting foods and repaying them during times of abundance[IV]

Pay-Day Cycles

In both sets of villages, managing fluctuations in income availability and cash flow were important considerations in women's food choice decisions. However, in the OP villages, the affordability of foods also varied with the bi-weekly payday cycle (or weekly in the OP villages. Many respondents reported eating different foods before and after payday due to the money available for purchasing. For example:

> *"...there is a big difference between the normal days before payday and the days after payday. Before, the food is normal, no meat, no [protein-based side dishes][6]," dishes, right? There are only vegetables... If [the salary has] already been paid, there must be [protein-based side dishes] dishes.*
>
> **Quote 9-12:** (OP_Vill3_KI_F)

> *"Yes it changes, before [pay-day] we eat vegetables, when you get more [money] you eat more meat"*
>
> **Quote 9-13:** (OP_Vill1_KI_F)

While many, like that above, referred to changes in diets based upon pay cycles as food shortages or even crises [V], others seemed accepting of the variation in diet this caused and did not see it as a major issue[VI]

Another way in which diets were affected by the pay cycle in the OP villages was in terms of the consumption of out-of-home foods. The degree to which cooked foods were consumed out of home consumption varied greatly by village. Mostly, women and men reported out-of-home consumption to be rare, but if they were consumed, it was most likely to be consumed after payday[VII]. However, it was slightly more common for men to report consuming cooked snacks at the edges of oil palm plantations during work breaks – catered for by mobile vendors congregating at strategic locations, and in a handful of villages, women reported occasionally consuming cooked breakfasts at oil palm barracks prior to starting work.

[6]The Indonesian term *Lauk* has no direct equivalent in English but is a protein-based side dish, which serves as a a supplement to a larger carbohydrate (usually rice) based dish. *Lauk* includes meat and fish as well as tofu and tempeh

Wild foods as a "safet-net"

In both the sites, wild Dark-Green Leafy Vegetables (DGLVs) were also considered reliably present at the sides of oil palm plantations – making them ideal supplementary food during times of food insecurity from pay cycles (see above)

> *"[if there is a shortage food] you can look for vegetables in the oil palm. If there is oil palm then there certainly are vegetables, they will definitely be there, there are lots you can pick"*
>
> **Quote 9-14:** (OP_Vill1_KI_F)

In the FOR villages, other types of wild foods also formed part of the food security safety-net, for example fishing and hunting

> *"If you have a crisis and you cannot buy food. If it is like that then the husband goes fishing, he does not buy."*
>
> **Quote 9-15:** (OP_Vill1_KI_F)

9.4.5 Livelihood Strategy

To some extent, respondents in both sets of villages viewed market foods as supplemental to foods from self-production. However, respondents in the sites differed in the way in which this was framed. A commonly expressed view in the FOR villages was that market foods were optional – nice to have if money was available – but unnecessary for survival. Purchasing market foods was occasionally even seen as a frivolous or imprudent expense. For example:

> *"If we have to buy all the time, it will be wasteful, we can grow [vegetables], we grow them ourselves, or find it in the forests, we don't have to buy it ourselves"*
>
> **Quote 9-16:** (FOR_Vill1_FGD_F)

In general, the attitude in the FOR villages was that income earned should be spent judiciously, and spending on food should be avoided unless absolutely necessary[VIII]

Market foods as necessary component

Respondents in the OP villages also viewed market foods as supplemental to own production, but in contrast with respondents in the FOR villages, rely solely on market foods would have been the ideal outcome, but lack of income from oil palm labour meant that the bulk of food had to come from own production. For example:

> *"Our own agriculture is usually enough, except for the at the end of the year, if the rice has not arrived, and the rice is finished, then we buy it, but we rarely buy it if we still have it ourselves"*
>
> **Quote 9-17:** (OP_Vill2_KI_F)

Probabilistic opportunism

Wild food collection events existed on a spectrum between pure opportunistic (i.e., chance encounters with no plan to obtain food) and pure on-demand (i.e. location visited where wild food is known to exist). Most opportunistic collections of foods existed somewhere between these two extremes. While wild and semi-wild foods were acquired opportunistically, both men and women deliberately placed themselves in lo- cations where opportunistic collection was likely, taking routes to and from fields via forests and fallows likely to have foods which could be collected. As such, households maximised the chance of success in collecting wild foods opportunistically by altering their activity spaces. The strategy of placing oneself in locations where chance encounters are most likely to occur was used in both sets of villages, but was much more prevalent in the FOR villages than the OP villages. One reason is that this strategy is inherently time-consuming and thus incompatible with the time scarcity experienced in the OP villages. Another reason is that daily lives in the FOR villages brought individuals in closer proximity to wild food-rich environments.

9.4.6 Food Preferences

Respondents in both sets of villages reported preferring locally produced foods (both wild and agricultural) to market-source foods from outside the village. Respondents cited multiple reasons, including taste, food quality and safety, freshness, and likelihood of contamination or adulteration. Wild foods were also said to add diversity to otherwise "boring" diets.

Local foods as trusted to be safe and free from harmful chemicals

Foods that were self-produced or collected from the wild were generally seen as healthier than foods from market sources due to possible contamination of the latter with chemicals.

> *"Forest food is without formalin [formaldehyde]Forest food is without formalin [formaldehyde]"*
>
> **Quote 9-18:** (OP_Vill1_KI_F)

Local foods fresher and safer than market foods

The preference for locally produced did not solely concern chemical contamination but also freshness, food safety and food quality. While for most foods, women were confident in their ability to detect poor quality food and avoid buying it (Quote 9-19), for some foods, such as chicken, it was not possible to tell – especially when sold or transported as frozen

> *"...if it's frozen, we don't know how long [it has been there], maybe a month or two months. For frozen chicken there is an expiration date on the box, but when the box has been disassembled, we don't know how long it was in there. We don't know anymore."*
>
> **Quote 9-19:** (OP_Vill4_KI_F)

Frozen chicken in was seen as less desirable than live chickens available locally. In the FOR villages, frozen chicken was more or less unheard of, while it was the norm in the OP villages, with fresh chicken being consumed as the exception.

> *"For example, like now it has just been Christmas and New Year, we usually buy fresh chicken. Therefore, usually there is an event or ceremony that requires live chicken, so we buy fresh. But if it's for daily consumption it's frozen"*
>
> **Quote 9-20:** (OP_Vill7_KI_F)

A particular concern in OP villages where supply chains were longer were foods imported from Malaysia, which were seen as less trustworthy than Indonesian products. The suspicion that Malaysian imported foods were of inferior quality and safety was heard extensively in regard to chicken – but also to other products. However, rather than being sure that such foods were inferior, the most widely held concern was the lack of ability to differentiate between good quality and products and the uncertainty about the food's origins, safety and quality (Quote 9-21)

> *"...we do not know whether the meat is good or not. Because this is a Malaysia product, we can't tell. Because they come from Malaysia, all meat, all chicken. It's unlike us in the market in the city right? We can tell the difference [in the city market market] – so this beef is fresh, this is not fresh– we can tell. But we can't tell with Malaysian products, because it's all the same as all Malaysian products"*
>
> **Quote 9-21:** (OP_Vill1_KI_F)

Wild foods add variety to diets

Respondents in both sets of villages reported being bored with the small number of foods available from agricultural and market sources, stating that seeking wild foods introduced variety into the diet (Quote 9-22). While respondents also cited cost-saving, taste and healthfulness reasons for seeking forest foods, boredom with the lack of variety of foods – whether general or seasonal – was often the impetus for searching for wild foods, especially forest foods.

> *"sometimes if we are bored of the other food"*
>
> **Quote 9-22:** (OP_Vill2_KI_F)

9.5 Mixed-Methods Integration and Discussion

As with most aspects of food preferences, respondents make food choices based on multiple simultaneous factors. Quote 9-23 below illustrates the ways in which respondents factored in multiple aspects at the same time when making food choice decisions. When deciding to acquire and consume wild vegetables, the respondent is simultaneously thinking of the benefits of adding variety to diet (i.e. increasing enjoyment), not paying for foods unnecessarily (conserving household income), the ease of finding wild foods (the probability of success), the effort saved by not cultivating foods, and the healthfulness or risk of chemical contamination of purchased foods.

> *"We often [collect wild foods] sometimes if we are bored of the other food, or for example we are afraid of buying vegetables from other people because we are afraid of chemicals. Therefore, we go to the forest to search. There are no chemicals there that we are afraid of. So, we do not have to buy. So, we go to the forest, and we do not have to farm. Just like that, it pops up, we pick it, and we don't worry about the chemicals"*
>
> **Quote 9-23:** (FOR_Vill3_KI_F)

9.5.1 Food Preferences

These results show that general food preferences do not differ greatly between sites – perhaps indicating that cultural and taste preferences have not changed significantly following the adoption of oil palm livelihoods (at least yet). Both qualitative and quantitative evidence suggest that both sets of villages overwhelmingly stated a preference for wild foods over purchased equivalents and locally produced foods over those originating from outside the village. These preferences were based upon a combined assessment that locally produced foods – particularly wild foods – were tastier, healthier, and free of chemicals and adulteration. In contrast, the unknown origin of foods from outside the village concerned respondents, and they had little trust in vendors to offer fresh foods, foods free from chemicals and contamination.

This study demonstrates the persistence – at least in the short term – of culturally valued foods, even if they comprise a smaller part of people's diets. Respondents in the OP villages frequently noted the continued importance of bushmeat consumption and swidden rice cultivation to their social and cultural identity – despite the former becoming more of a hobby than a livelihood and the latter contributing a smaller share of rice production. While some customs and traditions associated with more traditional swidden livelihoods (e.g. reciprocal labour exchange practices) have ceased to exist following the introduction of oil palm, observance of customary festivals associated with the traditional swidden cycle have been retained – and culturally important foods such as bushmeat are consumed around these times.

9.5.2 Activity Spaces

One of the main differences in drivers of food choice between sites is activity spaces. There are significant differences between the sites in terms of the places visited throughout the course of women's daily routines. In the FOR villages, respondents covered large distances over the course of any single day, often visiting rubber gardens in the morning and swidden fields in the afternoon. Walking to and from rubber gardens and swidden fields in the FOR villages involved walking through areas of forest, non-forest wild and fallow fields, or required only slight deviations to do so. Each of these locations contained different types of foods, some cultivated, some wild and some semi-cultivated. In contrast, most travel in the OP villages was conducted by road – either by walking or by motorbike to oil palm plantations or fields which had been relocated away from forested upland slopes closer to roads and villages. As a result, women spend less time in locations where wild foods can be collected – limiting them to the wild edible ferns and other DGLVs such as cassava leaves, which grow along roadsides and plantation edges.

In the FOR villages, routes to and from locations were optimised depending on the season and known availability of foods – for example, the route taken to travel to (or usually from) a swidden field may be taken to pass via fallows known to have certain fruit trees. In the case of wild and semi-cultivated foods, these visits were often speculative – i.e. designed to visit locations where the likelihood of finding particular foods was highest in what I have termed "probabilistic opportunism". The practice of "Probabilistic opportunism" appears to be most common for women in the FOR villages and less commonly practised by men in both sets of villages and women in the OP villages. Time scarcity (discussed below) interacts with activity spaces and appears to be a major factor driving the differences in this behaviour between sites. While women in the FOR villages leave take circumspect routes to and from fields, often leaving early to take such routes, women in the OP felt they did not have an opportunity to do so. Like women, men in the OP villages also engaged in less collection of wild foods due to differences in activity spaces – especially for wild roots, shoots, and palm-hearts, which were opportunistically collected. Men's activity spaces in the OP villages are generally far removed from the locations where such foods can be obtained (e.g. rubber gardens, forests, fallows and non-forest wild environments).

9.5.3 Time scarcity

As discussed above, time scarcity affects men and women's activity spaces, as individuals avoid making long trips to faraway places and take more direct routes (often taking motorised transport instead of walking). These activity spaces, in turn, affect the exposure individuals have to food environments and the opportunities they have to collect food. In addition to affecting the opportunistic collection of wild foods, time scarcity affects food consumption by influencing fishing and hunting – the former typically carried out by men, the latter exclusively.

Men's Hunting and Fishing

While men's lack of opportunistic collection of WEPs was driven primarily by different activity spaces, men's reduction in bushmeat hunting and fishing was driven by lack of available time. Bushmeat hunting, while occasionally done opportunistically in the FOR villages, was primarily a deliberate activity in both sets of villages. Men engaged in hunting and fishing activities significantly less in the FOR villages than in the OP villages, and when they did so, they often used different technologies, such as seine nets and snares. Chapter 8 showed that in both sets of villages, the frequency of hunting and fishing acquisition was deemed to have reduced over the preceding decade – but this opinion was more widely held in the OP villages than the FOR villages. For fishing, respondents in both sets of villages reported declining fish abundance and water quality degradation. Among those who expressed the opinion that hunting had declined, men in both sets of villages cited forest loss and lower abundance of animals. Respondents in both sets of villages reported that the time required to reach hunting grounds had increased.

Qualitative findings emphasise the importance of time scarcity and the distance required to reach hunting grounds. Hunting was viewed as incompatible with waged oil palm labour due to its time requirements and the fact that over-night hunting expeditions were incompatible with the early mornings required for oil palm labour. As such, hunting was primarily a leisure activity in the OP villages carried out on holidays. For hunters and fishers who still did so to acquire food, many in the OP villages had adapted their methods to increase the time and labour efficiency of the activities. One way was using snare traps instead of hunting with firearms or stationary seine nets in place of line fishing. While hunting with snare traps and seine nets is far from a modern innovation – traditional hunting also involves some use of traps and stationary fish traps/nets weaved from ratan and other Non-Timber Forest Products (NTFPs) are traditional in many Dayak communities – qualitative evidence suggests the deliberate use of these techniques as a time-saving measure in the OP villages.

Desire for Convenient Foods and Food Sources

There is strong evidence of a difference in the desirability of convenience foods in the OP villages, driven by women's time scarcity. While women in both sets of villages view similar foods as convenient, women in the OP villages were more likely to cook these foods due to time shortages. The effect of time scarcity on food choice and other nutritional pathways is discussed in greater detail in the next chapter, which explores the different ways changes in time allocation affect maternal and child nutrition. The vast majority of the literature has focused on convenience foods in terms of UPFs. Other, healthier convenience foods such as eggs and vegetables have been overlooked as convenience foods. This is perhaps a product of the focus on urban environments, where convenience foods tend to be pre-prepared foods or consumed out-of-home foods.

Time scarcity interacts with perceptions of a food or food source's reliability or dependability is an important consideration in their food choice decisions. The lack of reliability in the arrival times of mobile vendors in many villages at both sets of villages means that women do not plan on purchasing foods from them but instead buy from them opportunistically if and when they arrive (at times when they are also in the village). Instead, convenient sources of foods are those which are reliably present. In both sets of villages, the most reliably available source of foods is the village shop – which stocks predominantly non-perishable and packaged foods: some healthy (e.g. canned sardines) and some not (mainly packaged UPFs). However, in both sets of villages, wild edible ferns and cassava leaves acquired easily from roadsides and village surroundings are also consumed as convenience foods. The degree of reliance on the village shop as a convenient source of food when time scarce is far greater in the OP villages compared with the FOR villages – this is because it is one of the few reliable sources of purchased foods. In contrast, in the FOR villages, these are sources which contain largely healthy foods – primarily WEPs collected from women's activity spaces as well as fresh vegetables, meat and fish foods obtained from other village residents via peer-to-peer trade or exchange. In the OP villages, however, mobile vendors are one of the main sources of healthy perishable foods. The net nutritional effect of a shift towards convenience foods is, therefore, difficult to predict. On the one hand, many foods conveniently obtainable are considerably healthy. However, it may also result in increased consumption of packaged and UPFs. The potential nutritional implications in the context of overall diets are discussed further in Chapter 11.

9.5.4 Fluctuations in income and affordability

This chapter has shown that access to credit is an important dimension of food acquisition in both sets of villages. Both quantitative and qualitative results point to a significant role played by credit and debt in smoothing cash flow, allowing the purchasing of foods. However, there is some discordance between results from different methods. Questions relating to coping strategies were included in the women's survey. The results show a higher proportion of respondents in the OP reporting having obtained some food on credit in the preceding seven days (OP=56% FOR=36% p=0.00). However, for those who had obtained food on credit, there was no statistical difference in the average number of days they acquired food on credit (OP=2.15 FOR =1.87, p=0.10). These results are discordant with qualitative findings, which suggest the use of credit for obtaining food to be widespread in the FOR villages, but rarer in the OP villages where respondents depended on cash loans to buy food rather than purchasing food in credit. The discrepancy between qualitative and quantitative findings is perhaps attributable to methodological issues concerning question phrasing in the women's survey, which may not have adequately distinguished between purchasing food on credit and borrowing money (from elsewhere) to purchase food.

Access to credit and food choice

In both sets of villages, systems of credit and debt were widely used to smooth fluctuations in income. In the FOR villages, income from rubber tapping which was sold to traders in the village, with rubber tappers receiving income only when the traders sold on the rubber in a nearby town (usually monthly). For these rubber tappers, credit relations were a significant factor in smoothing income consumption. While cash advances for rubber were rarely, if ever, given, rubber-tapping households could purchase food on credit from the village shops owned by traders, with accounts settled and money owed debited from rubber profits when the rubber was sold (Quote 9-11). In the OP villages, regular salaries allowed oil palm workers to borrow food and repay it after payday from village shops.

There are two main mechanisms via which debt and credit relations may affect which foods are acquired and consumed. Firstly, households requiring food on credit may be constrained in which sources are available to them to purchase food. In both the OP villages and the FOR villages, the only sources offering food directly on credit are village shops – and these foods stock far fewer fresh perishable foods and far more processed and packaged foods. However, it is unlikely that credit constrains consumption in either sites. In the OP villages, this is because borrowing money is far more common than purchasing foods on credit, and the money borrowed is primarily used to purchase foods from mobile vendors. In the FOR villages, it is likely that lack of cash is not as significant a constraint on food acquisition as it is in the OP villages – due both to the ease with which wild foods can be acquired and the existence of an extensive network of peer-to-peer reciprocal gift giving which operates as a less formal credit system. The latter almost exclusively deals with fresh produce such as meat, fish, vegetables and fruits.

While the availability of credit does not constrain consumption, it is abundantly clear that in the OP villages, cycles of pay and temporary loans affect food consumption – with respondents explicitly stating that diets differ before and after a payday or loan. Before payday diets consist of more vegetables and fewer sources of animal source foods, whole meat is more likely to be consumed after payday. There is some evidence that in some villages, consumption of cooked foods out of a home may be higher after payday than before – but in most OP villages, out of home consumption of out-of-home foods is generally infrequent.

9.6 Conclusion

The preceding chapter of this thesis has shown that broadly speaking, relative to the OP villages, livelihoods in the FOR villages could be characterised as time-rich but low-income. While livelihoods in the OP villages generate greater cash incomes, they also create considerable time scarcity for both men and women. In Chapter 8, I showed how, in both sets of villages, most food groups can be obtained from both markets at relatively affordable prices as well as either agricultural or wild sources. The decision of where to acquire food and what foods to acquire thus reflects other aspects of the overall livelihood. In the traditional sites, most residents would prefer to spend time rather than money to obtain food. Faced with insufficient food for the day, most respondents stated that they would fish in the river or collect wild vegetables, both activities which reliably yielded foods with low risk of failure. Likewise, the quality of wild foods, particularly meat, fish, fruits and vegetables, was said to be more desirable than their market source equivalents, being both better tasting and free from chemicals. The preference for wild food, especially for bushmeat, was consistent in both sets of villages. In contrast, in the OP villages, time scarcity was seen as a major reason why foods were purchased rather than collected, despite the availability of other sources and a preference for wild foods. Time scarcity also played a role in food choice. Eggs and vegetables, as well as instant noodles, were considered the fastest and most convenient foods to eat. Some convenient sources of foods used when time-scarce (e.g. village shops) contain a high number of packaged and UPFs, but also contain healthier convenience foods. Additionally, wild DGLVs are considered easily available and highly convenient to both acquire and cook in both sets of villages. The net-nutritional effects of time scarcity are, therefore, difficult to predict.

This study has highlighted the central importance of activity-space-based research and of factoring in cycles of availability and affordability driven by payday cycles and payday markets. Both of these are likely to be crucial in a wide range of contexts – yet are typically absent in food choice, food environments and nutritional research. Similarly, the role in which credit and debt and social relations with vendors offering food on credit may play in constraining food choice is only recently beginning to be examined. For example, significant policy decisions are often made based on dietary intake surveys, which do not account for where in pay-cycle respondents are. The implications and need for further research on these topics are discussed further in the next chapter. This chapter has shown the importance of time scarcity as a driver of food choice. The next chapter aims to integrate the findings of this and the preceding empirical chapters. It examines how trade-offs in time and labour allocation result in changes in food systems and food choice, as well as focusing on some of the other ways women adapt to chronic time scarcity and their potential effects on nutrition and other time-related nutritional pathways.

Endnotes for Chapter 9

[I]

"For types of meat, yes we can eat it again, for vegetables not, it cannot be repeated again, if it is a [protein side dish] or fish, it can be repeated"

Quote 9-24: (OP_Vill1_KI_F)

"If the food you want to cook needs a long time, then it will be cooked in the afternoon, during the day we cook vegetables, vegetables don't take long, meat takes a long time"

Quote 9-25: (OP_Vill2_KI_F)

[II]

"If you cook with firewood, it is more delicious, but for practicality, a gas stove is more practical. It cooks faster but tastes different than when you cook with firewood."

Quote 9-26: (OP_Vill4_KI_F)

[III]

"No, if you buy, you buy. Yeah, you pay. There is no credit system. You pay immediately. They do not know you."

Quote 9-27: (FOR_Vill1_KI_F)

[IV]

R1: "So the that our comradeship does not break up like that, remember your brothers, remember your luck, share it"
R2: "Later on, if he gets a lot, he will give to us. That's why the comradeship must be maintained."

Quote 9-28: (FOR_Vill3_Mixed)

[V]

"Normally, vegetables. If there is meat, then meat... Of course, most often it is, eggs, [instant] noodles... The problem is if you do not have vegetables, that is the big dilemma. Especially when you haven't been paid for a long time, that's a crisis [laughs]"

Quote 9-29: (OP_Vill5_KI_F)

[VI]

"It changes, you don't eat lavishly every day... [laughs]...we would get bored if we ate meat every day."

Quote 9-30: (OP_Vill1_KI_F)

[VII]

"Sometimes we eat at a stall...food that has been cooked like in a restaurant, like meatballs, fried rice with egg. Sometimes, but not very often. It's rare. If we have just had a payday, then maybe... For me, in this house, it has not been for a long time, I think."

Quote 9-31: (OP_Vill1_FGD_F)

[VIII]

"If there is a lot of money, you can buy a little food, but usually, you are already short of money. We are economical here."

Quote 9-32: (FOR_Vill1_KI_F)

"We rarely buy [food]. Like here, there are lots of cassava leaves, lots of water spinach, we rarely buy them, unless the weather is bad can't go to the field itself, then buy it"

Quote 9-33: (FOR_Vill3_KI_F)

Chapter 10: Study Limitations, Caveats and Future Directions

Contents

10.1 Introduction

Each of the preceding three empirical chapters has contained its own discussion of the findings in the context of the broader study and the relevant literature. The next chapter explores connections between each of these empirical studies and how they contribute towards answering the research questions of this thesis. This chapter discusses caveats and limitations of the study as a whole, provides some additional methodological reflections and identifies key areas for further research.

10.2 Caveats and Study Limitations

Heterogeneity of Study Villages and Oil Palm Models

Due to the nature of the qualitative matching process by which study villages were selected, the sample is constrained only to villages where the primary ethnicities are local indigenous Dayak groups whose traditional livelihoods are upland swidden and forest-based activities. As such, we are unable to make inferences about different communities in the regions – especially communities consisting of migrant labourers, and transmigrant and Malayu communities.

The OP villages in this study covered a wide range of villages, each with individually negotiated contractual arrangements with various oil palm companies. A wide variety of conflicting opinions and perspectives were heard about contractual arrangements, but ground-truthing claims are extremely difficult without triangulation from multiple sources alongside long-term ethnographic investigations. This study covered too many villages to conduct a detailed investigation of contractual arrangements. Indeed, this topic was deliberately avoided to avoid bias following sensitivity around the topic encountered during pilot studies (see 5.6). Due to the large number of villages, there are likely to be multiple realities for different communities and different subpopulations. The contrast of our time allocation findings with those of different forms of smallholder palm oil in Sumatra (discussed in 7.2.2) further emphasise the need to avoid generalising findings to other oil palm models and regions of Indonesia.

While this study should not be generalised to all plasma oil palm, the relatively minor role of that plasma farming played in the livelihoods of these so-called “smallholder plasma farmers” is consistent with other studies of plasma oil palm in the region (see 6.9). For many smallholder plasma farmers, revenues from plasma itself tend to be well below the level required for supporting a family, necessitating households to engage in other forms of labour – predominantly waged plantation labour for oil palm companies Li (2015); Gecko Project (2022a,b). The exact revenues obtained from plasma as well as the types of alternative/additional non-monetary compensation provided (at individual or community levels) vary greatly between villages – with each community negotiating separate agreements with companies. These negotiated agreements also cover village residents’ entitlement to wage labour opportunities and the terms and conditions of such work. Further research is needed to desegregate the findings of this study by subtypes of plasma oil palm and to explore the impacts of different arrangements on time allocation and food choice behaviour.

Seasonal Variation

A major limitation of this research is the way in which it accounts for seasonal fluctuations, which affect both the time use and food systems components. As discussed in greater length in 5.4.3, there is a trade-off between the length of a recall period and its ability to capture seasonal variation. Ideally, households would be surveyed and resurveyed at multiple points throughout a year to capture seasonal changes in swidden livelihoods. Longitudinal studies are thus needed to explore the effects of seasonality.

From a food systems perspective, seasonal variation may affect both the availability and affordability of foods, as well as activity spaces and related opportunities to acquire foods. My data on seasonal food availability is limited to temporary markets located outside villages (which comprise only a small proportion of food acquisition), as well as relatively crude participatory data on perceived seasonal availability of foods. While neither source of data indicates major shortages in seasonal food availability, I cannot make definitive conclusions. Qualitative data in the FOR villages strongly indicates that there are few, if any, periods of reduced food availability. The findings on this topic in the OP villages are less conclusive. It is not clear whether market sources adequately compensate for the loss of resilience caused by the absence of the hyper-local food system and the reduced availability (due to land use and agrarian change) and opportunities to collect (due to time pressure and activity spaces) of wild and semi-cultivated foods. My tentative conclusion is that markets do, in fact, respond to some extent and that there are unlikely to be long periods in the OP villages where certain foods are unavailable[1]. However, there may be periods of reduced diversity of some foods (such as fruits) and periods where those foods which are available are more expensive and perceived to be less desirable than their locally produced equivalents. Full market surveys, including food prices of foods from both formal and informal food systems at the village level and surrounding sources are needed to determine whether this is the case, as well as whether this has any effect upon food choice decisions.

Future time-use studies are needed to examine seasonal fluctuations in time and labour allocation. Our study controlled for periods of high-labour demand from swidden (such as land clearing, planting and harvesting) and deliberately excluded households engaged in these activities. Qualitative data suggests that seasonal differences are likely to be greater in the FOR villages than the OP villages, as the latter may rely more heavily on labour-saving adaptations during these periods as well as hiring outside labour. Additionally, future research should pay close attention to work patterns throughout the week. As discussed in 7.3.1, Sundays were not included in the time allocation survey to ensure that comparisons could be made between FOR and OP villages in terms of working days. However, while Sundays are (generally) used for rest in the FOR villages, many households in the OP villages use the day off from plantation labour to work in their fields (especially as this is one of the few occasions when men and women can work side-by-side). As such, this study likely underestimates the extent of productive labour in the OP villages as well as underestimate differences in the availability of rest time between FOR and OP villages.

Household Definitions

This study formed part of a wider investigation into maternal and child diet and nutrition. As a result, the sample was limited to mothers of small children from indigenous Dayak ethnicities and their male partners (husbands). data were collected on their household activities and livelihoods using a standard definition of households for socio-economic surveys in agrarian contexts. As discussed in Chapter 5 (Section 5.3.4), such definitions only partially map onto the reality of contemporary Dayak social structures which include extended kin networks and community and collective labour and support groups.

The conservative definition of households used in this study has implications for household-level data reported throughout the study. For instance, Chapter 8 showed the importance of peer-to-peer trade and gift-giving in local food systems in the FOR villages in providing access to healthy and affordable fresh produce, and how this hyper-local food system is lost as a result of oil palm adoption. The qualitative

[1] At least in terms of typical seasonal fluctuations in food availability. Food shortages were, in fact, experienced after this period of data collection as a result of restrictions caused by the COVID-19 pandemic (see page 262).

data suggests that some proportion of this trade is conducted within extended kin-networks, which is not explicitly examined within the quantitative data due to our household definitions.

The husband/wife binary used in the time use study in Chapter 7 survey is a further reduction of the household model. While this approach is an improvement on the "unitary household model" and is able to show relative gender disparities within the household (Malapit et al., 2015) it does not fully capture household activities and livelihoods. It is important to note therefore that the total time allocated to different activities within the household cannot be estimated, and the contributions of other members of the household towards the production of income, food and goods and childcare and other forms of reproductive labour are not included in the survey. In particular, the contributions of adolescents and young (predominantly unmarried) adult children to the production of household production and income are often significant, while grandparents and older children may contribute significantly to caregiving and domestic labour. The latter is a clear finding from the qualitative research which suggests a significant proportion of childcare may be outsourced to older generations. Additionally, non-resident household members, such as migrants may continue to contribute to household livelihoods through remittances. Their time and labour and contributions to the household economy are also excluded from the study due to respondent selection.

Intersectionality

Our focus on Dayak mothers of young children, in majority-Dayak villages, means we are unable to explore intersections with numerous other characteristics within communities, such as wealth, ethnicity, age, migration and social and political capital within villages. In the OP villages, this caveat is particularly pertinent. It has been widely noted that oil palm is a "rich farmer's crop" (McCarthy, 2010) requiring substantial capital investments in seedlings and fertilizers, as well as the means to wait between planting and the first harvest. Access to oil palm, therefore, often requires prior wealth or access to credit[2] Over the long term, those who succeed in oil palm adoption are likely to be the wealthiest (Euler et al., 2017; Gatto et al., 2017; Krishna et al., 2017). Expansion of farm sizes is one of the primary mechanisms through which oil palm farmers become successful (Euler et al., 2017; Gatto et al., 2017; Krishna et al., 2017; Kubitza et al., 2019). Part of the way in which wealthier households accumulate land is by purchasing it from poorer households who are unable to endure the period between planting and first harvest (Li, 2015; Jelsma et al., 2017). As such, wealthier households expand their farm size, while poor farmers may be dispossessed of their land, often becoming landless plantation labourers or opting to migrate away from the region (Cramb, 2007; Bissonnette, 2013; Hasudungan, 2018; Hasudungan and Neilson, 2020). The cross-sectional nature of this study means such processes cannot be observed. Longitudinal studies spanning decades are needed to track the long-term effects of processes of inclusion and adverse incorporation.

In theory, smallholder plasma schemes are designed to overcome the technological, knowledge and capital barriers to oil palm adoption among smallholders by providing plasma farmers access to the capital, expertise and other resources required. However, it is also common for poorer households to sell their plasma stake back to the company, other wealthier residents or even outside investors (Li, 2015; Jelsma et al., 2017; Schoneveld et al., 2019a). Most plasma farmers in our study obtained the majority of their income from employment opportunities provided by the oil palm company managing the core plantation estate. Wealthier and more politically connected local elites often benefit disproportionately from such schemes (Yuliani et al., 2020). This likely includes access to different types of jobs – which can affect the

[2] Obtaining loans requires collateral – most often formally titled land. Obtaining land title certificates typically requires capital investment and/or political connections. Additionally, such titles are commonly given to male household heads, potentially dispossessing women from ownership of this land and excluding them from access to credit and financial services (Julia and White, 2012; Basnett et al., 2016; Elmhirst et al., 2017).

allocation of time, labour and household economies and strategies.

This study also overlooks the complex reality of intergenerational dispossession of land (Elmhirst et al., 2017) as well as the reality of migrant labour upon which oil palm production depends (Pye et al., 2012; Elmhirst et al., 2015; Lindquist, 2017; Maharani et al., 2019). Future studies, with larger and more diverse samples of respondents, are needed to fully explore these effects alongside the complementary qualitative research needed to interpret these findings. Likewise, communities may be divided along generational lines. Several studies have found that swidden may persist among older farmers who value traditional swidden for cultural reasons – even in some cases, farming at a loss (Potter, 2015). In contrast, for younger generations, swiddening is often viewed as less important and while oil palm may present more opportunities Hasudungan (2018).

10.3 Methodological Reflections

The Value of Mixed-Methods

While the study suffers from methodological weaknesses, I also believe the study warrants reflection on the value of mixed-methods in time-use studies and food systems and choice research. The value of mixed-methods approaches in the analysis of time and labour allocation has discussed widely (e.g. White, 1984; Stevano, 2019; Seymour et al., 2017), yet the study in Chapter 7 is the first ever to use such methods in the context of oil palm, and, to my knowledge, the first for many decades anywhere in rural Indonesia (see 7.7). In this study, many aspects of time and labour transition could not be explained by either quantitative or qualitative methods alone. For example, conclusions based just on qualitative data might have under-emphasised the degree to which women's agricultural labour is lower in the OP villages in absolute terms. Similarly, conclusions based only on the quantitative data would not have detected the complex set of interrelated decision-making processes nor the physical and mental stress of time pressure experienced by women. Increased use of mixed-method research could mitigate the use of over-simplistic narratives such as the "feminization of agriculture", "liberation from on-farm work" or "engagement in opportunities for off-farm labour" and instead focus on the suite of simultaneous drivers and feedback loops which determine well-being outcomes in contexts of rapid livelihood and landscape change.

The importance of robust time use data collection

The study also reveals the importance of using robust time-use methodologies with full-accounting 24-hour recall time-use methods able to capture simultaneous activities. Without such methods, it is impossible to observe the true effect of livelihood changes or the coping strategies employed to cope with time scarcity. Recent research has shown the promise of new and innovative approaches to time use research (e.g. accelerometers and GPS) (Picchioni et al., 2020; Srinivasan et al., 2020). Application of these methods combined with full-accounting time use recall methods could reveal the effects of agrarian and landscape change on energy expenditure and physical exertion. Future research could also benefit from further dis-aggregation of time use categories – in particular, different types of waged labour and disaggregation of time spent on agricultural production time by crop type and production system.

Participatory and Ethnobotanical Approaches

One of the innovations of this research was the use of participatory methods derived (largely) from ethnobotanical research for food systems research. This research shows the value of using such approaches, especially the use of free-listing, pile sorting, ranking and participatory mapping. Without these approaches, it is inconceivable that the list of foods or even food sources would have been complete, and vital components of the food environment would have been missed. For example, this study found that opportunistic or semi-opportunistic collection of foods was a major part of food acquisition strategies. Farm and crop surveys would (and did) fail to detect the extent of agrobiodiversity and wild and semi-cultivated foods within the production system. For instance, many wild edible plants found and harvested within rubber gardens were not considered crops but were part of the overall production system. Likewise, without participatory approaches, certain types of land classes would have been missed altogether – for instance, the fact that different ages of fallow land provided different sorts of foods. Some field types, such as mixed-agroforestry gardens and forest gardens, would not have been detected in farm surveys at all; they are often not considered "fields" in the context of farm-survey questions[3].

One advantage of the participatory approaches was the ability to produce quantitative estimates of individual and community perceptions. These so-called "participatory numbers" (Chambers, 2007) are likely to more accurately reflect the direct experience of village residents than more "objective" measures of food availability and prices such as inventories and surveys. The added advantage of this approach is that they work at the "all-source" level (as discussed above) which reduces the bias caused by overlooking or under-surveying particular parts of the food system (for instance informal peer-to-peer trade).

Activity Space Approaches

In recent years there have been calls to focus on and develop activity-space approaches to food environments research (Perchoux et al., 2013; Cummins et al., 2017), recognising that boundaries between food environments are highly fluid (Downs et al., 2018) and that people living in shared geographical location may be exposed to vastly different food environments (Surendran et al., 2020) and that people may actively seek out particular food environments (Turner, 2020). Our study reiterates the importance of activity-space approaches to food environments and highlights their importance even in remote rural areas with limited retail food environments. For example, most respondents in the OP villages reported that wild edible plants were still widely available in the forest but that opportunities to collect wild foods were limited due to reduced time spent walking through forested areas. Wild foods were still commonly collected in the OP villages but were dominated by the few wild foods available from the sides of roads and plantations and patches of forests close to oil palm. In contrast, the activity space of women in the FOR villages included regularly passing by fallows, low-maintenance agroforests and rubber fields, allowing multiple occasions of opportunistic collection of wild and semi-cultivated edible plants daily. Likewise, many villages in the OP villages are visited by mobile vendors during the day as traders pass through on their way to other villages – however, only a handful of village residents can take advantage of this as most are working in oil palm plantations during these times.

Despite calls for activity-space approaches, there have been few examples of this in research in practice, and no validated metrics exist. Researchers who focused on activity spaces have tended to use qualitative tools to do so – most noticeably, photovoice (Wertheim-Heck and Raneri, 2019; Spires et al., 2020; Turner, 2020). This study used details acquired from the time allocation research tool, combined with partici-

[3] Without having conducted prior FGDs detailing all types of land uses, cultivation systems and sources of foods, enumerators could not have explicitly prompted for these in the farm-survey, meaning that they would almost certainly have been overlooked.

patory mapping (supplemented by data from FGDs), to describe the spatial and temporal patterns of participants throughout the day. This mixed-method approach was relatively effective in this case (when time allocation data was being collected anyway) – but would be disproportionately labour-intensive if time allocation was not needed. Another drawback of this approach is that it is not spatially explicit – instead, relying on locally derived categorisations of land use and food environment. Depending on the purpose, more spatially explicit approaches may be beneficial (such as GPS tracking or georeferenced photovoice approaches).

Proposals for New Methods and Metrics

(a) The need for a rapid time-pressure survey instrument

In this study, I have demonstrated the utility of questions measuring women's time pressure and coping strategies to manage time scarcity and trade-offs in time allocation. The questions used in this study were derived from focus group discussions during preliminary research – adapting the Coping Strategies Index (CSI) method used for measuring food insecurity in the context of time scarcity. My original intention was to use these questions to create and validate a psychometric scale measuring women's time pressure, which could be used as an explanatory variable in food environment research – though this proved to be a much bigger task than anticipated (see 5.4.1). I believe there is still merit in this idea. A short set of Likert questions, validated to measure time pressure, would be enormously useful in a wide range of contexts, including dietary and nutrition research. A validated psychometric test which taps into a *time scarcity* or *time pressure* domain would be enormously beneficial as it would circumvent the need for time use recall surveys – the validated versions of which are long and complex to administer and rapid versions of which have been shown to introduce unacceptable levels of bias and inaccuracy.

I propose the two potential new measurement approaches:

(1) **A measurement scale of time scarcity and time pressure** using a psychometric approach. The scale would aim to measure the latent construct of "time pressure" – i.e., the experience of feeling pressured for time. A psychometric scale uses questions focused on observable characteristics of behaviours (in this case, time scarcity coping strategies) to measure an unobservable construct (time pressure) which cannot be directly measured but whose magnitude can be inferred from the measurement of the characteristics which it influences. Such a scale would have wide applications not only to food environment research but also to fields as diverse as gender studies, labour economics, well-being research and beyond.

(2) **A Time Scarcity Coping Strategy Index (TS-CSI)** inspired by the Coping Strategy Index (CSI) for food insecurity. Constructing the TS–CSI would work similarly to the CSI but focus on strategies employed to cope with time scarcity rather than with food insecurity. The process would mirror the CSI, beginning first with the generation of context-relevant coping strategies from FGDs, weighting the severity of these strategies using participatory ranking and weighting exercises, and then using a 7-day recall to measure the frequency with which these strategies have been implemented by the respondent. A TS-CSI score can then be calculated using a function which combines the frequency and severity of coping strategies. Like the CSI, upon which I modelled the approach, the T-CSI has the major advantage of being adaptable for local contexts while simultaneously providing quantitative estimates.

These two metrics have enormous potential to move forward research into food environments specifically and time use measurement more generally. If successfully validated for a range of contexts against gold-standard 24-hour recall time-use surveys and other measures of time pressure and scarcity, they may reduce the need for expensive and time-consuming time-use recall surveys which require specialist training of enumerators, replacing them with a simple set of standardised questions which can be used comparatively across contexts and as explanatory variables in a range of analyses. Of course, the creation of metrics is neither quick nor easy. A rigorous process of design, pilot testing, implementation in a range of contexts with a range of respondents, and validity and reliability testing would be required. Furthermore, there are dangers of creating rapid survey approaches and proxies, which can, over time, come to obscure the issues which they were originally designed to help solve[4].

(b) Measures of Production Diversity

Existing measures of production diversity currently used are based on food groups or counts of crops grown. This thesis shows how the prevalence of semi-cultivated and wild agrobiodiversity complicates such measures. Distinctions between cultivated and non-cultivated foods are not always clear (Powell et al., 2015), nor is not easy to define the taxonomic level at which wild and semi-cultivated foods should be distinguished from one another (Rapini, 2014), possibly leading to artificial inflation or deflation of production diversity . Additionally, there is a significant difference between wild foods which are theoretically available and those used and consumed. A large literature debates theoretical and empirical linkages between production diversity and diet quality (Jones et al., 2014; Sibhatu et al., 2015a; Berti, 2015; Koppmair and Qaim, 2017; Qaim and Sibhatu, 2017; Ludwig, 2018; Sibhatu and Qaim, 2018a,b), yet the issue of what is defined as a crop is rarely, if ever, discussed. In many contexts, this may not matter. However, in biodiverse contexts with extensive agricultural systems, the importance of these semi-cultivated and semi-wild foods can be significant. This thesis suggests that some form of standardisation may be desirable and that – at the very least – there should be increased transparency reported in methods about how authors accounted for such foods.

In Chapter 8, I created two novel metrics which I believe may have some utility or could potentially form the basis of an improved approach:

(1) **An Agrobiodiversity Index** which would include all foods which can be harvested but which are not explicitly planted (i.e. not captured in farm surveys). This approach avoids the difficulty discussed above of having to classify food as either cultivated or wild and avoids the issue of available foods being missed entirely (for instance, when relying on farm-level data). To avoid the pitfalls of ethnobotanical approaches, which may result in vast lists of species, many of which may be rarely consumed, I propose that the creation of the index is combined with focus group data, which uses free-listing and pile sorting first to generate an exhaustive list and then classify it into cultivated semi-cultivated and wild foods. This approach could also be combined with participatory categorisation of wild foods into those frequently consumed, occasionally consumed, and those used as a safety net.

(2) **The Farm System Diversity Index (FSDI)** metric measures the number of different production systems within a farming household's livelihood rather than the number of types of crops and could potentially be used in addition to a conventional crop diversity count to control for agrobiodiversity.

The FSDI represents the degree of specialisation of farms, as more marginal types of extensive agriculture

[4]Debate exists, for example, over the wisdom of the now mainstream focusing on childhood stunting as a nutritional target and problem to eradicate, when stunting was only ever intended to be a measure or a symptom of a more generalised form of malnutrition (Perumal et al., 2018; Leroy and Frongillo, 2019). Likewise, the accepted use of dietary diversity metrics as a proxy for dietary adequacy has recently received criticism due to the increasing volume of findings showing a lack of evidence that successful interventions which increase dietary diversity also result in improved nutritional status (Fongar et al., 2019)

are squeezed out of existence by changing economic incentives. The FSDI has several potential uses. Firstly, at least in the context of this study, the FSDI would be a fairly accurate proxy for relative exposure and access to agrobiodiversity. Secondly, with the increased focus on food systems resilience, farming households or communities with a high FSDI would likely weather shocks more easily – being more likely to have fallback alternatives when faced with economic shocks (such as price shocks) or other food system shocks.

Likewise, all existing tools which measure market food availability and prices are likely to miss the temporary pay-day markets, which spontaneously form around oil palm company offices at pay-day. Indeed, it is possible that a dietary intake survey taken before and after pay-day would likely reveal different patterns of dietary intake. Very few food environment studies have explicitly included pay-day cycles in their design. However, a number of studies have found similar findings to my, suggesting that the role of pay-day markets and pay-day cycles in affordability needs to be more readily considered.

Adapting Methods and Metrics for Biodiverse Environments

(c) Adapting Theory and Frameworks

Food environments is a rapidly developing field. When this thesis began, there was no set of methods specifically developed for food environments in LMICs, let alone rural agricultural LMICs. In subsequent years, several new methods and metrics have been proposed, but no consensus on methods or approaches has emerged. This thesis has tested, compared and contrasted different approaches to measuring food environments in biodiverse contexts in LMICs. Several lessons can be drawn from the variety of approaches used, and some of the methods developed for this thesis may have utility for other researchers. The methodical findings and innovations in the thesis lead to the following proposals for future food environments research and agriculture and nutrition research:

One illustrative example of how existing metrics and approaches would miss important changes can be seen by looking at chicken meat. Chicken meat is available and affordable in both sets of villages but produced, obtained and consumed in different ways. In the FOR villages, chickens consisted mainly of free-roaming village chickens (*ayam kampung*), predominantly eating insects and scraps. These village chickens, though considered tough and lacking in meat, were considered safe and reliable sources of meat, available at any time from either household production or via intra-village trade with trusted counterparties. Chicken in the FOR villages was eaten as part of a diversity of different meats, mainly of wild origin. In the OP villages, bushmeat, though available sporadically, was less easily obtained due to a scarcity of time generated by oil palm labour (and a reduction in availability from intra-village trade due to aggregate effects of adopting oil palm labour). Thus, in the OP villages, chicken became the primary source of meat. Free-roaming village chickens were also less common – partially due to the less hospitable village environment – and respondents relied mainly on chicken from mobile vendors and larger shops in node settlements. The origin of this chicken was usually unknown by consumers, but often assumed to have been transported frozen from Malaysian Borneo. As such, respondents reported concerns over the continuity of cold chain storage, and thus the safety and quality of the meat. As chicken meat was also not offered in village shops, respondents were required to travel to shops outside the village or else wait for mobile vendors selling (whose arrival and timings were not always predictable).

(d) Beyond Market Inventories

For this study, I developed an "all-source village food inventory" by triangulating data from multiple sources. The all-source food inventory includes data from traditional food environment methods, such as store inventories, alongside data generated from FGDs, farm surveys and direct observation. A major advantage of this approach is that it is far more likely to reflect the actual availability of foods for village residents than the combined use of market surveys and farm surveys. It also reflects the prevalence of agrobiodiversity, intra-village and hyper-local village-to-village trade often missing from other approaches.

Food environment research has historically relied heavily on market inventories of foods and prices. Indeed, in recent years, calls have been made to drop many aspects of food environment frameworks beyond this (see Toure et al., 2021, for a discussion). This study demonstrates clearly that relying solely on market surveys and inventories would completely miss many essential components of food availability and affordability. The findings of this thesis suggest that market inventory approaches are particularly insufficient for biodiverse agricultural settings as they fail to capture the extent of both hyperlocal informal trade systems, which comprise most food purchase acquisitions.

In Chapter 8, I showed how market inventories would almost certainly miss the essential function of intra-village trade in agricultural and wild products, which comprises a major – if not *the* major – part of food availability in the FOR villages. Market inventories would almost certainly miss the essential function of mobile vendors, which is the main – and in some cases only – source of fresh foods in the OP villages. While this study was able to capture the availability of foods from mobile vendors and intra-village through free-listing exercises with key informants as well as in FGDs, even this is insufficient to capture temporal dynamics in availability on a daily, weekly and seasonal basis. For example, while qualitative evidence clearly showed the effect of pay-day cycles on the availability and affordability of foods on the OP villages – no quantitative data were collected at a scale which could reflect this. Based upon these findings, food environments research in similar contexts where intra-village trade and use of mobile vendors is likely to be high, alternative and/or additional survey methods are required. This research shows it is vitally important that any such metrics should account for peer-to-peer trade and other forms of hyper-local food systems.

10.4 Further Research Exploring Impacts in Diets and Nutrition

The above sections have discussed several avenues of future research. These include the need for longitudinal surveys to capture seasonal and other temporal changes, examining the contributions of wider family, household and extended kin networks as well as exploring intersections with wealth, class, age, ethnicity within the communities as well as with non-indigenous populations in the region (e.g. transmigrants and temporary migrant labourers). This section outlines some of the dietary and non-dietary pathways through which the changes described in this thesis may impact on maternal and child nutrition.

Food Systems, Food Choice and Dietary Intake

As well as these measures, the next critical step is to determine empirically whether causal pathways can be established between the changes in food system and food choices documented in this thesis, with changes in diets and nutritional status. To determine what, if any effects, they have on maternal and child nutrition will require demonstrating causal effects on dietary intake and nutritional status, while also considering these effects within the broader context of the population's nutritional status. This will require simultaneous research investigating food systems, food environments and dietary intake using robust quantitative survey methods alongside in-depth qualitative research.

The results of this thesis warrant an investigation as to whether time-scarcity is correlated with dietary intake and nutrition. Such research will require time allocation surveys and 24-hour recall surveys to be conducted simultaneously. Such research should also include qualitative approaches to enrich the understanding of food choice decision-making. Another potential avenue for research is the effect of the loss of wild food acquisition and the hyper-local trade system on food consumption. This study indicates that wild foods are a highly important part of food consumption patterns in the FOR villages. While less important in the OP villages, they still appear to provide an easily accessible and convenient source of DGLVs. This study suggests that the loss of wild foods (as well the absence of a local system of trade in wild foods) could affect the consumption of some food groups. For example, while households in the FOR villages consumed a diverse range of meats, in the OP villages, the vast majority of meat consumed appears to be chicken. Likewise, the availability of fruits in the OP villages appears to be less diverse than in the FOR villages – and potentially more subject to seasonal shocks. Examining the contributions of wild food consumption will require detailed and contextually adapted dietary recall surveys which are able to distinguish between wild and semi-cultivated foods as well as identify wild-origin foods within the market system.

To date, the few empirical studies to examine the loss of wild foods during agricultural transitions. Broegaard et al. (2017) studied the transition from swidden livelihoods and wild foods towards cash crop production (of maize) in northern Laos but did not conduct dietary assessments to quantify the contributions of wild foods. However, the authors did estimate the percentage of recommended protein intake obtained from wild foods in swidden and commercial villages. Agricultural fields were the most important type location for the collection of wild foods in both types of systems – but the collection of wild foods was much lower for commercial agriculture than swidden. The study identified a 'protein gap' between the two sets of villages was not filled by livestock or purchased Animal Source Foods (ASF). However, without a dietary intake assessment, such conclusions cannot be validated. Other studies have examined nutrition transitions over land-use gradients with specific reference to wild foods. Van Vliet et al. (2015) investigated the effects of a rural-urban gradient on bushmeat consumption in the Bolivian Amazon The study bushmeat and fish, consumed more rural areas, was substituted by farmed chicken and eggs. The study also identified the effects of income differentiation were different in rural and urban areas with wealthy urban households consuming more beef than chicken and wealthy rural households consuming more chicken than bushmeat and fish. Similar findings of a nutrition transition in the Amazon region have been found by multiple other authors who document in the increased consumption of processed foods, industrial meat and decreased consumption of bushmeat – though urban bushmeat markets still serve high demand (Sarti et al., 2015).

Non-Dietary Pathways to Nutrition

Childcare and reproductive labour

Chapter 7 has highlighted the effects of oil palm adoption on childcare. Due to women's work on plantations, where children cannot accompany them, children spend more time with their grandparents and/or spend more time in day-care facilities provided by the companies. The presence of the latter is interesting in various ways that are beyond the scope of this thesis. One interesting observation is that these childcare facilities are provided by oil palm companies to allow women to carry out plantation work. As such, exploring the provision of this childcare through a social reproduction lens (Bakker, 2007) may yield interesting findings. Another observation worthy of further investigation but which is beyond the scope of this thesis is that the fees for this childcare are deducted from women's wages – thus potentially further exacerbating gendered pay disparities at the household level.

Changes in the provision of childcare may affect child nutrition in several ways. Firstly, the increased time spent with grandparents alters who feeds the children the most. Grandparents may or may not be provided with food by the mother for the duration of the stay. One anecdotal observation – but one which I do not have strong data to support – suggests this may be a partial driver changing household dynamics. Older men and women may stop working in fields at a younger age in the OP villages compared with the FOR villages partially to take on these responsibilities. Secondly, when children are left with oil palm workers in daycare, they are usually provided with food by the mothers, although this may be purchased from mobile vendors selling cooked food when time is scarce. This may affect children's diets, including potentially increasing consumption of pre-cooked foods from mobile vendors, this potential pathway has not been analysed in depth in this study.

Women's Health and Energy Expenditure

One way in which maternal health and nutrition may be affected is through women's energy expenditures. It is not immediately clear what the effects of the changes in time allocation shown in this study may be upon men and women's energy expenditures. On the one hand, the number of productive hours is greatly increased for both men and women, but on the other hand, access to machinery and motorised transport, flatter terrain and access to chemical inputs will all reduce energy expenditures. While I cannot speculate here upon energy expenditures, it is certainly true that respondents farm more frequently complained of physical exhaustion in the OP villages. Measuring energy expenditure through approximation via coefficients for activities is highly inaccurate compared with better suited methods such as methodologies involving GPS tracking and/or accelerometers (Picchioni et al., 2020). This is particularly the case in steep upland regions where the inclines greatly affect expenditure. I therefore did not attempt to calculate energy expenditures. This study indicates that an analysis of women's energy expenditures before and after oil palm adoption would be worthy of investigation. However, it falls beyond the scope of this thesis which is focused on nutritional pathways mediated by food intake.

Control of food and non-food expenditure

It is well documented that women's control of income and expenditure is directly associated with food choice and maternal and child nutrition. Detailed analysis of this pathway would require a complementary approach to the one taken in this thesis, which focusses on food system pathways and their linkages to agrarian and landscape change. However, it is clear from the results above that the oil palm transition results in a shift in responsibility of income generation from being relatively equal to being increasingly dominated by men. The distinction between FOR and OP villages is clear. In the FOR villages, the most common model is that household income is pooled, from which an allowance is given to the man for their sole expenses, such as tobacco, while women and men together manage expenses, with women purchasing most food within a negotiated food budget. There are exceptions to this , however, especially where men are engaged in migratory work or agarwood-seeking activities. In these cases, men often control most expenditures, simply giving an allowance for food to women. It is this latter model which appears to be more prevalent in the OP villages.

Changes in income generation do not automatically translate to changes in power or intra-household decision-making over expenditure. Simply because men could exclude women from decision-making over expenditure, that does not mean that they do. Culturally, Dayaks in forest communities have been considered to be *"comparatively egalitarian"* (Colfer, 2008b) – a product of low population densities, the importance of women in agriculture, bilateral kinship, and historical remoteness and separateness from the state (Dove, 1983; Tsing, 1990; Colfer, 2008a; Elmhirst et al., 2017). Few studies have investigated this aspect, though Li (2015) finds mild complaints over men's excessive spending, but were unable to determine the scale of the problem due to cultural norms in reporting. It is also not strictly true that income is generated equally in forest areas in all cases. While households whose livelihoods consist exclusively of swidden, rubber and the sale of forest products may have equal claim and control over income, many men do engage in income-seeking activities from which women do not have access such as seeking gaharu (agarwood), artisanal gold mining, or as migrant workers in oil palm (in Indonesia or Malaysia) and as such may both produce the majority share of the household income, but also be away from home for weeks or months at a time. Studies in such communities have indicated that women retain significant control over household expenditure even where men are the primary earners (Shantiko, 2012).

Chapter 11: Conclusion

Contents

11.1 Introduction

The initial conceptualisation of the thesis was to explore the value of applying a food systems and food environment framework to the study of agrarian change in rapidly transitioning landscapes. Research on agricultural transitions and food systems has often focused on the trade-offs between agricultural commercialisation and diversification (Jones, 2017a; Sibhatu and Qaim, 2018b). The nature and magnitude of these trade-offs are highly context-dependent and mediated by local food systems, markets and agricultural production systems (Ruel et al., 2018; Nandi et al., 2021). To date, most research has focused on the trade-offs in terms of crop substitution decisions by smallholder farmers, neglecting the broader context of agrarian transitions, landscape change, and bidirectional relationships between food systems, food markets and local food production (Ickowitz et al., 2019). Additionally, the debate has tended to under-emphasise the important role of agrobiodiversity, wild and semi-cultivated within food systems (Powell et al., 2015; Broegaard et al., 2017; Rasmussen et al., 2017) as well as the broader role that livelihood transitions have in shaping food systems and food choices (Karanja et al., 2022; Kenney et al., 2024). Similarly, the food environments literature has been dominated by studies in HIC settings (Turner et al., 2019). While a small set of studies have been carried out in LMIC settings, most have focused on urban obesogenic food environments, with little to no research conducted in biodiverse rural contexts (Heim, 2021; Nordhagen et al., 2022).

The role of context as a modifier of agrarian transition outcomes is also increasingly recognised in the study of oil palm transitions in Indonesia. Recent research has highlighted how factors such as the type of oil palm model and the degree of prior subsistence orientation of farmers, significantly influence the welfare and well-being outcomes of oil palm engagement (Santika et al., 2019a,b). These findings have led to calls for greater caution in generalizing results from specific contexts and models to oil palm as a whole (Nurhasan et al., 2020a; Sibhatu, 2023; Tabe-Ojong, 2023). As I demonstrate in Chapter 3, avoiding such generalisations is vitally important given the highly politicised context, in which research is frequently quoted and misquoted by well-funded media operations advancing particular agendas.

This thesis aims to explicitly examine the role of context as a key modifier in food systems change within communities engaging who are engaging with oil palm in Kapuas Hulu District, West Kalimantan. I situate my research within the context of swidden transitions, which are modified and accelerated by oil palm expansion – but also occur independently of oil palm. In this context, oil palm adoption cannot be viewed merely as a crop substitution or farm expansion but as an entire reorientation of livelihoods and the social, cultural, economic and landscape context in which they operate. My focus is one specific model of smallholder oil palm adoption – that of "shareholder" models of smallholder plasma schemes. As I show in Chapter 6, despite such farmers being officially classified as "smallholder oil palm farmers" in reality, growing oil palm plays a minor, almost insignificant, role in livelihood strategies. Rather, livelihoods are re-orientated towards waged plantation labour – though this pays insufficiently to allow most households to abandon subsistence food production. This finding is corroborated by multiple other studies of similar schemes in West Kalimantan (Li, 2015; Gecko Project, 2022a). Combining income-generating activities with subsistence farming is not new for Dayak farmers, who have maintained "duel livelihoods" strategies for centuries (Dove, 1996, 2011a). As I demonstrate in Chapter 6, what has changed is in inflexibility of oil palm labour compared with previous and alternative sources of income – resulting in significant trade-offs between income-producing and food-producing activities. Chapter 7 shows how the constraints of increasing time spent in off-farm labour, while simultaneously self-producing the majority of food, results in a significant increase in time pressure at the household level. Chapters 8 and 9, examine how the strategies and adaptations deployed by the households to manage these trade-offs in time result in substantial changes to food production and food choice.

The thesis aimed to answer the following research questions:

RQ 1: How does oil palm adoption by smallholder swidden farmers affect the intra-household allocation of time?

RQ 2: What effects does community-wide adoption of oil palm have on local food systems?

RQ 3: How do changes in food systems and time use impact food choice decisions?

11.2 Research Question 1: How does oil palm adoption by smallholder swidden farmers affect the intra-household allocation of time?

The transition from forest-based swidden livelihoods to oil palm-based livelihoods drives a vast suite of accompanying changes. Among these are changes in the way that households allocate time and labour. Previous studies have found mixed effects depending on context. Studies of commercialised rubber farmers suggest independent oil palm adoption increases participation in off-farm labour for men but not women (Chrisendo et al., 2020; Mehraban et al., 2022) while studies of subsistence farmers participating in smallholder schemes have shown increased participation in off-farm labour for both men and women (Bissonnette, 2013; Li, 2015; Maharani et al., 2019). However, the latter has also been associated with shifts in the gendered allocation of household labour – with men taking an increasingly dominant role in income generation (through waged plantation labour) and women taking on a greater proportion of subsistence agricultural activities (Julia and White, 2012; Elmhirst et al., 2015, 2017; Maharani et al., 2019).

Adopting oil palm-based livelihoods creates gendered shifts in the allocation of household time. The effects of smallholder oil palm adoption on intra-household gender dynamics and allocation of time and labour will depend not only on the model of oil palm production but also on the baseline conditions and livelihoods of the adopting households. For example, among commercialised farmers in Sumatra, independently switching from rubber to oil palm reduced on-farm labour for both men and women but increased participation in off-farm labour only for men (Chrisendo et al., 2020; Mehraban et al., 2022). However, for former subsistence farmers in Kalimantan participating in oil palm plasma schemes both men and women's participation in off-farm labour is increased, though at different rates, leading to shifts in the gendered allocation of household labour (Julia and White, 2012; Li, 2015; Elmhirst et al., 2015, 2017; Maharani et al., 2019; Toumbourou and Dressler, 2020).

Building upon previous studies of gendered labour dynamics in oil palm-adopting communities, this study uses primary data collected using robust standardised time-research methods among both women and men in oil palm and non-oil palm communities combined with qualitative research on men and women's experience of time as well as the causes, experience and management of trade-offs in time allocation between different activities. Our results suggest that oil palm adoption (participation in smallholder plasma schemes) among former swidden farmers drastically alters the intra-household allocation of time and labour. Oil palm adoption is associated with more time spent in off-farm labour for both men and women – but significantly more so for men than for women. Likewise, oil palm adoption is associated with less time spent in agricultural and forest activities for both men and women – but significantly more so for men than for women. These findings indicate a trade-off between time spent in off-farm labour and time spent in agricultural and forest-based activities. This trade-off is corroborated by the qualitative findings, which indicate that households in the oil palm villages maximise time spent in off-farm labour and minimise time spent in agricultural and forest-based activities at the household level, shifting as much agricultural labour towards women as possible. This is achieved through a series of changes to agricultural production, which interact in complex, non-linear ways with broader landscape processes of land use and agrarian change.

The increased time women spend in productive labour in the oil palm comes at the cost of personal and leisure time as well as sleep. Our qualitative findings confirm that women perceived an overall scarcity of time, and that this time pressure manifests itself in the form of mental and physical stress. Time pressure may have significant effects upon maternal and child nutrition as well as subjective well-being and women's empowerment (Kadiyala et al., 2014; Johnston et al., 2015, 2018; Stevano et al., 2019). Further research is required to integrate time use with new and emerging measures of subjective well-being (Diener et al., 2018a). Investigation of these pathways is urgently needed to fully understand the welfare effects of oil palm adoption in Indonesia. At the same time, effects of time pressure on maternal and child nutrition should be explored through the lens of food acquisition and food choice behaviour and through the effect on women's energy expenditure. This study indicates that oil palm adoption (participation in smallholder plasma schemes) among formerly subsistence swidden farmers in Kalimantan may have significant implications for gender equity, well-being and maternal and child nutrition via changes in household time allocation. Similar studies using specialised time use methods but using longitudinal study designs are needed to determine whether these findings have general applicability. Our results reflect one specific context, at once specific stage of a broader landscape, agrarian and economic transition. In addition, our sample was restricted to a relatively homogeneous group of ethnically similar, indigenous land-owning households with mothers of small children. Further investigation of time use effects in different contexts and different models of oil palm adoption are needed, as well as investigations into how wealth, class, age, ethnicity, land ownership, migrant status, and education interact with labour transitions.

The underlying driver behind changes in time and labour allocation were changes in the opportunity costs of time and labour and the incompatibility of oil palm labour with other activities. In the FOR villages, the opportunity costs of time and labour are comparatively low due to the limited options of engaging in off-farm work and the comparatively low-levels of income that can be obtained from rubber. As such, households tend to prefer allocating time rather than capital. For instance, respondents stated that purchasing chemical inputs was wasteful when the same effects could be achieved through traditional swidden techniques such as fallow cycling. Likewise, respondents viewed expenditure on many foods as extravagant, particularly when similar foods could be collected from the wild. In the oil palm villages, however, purchasing foods or chemical inputs was necessary to reduce time spent in self-production and thus enable them to engage in, and maximise time spent, in off-farm labour.

Waged plantation labour on oil palm plantations (though notably not smallholder plasma) offers a higher return on labour than alternative sources of income (such as rubber). As such, it is rational that households reallocate labour away from other sources of income towards it. Previous studies have assumed that time and labour can be reallocated freely without constraint between various activities for all members of the household (Krishna et al., 2017; Kubitza et al., 2021; Chrisendo et al., 2021; Mehraban et al., 2022). However, in this context, the combined income from oil palm plasma and waged plantation labour is insufficient to abandon food production. As such, the overwhelming majority of oil palm adopting households are required to manage trade-offs between on-farm food production and off-farm labour.

Driving changes in the intra-household allocation of time are a mix of economic and cultural forces. Engagement with oil palm alters the opportunity costs of on-farm labour differently for men and women as men have access to a wider range of higher-paying and more flexible positions. Gendered differences in salaries and access to off-farm work drive gendered differences in the opportunity cost of on-farm labour. It is therefore, a rational "joint-utility maximising" strategy (Becker, 1965) to maximise men's time in off-farm labour and shift as much on-farm labour as possible towards women. These gendered opportunity costs are inseparable from wider cultural gender norms. Wage differentials and barriers to employment are a product of expectations regarding women's role in domestic and reproductive labour and their perceived ability and interest in technical and physical work as well as traditionally male-dominated work such as truck driving and security.

11.3 Research Question 2: Food Systems and Food Choice

The food systems research was premised on the idea that the availability and affordability of foods at the village is an emergent outcome of three interacting food-sub-systems: the agricultural sub-system, the wild foods sub-system and the market subsystem. By comparing these sub-systems between the oil palm-adopting and non-oil palm-adopting villages, it is possible to observe some of the effects of the divergent trajectories they have taken.

11.3.1 Effects on Food Sub-Systems

Agricultural Production Sub-System

The agricultural production sub-system is far less diverse in the OP villages and produces a less diverse range of foods. In particular, on average, farms in the oil palm-adopting villages produce fewer types of vegetables and fruits. Differences in production diversity between sets of villages are even greater when including agrobiodiversity (wild and semi-cultivated foods within fields) in crop counts.

Driving the lower production diversity in the oil palm adopting villages is both a reduction in in-field diversity and a reduction in the diversity of farm production systems (i.e. fewer types of fields). While the farm system in the non-oil palm-adopting villages consists of a diverse combination of extensive, low-input, low-output production systems, these have been replaced with more intensified production systems following oil palm adoption in the oil palm villages. Driving this is a combination of complex land use and socio-ecological factors. Firstly, the increased opportunity costs of on-farm time discussed above have exacerbated the trend to relocate fields away from remote upland slopes towards land nearer to roads and villages. This has generated localised land scarcity[1] and precipitated the emergence of local land markets, which have begun to replace customary tenure regimes (further exacerbating land scarcity[2]). This conveniently located lowland land also competes with oil palm cultivation and is likely technically owned by oil palm companies – for the time being, however, oil palm companies are permitting local people to farm this land. In some cases, extensive fields such as these were directly replaced with oil palm as part of plasma agreements. However, such lands were also lost simply due to the opportunity cost of maintaining ownership of them. Another driver of reduced agricultural production diversity is the transition from rubber to pepper as the main cash crop – driven again by opportunity costs of time and enabled by increased access to and affordability of chemical inputs. Rubber cultivation, as practised in the FOR and OP villages, is still (somewhat) agroforestry based and produces a wide range of wild, cultivated and semi-cultivated fruits, vegetables, nuts and seeds.

[1] Though notably not land scarcity over a wider area, especially upland forested slopes which are no longer desirable for oil palm and no-longer desirable for swidden.

[2] Land markets further exacerbate lands scarcity for two reasons – firstly there is an incentive to "claim" or purchase land which may have future value and secondly because the customary form of passing on land to descendants (opening new swiddens on upland slopes) has been devalued.

Wild-Food Production Sub-System

The wild food production sub-system in the oil palm-adopting villages produces much lower quantities and a smaller range of foods. However, it is remarkable the extent to which some wild foods remain essential even after adopting oil palm – something that analyses of oil palm adoption relying on farm surveys would likely miss. In particular, wild Dark-Green Leafy Vegetables (DGLVs) which grow on roadsides and plantation edges (especially wild ferns and cassava leaves) continue to be the convenience food of choice (see below).

The diminished production of wild foods following the adoption of oil palm may be caused by one of two things: reduced availability of wild foods, or reduced acquisition of wild foods which are still available. It is difficult to disentangle these two forces as there is a feedback loop between them (households are less likely to acquire foods if the probability of success is lower). On the whole, however, it appears that most wild foods are still available[3] , but there is an active choice not to collect them. This decision is caused by two factors. Firstly, oil palm adoption has changed men's and women's activity spaces – no longer bringing them close to the richest environments for collecting wild and semi-cultivated foods. Secondly, time scarcity prevents men and women from engaging in such activities. For men, time scarcity results in an inability to go hunting and fishing, while for women, it is an inability to engage in "probabilistic opportunism" (taking slight detours to maximise the probability of encountering desirable wild foods).

Market Food Sub-System

The market food sub-system in both sets of villages is composed of three components: retail establishments; mobile vendors operating as sole traders on motorcycles; and hyperlocal trade (primarily intra-village peer-to-peer trade as well as localised inter-village trade). There are two main structural differences in local food systems between sets of villages: Firstly, while hyper-local trade in the non-oil palm-adopting villages is pervasive and extends to almost all agriculturally produced foods and wild foods available, it has been almost entirely lost in the oil palm villages following the adoption of oil palm. There is a simple reason for this – households no longer produce surplus food from agriculture or wild food acquisition to sell (for the reasons outlined above). Secondly, while mobile vendors are present in almost all villages in both sets of villages – they visit villages (on average) more frequently in the oil palm-adopting villages as well as converging bi-weekly around oil palm company offices when salaries are paid, forming temporary markets.

The question is, therefore, do the other parts of the market food system respond to this reduced local supply? The answer is: partially. Certainly, mobile vendors visit (on average) more frequently in the oil palm adopting villages – though variation between their villages is high and appears to be driven largely by village connectivity rather by variation in local supply or ability/willingness to pay. Another structural difference in food systems between sets of villages is the existence of pay-day markets in the oil palm-adopting villages – conglomerations of assembled individual mobile vendors who converge outside oil palm company offices when salaries are due to be paid. This indicates a significant response to supply and demand dynamics, which has major effects on consumption patterns – with respondents reporting being short of income before payday and relying on cheaper foods (including wild foods) while consuming different, more expensive foods after payday, often purchased from payday markets.

[3]A tiny minority of villages and respondents suggested that wild fish availability had decreased due to oil palm-related pollution of rivers. Additionally, respondents in both sets of villages reported lower bushmeat animal abundance (but more so in the oil palm-adopting villages. However, the latter was given as the reason for reduced hunting frequency only in a small minority of cases

11.3.2 Effects of Village-Level Availability and Prices

A natural question arises from the changes to food systems discussed above: is the reduction in local agricultural and wild food production and loss of the intra-village trade system adequately compensated for by the increase in access to mobile vendors? This seems to be true only partially. On the one hand, at the food group level, there are few differences between sets of villages, with most villages having access to a similar set of food groups. However, it is clear that the total diversity of available foods is substantially lower in the oil palm-adopting villages – with far fewer types of meat, fruits and vegetables. Additionally, foods were, on average, available from fewer different types of sources. While this may reduce the food system resilience (Béné, 2020; Hertel et al., 2021; Nurhasan et al., 2021), it does not appear to affect availability and access to foods within the period I studied[4]

While oil palm adoption reduces overall food availability in terms of diversity, most food groups were still available to some extent in all villages. Few respondents, in either set of villages, problems with availability or access to foods in either set of villages. The loss of the hyper-local food system may, however, have significant effects on food prices. Comparing average food-group prices across different foods, sources, and vendors is not easy (see 8.2[5]). My results indicate that for foods of outside-village origin, there is no difference in average food prices between the two sets of villages. Thus, it is clear that oil palm development does not lower market prices of outside-foods by either reducing transaction costs or increasing demand and competition. However, I do find that foods of outside-village origin are considerably more expensive than similar locally produced foods which are available to purchase via informal trade. Given the high prevalence and importance of local trade in the FOR villages, and it's disappearance in the OP villages following the introduction of oil palm, it is likely that FOR villages residents have access to cheaper foods than residents in the OP villages. This is especially true for meat, where bushmeat constitutes a substantial proportion of meat availability.

11.4 Research Question 3: Impacts of Food Systems and Time Use Change on Food Choice

11.4.1 Time Scarcity, Convenience and Food Choice

One of the main hypothesised pathways was that time scarcity generated by oil palm adoption might lead to an increased desire for convenience foods – and that this desire would be met by market sources providing greater access to them. The former, indeed, appears to be the case and is supported by both quantitative and qualitative evidence. The latter, however, does not appear to be true – the most commonly consumed convenience foods are widely available in both sets of villages. Part of the reason for this is that convenience foods are not – as I had visualised prior to my research – primarily Ultra Processed Foods (UPFs). While some UPFs (particularly instant noodles) are certainly convenience foods, many others were, in fact, healthy; DGLVs and eggs, in particular, were seen as quick foods to cook and acquire.

Convenience foods are foods which are both quick to cook and quick to acquire. Convenience as a

[4] The COVID-19 Pandemic may have changed this entirely. Whatsapp messages with informants and colleagues living in the area during the COVID-19 pandemic strongly indicate that the loss of local production had profound effects on the resilience of local food systems following rationing in the markets from which mobile vendors source their foods. However, I do not have data to support this. During my fieldwork time, respondents perceived relatively good availability and access to foods via mobile vendors and few seasonal fluctuations in availability. This may have subsequently changed following the pandemic, but I can only speculate based on anecdotal evidence.

[5] Inflation by number of species

food environment domain therefore encompasses both the perceived properties of foods, as well as their location and method of acquisition — which interact with the activity spaces of those acquiring foods. Which foods are easy to acquire depends on the food environments women are exposed to, which in turn are a product of their activity spaces and the nature of local food systems. For women in the non-oil palm adopting villages, their activity spaces brought them in close proximity to a great variety of wild and semi-cultivated food environments, providing abundant opportunities for conveniently collecting foods. Additionally, at certain times of the day (particularly early afternoons and evenings, when women most wanted to acquire foods), it was possible to obtain a wide range of fresh foods conveniently via friends and neighbours selling, gifting or exchanging agricultural and wild foods. In contrast, in the oil palm-adopting villages, activity spaces brought women in contact with far fewer opportunities to acquire wild foods (with the exception of the DGLVs discussed above). Likewise, the oil palm-adopting villages contained little to no intra-village trade and the only source market source of fresh produce (mobile vendors) was seen as highly inconvenient due to their erratic arrival times. Instead, the most convenient source of food was village shops – which stocked primarily non-perishable foods. That is not to say, however, that these foods were necessarily less healthy – for instance, village shops were sources of several healthy, convenient foods, including eggs, as well as canned sardines and dried and salted fish. As discussed below in 11.5, the net nutritional effects of the increased desire for convenience foods are thus difficult to predict.

11.4.2 Affordability

For equivalent foods, there are few differences in prices for market-source foods from outside origin between sets of villages. However, household incomes are undoubtedly higher in the OP villages – reflecting the greater access to better paying work. Thus, in theory, the affordability of these particular foods may be higher. However, this is not the full story. While there are few differences in prices of outside market foods, there is evidence that residents in FOR villages have greater access to a hyper-local food market system, which provides cheaper alternatives.

To accurately account for affordability, it is necessary to conduct a full-expenditure survey as well as produce more reliable estimates of household income, which include sources of environmental income. The qualitative component of the research revealed the perception of affordability was less about income and food prices as it was livelihood priorities and available alternatives. In the FOR villages, spending money on food was seen as an unnecessary extravagance when free alternatives such as wild foods were freely available. The same attitude also applied to many agricultural inputs, when the same results could be achieved through traditional swidden practices. Thus, faced with the option, many FOR residents would prefer to spend time rather than money to obtain food. Conversely, the absence of such time (to either collect wild foods or to use traditional swidden practices) was the reason given in the OP villages as to why they purchased foods or chemical inputs.

One unexpected finding of this research is the importance of pay-day cycles in affecting food choice. The stated affordability of market foods in the OP fluctuated greatly over the course of any month, with foods selected prior to pay-days being very different to the foods selected afterwards. The study also highlights the interrelationship between cycles of affordability, cash-flow fluctuations and systems of debt and credit. Access to the latter was also mediated via social-relations, themselves affected by livelihood and landscape change.

In recent iterations, food environment frameworks have included access to credit as an aspect of the affordability of foods, as well as social capital (Downs et al., 2020; Turner, 2020; Constantinides et al., 2021). This study strongly supports their inclusion of these in food environment frameworks, as they were found to be essential components of food choice decision-making. Future iterations of food environment frameworks could also include fluctuating cash-flow and affordability caused by pay-day cycles.

11.4.3 Preferences for Foods from Local Food Systems

As discussed above, a crucial factor which influenced food choice was the availability (or not) of a hyper-local food system consisting of peer-to-peer trade and local inter-village trade, and likely results in lower average prices for fresh foods in the non-oil palm adopting villages. However, the relevance of this system extends far beyond food availability and prices. This study consistently found that locally produced foods (from both local agriculture and wild foods) were preferred to foods of outside origin. This preference was consistent and ubiquitous in both sets of villages, and is supported by both quantitative and qualitative evidence. This preference was based partially on taste and cultural importance – but the most important factor appears to be a general distrust of foods from outside the region due to their unknown origin and possible contamination is harmful chemicals (in the case of fruits and vegetables) or food safety and quality (in the case of meat and fish). Thus, while outside market sources compensate for the loss of the hyper-local food system by providing more meat, fish, fruits and vegetables (though still a lower diversity of types) – the desirability of these market foods is lowered.

11.5 Implications for Oil Palm in Indonesia

Chapters 2 and 3 discuss the emergence of a development-focused narrative of oil palm as a tool for combating poverty, food insecurity and improving the welfare of rural populations – especially smallholders. While there is some evidence that some forms of smallholder oil palm, in some locations and some contexts, lead to positive economic and other wellbeing outcomes (Qaim et al., 2020) – such effects greatly depend on context (Santika et al., 2019a,b). Furthermore, an extremely narrow range of welfare/wellbeing indicators have examined – the overwhelming majority of which have failed to explore intra-household gendered effects (Reiss-Woolever et al., 2021). As discussed in Section 2.4, the "oil palm for development" narrative is being amplified and propagated by vested interests who selectively miss-quote, miss-represent and generalise academic analyses. In this context, it is vital that researchers resit the urge to generalise findings from specific contexts and emphasise how different well-being indicators may respond in different, sometimes opposing, ways in different contexts for different sets of people.

This study is a clear demonstration of the need to explore multiple well-being outcomes simultaneously and to explore these effects on different subgroups of the population. Prior to this study, time-poverty, the associated stress and burden on women, and the potential knock-on effects for childcare and maternal and child nutrition has never been examined. Nor have the ways in which changes in livelihoods, food systems, and food environments may influence food acquisition and consumption beyond the narrow focus on productionist and market-driven pathways. The magnitude of these effects suggest that they have major effects on wellbeing – some of which may disproportionately affect women. Conclusions based solely on crude economic or food security indicators, especially household-level indicators, would miss a much more complex picture of trade-offs between different outcomes as well as welfare trade-offs for different household members and subpopulations.

Importance of Oil Palm Model and Context

Past studies of oil palm labour and time have almost exclusively focused on rubber farmers in Sumatra who adopt oil palm as independent smallholders (Krishna et al., 2017; Kubitza et al., 2018, 2019;

Chrisendo et al., 2020; Mehraban et al., 2022). In this context, as smallholders are already fully commercialised, oil palm adoption does not compete with food production for labour and time. As such the improved labour efficiency of oil palm relative to rubber allows households to reallocate labour towards expanding their farms or perusing off-farm labour – the primary mechanisms through which oil palm adoption appears to improve financial well-being (Euler et al., 2017; Gatto et al., 2017).

While the "labou-saving" benefits of oil palm may "free-up time" and improve economic well-being for independent, commercialised rubber smallholders in Sumatra, this study suggests that the same is not true for participants in "partnership" smallholder plasma schemes in West Kalimantan. In this context, the necessity to continue to produce the bulk of the family's food supply while simultaneously allocating more hours to off-farm labour results in a significant scarcity of time with potentially concerning effects on well-being outcomes. Our results suggest that changes in time allocation may have significant consequences for women's well-being and gender equity. Women in the OP villages experienced greater stress over time scarcity and employed coping strategies more frequently.

The ambiguity of official statistics and smallholder classifications means it is impossible to know for sure which of the two models above are the most prevalent or the fastest growing sectors of smallholder oil palm in Indonesia. As such, it would be unwise to generalise findings from either context to the smallholder oil palm industry at large. Nevertheless, as I argue in in Chapters 2 and 3, the latter model may be the most representative of the type of oil palm adopted by most "new" smallholders over the coming years. There are two reasons to suspect that the independent smallholders are a minority of oil palm smallholders. Firstly, the official statistics which do exist most likely over-estimate the extent of independent smallholders. Primary surveys indicate that many farmers who are classified as independent smallholders are, in fact, neither small nor independent but a mix of wealthy medium or large-scale farmers, local strongmen or outside investors (IFC, 2013; Potter, 2016a; Jelsma et al., 2017; Dauvergne, 2018; Andrianto et al., 2019a; Schoneveld et al., 2019a). Secondly, while independent smallholders may be on the rise in certain provinces such as Jambi with long histories of oil palm and other plantation agriculture, they are far less commonly found in regions and provinces where oil palm is expanding fastest today. Furthermore, all companies are legally mandated to implement smallholder plasma schemes, and increasingly prefer to enact "partnership" or "shareholder" models over out-grower models (Hasudungan, 2018; Hasudungan and Neilson, 2020). In the regions of Indonesia where oil palm expansion is fastest, most of those included in such schemes are likely to be subsistence-orientated, rather than commercialised cash-crop farmers.

Time Use as a Well-Being Outcome

Women's time use, and in particular women's time scarcity, has been shown to been shown to have major effects on subjective well-being, women's empowerment, and maternal and child nutrition (Johnson et al., 2017; Ruel et al., 2018). This study clearly shows that time use should be considered as an important well-being outcome of oil palm transitions. Further research is required to integrate these findings with new and emerging measures of subjective well-being. So severe are the time-pressure effects of oil palm in this study that measures of time use should be incorporated into the suite of metrics used to explore the social impacts of oil palm adoption in Indonesia. This may require the development of validated rapid survey instruments which can identify time scarcity without the need for long and complex time use recall surveys. I tentatively propose exploring a coping strategies approach as discussed in 10.3, which may circumvent the inherent bias and inaccuracy of shortened forms of time use recall surveys.

Our findings indicate that time allocation could be used as an indicator of the effects of oil palm expansion and adoption on well-being and that potential effects of oil palm on well-being, gender equity, and maternal and child nutrition should be considered by policymakers when making land use decisions.

Further research is required to integrate time use with new and emerging measures of subjective well-being Diener et al. (2018a,b). Investigation of these pathways is needed to fully understand the welfare effects of oil palm adoption in Indonesia.

Time Scarcity and Food Choice in Oil Palm Contexts

This study shows that the time scarcity experienced by plasma scheme participants is a major factor in food choice decision-making. This is particularly true for women, who both experience the greatest time scarcity and are most responsible for acquiring household foods. The study shows that time scarcity results in a greater prioritisation of the convenience of foods – both in terms if cooking and acquisition.The former is evident in the greater prioritisation of foods which are quick to prepare and cook in the OP villages. However, it is interesting to note that as well as UPFs such as instant noodles, many such convenience foods are considered healthy (e.g. eggs, vegetables). This runs counter to existing narratives of time scarcity and food choice, developed primarily from studies in urban contexts, which focus on the consumption of pre-prepared, packaged and other UPFs (Jabs and Devine, 2006; Ruel et al., 2008) and highlights the modifying effect of food environments. The latter interact with activity spaces – also altered by oil palm engagement – which change what food environments women are exposed to and thus which food sources are most convenient. For example, wild foods are seen as a highly convenient source of food in the FOR villages as they can be collected opportunistically and semi-opportunistically as women go about their daily activities. While this is still true in the OP villages, the changes in women's activity spaces means they encounter a less diverse range of wild foods less often.

Given the mix of healthy and unhealthy foods which are likely to be acquired and consumed when women are experiencing time scarcity, future research should test whether this manifests itself into meaningful dietary and nutritional effects. Quantitative studies linking dietary intake using validated 24-hour recall dietary surveys are needed alongside time-allocation surveys to test if such a causal link exists. Studies must also go beyond causal inference and model outcomes in the context of overall diets to establish whether they are nutritionally significant.

11.6 Implications for Food Systems, Food Choice and Food Environment in Biodiverse Rural Contexts in LMICs

This study focuses on an under-researched topic within the literature on food systems, food choice and food environments, providing a case-study from a biodiverse context where the consumption of wild and semi-cultivated foods is widespread. Wild foods are essential parts of food systems in contexts in many biodiverse rural environments – especially where traditional and indigenous food systems are prevalent (Damman et al., 2008; Powell et al., 2015; Byker Shanks et al., 2020; Smith et al., 2019) – yet the theoretical conceptualisation remains underdeveloped. While some recent conceptual frameworks acknowledge the existence wild food environments (e.g. Ahmed, 2017; Downs et al., 2020), they remain somewhat simplistic, failing to account for (among other things) bidirectional relationships between local production and food markets, the role of semi-cultivated foods and agrobiodiversity and informal and semiformal trade. Additionally, existing frameworks assume a linear progression from hunter-gathering societies, through subsistence, to market-orientation, failing to acknowledge that many societies may exhibit characteristics of each simultaneously, and the existence of non-agrarian rural environments (Nordhagen et al., 2022).

The lack of conceptual development of wild food environments is perhaps a result of the paucity of empirical studies conducted in such contexts – particularly among indigenous populations for whom hunting and gathering is a major component of their livelihood strategies. To the best of my knowledge, this research, along with a study by Heim (2021) from Namibia are the only examples from such a context where an explicit attempt is made to integrate food environment methods and theory. Although I was not aware of the work of Heim at the time[6], we appear to have both converged upon similar conclusions. For instance, we both recognise that food environment theory and methodology, designed as it is primarily with formal markets and built environments in mind, are inadequate for contexts where non-market-based foods are prevalent. We both also advocate strongly for mixed-method approaches to food environment research in general – and view it as the only viable approach for contexts where wild foods are an intrinsic part of the food system.

Diversity

One important aspect of food choice found in this study which is not included in existing theories or methodology is the importance of diversity within the diet. The role that wild foods played in adding variety to otherwise monotonous diets was one of the most commonly cited reasons as to why wild foods were consumed[7]. This finding is remarkably similar to those of Heim (2021) in who also found that "diversity" of wild foods play in supplementing otherwise "simplified diets" was highly valued. Wild foods are highly valued in the oil palm-adopting villages due to the variation they provide in the diet that would otherwise be monotonous.

Existing literature tends to discuss the diversity of foods within food systems in terms of food-system resilience (e.g. Hertel et al., 2021) or in terms of its links to dietary diversity (e.g. Jones, 2017a). However, has been much less consideration of the importance of it in terms of food choice and food variety. I would extend the value of diversity beyond food types, to include also food sources, which interact with activity spaces to influence accessibility and convenience.

Aggregate Effects of Agrarian Change: Food Sheds and Hyper-Local Trade

Much of the existing literature on agricultural transitions is focused on the farm level and explores the impacts of farmers of switching between crops or agricultural systems. Much less attention has been paid to the collective impact when entire communities undergo a transition simultaneously (Ickowitz et al., 2019). Over recent decades, increasing focus on dietary sustainability and food system resilience has led to a resurgence of interest in "foodsheds" as a "tool for understanding the flow of food in the food system and as a framework for envisioning alternative food systems" (Peters et al., 2009b). Several authors have posited a trade-off between agricultural intensification and production diversity at different levels (Broegaard et al., 2017; Ickowitz et al., 2019). On the one hand, agricultural intensification may increase income, providing access to market foods. On the other hand, the aggregate effect of widespread intensification may reduce the diversity of foods within the local food system as fewer foods enter the "foodshed". This may particularly be true for perishable foods, which are often the most nutritious, as transporting them over large distances requires a greater degree of market infrastructure (e.g. continuous cold storage).

This research provides a clear example of such effects – the disappearance of the hyper-local food system consisting of intra-village and inter-village peer-to-peer trade is a direct consequence of the aggregate loss of a production surplus as households re-orientate labour away from agricultural production and

[6] Their study results were published several years after I had already returned from fieldwork. See also Heim and Pyhälä (2020).

[7] Most respondents used the word "*bosan*", meaning bored, fed-up, tried.

wild foods. If only one or two farmers in a community were to switch from traditional swidden to oil palm-orientated livelihoods, they would still be able to access a large, diverse informal market network of locally produced foods – many of which are cheaper than their market equivalents from outside the locality. However, because such transitions occur *en masse* at the community and landscape level, access to these local foods become restricted.

Infrastructure, Market Access and Mobile Vendors

Prior to conducting this research, I had assumed that oil palm would bring with it greater access to markets. I believed this would be partially driven by greater demand (through increased incomes and decreased local supply) and partially due to infrastructure development which accompanies oil palm development (through lowering transaction costs). The former appears to be true – oil palm development leads to a greater range and better access to market foods in response to increased demand caused by higher incomes and lower availability of locally produced foods. However, the latter does not appear to be true. There is little evidence that infrastructure development in the OP villages has significantly improved market access and lowered transaction costs for sellers. The reasons for this are two-fold. Firstly, oil palm company-built roads are not necessarily superior to the pre-existing roads – especially when accounting for the vastly higher traffic of heavy vehicles, which degrade them. Many oil palm-adopting villages were as difficult, if not more difficult, to reach during periods of heavy rains than non-oil palm-adopting villages. Secondly, mobile vendors operating on motorcycles appear largely undeterred by poor road quality and thus access to market food goods even in the most difficult-to-reach villages.

Mobile Vendors and Supply and Demand Dynamics

Hitherto, food environments research has been markedly ‘static’ and is often premised on uni-directional pathways whereby consumers are “exposed” to food environments, which in turn affect their consumption through constraints and influences on food choice. This thesis argues for a more dynamic understanding of food environments and food systems, that moves beyond the view of food environments as an exposure or determinant of dietary intake. This requires acknowledgement that supply and demand dynamics mean that food environments may often partially reflect aggregate demand.

The role that mobile vendors play in both sets of villages is a clear demonstration of these supply and demand dynamics in action. Unlike static food retailers, they can respond to temporal (seasonal, weekly, and even daily) fluctuations in supply and demand. Able to travel on roads considered impassable to other vehicles, and with dramatically smaller transaction costs than other retailers, mobile vendors were able to serve even the most remote and difficult-to-access villages. Furthermore, they were able to provide a source of healthy perishable foods largely absent from other market food sources that sold predominantly non-perishable foods (due to infrequent restocking). While mobile vendors visited less frequently and provide smaller range of foods in the non-oil palm adopting villages, there is little evidence that there is any unmet demand. In fact, it is likely that mobile vendor visitation is proportional to the demand for their foods. There is evidence that mobile vendors are highly responsive to changes in demand. Mobile vendors were seen to prioritise those villages with the most demand and income, optimising the foods they sold, and the villages they sold them in accordingly. This is evident both from the existence of pay-day markets and the routes mobile vendors took, which were said to ensure they arrived at high-demand villages at the optimal time when most customers would be around.

This role that mobile vendors play in meeting demand when transaction costs are prohibitive for larger, static-vendors and retailers has been overlooked in food systems analysis which often recommend ways of “lowering transaction costs” as a way of enabling better access to markets (Brouwer et al., 2020).

One reason for this may be because mobile vendors are likely to be typically excluded from all existing market survey methods (see 8.2). I have neither the data nor experience to estimate the extent globally of rural markets catered for by mobile vendors. In my experience of Kalimantan, however, that there are likely to few villages which are accessible by road where there is not at least occasional visitation by such vendors[8]. Investigating the scale of this phenomenon regionally and globally is worth avenue of potential research (see 11.6). If as widespread in other regions as it is in Kalimantan and other parts of Indonesia, future food system frameworks should be updated to recognise the importance of mobile vendors in responding to changes in supply and demand dynamics.

Food Environment and Food System Transitions

While theories of nutrition transitions have been long-established, less attention has paid to food system and environment transitions. The predominant conceptualisation of food environments in such contexts is the Downs et al. (2020) typology for food environment transitions. The typology identifies four types of food environments: wild; cultivated; informal built, and formal built, with new food environments blending and ultimately replacing previous food environments at each successive stage of the transition[9]. However, while the Downs framework describes generalised high-level, the reality of local food systems and food environments in rural LMIC contexts are often more complex and do not necessarily translate easily into such categories. One criticism made of the framework has been that it has "largely omitted non-agrarian settings" (Nordhagen et al., 2022) and fails to recognise the complex blending of food environments in many rural contexts. This may be especially true in contexts where partial subsistence is combined with (relative to agriculture) high-income generating activities such as mining, commercial forestry or plantation labour on export-orientated agribusiness estates (e.g. oil palm, rubber etc.).

Neither the oil palm and non-oil palm adopting villages can be easily characterised with existing frameworks as they fail to acknowledge the extent and importance of wild foods and hyper-local production in the market food systems as well as the extent to which even the remotest villages are integrated into market food systems. Indeed, there has been a historical tendency to consistently under-estimate the degree of market integration of forest dwellers generally, including in Borneo where a large ethnographic literature shows apparently isolated, and self-sufficient communities have in fact, been active in local and global markets for centuries (Sellato, 1994; Lumenta, 2010; Dove, 2011a).

Temporal Cycles of Availability and Affordability: The Effect of Pay-Day Cycles

This research highlights the significant role that pay-day cycles play in determining local food availability and affordability. While there has been some study of temporal effects of pay-cycles in HICs (e.g. Wilde and Ranney, 2000; Widener and Shannon, 2014), it has received little attention in food systems research in LMICs. This is especially true in rural contexts, where the impacts of wage-labour are often overlooked (Nordhagen et al., 2022). This study shows that pay-day cycles substantially affect both affordability and availability of foods in the OP villages. One of the most commonly cited factors in food choice decisions

[8]Personal Observation: Indeed, there are probably very few, if any, villages remaining in Kalimantan which do not have some access to market-source foods – facilitated in part by mobile vendors as discussed above. The author has, over the past decade and a half, visited countless villages across Kalimantan, especially in two of the most forested districts – Kapuas Hulu, West Kalimantan and Murung Raya, Central Kalimantan. In the author's opinion, most of the FOR villages in this study could be considered relatively accessible compared with other swidden-centric communities, but some were comparatively remote and could be considered as difficult to access as any other forest-based village accessible by road. The most remote villages in Kalimantan are still only accessible by boat, but in the author's experience, these villages also have surprisingly high levels of market access and their food environments.

[9]The typology of transition is based on Popkin's 2002 five stages of nutrition transition. The food environment transition begins with those found in hunter-gatherer societies (Pattern 1) through to "developed urban societies"(pattern 5) – adding a sixth stage representing a "societies with concerns for sustainable diets and planetary health".

among women in households engaged in oil palm labour was whether there had recently been a pay-day. Respondents frequently reported purchasing pricier food products such as meat, fish, tempeh or tofu after pay-days, but relying on (often wild) vegetables in the days before. Responding to these fluctuations in demand, market availability of foods similarly fluctuated. Mobile vendors reported deliberately targeting communities who had recently been paid, even forming informal pay-day markets at the locations workers obtained their salaries.

The extent to which pay-cycles affected the availability and affordability of foods is such that any cross-sectional survey of food markets, food systems or purchasing and food choice behaviour would be greatly influenced by the stage of the cycle when the survey was taken. Not accounting for this temporal fluctuation could potentially result in systematic bias and error in food systems methods[10]. To my knowledge, this potential source of bias has not been explicitly addressed in the food systems literature. However, anecdotal evidence suggests that other researchers have observed similar effects in other locations[11].

11.7 Conclusion

Oil palm transitions have traditionally been studied through the lens of agricultural change – focusing on oil palm adoption as crop addition or substitution. This study demonstrates that such framing is inadequate. Engagement with oil palm should instead be viewed as an entire livelihood transition – particularly in the context of smallholder plasma schemes, where off-farm labour (typically on commercial oil palm plantations) has greater livelihood significance than the smallholder plasma itself. The latter also underscores the importance of considering context and model type, cautioning against the over-generalisation of findings from specific contexts and models to oil palm engagement more broadly. This study also demonstrates the importance of considering transitions as dynamic socio-ecological systems – including complex supply and demand dynamics and emergent effects resulting from the aggregate impact of widespread individual livelihood changes.

While there are differences in the food environments between the oil palm and non-oil palm villages, these differences alone are insufficient to explain changes in food choice. Rather, food choice behaviour emerges from the bidirectional interaction between the food environment and broader livelihood strategies. Livelihood transitions result in a changing suite of household priorities and tradeoffs, as well as altering individuals' physical proximity and access to different food environments. A critical trade-off identified in this study is the degree to which households prioritise off-farm income generation over food production. The degree to which households prioritise one over the other reflects both the household and intra-household opportunity costs of labour and time. The study also demonstrates how food availability and food choice are influenced by system dynamics. As more and more individual households specialise in oil palm, less surplus agricultural and wild foods enters the local food system – which reshapes local food supply and demand dynamics. The resulting food environments thus simultaneously reflect individual changes in livelihoods and priorities, the emergent effects of these changes on food systems, and the market response to these changes.

This thesis highlights the inadequacy of existing approaches to measuring the effects of livelihood and agrarian change on diets in biodiverse rural contexts. Both econometric approaches (focused on income and crop production) and food system/food environment frameworks (which emphasise food availability and affordability, and to a lesser extent convenience and desirability) fail to sufficiently capture the

[10] While, in large randomised samples, any potential source of bias may be minimised, it is not uncommon for small teams of researchers to move locations over time – perhaps resulting in surveying one population before payday and another after

[11] Discussions with other food systems researchers individually and in discussion groups (FERN, 2020; Laar et al., 2022) who have found similar effects in South Africa. Preliminary results from own research also identified similar effects in Central Kalimantan and Lombok

complex dynamics which drive food choice behaviour. Understanding such dynamics is essential for both explaining and predicting the impact of rural transitions on diets. Crude indicators such as crop diversity or income/market access are insufficient to explain changes in diets. Likewise, measures of the physical food environment – while more comprehensive – inadequately capture how changes in household priorities, trade-offs, decision-making, and activity spaces interact with these food environments to shape patterns of food acquisition and consumption. This study also illustrates some of the complexity of supply and demand relationships often absent in analyses of food environments. While market availability of foods, in terms of items available and food prices, was not substantially different between sets of villages in West Kalimantan, the frequency and quantities of market source foods did differ. Market actors, particularly mobile vendors, clearly respond to demand for purchased foods driven by increased income and time scarcity. While there was a degree of variation between sets of villages, based among other factors on road quality and distance/time, pay frequencies and schedules, mobile vendors visited more often in the oil palm villages relative to the forest sites. The foods provided by these vendors clearly responded to consumer demand, focusing on foods not available through local production at the village level.

To understand the impacts of landscape transitions on local diets in rural LMICs, a more sophisticated food environment and food systems transition framework is needed. New iterations of food environment transition frameworks should recognise: (a) that not all rural contexts are wholly agrarian and that many agrarian livelihoods are combined with cash-based livelihoods; (b) the centrality of hyper-local trade of both wild and agricultural foods in local market food systems; and (c) complex supply and demand dynamics which emerge from aggregate effects of changes in local production as well as the ability and willingness to pay for market foods, as well as the critical role of mobile vendors in facilitating market responses.

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Appendices

Appendix A:
Notes and Supplementary Information

A.1 Collaboration with CIFOR

Discussed in Chapter 5, Section 5.3

While the work presented in this thesis is entirely my own, my project was a collaboration with Center for International Forestry Research (CIFOR) as part of their Drivers of Food Choice (DFC) Project funded by the Drivers of Food Choice Competitive Grants Program[1]. Details of this collaboration are outlined in the Statement on Originality.

The DFC project consisted of three field seasons plus a market-survey module collected bi-monthly. In each of the field seasons, the research was composed of a survey instrument plus Focus Group Discussions (FGDs). The core component of the study consists of a modified multiple-pass 24-hour recall dietary intake survey – the gold-standard of dietary intake research methods (Karvetti and Knuts, 1985; Johnson et al., 1996). Primary respondents are mothers with children between 12 months and five years of age, and the recall is taken for both mother and child.

The 24-hour recall was been modified in two crucial ways. First, the source of each food is added, allowing quantification of different foods from different origins. This includes multiple different types of forest and natural environments (identified through FGDs) as well as various types of retail, market and vendor outlets. The second modification is the first 'quick' pass section. Usually, in a 24-hour recall, the quick pass is designed to go though the respondents day in an informal manner, prompting them of the major events and the location and type of meal consumed as well as identified snacks. In the modified version this "quick pass" was changed into a rough time-use recall. In addition to the dietary recall survey the, main survey instrument consists a wide range of socio-economic variables, general questions about health and child feeding practices as well as preliminary 7-day recall questions about patterns of behaviour relevant for food environments research.

The survey was administered seasonally to capture pre-and post-harvest variation. The 24-hour recall, the food environments data (and any other variables that may change seasonally) were on both the pre- and post-harvest questionnaire. However, other questions change from the first season to the second including questions of farming, oil palm growing, planting, labour and other agricultural practices.

In addition to the two field seasons, local research assistants were hired to collect bi-monthly data on food availability and prices at sub-district-level food markets. I was not involved in the design of this survey but provided some logistical support and advice as I was in the field at that time. The data consists of vendor and market surveys and is a comprehensive checklist of food availability and prices and is discussed in Chapter 8

A.2 A Note on Ethnic and Indigenous Groups

Discussed in Section 104

There is a distinct difference between tribal and indigenous people. Indigenous refers to the origin of ethnic groups who are a minority but whose presence in the region predates the current ethnic majority. Tribal, on the other hand, refers to a "distinct people, dependent on their land for their livelihood, largely self-sufficient, and not integrated into the national society" (Survival International, 2023).

In Indonesia, these terms are further complicated, as most ethnic groups are indigenous in some way and few are dominant numerically (though some are politically). For the purpose of this research, all Dayak sub-ethnicities are counted as Indigenous – as self-identified by Indonesian indigenous rights organisations. These organisations, mobilise the term mainly in opposition to the central government (viewed as overwhelmingly Javanese) but also against provincial and regional arms of the state (who often also consist of indigenous ethnicities). As such, the term takes on a more political meaning contesting the dominance of the nation-state over local customary laws, land tenure and traditions. Dayak translates as "tribe", and is European colonial term for all non-Malay inhabitants of the island of Borneo. However, linguistic analysis and oral histories suggest a strong historical

[1] From Growing Food to Growing Cash: Understanding the Drivers of Food Choice in the context of Rapid Agrarian Change in Indonesia See Details

interconnection and union between sub-ethnicities and today most Dayak groups proudly use and politically unionise around the term Dayak.

Appendix B: Supplementary Information for Chapter 2

B.1 Historical Development of Oil Palm In Indonesia

Large-scale commercial oil palm was established in the 1970s, but the origins of the plantation system originate from colonial times. Oil palm was introduced to the Dutch East Indies in 1848, though commercial planting was not established until 1911. However, the legacy of colonialism on modern day oil palm lies in the legal system of land tenure and the relationship between the state and private commercial actors. For hundreds of years, Dutch colonialism had been mainly focused on the spice trade, combined with taxation of (mainly Javanese) peasant agriculture. By the 1830s, the Dutch state, struggling financially from the Napoleonic Wars (and financing conflicts in Indonesia), introduced a plantation system designed for export crops (Drakeley, 2005).

The increasing involvement of the private sector led to the 1870 Agrarian Law, which paved the way for tobacco and other cash crop plantations in Sumatra and Java, which remains the legal precursor of the system present today. The law established the right of the colonial authorities to lease land to planters for a fixed period of up to 75 years in return for taxation. At the same time, it granted ownership of all non-documented land to the state control, heedless of the existing sophisticated customary land tenure arrangements (Colchester et al., 2006). The same system has existed in post-independence Indonesia up to the present – though recent developments may change this (discussed below). Since the 1945 constitution, the state has claimed all forest land not otherwise legally owned, oblivious of customary land tenure, and grants fixed-length licenses of 30-35 years (in return for tariffs) for exploitation or conversion to other land uses (Wakker et al., 2004; Marti, 2008).

Commercial oil palm production began in Indonesia (almost exclusively in Sumatra) before the First World War, via Belgium nationals exporting the crop the DRC. Milling technology was established by the 1920s along with commercial trade with Europe for oil palm production for food products such as margarine. By the outbreak of World War II, Sumatran palm oil exports accounted for 26% of world exports – the remainder mainly from African states such as Nigeria (Byerlee et al., 2017). However, WWII and the post-war independence struggle wiped out much of the established industry, and the industry languished while Malaysia rapidly became the largest producer. Though oil palm and the system of land tenure has colonial origins, the industrial scale industry seen today has its origins in Suharto's New Order government. Suharto, supported by the World Bank and the Asian Development Bank, encouraged the development of oil palm on state land in outer islands acquired after independence, but on which Indonesia's first president Soehkarno's "Java Centric" had ignored in favour of a focus on food security through rice production (Casson, 2005) Initially, development was conducted by state-owned companies on existing agricultural land, which by the mid-1980s controlled 70% of available land. As well as direct state involvement in the oil palm sector, Indonesia enacted several taxation policies, mainly aimed at ensuring self-sufficiency in vegetable oils, such as variable export levies, substantial tax breaks, quotas, minimum pricing and period export bans (Fane and Warr, 2008).

Transmigration

Suharto championed the oil palm sector not only as a way of both driving agricultural economic growth but also as a solution to perceived social and demographic problems. With overpopulation in certain islands (especially Java, Bali and Madura) and underpopulated in the densely forested regions of Sumatra, Kalimantan and Papua – the inhabitants of whom the Java-centric Suharto viewed as backward savages in need of civilisation – palm oil offered an opportunity for resettlement programmes. The history of oil palm in Indonesia is inseparable from the policy of transmigration, the policy of resettlement championed by Soeharto and funded by the World Bank to the tune of US$ 560 million (Fearnside, 1997) Under the policy, poor populations from overpopulated areas were offered incentives in the form free housing and land along with technical support to establish smallholder plantations. Initially, state-owned oil palm companies operating core plantations and mills provided support and backing for smallholders, though from the late 1980s, responsibilities were transferred to private companies.

The policy of transmigration no doubt accelerated the expansion of oil palm but also led to significant social and ethnic tensions as well as widespread deforestation. Local people, especially in Papua, but also in Kalimantan, have viewed transmigration as an effort by the state to force integration into a greater Indonesian (and Javanese dominated) state and neutralise local movements for independence (Elmslie, 2002; King, 2004). Transmigration has driven tensions behind several ethnic conflicts, including several outbreaks of ethnic violence[1] between

[1] It is difficult to summarise these conflicts in one or two lines. Different authors have described them as ethnic "violence", "incidents", "riots'", and "ethnic cleansing". The conflicts led to thousands of Madurese dead and hundreds of thousands

Madurese immigrants and Dayaks in West and Central Kalimantan during the years 1996/1997, 1999 and 2001 (Dove, 2006). Transmigration has also led to competition over forest resources, partially due to lower than expected production of many transmigrant projects (O'Connor, 2004).

The legacy of transmigration policies can be felt, not only regarding the expansion of the oil palm industry and periodic ethnic tensions and violence but also in the forms that oil palm is produced. The Nucleus Estate and Smallholder (NES) emerged out of the need to link inexperienced smallholders to company or state plantations and mills, thereby providing support, training, financing, agricultural, etc., in return for direct sales to the company. The development of such schemes fundamentally changed the nature of oil palm in Indonesia from one dominated by large state or corporate entities to one with increasing dominance by smallholders. Today, all new concessions granted must have some form of smallholder scheme incorporated into the proposals.

B.2 Contemporary Oil Palm in Indonesia

Table B.1: Oil Palm Production by Region in Indonesia.

Calculated using data from (BPS, 2021)

Region	**Area (%)**	**CPO (%)**
Sumatra	55.0	56.8
Kalimantan	40.3	40.3
Sulawesi	2.9	1.9
Papua	1.6	1.1
Java	0.2	0.1
Maluku	0.1	0.0

B.3 Changing Nature of Oil Palm Opposition

Demand for palm oil is not going away. Nor is the willingness of countries like Indonesia to supply it. Oil palm is an important driver of economic growth, contributing around 3% of GDP nationally and 12-14% in some rural regions. In 2016, Indonesia produced 32 million tonnes of crude palm oil (CPO), of which 27 million tonnes were exported, bringing 18.6 billion dollars of foreign exchange into the country (Indonesia Investments 2017). The Indonesian government has established targets to increase the production and export of crude palm oil by 50 million tonnes by 2020; in response district governments have released a predicted 20 million ha concessions, mostly from forest estate (Anderson et al., 2015). Indonesia has also invested heavily in improving its upstream processing, including refining (which doubled over a 2-year period 2012-2014) as well increasing the percentage blend of biofuels in diesel from 7.5% to 10% and aiming for a one-fifth blend in power plants.

The fact that the Indonesian palm oil industry will continue to grow has become more widely accepted – even amongst civil society groups staunchly opposed to it. Even previously virulent campaigners against palm oil now lobby for 'best practice' rather than opposing oil palm completely (Rival and Levang, 2014). Some strident environmental NGOs now even collaborate with companies they previously campaigned against to improve management practices, ensure compliance with sustainability criteria and increase supply chain transparency (Greenpeace International 2014). At the same time, development organisations – who from the 1970s and 1980s explicitly supported oil palm development before nervously distancing themselves in the face of international pressure – have renewed interest in leveraging oil palm for poverty reduction economic growth (albeit with additional commitments to 'sustainability') (World Bank, 2011) The recognition that palm oil may be more complex than the binary narratives often presented has led to renewed interest in 'landscape approaches' to managing oil palm. In the same way, the promise of palm oil as a poverty reduction strategy has led to a strong rise in the emphasis on smallholder production. The success of the smallholder narrative is due to three main factors: smallholders are intrinsically harder for NGOs to argue against than companies; the model is in keeping with the neoliberal ideology of international development organizations; and supporting small-scale farmers popular, nationalist position for Indonesia's politicians (especially when framed as resisting the neoliberal and neocolonial interference of the RSPO and iNGOs).

displaced. For further reading, see De Jonge and Nooteboom (2006), Smith and Bouvier (2006) and Dove (2006).

B.4 Voluntary Sustainability Standards

It is unlikely that schemes such as the oil palm sustainability standards such as the Roundtable For Sustainable Palm Oil (RSPO) have any effect at a landscape level. While RSPO certification lowered deforestation by around one-third compared with counterfactuals, this is likely due to the fact that most certified plantations contain little to know forests to begin with. Carlson et al. (2018) estimate that by the year 2015, areas falling under RSPO certification contained less than 1% forests. Likewise, there appears to be little to no effect on reducing forest fires (Cattau et al., 2016; Carlson et al., 2018)

B.5 Pathways to Becoming an Independent Smallholder

Table B.2: Pathways to becoming an independent oil palm smallholder

Source: Author based on IFC (2013); Hidayat et al. (2015); Daemeter (2015); Potter (2016b); Daemeter (2016); Zen and Nibulan (2018); Schoneveld et al. (2019a)

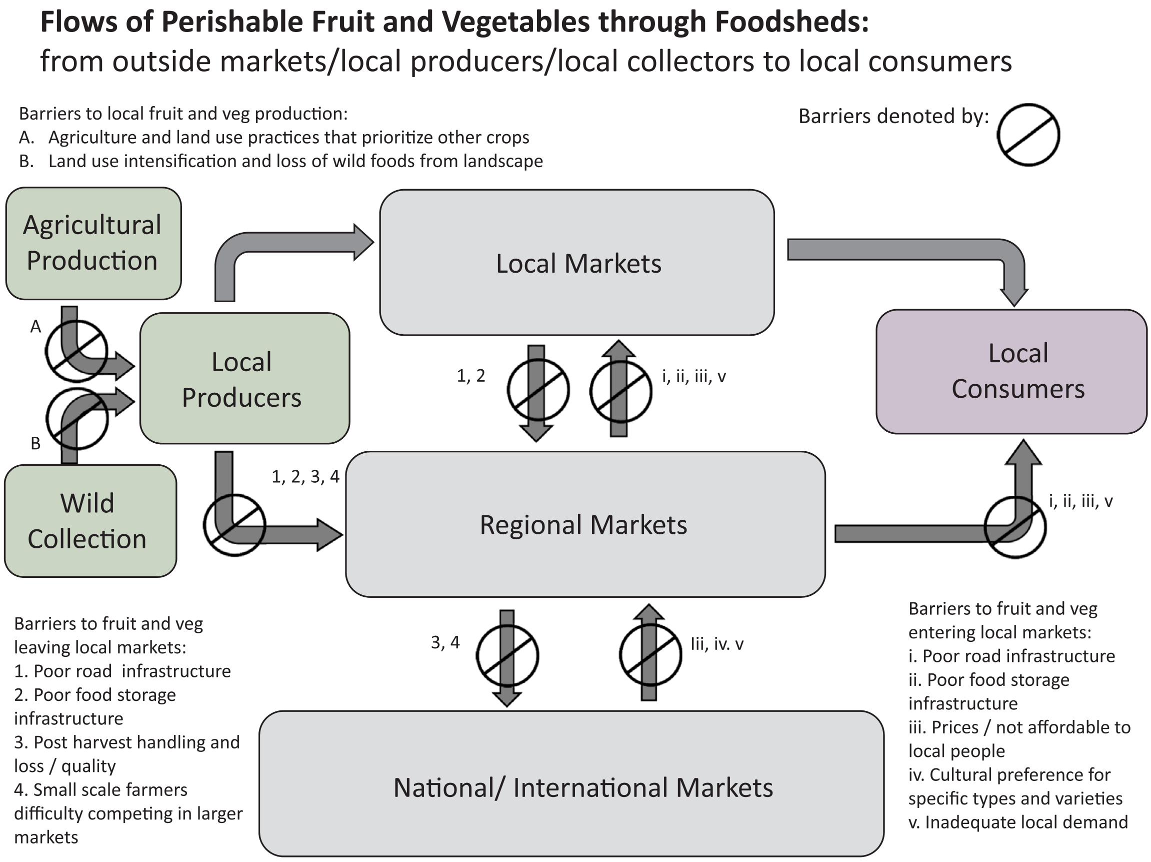
Pathway	Description	Opportunities	Barriers	Occurrence
1. Graduation from Scheme	A former smallholder scheme participant becomes independent after the scheme ends.	Knowledge and experience accumulated. Access to seeds, chemical inputs. Access to local oil palm infrastructure (e.g., mills).	Legal tenure of smallholder plots may be absent or ambiguous. Difficulty accessing finance for replanting. Mills to sell FFBs to may be limited, reducing bargaining power.	Possible under older versions of NES Schemes, much less common in more recent, less generous smallholder schemes. Found in parts of Indonesia where NES schemes have existed the longest (e.g., Sumatra).
2. Supplement to Plasma	A current smallholder scheme participant grows small areas of additional independent oil palm.	Knowledge and experience accumulated. Access to seeds, chemical inputs.	Scarcity of suitable land. Difficulties accessing finance. May be required to sell to the company, agent, or tied mill.	Plot sites tend to be small and insufficient to support the family alone. Likely to only occur for successful wealthy farmers. May be cheaper to purchase plasma plots from other farmers (i.e., pathway 4).
3. Expansion/Substitution	A farmer with little to no experience of oil palm plants oil palm as an alternative to crops such as rubber.	Oil palm as a crop offers higher returns on land and labour than many competing crops such as rubber.	Requires legally titled land to access capital. Requires sufficient wealth to wait between planting and harvest.	Occurs in areas with long histories of oil palm development where oil palm infrastructure is good and farmers can benefit from spill-over effects. Farmers tend to be successful commercialized cash-crop farmers as subsistence farmers are likely to lack capital.
4. Accumulation	Wealthy and successful oil palm farmers purchase plasma land or partnership rights from poorer or less successful smallholders who are unable to endure the period between planting and harvest.	Purchasing the rights to plasma plots may be possible at a discount due to poorer farmers needing to sell as unable to support the household with plasma revenue. May benefit from economies of scale.	Significant existing wealth or legally titled land as collateral for financing.	A common outcome due to insufficient plasma revenue forcing smaller, poorer farmers to sell land. Most likely to occur during the first few years of smallholder scheme. Under out-grower schemes, farmers purchase the land title. Under partnership schemes, farmers purchase the rights to plasma revenues.
5. Outside Investment	Wealthy outside investors purchase plasma plots or partnership rights from poorer or less successful smallholders who are unable to endure the period between planting and harvesting.	Possible to purchase at a discount due to poorer farmers needing to sell as unable to support the household. Plentiful supply of cheap labor due to the new class of landless laborer from those farmers who sold land.	Requires both social/political connections with communities and access to significant up-front capital.	Existing surveys of smallholders suggest this model comprises a significant proportion of so-called "independent smallholders." Can occur during the early years of smallholder schemes or long after.

Appendix C: Supplementary Information for Chapter 3

C.1 Food Sheds and Flows of Perishable Foods

Figure C-1: Flows of Perishable Foods Through Foodsheds

Source: Ickowitz et al. (2019)



Appendix D: Supplementary Information for Chapter 4

D.1 Recommendations from Recent Reports into Food Systems

Future Food Systems: For people, our planet and prosperity (Global Panel, 2020)
Key Interventions in Food Systems:

1. Make sufficient nutrient-rich and staple foods available to all, produced sustainably
2. Ensure foods move along value chains more efficiently, improving accessibility and resulting in lower cost and less loss
3. Ensure sustainable, healthy diets are affordable to all, with lower demand for ultra-processed products
4. Empower consumers to make more informed food choices, fueling rising demand for sustainable, healthy diets

2020 Global Nutrition Report (Mannar et al., 2020)
Four Challenges facing current food systems:

1. Existing agriculture does not produce sufficiently diverse crops
2. Fresh food is often less affordable and accessible
3. Many processed foods do not meet international health standards
4. Ultra-processed foods are cheap and marketed to low income groups

Food Security and Nutrition: Building A Global Narrative Towards 2030 (HLPE, 2020)
Four Policy Shifts Required:

1. A transformation of the food system beyond a productionist paradigm to focus on food-quality and quality of life
2. Increased focus on the complexity of food systems and the linkages between food systems and other complex systems (including economic, environmental and health systems)
3. Increased focus on micronutrient deficiency and diet-related non-communicable diseases
4. A move away from global 'one-size-fits-all' solutions towards a set of diverse, context-specific solutions

Food in the Anthropocene: the EAT-Lancet Commission on healthy diets from sustainable food systems (Willett et al., 2019) Five strategies towards a healthier more sustainable food system:

1. Global Dietary shift towards a healthier, low impact 'planetary health' diet
2. Re-orient agricultural priorities towards healthy foods
3. Sustainable intensification to include both reduced use of chemical inputs but also carbon mitigation
4. Coordinated governance of land and oceans
5. Halve Food Loss/Waste

D.2 Definitions of Food Environments

Swinburn et al. (2013):

> "The collective physical, economic, policy and socio-cultural surroundings, opportunities and conditions that influence people's food and beverage choices and nutritional status"

HLPE (2017):

> "the physical, economic, political and socio-cultural context in which consumers engage with the food system to acquire, prepare and consume food"

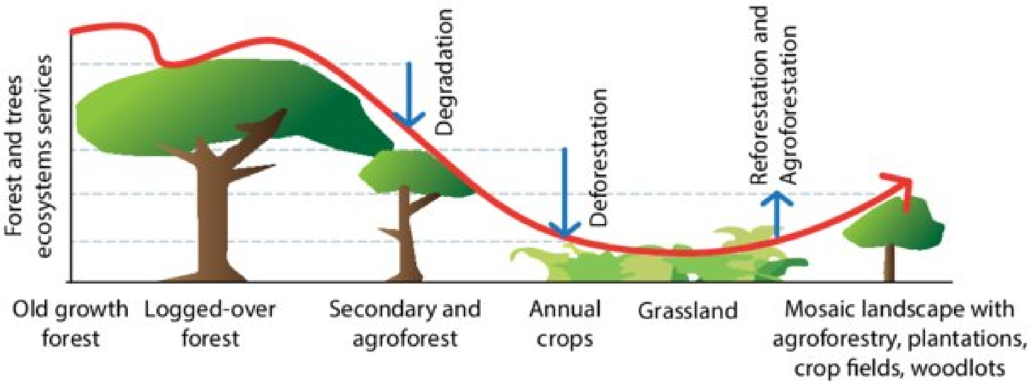
Turner et al. (2017):

> "the interface that mediates one's food acquisition and consumption within the wider food system. It encompasses multiple dimensions such as the availability, accessibility, affordability, desirability, convenience, marketing, and properties of food sources and products"

Grace (2016)

“All the foods which are available and accessible to people in the settings in which they go about their daily lives. That is, the range of foods in supermarkets, small retail outlets, wet markets, street food stalls, coffee shops, tea houses, school canteens, restaurants and all the other venues where people procure and eat food. Food environments differ enormously depending on context... they determine what foods consumers can access at a given time, at what price and with what degree of convenience, food environments both constrain and prompt food choices.”

Figure D-1: Forest Transition Curve. Source: Gitz et al. (2020), adapted from Hlpe (2017)



D.3 Forest Transition Curves and Landscape Change

Socio-ecological transitions occurring in forested areas are often situated within the context of a forest transition curve. Such curves are conceptually similar to Environmental Kuznets Curves (EKC) which state that an inverted U-shaped relationship exists between per-capita income and measures of environmental degradation, with rapid environmental pressures during early development but net gains in environmental quality at higher levels of development. The empirical evidence for the existence EKC is highly contested and is beyond the scope of this research (Dinda, 2004; Stern, 2004). Forest transition curves state that deforestation accelerates with rapid growth at the beginning of a country's economic development, and reforestation occurs on degraded land at higher levels of economic growth (Keenan et al., 2015) and are better supported by the empirical evidence than EKC (Meyfroidt and Lambin, 2011), although perhaps not in Asia (Culas, 2012). Though many countries have been shown to experience similar forest transition curves, the reasons behind the curve are varied. Deforestation at the early stages of the curve is typically driven by a combination of population growth, poverty and needs for agricultural commodities as well as timber and fibres. Afforestation can be caused by factors as varied as deliberate replanting (through state policy or public demand) or natural regeneration, abandonment of agriculture due to war or urbanisation and/or return to agroforestry practices (Rudel et al., 2005; Lambin et al., 2001; Lambin and Meyfroidt, 2010)

During the early stages of economic development in low-income countries, forest cover tends to decrease and is replaced with agricultural land uses. The landscape undergoes more than just a forest transition but an entire landscape transition. Figure D-1 is a schematic of how this landscape transition occurs in most low-income countries – including Indonesia. As the old-growth forest is lost to agricultural uses, the transition passes through a mixed land use phase consisting of fragments of old-growth forest, secondary forest and agricultural land (corresponding to a land-sharing configuration) before being replaced by agricultural land and secondary regrowth (which, if combined with protected areas corresponds to a land sparing configuration).

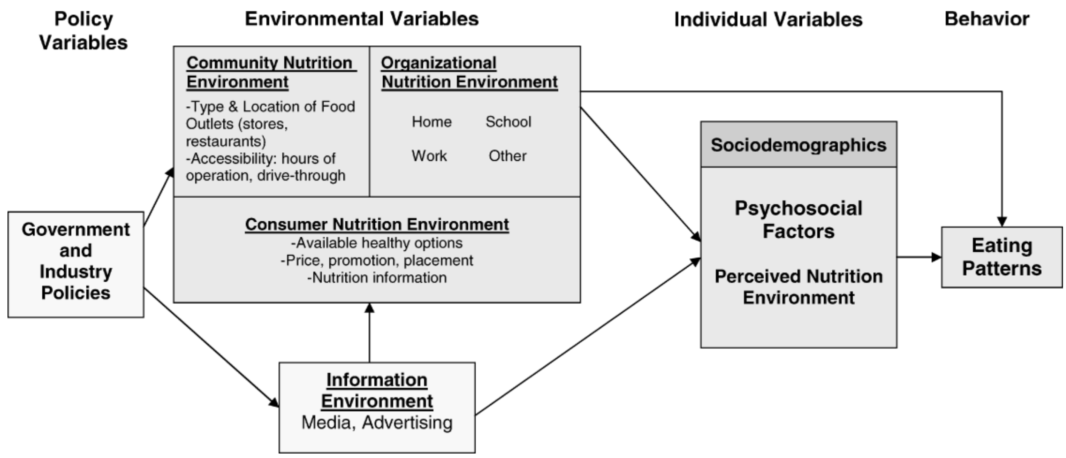
Forest transitions (or migration out of forest areas) may be economically desirable to some indigenous people, who are pragmatic about their current state of poverty and options to relieve themselves from it (Levang et al., 2005). While the idea that indigenous people have a "special connection" to the forest is fallacious, many forest dwellers do consider it essential to their well-being (Colchester, 2000). Landscape transitions are likely to favour the elites and marginalise the poor. Elites tend to be old and male. Studies from Central Kalimantan have shown significant generational differences in attitudes to commercial forest use with older people being more in favour of forest conversion than the young (who rely on forests for sources of income) (Hoeing et al., 2015a,b).

As a landscape transitions from forest to agriculture, the livelihoods of local people transition from forest-based livelihoods to agricultural livelihoods. The transition from forest-based livelihoods (swidden agriculture, hunting and gathering) towards commercialised agriculture is much more complicated than agricultural commercialization processes typically described in the literature. As a result, conceptual frameworks designed for smallholder commercialization processes are insufficient to explain changes in dietary intake. Dounias and Froment (2011) commenting on a similar transition describe diets and nutrition as "sensitive indicators of the ecological and social costs" of shifting livelihoods and integration into the modern market economy. These changes typically occur as a suite of simultaneous agricultural, livelihood, landscape, demographic and economic transitions (Deakin et al., 2016). A broader vision of the nature of these transitions is in keeping with the 'landscape approach' to multi-stakeholder, multi-objective land use planning. More broadly the need for "nutrition sensitive landscapes" is increasingly acknowledged (Powell et al., 2013). This requires a greater understanding of the intersection between diets and land use.

D.4 Early Socio-Ecological Models of Food Environments

One widely accepted social-ecological model of food environments is shown in figure D-2. The Glanz et al. (2005) model is divided into environmental (i.e. external) and individual (i.e. personal) food environments. Studies of the external food environment focus on how outside influences trigger food consumption behaviour via signals such as food availability and prices, food outlet type and density, volume/amount/type of advertising, and health messaging. As such, external food environment research is population-based, cross-sectional and correlative. Personal food environment research, however, focuses on the individual experiences of consumers and places more emphasis on the physiological determinants of food choice. They aim to understand the interaction between external stimuli and the lived experience of the individual and as such aim to establish tentative, causal explanations for food consumption behaviour. It aims to examine how "environmental conditions can override individual physical and psychological regulatory systems" (Brownell et al., 2010). The framework identifies four domains; the community food environment, which identifies neighbourhood characteristics including food availability and convenience; the organizational food environment, which focuses on prompts for food consumption within specific time-bound locations such as schools, workplaces, and hospitals; the consumer food environment, which focuses on the individual experience of the consumer, their perceptions and attitudes towards foods; and the informational food environment which identifies the combined influences of advertising, health information and promotion and received wisdom over what determines healthy choices (Glanz et al., 2005)

Figure D-2: Glanz et al. (2005) Framework for Community Nutrition Environments



D.5 Historical Development of Food Environments Research

(a) External Food Environments

External food environments exert their influence over food choice by constraining or encouraging the purchase and consumption of food. As such, they form a major part of the structural determinants of food choice (Antin and Hunt, 2012). They do so by either restricting choice or affecting the convenience and desirability of foods – usually through food markets, retailers and outlets, but also through advertising, health messaging and normative forces. External food environment studies tend to utilize primarily either GIS-based or market-based metrics for research. GIS research often examines the relationship between the distribution of markets, supermarkets, fast food outlets in an area and food consumption patterns. Market-based research tends to use surveys, retail audits, consumer baskets or price data to examine the relationship between availability and price of foods in a specific geographical area and food consumption patterns. This research, focused on the USA, has shown consumers to be highly responsive to both the price and availability of foods as well as how they are packaged and marketed (Glanz, 2009).

Central to external food environments research has been the concept of 'food deserts' – geographical areas where healthy foods are unavailable or unaffordable – particularly in deprived urban landscapes in the USA (Caspi et al., 2012). Empirical evidence shows that ethnic and economic inequalities are linked to obesity (Wang and Beydoun, 2007). Food deserts may be a causal explanation of these patterns. For instance, in North America, studies have shown that 'healthy' foods are less available and more expensive in lower Socio-Economic Status (SES) and black neighbourhoods. This is driven by the absence of supermarkets and the abundance of smaller independent shops, which charge higher prices for healthy foods and devote less shelf space to these items (Cummins and Macintyre, 2006). The explanatory power of these explanations is further strengthened by the fact that dose-response relationships exist, with increasing the number of supermarkets in an area leading to increased consumption of fruit and vegetables (Morland et al., 2002), and proximity to supermarkets highly correlated with fruit and vegetable consumption if low-income households (Rose and Richards, 2004).

The inverse of the food deserts approach, food swamps, focuses on the links between the abundant availability of unhealthy foods, in particular, energy-dense fast foods, and food consumption decisions. There is evidence that poorer, minority ethnic and deprived neighbourhoods have higher concentrations of fast-food outlets, yet only a few studies have attributed this directly to consumption decisions. One state-level analysis in the USA estimated that the density of fast food outlets might account for around 6% of the variance in obesity (Maddock, 2004).

Both food swamp and food desert studies are mostly correlational (Brug et al., 2006). There have been growing calls for intervention studies in order to establish causal relationships between food environments and nutrition outcomes (Robinson and Sirard, 2005; Brug et al., 2006, 2008). Studies of food environments in occupational settings, such as workplaces, schools and hospital cafeterias, offer the chance to conduct experimental studies based on interventions in the food environment. For example, in a nine-month longitudinal intervention in a cafeteria in Boston, the introduction of traffic-light-style food labelling in a hospital cafeteria in Boston increased the consumption of healthy foods and reduced the consumption of unhealthy foods (Levy et al., 2012). The same study also showed a positive effect of a 'choice architecture' intervention (physically rearranging foods to affect availability). However, while both interventions were successful against the baseline in all ethnic groups, they were insufficient to reduce disparities between ethnic groups.

Food consumption decisions are not being made in a vacuum. An information environment consisting of health messaging and advertising also influences food choice decisions. In the USA, the fast food industry spent $4.6 billion dollars on advertising in 2013 alone (Swinburn et al., 2013). Much of this is directed towards children, using company mascots and packaging proven to increase desire and perceived enjoyment of energy-rich foods (McGinnis and Ostrom, 2014). Spending on promoting safe and nutritious diets is negligible by comparison. While much of this spending results in ubiquitous advertising, concentrations of advertising and marketing to specific sub-populations can create unique information environments.

(b) Personal Food Environments

Measures of the external food environment may lack explanatory power because of the way these environments are perceived and interpreted by individuals varies greatly. For instance, the perception of food price has been shown to be a better predictor of food choice than objective price data (Giskes et al., 2007). Similar effects have been found for the perception of the availability of foods, healthiness of foods, and the physical environment (Brug et al., 2008). External measures of the food environment do not reflect the way that individuals interact with this environment and do not account for how people move through physical space, how much time and exposure they have to different stimuli and how they engage with these factors. To counter this, personal food environments focus on the individual experience. Personal food environment research is varied and includes a wide range of approaches and disciplines. Included are anthropological approaches to social and cultural food choice and preferences, GPS tracking of individuals, semi-structured focus groups and interviews, and physiological studies.

Qualitative studies on food choice can go beyond the deterministic constraints and add the personal experience and cultural meanings behind decisions (Antin and Hunt, 2012). Other approaches aim to track the movement of people through time and space, either through time-use methods (such as recall interviews or diaries) or personal GPS tracking. Recent advances in smartphone technology have opened new avenues in this area, allowing for the tracking of both geolocation and activity over time, helping to overcome the previous overemphasis in the literature on residential neighbourhoods (Chaix et al., 2011). These technologies have improved the measurement of exposure to food environments and the accuracy of time-use recall methods.

Despite the apparent ability of qualitative research to reveal otherwise motivations behind food consumption decisions, many of the exact mechanisms may be invisible even to the respondent. Psychological studies have revealed the 'hidden' motivations behind food consumption decisions. These studies suggest that respondents are not always consciously aware of their motivations. For instance, stress and anxiety have been shown to play a substantial role in predicting both health and nutritional outcomes, as demonstrated by a now classic longitudinal study of over 10,300 U.K. civil servants; respondents working in departments rumoured to be privatized (over a 5 year period) had significantly higher increases in body mass index (as well as a range of health marker and self-reported health outcomes) than civil servants in perceived secure jobs (Ferrie et al., 1998).

D.6 Historical Perspective on Agriculture-Nutrition Linkages

Agricultural Commercialisation and Diversification

(a) History of Agricultural Commercialisation and Nutrition

The debate on the impacts of agricultural commercialisation on Food Security and Nutrition (FSN) has proceeded through a number of stages, culminating most recently in new systems approaches which incorporate trade-offs and non-linearities between different pathways (see Section 4.4). Early studies focused primarily on measures of food security and calorie intake. An International Food Policy Research Institute (IFPRI) project to review and review empirical evidence in the 1990s concluded there tends to be a small but significant positive effect of agricultural commercialization on nutritional outcomes (von Braun and Kennedy, 1994). However, the overwhelming majority of studies focused solely on calorie intake – not nutritional quality.

Updating the available evidence since the IFPRI studies, Carletto et al. (2016) found similar small but significant positive effects on nutritional outcomes – explained partially due to the fact that some degree of agricultural commercialization existed in most places and that the majority of cash crops grown were, in fact, staple crops sold to markets. The impact of non-staple foods (e.g. oil palm) was less clear. A similar review of the literature by Wiggins et al. (2011) found little evidence of negative effects of commercialization on nutrition but also highlighted the false dichotomy in the literature between "commercial" and "subsistence" farms. The review also highlighted that some form of market integration is widespread, as is some form of subsistence farming among cash crop farmers– with few farms being either entirely subsistence of entirely commercialised.

(b) Impacts of Commercialisation on Diets and Nutrition

The benefits of agricultural commercialisation come primarily through income-related pathways. Higher incomes due to commercialised agriculture improve financial access to markets – resulting in an increased diversity of foods available to consumers. Additionally, smallholder commercialisation is associated with beneficial spill-over effects. For instance, cash cropping can provide access to credit, fertiliser, animal traction/mechanisation, support and training that can also be applied to food crops for own consumption. These spill-over effects may indeed be regional – extending beyond the individual commercialising farmers to other farmers in the region (Govereh and Jayne, 2003).

(c) Production Diversity and Agricultural Diversification

PD refers to the diversity of crops and livestock produced on a household farm. PD is measured either as a simple crop and livestock species count, or by using methods borrowed from biological sciences which produce indices of diversity taking into account both the total diversity, and the abundance of each (such as Simpson's Index).

Multiple studies have established a link between the degree of and more nutritious diets. Early evidence, relying on cross-sectional data showed households with more diverse production systems had both more diverse diets and higher consumption of healthy food groups such as fruits, vegetables and legumes (e.g. Jones et al., 2014). Subsequent studies, have confirmed these findings using panel data methods (e.g. Habtemariam et al., 2021).

Given the link between PD and Dietary Diversity (DD), it may be possible to improve the diets of smallholders through agricultural interventions ranging from establishing community gardens, livestock diversification programs, the promotion of vegetable production, and fruit-focused agroforestry interventions. Fanzo et al. (2013) and Powell et al. (2015) both review the literature finding consistently positive associations between agricultural interventions diversifying production and dietary diversity. As well as operating the self-production pathway, increasing production diversity in food systems may have effects at the national level Remans et al. (2014).

As with commercialisation, the impacts of diversification are modified through a wide range of contextual factors such as women's empowerment, market-integration and SES. The benefits of agricultural diversification are likely to be greatest in contexts where production diversity is initially low, where markets are imperfectly functioning (Ruel et al., 2018). The evidence is also hamstrung by a lack of consistency in approach to measuring and analysing production diversity. While diversification programs are often effective at improving diet quality – they do so while incurring opportunity cost of increased specialisation and commercialisation – the debate around which is discussed in the next section.

(d) Weighing Up Diversification Vs Commercialisation

Both commercialisation and diversification interventions may result in adverse impacts are the opportunity costs of implementing the wrong type of intervention. In the case of agricultural diversification programs, the opportunity cost is the income foregone that could have been obtained through commercialisation – which could have potentially be invested to improve or expand the farm or household economies. In the case of commercialisation programs, a reduction in PD may result in reduced food availability at the farm household level (if markets do not supply or households do not choose to purchase market substitute market foods.

While the current evidence suffers from methodological flaws and controversies. in many, if not most, contexts, it is likely more effective to encourage commercialisation than diversification to improve nutritional outcomes (Ruel et al., 2018; Sibhatu and Qaim, 2018a). One reason for this that, while there are consistent positive effects between PD and DD (Jones et al., 2014), the effect sizes may be small. In a meta-analysis of 45 original studies from 26 countries, Sibhatu and Qaim (2018b) found effect sizes ranged by region but that – average effect sizes[1] – were so low that households would have "produce 16 additional crop or livestock species to increase dietary diversity by one food group.". The same study also highlighted that in many studies demonstrating positive effects of diversification, the effect sizes of market pathways were often higher.

[1] Average effect sizes may be misleading as take into account studies where no effect or negative effects were found. Average effect sizes may disguise the fact that interventions may be highly effective in a minority of specific contexts. Additionally, the inclusion of studies with using different metrics may influence findings. Nevertheless, the evidence presented in Sibhatu and Qaim (2018b) paints a picture of generally low effect sizes of interventions which compare unfavourably with interventions which improve income and market-access.

Box AD.6(1): Neoclassical and Heterodox Perspectives on Agricultural Comercialisation

Wiggins et al. (2011) groups perspectives on agricultural commercialisation into three categories:

Persistence of Small Farms: Neo-liberal Perspective
The neoliberal perspective views market forces as generating inequality between farmers, but overall benefiting all types of farmers, reducing poverty and improving living standards. While market forces create differentiation between farmers, smallholders survive by adopting scale-neutral technologies and benefiting from spill-over effects of rural transformations precipitated by larger farms – such as access to supply chains, and growth in the processing, trade, and transport sectors as well as broader regional benefits such as rural economic growth of non-agricultural sectors stimulated by increased aggregate demand (Wiggins et al., 2011). While there is evidence that small farms have persisted far longer than anticipated (Samberg et al., 2016), common market failures often prevent smallholders from benefiting from such rural economic growth – most commonly insecure land tenure, high-transaction costs, and asymmetrical power relationships between producers and traders (Wiggins et al., 2011).

The Disappearance of Small Farms
A perspective shared by both Marxist agrarian scholars and more classical economists is the view that small farms may eventually disappear, to be replaced with large-scale commercial agribusiness. Different political and economic philosophies interpret this outcome in different ways. A classically Marxian variant of this perspective sees the replacement of large farms with smaller resulting in the reduced economic welfare of the now landless rural labourers. Other Marxian variants see smallholders as suffering from a "reproductive squeeze" (Bernstein, 1977, 2010) through falling prices driven by market competition, combined with increased costs driven by attempts to improve productivity (Wiggins et al., 2011). The end result is the displacement of peasant farmers, creating a landless proletariat who are then subsumed by an industrial revolution that requires a large cheap, exploitable labour force (Bernstein, 2010). An alternative view sees the inherent efficiency of large farms as desirable (Collier and Gunning, 1999; Collier and Dercon, 2014), seeing the changes in agriculture part of a broader "structural transformation" which results in overall economic growth and poverty reduction (Christiaensen and Martin, 2018).

Persistence of Small Farms: Chayanov Perspective
The second perspective argues that peasant farming cannot be viewed as a typical capitalist transition because peasant farming follows is own unique logic. This perspective based on work by Chayanov (e.g. Chayanov, 1966). This tradition argues that within the internal logic of peasant farm dynamics, those with capital tend to be older households who have had more time to accumulate wealth and assets. Peasants are unlikely to hire waged labour, both because labour is the main cost and would make farmers less resilient to shocks in prices. Others have developed this theory introducing other aspects of peasant culture, arguing that the economic transition but is mediated strongly through customs, social hierarchy and social relations (Berry, 1993).

(e) Broader Debates on Agricultural Commercialisation

Debates surrounding the benefits of agricultural commercialisation are inseparable from broader debates surrounding the effects agricultural commercialisation more generally in terms of the agricultural development and rural economic transitions. Much of the controversy originates from concerns beyond nutrition – and is rooted in different political and economic philosophies. Wiggins et al. (2011) argue that much of the controversy discussed above stems from fundamentally different theoretical, ideological and epistemological approaches in different traditions and disciplines. A summary of different historical perspectives can be found in Wiggins et al. (2011) who groups perspectives into three categories, summarised briefly in the box below. However, the controversy continues to affect the literature on the effects of agrarian change on FSN.

(f) Context Matters

It should be noted that the findings discussed above – that commercialisation in many contexts may be more effective at improving diets than diversification – applies to agricultural interventions in general. Specific interventions targeted towards specific food groups where such food groups are absent from local food systems are likely to be more effective. This appears to be particularly the case for interventions which improve access to dairy (Ruel et al., 2018). The finding is also likely premised on the fact that commercialisation often does not come at the cost of production diversity – with farmers often adding additional cash crops rather than replacing food crops (Wiggins et al., 2011). Thus, there may be different findings in cases where specialisation reduces production diversity of edible crops at the farm level or where production diversity is lowered in non-intervention settings.

The most effective approach is likely to depend on the specific context. A new systems science of agriculture-nutrition linkages is emerging, which has identified a number of important modifiers of effects – in particular market access, gender equity and women's empowerment, effects on women's time use and the context of local food environments. Broadly speaking, however, a consensus is emerging that smallholder commercialization is generally more beneficial for food security and nutrition in contexts with well-functioning markets and where PD is already high Ruel et al. (2018). However, where market integration and access is low, agricultural diversification may be more effective (Ruel et al., 2018).

(g) Beyond the Diversification-Commercialisation Dichotomy

The framing of agricultural commercialisation vs diversification is, in many ways, a false dichotomy. While the balance of evidence appears to show that increasing PD when PD is low has positive effects on DD, but that commercialisation may be more effective in contexts of initial high PD (Sibhatu et al., 2015a), it is also true that – outside of agricultural interventions – this is precisely what farmers appear to do. As Wiggins et al. (2011) point out, on the whole, it appears that most households appear to commercialise only when sufficient food is being produced for the household. Additionally, commercialisation does not always come at the cost of reduced PD – as often cash crops do are not grown in addition to, rather than as a replacement for other crops (Wiggins et al., 2011).

There may also be synergistic linkages between diversification and commercialisation. For example, the application of agricultural inputs on cash crops may produce spill-over effects via increased yields of crops produced for own consumption. Alternatively, both subsistence and cash crops may be improved through cross-application or through residual improvements in soil quality during crop rotation (Bassett, 1988; Minten et al., 2009; Dorward et al., 2004).

The field of agriculture-nutrition is increasingly moving beyond such dichotomies, instead adopting a systems approach, which acknowledges complexity and trade-offs in linkages between agriculture and nutrition as well as the ways in which contexts such as market access and integration, women's empowerment modify relationships between interventions and dietary outcomes. This new systems approach to agriculture-nutrition linkages is discussed in the next section.

D.7 Contribution of Wild Foods to Diets

Wild and semi-cultivated foods found within agricultural fields are often vegetables – most often DGLV. Wild forest foods typically consist of fruits, vegetables, nuts and seeds (collectively known as WEPs) as well as bushmeat and fish. Staple foods are rarely consumed as forest foods and, wild foods can be more nutrient-dense than agricultural equivalents. Wild edible plants are highly rich in iron, phosphorus, calcium and vitamin A, B, C and niacin (Guerrero 1998), while fish and bushmeat are dense in highly bio-available protein and minerals including iron, zinc and calcium (Fa et al., 2003; Bennett, 2016).

Global estimates of wild forest food consumption are difficult to determine. Global research efforts are unevenly distributed and typically do not link wild food acquisition behaviours to dietary intake (Rosenstock et al., 2023). The FAO estimates that around 76,138 tonnes of forest foods are consumed globally – around 95% of which could be classified as NTFPs-— equivalent to around 0.6% of global food supply (Fao, 2016). Bharucha and Pretty (2010) estimate from available studies that the average number of wild foods consumed ranged from between 90-100 per location in agricultural and foraging communities (in Asia and Africa) and averaged 120 for indigenous communities in high and low-income countries. Noting both the scale and the lack of accounting for wild foods in mainstream agricultural and economic research some authors have labelled the consumption of wild foods "the hidden harvest" (Grivetti and Ogle, 2000). However, as Powell et al. (2015) point out – the ubiquity of use does not equate to their nutritional importance, and studies examining contributions to energy requirements have found negligible impacts. While contributions in supply volume and calories may be low, the nutritional importance to local people in some areas may be high. For example, wild foods have been found to contribute over one-third of vitamin A and one-fifth of iron requirements in sites in Gabon (Blaney et al., 2009). Similar patterns have been found in the Philippines and Tanzania (Schlegel and Guthrie, 1973; Powell et al., 2011)

While small amounts of animal source foods may make substantial contributions to nutritional status (Neumann et al. 2007), wild edible plants may require more than casual usage to play an important role in the diet. In addition, their contribution to nutrition is dependent on the other components of the diets and the availability of other sources of foods. Very few studies have quantified the contributions of wild foods to the overall diet. In addition, forest foods – especially wild foods have been discussed as 'safety net' foods for managing seasonal shortages or food crises (Angelsen et al. 2014). Thus ethnobotanical research which identifies knowledge and use of wild foods often cannot comment on the nutritional importance, and dietary recall studies often will miss seasonal patterns of use (or often miss wild foods entirely). A comparative analysis of the patterns of wild food (collected quarterly over a 12 month period) in 25 countries, use showed that the importance of forest foods in diets varies according to patterns of usage – ranging from low-level supplementation to wild food dependence (Rowland et al., 2016). Where low-level supplementation occurs consumption contributions to minimum dietary recommendations are negligible, but for high-level consumers, the quantities consumed from wild forest sources not only exceeded minimum requirements but also exceeded the contributions made by crop and livestock agriculture. Though the study did not utilise dietary intake surveys, the patterns identified to correspond with existing studies in the literature that show a vast range of nutritional contributions from the negligible (e.g. Termote et al., 2012) through to substantial impacts on nutritional status (Powell et al., 2011) Some studies have even suggested that wild food consumption positively impacts upon health outcomes (Golden et al., 2011).The contribution of wild forest foods is thought to be a partial explanation of the association between forest cover and dietary diversity discussed above – though is likely insufficient to fully explain the patterns observed (Johnson et al., 2013; Ickowitz et al., 2013, 2016).

A wide range of studies have demonstrated the nutritional importance of the consumption of bushmeat and capture fisheries. One estimate suggests that in some communities in the DRC, 80% of protein comes from bushmeat sources (Nasi et al. 2011). Other studies have reported figures of between 6 and 68% of protein and 0.6 and 69% of energy (Powell et al. 2015). Capture fisheries can in some coastal, coastal communities provide the only source of an animal protein in diets (Tacon & Metian 2013). Few (if any) studies have directly quantified the contributions of freshwater fish from forests in diets. A small number of studies have examined the micronutrient contributions of bushmeat. For example, Sarti et al. (2015) found bushmeat consuming households to consume higher quantities of iron, zinc and protein than equivalent non-bushmeat consuming households. Such importance to diets suggests that loss of access to these foods may result in higher morbidity. Golden et al. (2011) estimated that loss of bushmeat would result in a 29% increase in anaemia amongst children in a forested community in Madagascar. However, excessive consumption of bushmeat could also have potentially negative effects on health. For example, in the tri-state region of Brazil, Columbia and Peru, consumption of bushmeat was a significant factor in unhealthy quantities of cholesterol and saturated fatty acid consumption (van Vliet et al., 2013).

There is far less evidence of the importance of WEPs in the diet. This partially as a result of disciplinary focus. A wide range of ethnobotanical studies have documented local knowledge and use of wild plants and qualitatively described the importance these foods, economic studies have examined the income from wild resources, food composition studies have shown that they compare favorably with agricultural plant foods but dietary intake surveys have typically ignored wild foods (Penafiel et al., 2011; Rowland et al., 2015). Despite some studies showing that WEPs can make up most if not all of the vegetables or fruits in some diets (Newman 1975; Fleuret 1979; Ogle 2001; Herzog et al. 1994), studies that have examined the contribution WEPs make to the overall diet have typically found marginal impacts on nutrition (Termote et al. 2012; Campbell 1987). Some studies have gone on to show the disconnect between knowledge of WEPs, their cultural importance and valuation and their actual use. For example, do Nascimento et al. (2013), find that though an indigenous community in Brazil was able to document hundreds of WEPs highly valued by the community, there were very few instances of actual consumption. A related study found greater valuation of WEPs that were associated with famine foods, suggesting the valuation of these foods was related to their role as 'safety nets' (do Nascimento et al. 2012). Indeed, WEPs are valued highly for this role around the world, but empirical evidence of their use is limited (Campbell 1987; Angelsen et al. 2014; Bakkegaard et al. 2016).

Impacts of loss of wild foods

To date few empirical studies examine the loss of wild foods during agricultural transitions. Broegaard et al. (2017) studied the transition from swidden livelihoods and wild foods towards cash crop production (of maize) in northern Laos but did not conduct dietary assessments to quantify the contributions of wild foods. However, the authors did estimate the percentage of recommended protein intake obtained from wild foods in swidden and commercial villages. Agricultural fields were the most important type location for the collection of wild foods in both types of systems – but the collection of wild foods was much lower for commercial agriculture than swidden. The study identified a 'protein gap' between the two sets of villages was not filled by livestock or purchased ASF. However, without a dietary intake assessment, such conclusions cannot be validated. Other studies have examined nutrition transitions over land-use gradients with specific reference to wild foods. Vliet et al. (2015) investigated the effects of a rural-urban gradient on bushmeat consumption in the Bolivian Amazon The study bushmeat and fish, consumed more rural areas, was substituted by farmed chicken and eggs. The study also identified the effects of income differentiation were different in rural and urban areas with wealthy urban households consuming more beef than chicken and wealthy rural households consuming more chicken than bushmeat and fish. Similar findings of a nutrition transition in the Amazon region have been found by multiple other authors who document in the increased consumption of processed foods, industrial meat and decreased consumption of bushmeat – though urban bushmeat markets still serve high demand (Sarti et al. 2015).

Though lacking a broad range of rigorous studies, the contribution of wild forest foods is substantial enough that several authors have hypothesized that loss of forest access during agricultural landscape transitions could have detrimental effects upon local people's nutritional status (Sunderland et al. 2015; Powell et al. 2015; Penafiel et al. 2011; Nasi et al. 2008). However, it should also be noted that the inverse – that conservation of forests, therefore if implemented in a way that restricts access to forests and exerts control over forest-based agriculture, hunting and extraction of forest resources is also a threat to diets (Nasi et al. 2008; Swamy & Pinedo-Vasquez 2014)

D.8 Energy Pathway in Landscape – Nutrition Frameworks

The relationship between energy pathways and health outcomes has been explored in various contexts. While cooking can enhance the bio-availability of certain nutrients, thereby positively contributing to nutritional intake (Anand and Roy, 2016; Fabbri and Crosby, 2016), the use of certain indoor fuels has been linked to an array of respiratory ailments, and remains a significant cause of morbidity and mortality globally (Hanna et al., 2016). When examining the linkages between landscapes and nutrition, multiple other mechanisms warrant investigation. A handful of studies have shown a variety of mechanisms. For example, Baudron et al. (2017) showed the use of firewood as a fuel decreased with distance from the forest in a mixed forested landscape in Ethiopia, with increasingly using cattle dung as a fuel the further away from the forest they were, and with the households furthest away purchasing firewood. This example indicates two potential mechanisms. The first is that the type of cooking fuel used may influence which foods are cooked [2]. The second is that the energy pathway interacts with the income pathways as fuelwood is not available (or easily accessible) for households further from forests are required to purchase it. This fuelwood in this context is a form of "environmental income".

Another example of the trade-offs between parts of the energy pathway can be seen in Wan et al. (2011), who discuss the collection of fuelwood among women in West Kalimantan. Here, the authors found a trade-off between the environmental income and use of fuelwood for cooking with energy expenditure and drudgery of women's time allocated to collecting it – time which competed with other demands on women's time such as childcare and cooking.

[2] As it happens, in this study, there was no relationship between foods cooked and fuel type used. However, other studies have found links, e.g. Mekonnen and Köhlin (2009)

Appendix E: Supplementary Information for Methods Chapter 5

E.1 Household-Level or Village-Level Adoption

This study attempts to understand the effects of an on-going landscape change transition driven by oil palm expansion consisting of multiple, simultaneously connected social, economic, geographic, cultural and land use change transitions. The ideal mode of study would be decades-long cohort studies with randomised communities and households – some of whom adopted oil palm and some of whom did not – ideally in a context where some exogenous factor predicts the development of oil palm, creating the condition of a natural experiment. However, no such data is publicly available. In the absence of long-term cohort studies, we must make do with observational data in the form of cross-sectional study designs.

Any cross-sectional approach must compare adopters of oil palm with non-adopters of oil palm. Any cross-sectional study design based upon a comparison of oil palm and non-oil palm adopting households raises the issue of potential endogeneity. It is possible that there may be inherent differences in households and/or villages, which make them more or less likely to adopt oil palm, which may also influence outcome variables. In Chapter 3, I discuss the limitations of past research which attempts to use econometric techniques, such as the use of instrumental variables and/or propensity score matching at the household level. I believe that for many modes of oil palm adoption – particularly those where communities collectively give or withhold consent for oil palm – issues with endogeneity are likely to be far greater at the individual level than the community level.

Given the weaknesses of econometric approaches to controlling for endogeneity and selection bias at the household level and the fact that the study focuses on smallholder plasma scheme participants (rather than individual oil palm adopters), we[1] opted for comparisons between randomly selected households within oil palm and non-oil-palm villages, as opposed to the random selection of oil palm and non-oil-palm-adopting households within villages with both oil palm and non-oil-palm households.

I believe that this approach, while flawed (see 5.6 and 5.6.1) – has major advantages over the alternative approach of randomly selecting oil palm and non-oil palm-adopting households for the following reasons:

1. Comparisons of oil-palm and non-oil-palm adopting households within mixed villages are likely to suffer from important omitted variable biases due to difficulty in controlling for such important potential issues such as a household's political connectedness and local influence in land use and land rights decisions;
2. Comparisons between oil-palm and non-oil palm adopting households are likely to suffer from survivorship bias with households who were successful at oil palm being over-sampled while unsuccessful oil palm farmers risk being categorised as non-oil palm adopters. This effect likely increases with time as unsuccessful farmers sell their land to more successful farmers and adopt alternative livelihoods or migrate out of villages;
3. Oil-palm plasma agreements are made at community levels – with consent being granted by village authorities on behalf of village residents and where dividends, compensation and other forms of payments are collectively bargained. This involves a substantial reorientation of the village economy and a massive transfer of land tenure from communities to companies which affect even those who do not adopt oil palm;
4. Non-oil palm livelihoods are dependent on diverse landscape mosaics of forests, fallows, agroforests and fields which may be reduced or lost after oil palm development;
5. Oil palm often precipitates a loss of customary rights and land tenure upon which forest-based swidden livelihoods depend.

E.2 Space-For-Time Substitutions

A common approach where long-term data is not available is the use of space for time transitions, in which spatial differences can be viewed as proxies for temporal changes (Pickett, 1989). While originating in ecology, in recent years, this approach has been applied to socio-ecological effects of landscape change transitions (Deakin et al., 2016; Sunderland et al., 2017; Ahammad et al., 2021). In this approach, regional landscape transitions are first characterised, and then areas and communities within these landscape transitions are purposely sampled to represent "stages" of a broader transition.

There are methodological advantages and disadvantages of this approach. The advantages are that such studies can provide an additional perspective of the long-term impacts of transitions in contexts where longitudinal data is not available. Additionally, so long as the research area is sufficiently diverse and sample sizes are sufficiently large, it can capture

[1] The CIFOR DFC study produced the original study design. While I am a co-investigator of this project, this high-level project design was largely done by the principal investigator along with the nutrition team and focused on the core dietary intake research.

Table E.1: Sources of Potential Bias and Steps Taken to Mitigate Them

Bias Type	Description	Risk	Example of Possible Bias	Steps to mitigate
Selection	Introducing bias through choice of respondents	Low	Key informants are often of higher social status	Stratified random sampling
Question Order	Influencing later answers due to line of questioning	Medium	Asking about government/company followed by customary land rights	Contentious questions left until end of survey/questionnaire/FGD
Gender	Women answering differently to male interviewees	Very high	Awkward topics such as childbirth, menstruation	Female research assistant recruited
Cultural	Ethnocentrism of research	High	Over-emphasising wild foods because of pre-conceived notion of importance	Research assistant from local area, reflexivity, base upon DFC data
Acquiescence	Tendency of respondent to agree with interviewer	Low	If interviewer declares interest in forest foods, respondent overemphasises importance	Clear explanation of role of researcher, starting research after socialisation period
Recall	Some events more memorable than others, declines with increasing time between event and recall	High	Memorable events such as agricultural work more likely to be remembered than less memorable work such as child care	Short recall periods (24-hours, 7 days) with maximum recall period 1 month. Prompting and structured recall.
Social Desirability	Respondent answers questions in a way as to please the respondent	Very high	Respondent assumes that foreigner has a hidden agenda – potentially from an anti-palm oil NGO and/or aligned with companies/village elites	Socialisation period and village meeting, reconfirmation of neutrality of researcher at start of survey/interview/FGD
Interviewer bias	Respondents reply different to different interviewers	Very high	Interviewer responds different to female of local interviewer than foreigner	Post hoc testing

snapshots across a whole range of landscape conditions, identifying the effect of heterogeneity beyond the dominant land use change drivers (Reed et al., 2021). A major disadvantage of this approach is that, while generalised outcomes may be examined, the interconnected nature of drivers and feedback mechanisms are difficult to disentangle. Landscape change transitions consist of economic, social and political changes are interconnected (Lambin et al., 2003). As such, attributing the effects of the transition to any one factor is extremely difficult.

While no doubt influenced by recent CIFOR studies using space-for-time substitutions to measure landscape change (e.g. Sunderland et al., 2017), this study deviates from this approach because it explicitly situates the research within the context of two different transitions. In the space-for-time approach, sites are representations of the stages of the same underlying transition. In this approach, two different transitions are occurring from a departure point where livelihoods and landscapes were more similar.

E.3 Mitigating Bias and Inaccuracy

There is no way to eliminate all bias in this research, nor were some ways of mitigating bias (e.g. prolonged participant observation) logistically feasible. However, where possible, I deployed strategies to reduce the risk of certain types of bias. A summary of these strategies are shown in Table E.4

E.4 Mitigating Endogeneity

Types of Endogenity

Cultural endogeneity would exist if communities in villages that adopted oil palm differed from communities' villages which did not adopt oil palm in terms of their ethnic make-up or social and cultural laws and traditions, which affected both the likelihood of a community rejecting oil-palm companies as well as the range of agricultural and other livelihood activities carried out. One example of cultural endogeneity might be differences at the baseline period in customary rules and practices. Stronger customary laws over land tenure could lead to a rejection of oil palm companies whilst also affecting the likelihood that certain livelihoods were practised such as NTFP extraction or rotational shifting cultivation. Differences in these livelihood activities would then explain differences in time and labour allocation.

Geographical endogeneity would exist if oil palm and non-oil palm adopting villages differed at the baseline period in such a way that affected the viability of oil palm development or the likelihood of the issuance of government permits to grow oil palm as well as the allocation of time and labour, food systems and food choice, food systems and food choice. Examples of geographical endogeneity include current land-use practices and industry (e.g., the presence of logging), which may have affected livelihood occupations or if different slopes or soil types prevented certain types of agricultural production.

Economic endogeneity would exist if, at the baseline period, oil-palm and non-oil-palm-adopting villages differed in terms of wealth, access to financial services such as credit, infrastructure and market access in such a way that it also affected the allocation of time and labour, food systems and food choice. For example, communities with better access to markers and better access to financial services might be more likely to engage in cash crop production, which affected the allocation of time and labour, food systems and food choice.

Political endogeneity would exist if, at the baseline period, land use zoning by government authorities which affected whether oil palm could be developed in an area in or around a village also affects the livelihood options available to any particular community. For example, if land was classified as a national park on conservation area which prevented both oil palm development but also slash and burn agriculture.

Table E.2: Selection Criteria used to reduce endogeneity and bias

Type of Endogeneity	Reason for adopting/ not adopting oil palm	Potential Effect Upon Measured Outcome	Selection Criteria
Cultural	• Rejection of oil palm stronger in some cultural groups or in communities with stronger influence of customary rights and laws	• Different ethnic and cultural groups may specialize in different livelihoods, grow different crops, have different attitudes and preferences to foods	• All villages to be majority ethnic Dyakas at both baseline and survey period • No transmigrant villages or villages with significant immigration included • Similar cultural traditions regarding customary practices surrounding agriculture, forest use and livelihood
Geographical	• Oil palm not viable due to steep slopes / poor soils • Different forest cover levels at baseline	• Different crops / livelihood activities are viable / not viable • Different livelihood options available	• Similar gradients and soil types in all villages • All villages heavily forested at baseline period. No history of logging or large-scale plantation agriculture.
Economic	• Current livelihood practices affect the probability of community giving or refusing consent to oil palm companies • Wealthier villages more likely to accept/reject oil palm • Villages with poor market access less likely to be desired as oil palm sites • Different access to financial and credit services affect alternative non-oil palm livelihood opportunities	• Differences in livelihoods affect allocation of time and labour • Households will allocate time differently in wealthy villages from less wealthy villages due to livelihood opportunities • Differences in market access may affect opportunities for commercialized agriculture and livelihood opportunities • Differences in access to credit may affect opportunities for commercialized agriculture and livelihood opportunities	• All villages at baseline period predominantly engaged in swidden agriculture combined with NTFP extraction and smallholder rubber agroforestry • Similar levels of village wealth at baseline period • All villages have similar levels of market access in terms of both time and difficulty • All villages have similar levels of access to financial and credit service
Political	• Government land use zoning encourages or forbids oil palm development	• Government land use zoning also explicitly encourages or forbids other livelihood options	• No livelihood options (e.g. swidden cultivation) are forbidden by authorities

E.5 Post-Hoc measures of validity and reliability

The many possible sources of bias discussed above, combined with the lack of survey instruments validated for this context, created a necessity for validity and reliability testing. Lack of reporting of validity and reliability was a major problem within food environment research. For instance, the systematic review by (Lytle and Sokol, 2017) found that 57.6% of studies on food environments cited neither reliability nor validity. The link in the logic chain most vulnerable to lack of validity and reliability in this research was the use of a representative sub-sample to generalize the large sample (and therefore the population). To mitigate some of this risk, some instruments were assessed for test-retest reliability (a re-sampling at a different point in time). Parallel-forms reliability was also conducted on the time-use recall survey as respondents were given both the quick-pass and the 24-hour recall time-use survey, and the degree of agreement between these instruments was tested. If the quick-pass was reliable (as was unlikely), this would have allowed the use of the quick-pass in the main survey to be used as time-use data itself. Testing inter-observer reliability was also necessary for all of the research. The difference in responses given to a foreign, white male interviewer and a Dayak female interviewer was likely to be high. There were four types of interviews conducted (male foreigner alone, female Dayak alone, together with male asking questions, together with female asking questions). This was recorded on the questionnaire for post-hoc testing. The validity of instruments was more challenging to detect. Some, such as the Women's Empowerment in Agriculture Index (WEAI) modules as well as questions adapted from other standardized questionnaires, have already been validated for several rural agrarian contexts in LMICs. Given the wide range of variables under investigation, it was not feasible to test the internal validity and reliability of these instruments independently.

E.6 Analysis of Secondary Data

Very little historical data are available to validate our village selection based upon qualitative research. Only one publicly available dataset is available for the study villages at a time period prior to our historical baseline (BPS, 1996). While indicators are broad, this data supports our presumption that oil palm and swidden villages were broadly similar prior to the arrival of oil palm.

Table E.3 shows a comparison of village-level data between the two sites in 1996, the earliest available date of publicly available village data. In every village included in the study, the main occupation of the majority of respondents was reported as food-producing agriculture in 1996. No villages in the study had irrigated rice in the year 1996, and villages in each site had similar areas of non-irrigated rice per household, and similar areas of plantation (including rubber agroforestry) per household. There was a higher (though not statistically significant) area of non-rice agricultural fields in the OP site compared with the swidden site – but this category is broad, encompassing a wide range of land uses. There were no major differences between oil palm and swidden villages in terms of infrastructure and market access. Both sites had a mixture of villages which were primarily accessible by boat and villages which were accessible by road. In the case of villages accessible by road, all were roads from soil or other materials with no villages having stone or asphalt roads. The time to a permanent market via usual transportation was similar in most villages except for two villages in the OP site which were slightly further away.

Table E.3: Pre-Oil-Palm Differences Between Sites

Analysis of Government Village Potential Data for 1996 (BPS, 1996)

	Forest	**sd**	**OP**	**sd**
Demographics				
Number of Households	363	84	347	175
Livelihoods				
Main occupation agriculture (% of villages)	100	-	100	-
Proportion of Households Farmers[1]	0.9	0.09	0.94	0.03
Main agricultural sub-sector = Food Crops	100	-	100	-
Agriculture and Land Use				
Total Village Area (thousands ha)	79.9	118.2	93.5	94.5
Village Locality:				
Hill Area	50	-	50	-
Non-Hill Area	50	-	50	-
Area of land (ha per hh):				
Rice (any)	1.03	0.26	0.99	0.44
Irrigated Rice	0	-	0	-
Unirrigated Rice	2.06	0.51	2.34	0.99
Non-rice Agriculture	8.29	1.47	15.67	10.59
Plantation (including rubber agroforestry)	93.32	132.38	90.22	74.51
Infrastructure				
Village Access (% of villages):				
Main access via road	0.67	-	0.5	-
Main Access via Boat	0.33	-	0.5	-
Type of road (if present)				
Soil/earth	100	-	100	-
Market Access				
Time to nearest market[2] (hours)	44.8	16.59	66.29	36.04
Perceived access to market				
difficult/very difficult[3]	100	-	100	-
Market in villages (% of villages)	0	-	0	-
Financial Services				
Access to credit:				
Bank Services	0	-	0	-
Credit Unions	0	-	0	-

Note: Based upon village level data from PODES 1996 (BPS, 1996). [1] Main occupation of the majority of village residents [2] Time to market with permanent building [3] Subjective rating of easiness/difficulty of accessing market with permanent building (likert scale)

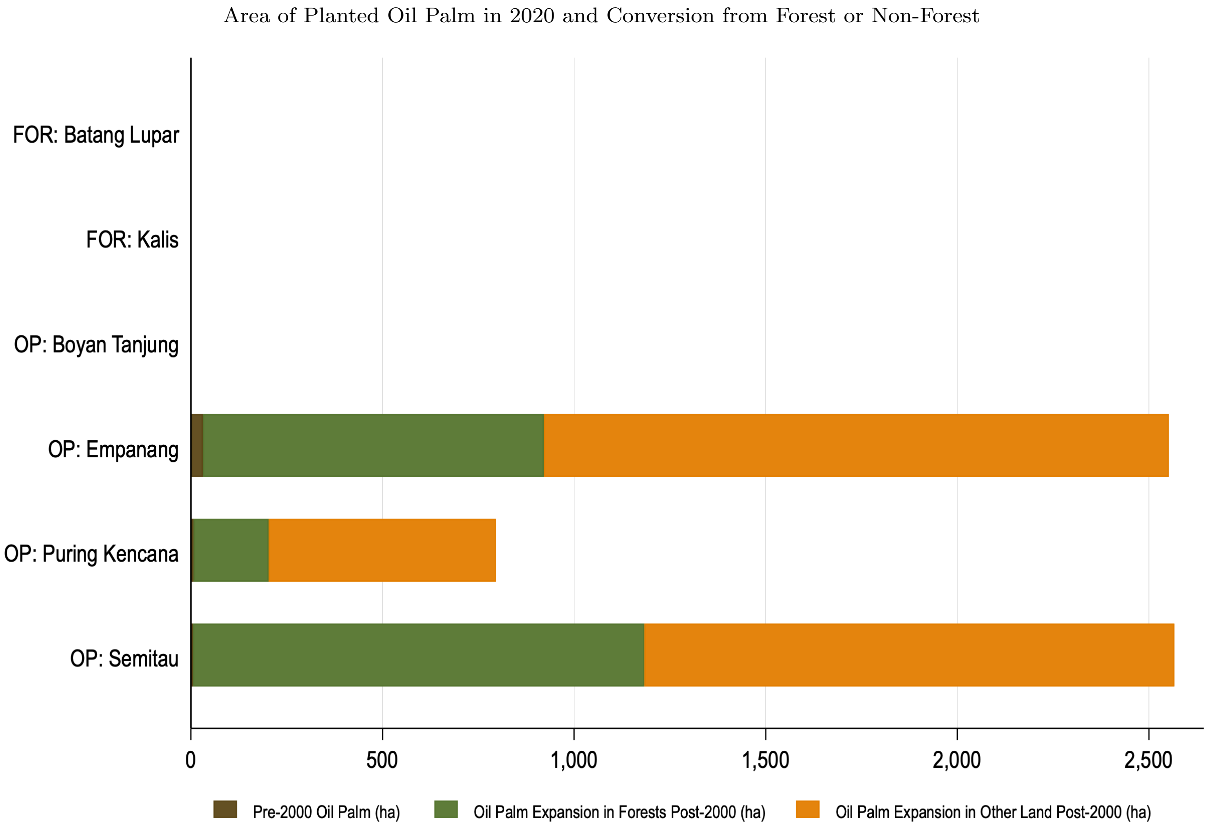
E.7 Analysis of GIS Data

Figure E-1 shows the area planted with oil palm in the year 2020 along with the time in which the expansion has occurred and the land type converted to oil palm since the year 2000 averaged for study villages across the sub-district. Only in study villages in one sub-district was there any oil palm planted pre-2000. For all OP sites, the vast majority of oil palm was grown post-2000. Figure E-1 shows the proportion of oil palm expansion after the year 2000 which replaces forested land. For study villages in each sub-district, the average proportion was approximately 40% with the remaining oil palm expansion converting other land uses.

Analysis of historical data confirms the findings of the village-matching exercises. Figure E-3a shows cumulative forest loss relative to a baseline in the year 2000 at the sub-district level while Figure E-3b shows cumulative forest loss at the village level. Data is taken from Nusantara Atlas (2023)[2]The figures show two divergent patterns of forest loss since the year 2000, with relatively little loss of forest cover since 2000 in the FOR sites. While the overall patterns are clear, forest loss at the village level (in a 5km buffer from the village) has a wide range of outcomes with the OP site villages with the forest loss having experienced comparable levels to the villages with the most forest loss at the FOR site. Village-level data, however, should not be too precisely interpreted however as GIS data is often unable to account for different types of forest loss and regrowth (e.g. distinguishing between old fallows and forests). The general trend however confirms the findings of the qualitative study.

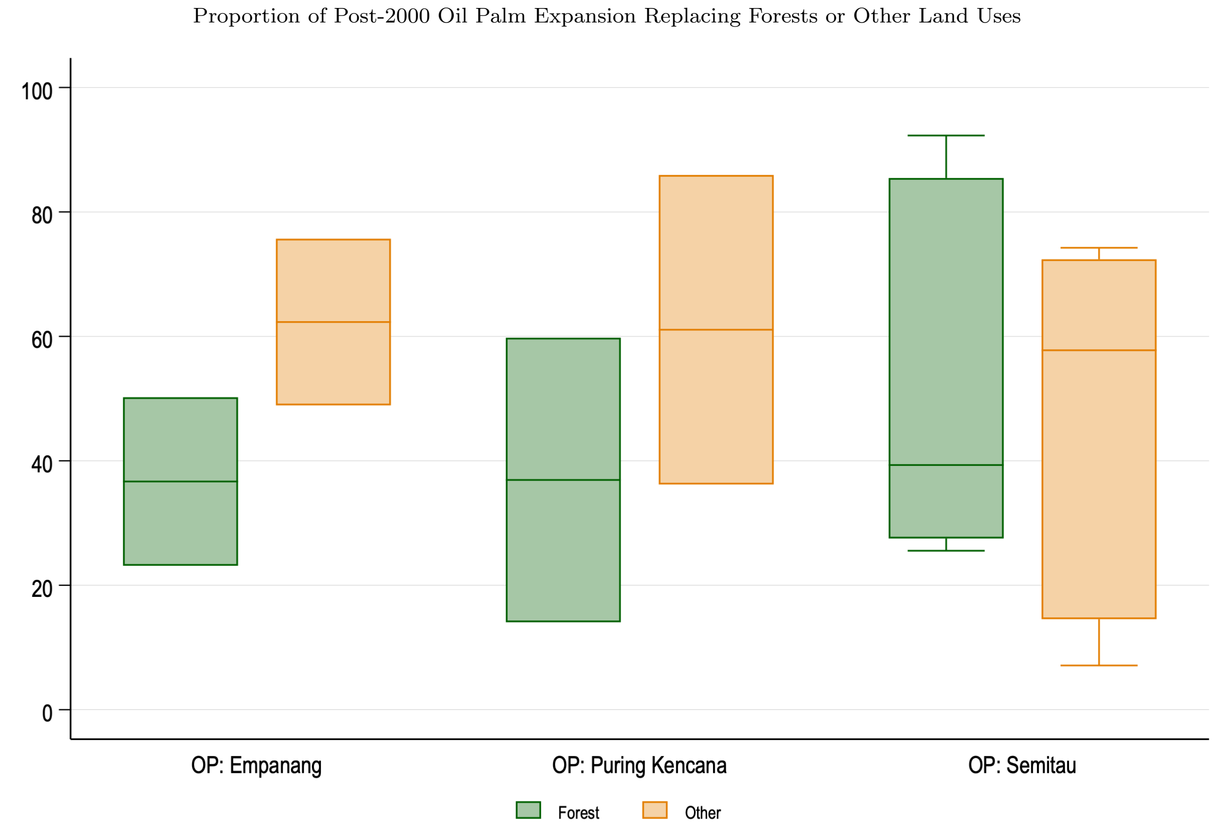
[2]Nusantara Atlas (2023) "brings satellite images (Planet/NICFI, Sentinel-2, Landsat, NOAA-20, S-NPP, Aqua and Terra), near-real-time deforestation alerts (RADD ; GLAD), fire hotspots (VIIRS and MODIS) and rich cadastral information in one space". The underlying data has been peer-reviewed in the following publications: Hansen et al. (2013); Gaveau et al. (2021); and Gaveau et al. (2022)

Figure E-1: Sub-District Level Oil Palm Expansion



Note: Graph shows the area planted with oil palm within the set of villages included in the study averaged by sub-district in the year 2020 as well as the areas planted before the year 2000, and the oil-palm area replacing forests or other land classifications from 2000-2020. Data is taken from Nusantara Atlas (2023).

Figure E-2: Land Use Conversion to Oil Palm Post 2000

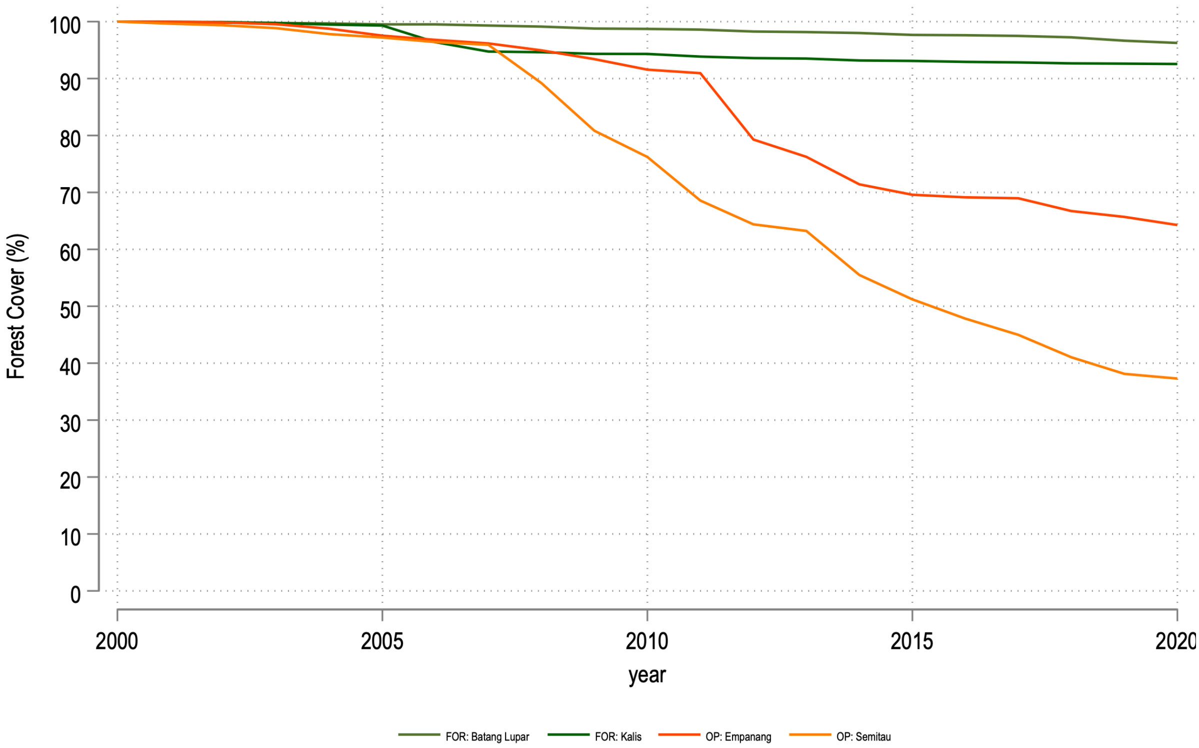


Note: Graph shows the area planted with oil palm within the set of villages included in the study averaged by sub-district in the year 2020 as well as the areas planted before the year 2000, and the oil-palm area replacing forests or other land classifications from 2000-2020. Data is taken from Nusantara Atlas (2023).

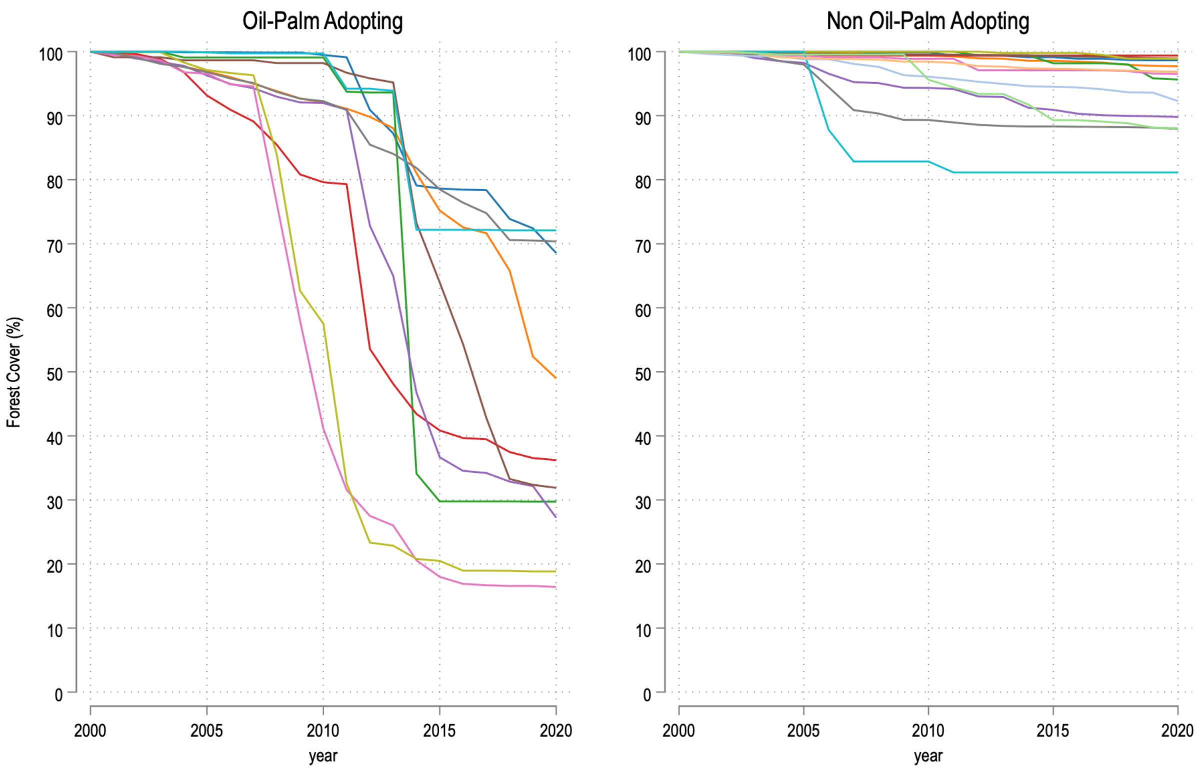
Figure E-3: Cumulative Forest Loss at Sub-District and Village Level

Cumulative Forest Loss From Year 2000 Baseline

(a) Sub-District Level



(b) Village Level



Note: Graph E-3a shows cumulative forest loss within the set of villages included in the study averaged by sub-district from the year 2000. Graph E-3b shows cumulative forest loss within a 5km buffer of each village. Data is taken from Nusantara Atlas (2023). Villages are not labelled due to the need to keep respondents anonymous (Discussed in Section 5.7.1).

E.8 Purposive vs Probabilistic Sampling Strategies

Designing mixed-methods research requires careful examination of the sampling frame to ensure that research strands are designed to address the research questions. A key dichotomy in sampling approaches is that of probability-based vs purposive based sampling. Teddlie and Yu (2007) explain the difference in approaches thus:

> A purposive sample is typically designed to pick a small number of cases that will yield the most information about a particular phenomenon, whereas a probability sample is planned to select a large number of cases that are collectively representative of the population of interest.

Figure E-4: Continuum Between Purposive and Probability-Based Sampling With Mixed Methods Designs

Adapted from Teddlie and Yu (2007)

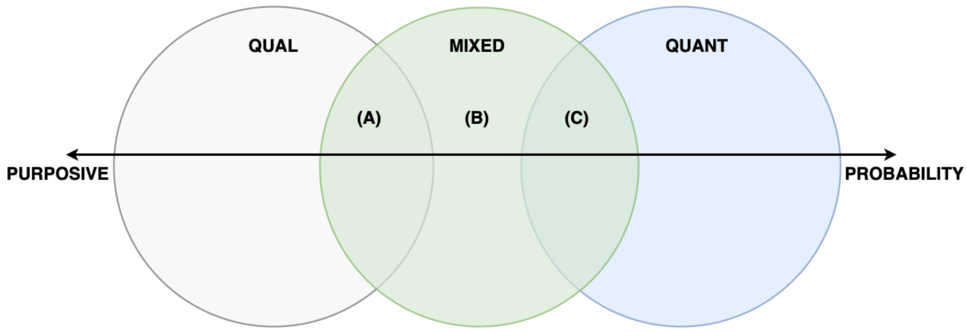


Figure E-4 shows a continuum between purposive and probability-based sampling taken from Teddlie and Yu (2007). Research consisting of qualitative research with a small additional quantitative component and vice versa are represented by Zones A and C respectively. The authors argue that mixed methods research closer towards the centre of the continuum tends to be better integrated than research at the extremes. Generally, speaking, quantitative sampling strategies are probability-based – i.e.they are designed to be representative in some way of a larger population (e.g. through randomisation, stratified randomisation etc.), while qualitative sampling tends to be purposive – with greater detail being obtained about fewer subjects, but with the selection of respondents guided by factors than representativeness of the wider population (e.g. theory based, snowball, convenience sampling etc.). While both types aim for generalisability, they do so in different ways: In quantitative studies the aim is for external validity – the selected sample should represent the subject population, and replication of the study should yield similar results; In qualitative studies, the aim is for transferability – the idea that the study findings, or theoretical development, may apply in other contexts or populations (Finfgeld-Connett, 2010).

E.9 Ethics and Obtaining Consent

Free Prior Informed Consent

Free Prior Informed Consent (FPIC) is a framework developed by the UN and adopted by numerous other international organisations such as the International Labor Organization (ILO) which states that consent should be granted free from coercion, conducted sufficiently in advance of activities, and that participants should be fully informed of activities and consequences (FAO, 2016). The latter, *informed*, part of FPIC is often overlooked by researchers – participants cannot grant informed consent unless they know how the data will be used and the potential consequences of speaking to researchers. It was thus necessary to be explicit about what and how research findings would be shared, as well as the overall purpose of the research activities.

Consent Statements and Consent Forms

In many contexts, a system of "dynamic informed consent procedures, such as verbal informed consent" are preferable to form-filling, which may simply become a way to "operationalise" consent (Xu et al., 2020). Verbal consent was obtained before interviews and focus groups. Verbal consent was preferred to written consent because the latter may, in specific contexts, paradoxically undermine the respondent's ethical treatment, leading to misunderstandings about their withdrawal rights and reinforcing undesirable power relations (Brear, 2020). Additionally, as discussed in Chapter 5 (Section 5.7.1), the use of forms of attendance at meetings is a routine technique employed by oil-palm companies to imply community consent when FPIC may not have, in fact, been given. Signing forms can therefore hinder the quality of research by counteracting the rapport and trust-building and making interviews more "official". My research was partially funded by CIFOR however, who requires the use of consent forms unless otherwise specified. For the component of the research directly contributing to the CIFOR DFC study, whose ethics approval required the use of consent forms I used a modified version of the consent forms approved by internal ethics review – in addition to the dynamic verbal consent used elsewhere. For research funded from other sources, and for which I had obtained independent ethics approval from the University of Indonesia's Ethics Committee, I used only dynamic verbal consent. While this was an ongoing process which aims to avoid the "stationary" nature of consent forms (Tauginienė et al., 2021), respondents were also read and shown a statement and provided with names and numbers they could call[3] for with questions, comments, concerns or complaints or to withdraw complaints at any time.

Research Permits and Ethical Review

All national laws and regulations were obeyed for research including obtaining a research visa, permit and reporting to relevant offices and police stations

CIFOR DFC Study Component

Ethics approval for the DFC project was been granted internally by CIFOR and partner universities involved in the study. The study obtained permission from Badan Kesatuan Bangsa dan Politik (The National and Political Unity Body) at the provincial and district level, as well as Dinas Kesehatan (the Public Health Office) at the district and sub-district levels. The study protocol was approved by the Ethics Committee of the Health Polytechnic Makassar, Indonesia, no. 302/KEPK-PTKMKS/XI/2016.

Additional PhD Component

The proposal for the entire PhD fieldwork study was approved by the SOAS fieldwork ethics committee before going to the field. A research permit was applied for and granted by the Indonesian Foreign Research Permit Division Ministry of Research, Technology, and Higher Education (RISTEK) (Permit No. 50/SIP/FRP/E5/Dit.KI/II/2018,). As part of this process, permission was also obtained from the Ministry of Environment and Forestry, Innovation Research Agency, Secretariat of Development and Innovation Research Agency (No. 5.118/SET/PK/KLN.1/1/2018). Additional ethics approval was applied for and granted by an accredited independent third party – The Health Research Ethics Committee, Faculty of Medicine, University of Indonesia (No.95/UN2.F1/ETIK/I/2018).

Confidentiality and Anonymity

It was necessary to ensure respondent confidentiality, both at the intra-household level and beyond. To ensure intra-household level confidentiality all efforts were taken to collect data at times and in places where individuals can not

[3]Both general office numbers and Whatsapp numbers of both researchers and line managers.

be overheard by spouses or other family members and the data. In the case of women's interviews, this was relatively easy to arrange as there were times of the day when it was usual for men to be away from home. For men, this was more challenging (though arguably likely less critical). For men's surveys, the majority were conducted along side other interviews or questionnaires with other household members, but where interviewers split up to conduct interviews in separate locations or where men were lead to a more secluded location. Summaries of the data or the content of interviews were not shared with anyone else not directly involved in the research team – and even then data was stripped of identifying details before sharing.

Maintaining confidentiality is naturally harder in contexts of FGDs and participatory research. We used many of the recommended strategies suggested by Petrova et al. (2016) for ethical conduct for participatory health research including: participants choosing or having input into the location of the activities; revisiting consent during and after the discussions. However, other recommendations – such as referring to respondents using anonymised codes which do not indicate whether the respondent was make or female – were not possible as it would prevent a gendered analysis of the data. As discussed in Section 5.6, we also employed several strategies to ensure that women-only FGDs were not joined by men spontaneously turning up during the course of the activities.

E.10 Compensation for Respondent's Time

Survey participants in this study were all participants in the larger DFC study which consisted of several time-intensive surveys and questionnaires across multiple seasons. As such, a decision was made by the project leaders of the DFC study that some form of non-financial compensation should be provided in the form of small gifts of low monetary value that were nonetheless valued by participants (e.g. bars of soap, small hand towels). Given that this PhD research involved re-surveying the same research participants, it was thought that similar compensation should be provided. Small gifts were handed out to all research participants, including survey questionnaire respondents, interviewees and participants in focus groups other participatory activities. Additionally, we provided refreshments in the form of coffee and sweet and savoury snacks for focus groups.

E.11 Reflexive Account of Fieldwork Activities

Reflections On Being a Foreign Researcher

Eilenberg (2012) provides a colourful description of many of the challenges faced by researchers, especially foreign ones, operating in Kapuas Hulu:

> "Being the only researcher, or Westerner for that matter, in the whole borderland certainly makes one stand out and draws plenty of attention, not least from persons with 'shadow' qualities, such as policemen, military and other state agents at the border, but also from vigilantes, smugglers and other entrepreneurs operating on the verge of legality.... Numerous colourful rumours about the raison d'être of my presence flourished, especially at the outset of fieldwork before the main purpose of my presence had become common knowledge. The three most common assumptions were that I was an audacious and slightly eccentric timber buyer, a central government spy, or just a bewildered conservationist. During my latest visit in 2007, after the government banned logging, locals told me that during my previous stays timber barons had carefully monitored my movements."
> Eilenberg (2012)

While in many respects, residents of Kapuas Hulu are more used to foreign researchers since Eilenberg's account (oil palm development has brought interest from environmental and social NGOs as well as research institutes such as CIFOR), this has perhaps only increased suspicions that researchers may have covert intentions. Most researchers in the region are of Indonesian origin and foreign researchers – especially those conducting research themselves and who speak Indonesian – are a significant novelty which generates substantial interest and attention – resulting in rumours of one's agenda spreading rapidly through the local area.

Conducting research in Kapuas Hulu as a foreign researcher today, therefore, has two main challenges. Firstly, while not unheard of, visits by foreign researchers are still sporadic and infrequent – with most spending very little time integrating into the day-to-day life of the village. Secondly, on the occasions that foreign researchers do visit, they typically have an unambiguous agenda – usually either pro or anti-palm oil. It is necessary, therefore, to spend significant time building trust and explaining one's purpose before any research can be carried out at all. Without doing so, researchers – especially foreign ones – on rapid visits are likely to find exactly what they are looking for as respondents seek to tailor their answers to what they perceive the researcher is looking for.

Difficulties in Maintaining Privacy or Limiting FGD Attendees

At a more prosaic level, being a foreign researcher results in practical challenges which must be overcome to ensure good-quality data. A significant problem is that it is challenging to conduct interviews privately without others joining to see what is going on. This applies especially to women-only focus groups, where it was common for men to show up during the activity and, upon joining in, quickly dominate the conversation. Our team developed a highly effective technique for dealing with the reoccurring situation. If, as they often did, a man turned up to a woman-only focus group, one of the team would ask them if they could interview them individually and then lead them to a separate location to conduct a key-informant interview, allowing the women-only focus group to continue undisturbed.

Courtesy, Procedure Adherence and Perceived Independence

Another major challenge of being a foreign researcher in Indonesia is need to balance obtaining the approval of authorities (both government and customary) for your activities, while not being not be seen as aligned with particular power centres and interests. Again, Eilenberg describes this process succinctly:

> "Overcoming suspicions demanded endless hours of courtesy visits to the various state and non-state authorities (timber barons, adat elders, village heads etc.) in the region explaining the purpose of my visit as a researcher and the rules of confidentiality that bound me...one of my biggest problems was how to walk the fine line between talking with one group without losing the trust of others."

While I did not have to pay courtesy visits to timber (or oil palm companies) I dedicated considerable time to courtesy visits to village heads, adat leaders, on top of obtaining a chain of authorising letters from government authorities. In this relay-baton of bureaucracy, each official received a letter from the last, and then issued their own letter to the next official in a chain beginning in Jakarta, passing through multiple government departments and police stations in Pontianak and Putussibau, to each government and customary leader in each sub-district, through to village and hamlet level officials and customary leaders, all while stopping and self-reporting at each police post passed – knowing that if you did not self-report you would regardless receive a visit at your destination.

While complying with these reporting requirements were a necessary part of operating as a foreign researcher according to the law, it was also important that respondents knew they would not get into trouble for speaking to me. More than a few times, respondents checked with me and other team members that we had permission to do research from the village head. However, having obtained permission from village authorities I was conscious of appearing to be allied to them in some ways. Many authors have described how village elites in oil palm (and non-oil palm) have been intrumentalised by other actors in order to marshal the community to respond in particular ways to accept or reject the vested interests of outside parties (Hasudungan, 2018; Hasudungan and Neilson, 2020; Yuliani et al., 2020). This appearance is not helped by village authorities (with seemingly no agenda beyond helpfulness) offering to arrange participants for focus groups or offering us to stay in their homes. In these cases, the helpful gestures are doubly undesirable as it not only creates the illusion that the researcher and the village leaders are allied, but also creates serious risk of the researcher being influenced by careful selection of participants, or unspoken influence by the village head. As discussed in Section 5.6, our strategy for minimizing this issue was to center our activities the health center, health staff and volunteer health workers. However, there were numerous occasions where it would have been impolite not to accept offers of help and would have created consternation that could have derailed research in other ways.

Integrating into Busy Communities

Despite many years of prior experience conducting research in various locations across Kalimantan (including in Kapuas Hulu[4]), I found integrating myself into the community more challenging than I had anticipated and initially struggled to expand my contacts and relationships beyond those I was introduced to by village authorities. In previous research, I have relied on two main strategies, neither of which were particularly effective on this occasion.

One of my preferred strategies in past research has been washing in the river during the times of day when this is most sociable (for example, late afternoons/early evenings). This has tended to attract curious observance (and often hilarity) by adults, but I found I am quickly joined by the braver amongst the village children (who in return recruit their friends to the cause), who swim alongside me asking me questions. Another favoured strategy has been to join in with sports activities. Almost every village in Kalimantan will have either a badminton or a volleyball court. I have found these excellent points of entry into the community, particularly if there is an overlooking *warung* (vilage shop) from which to buy instant coffee. After spectating for a while it is never long before I am invited to join in – often by the teenagers and young adults who can be the hardest to integrate with in other contexts. Once their initial enthusiasm has waned, and they become tired of my sporting incompetence, I can retire to the edges and spectate once more but this time more easily able to chat and socialise with other spectators, explain my purpose for being there and answer questions.

[4]Prior to this study I was familiar with the district of Kapuas Hulu, having participated in several CIFOR research projects located in the area, including co-authoring a taxonomy of land use change dynamics (Leonald and Rowland, 2016). In scoping potential locations for this previous study, my research partner and I travelled extensively by motorcycle across much of the district, as well as visiting up-river areas without roads by boat. I was also familiar with Kalimantan more broadly, having worked and conducted research in two different districts of Central Kalimantan.

During this fieldwork, both of these usual strategies were not particularly successful. Firstly, in both the FOR and OP sites, most homes now had private areas for bathing behind houses, and in only a few of the villages was there communal bathing in the rivers. On the few occasions I tried anyway, this seemed to create more focus on my strangeness and led confusion as to why I was refusing offers to bathe privately. The second issue was that most village residents were much busier throughout the day than I was used to. In past research, particularly in forest areas, the diversity of different livelhood approaches meant that that there were always at least some people around at anyone time. However, the narrowing of livelihood strategies in both sites had meant that villages were often fairly empty during the day, except for a few mothers of young children and one or two village *aparat pemerintah* (civil servants).

Residents in the OP site were so extremely busy that many villages appeared to be almost entirely deserted until the early evening – and even then there was little public socialising in communal areas such as river banks and volleyball courts. In the FOR site, while more men and women were to be found during the day, those present were likely to be less representative of typical livelihoods – usually having recently returned from periods away from the village – either engaged in oil palm labour in Malaysia or elsewhere in Kapuas Hulu, or *gaharu* (Agarwood) expeditions[5]. This created two challenges, the first was that these households, while representing the livelihoods of a sub-set of households, were not representative of the broader population. There was risk, therefore, that convenience sampling would lead to selection bias. Secondly, some men who had achieved financial success either from gaharu or oil palm, could begin drinking rice wine much earlier during the day than those working in fields or the forest. This introduces its another set of research challenges – not least how to integrate and socialise without either turning down multiple offers to join in or becoming incapacitated by drink (and alienating oneself from other, non-drinkers).

Research Assistant and Research Team

To gain trust, therefore, I was required to rely on different strategies. I was helped immeasurably, by the fact that my team consisted of local Indonesians – all of them from West Kalimantan, most of them form Kapuas Hulu. Some of the team spoke multiple Dayak languages, being fluent in several, and were familiar with aspects of dialects in many more. These team members were able to socialise and build trust by speaking in a combination of Dayak languages. For Dayaks, it is common to mix and match languages depending on the interlocutors, combining different words and phrases from different languages and dialects, often in the same sentence. While this helped build trust in the team overall, it made my integration as a non-speaker of any Dayak languages slightly harder – frequently being unsure if my lack of following the conversation was due to the level of my Indonesian or that Dayak words and phrases were being used. In interviews and focus groups, the primary language was Indonesian however, except for when local names were being used or collected (e.g. for forest products). Nevertheless, I was not as active in the social life of the villages as I have been during previous research and this no doubt affected the quality of data.

One approach I found extremely helpful was to interview members of my field team themselves after research was concluded. I also maintained communication with my team via Whatsapp while coding transcripts and conducting analysis to check and verify details and to act as a break against the temptation to "over-fit" data (McSweeney, 2021; Schumm, 2021). The importance of acknowledgement of the role of research assistants as active participants in research has long been overlooked and has only recently begun to receive critical attention from scholars (Deane and Stevano, 2016; Stevano and Deane, 2017). By formalising to some extent my learning from them, and by being explicit in my reliance on them for different perspectives, I hoped to reduce my own bias and stimulate reflexivity (Temple and Edwards, 2002; Caretta, 2015).

Focusing on Health and Nutrition

The other strategy I used to build trust was to emphasise the fact that I was a student conducting research for my thesis and that this research was focused on health and nutrition. This was, again, helped by the fact that the team were young, current or recently graduated students from West Kalimantan Universities. I also discussed my links with my host-institution and research sponsor at Politeknik Kesehatan Kementerian Kesehatan (POLTEKKES), specifically with the nutrition department. I was absolutely clear about my links with CIFOR (with whom participants were already familiar due to the early survey rounds), and this was also explicitly discussed during the process of obtaining consent for interviews and focus groups. However, the fact that the CIFOR study was so clearly about nutrition, and both my team and the CIFOR team tended to operate with the help of the community health workers and volunteers, helped to reassure respondents that we were not focused on being pro- or anti-oil palm.

Avoiding Controversial Issues

I believe that focusing on health and nutrition and not on oil palm specifically significantly increased the likelihood that surveys did not contain systematic bias and that interviewees were more open and less guarded with their responses. The downside, however, is that my data on the oil palm part of livelihoods is less rich. Some data (e.g. company names and concessions) can be obtained from secondary sources. Likewise, other studies report regions and villages in which oil palm

[5]Gaharu expeditions can last between a few days and a few weeks (and in extreme cases months). The periodicity of time allocation is discussed further in Chapter 7, but for these types of households, a period of intense work would be followed by a lower-intensity rest period. If households had cash, and there was no swidden activities to carry out, men would often hang around in the villages before returning to seek income again.

permits have been rejected or where there has been disputes between communities and oil palm companies. However, there are many interesting and relevant aspects of oil palm-related livelihoods which are relevant to the research but which I have not been able to obtain. I was aware, although I chose not to discuss it, that some village's disputes and disagreements were ongoing. I explicitly did not ask about contractual arrangements, and the only data I have relating to this was entirely volunteered without prompting by respondents. I believe it was neither possible nor desirable for me to explore this topic further as it would have compromised the quality of the main focus of my research. Even if I had tried, it is impossible that could have obtained the level of insight that Indonesian researchers have –for example, in the excellent recent research by Yuliani et al. (2020, 2022) and Hasudungan (2018); Hasudungan and Neilson (2020).

Another downside of my focusing on health and nutrition angles during my research and avoiding potentially controversial subjectsm may be aquiessance bias of a differnt nature. Respondents may have felt the need to emphasise the degree to which diets are healthy due to not wanting to be judged. This may lead in some cases to increased emphasis on the consumption of vegetables, fruits and some ASF, and a downplaying of the consumption of processed foods. However, as this is not my main focus – and is more than adequately covered by the CIFOR DFC study (conducted by Indonesian researchers), the bias is likely to have a relatively minor effect. It is worth bearing in mind, however, the difference bewteen theoretically being to able to obtain foods and actually choosing to consume these foods. This is a theme which will be explored throughout the analysis chapters which follow.

Assessing and Resisting Bias

Despite my efforts to minimize the chance of bias, it is inconceivable that my presence as a foreign male researcher did not have some effect on the responses and the quality of the research. This is true for almost all research, but especially for controversial topics and locations such as oil palm in West Kalimantan where local experience of foreigners and researchers are that they rarely, if ever, have no agenda. Additionally, the topic of gender time and labour allocation naturally leads to the topic of intra-household decision-making and power. Again, it is inconceivable that my presence did not influence respondents' openness about certain topics and what they chose to reveal.

The effect on survey answers of my presence, or the presence of any one of the team, and whether the enumerator was male or female can be tested to some extent through quantitative approaches. This can be done by introducing the interviewer or enumerator as a dummy variable in statistical analysis and observing whether an effect can be found. Likewise, in cases where respondents are asked the same question multiple times (e.g. during pilot surveys), inter-rater reliability can be assessed as to whether my presence during the survey. Tests I performed of this nature did not reveal any differences in who the interviewer or enumerator was, but the closed nature of survey questions means this can not be extrapolated to the rest of the data. This issue is far more likely to emerge in open-ended and semi-structured qualitative research, with respondents avoiding certain topics or portraying them in cautious, neutral terms.

Ultimately, it is impossible to know all the ways in which my presence may have affected the results. Only with time and comparisons with the findings of other researchers can we begin to draw more robust conclusions. I can, however, identify a couple of instances where respondents may be altering the way they speak about certain issues for my benefit. One potential case is discussed in Chapter 8: I encountered vastly different views within single villages on the degree of access to forest lands and the abundance of wild animals and plants for eating within oil palm areas – with some respondents suggesting that there was still a plentiful supply of forests and an abundance of animals and others stating that there was a scarcity. Differences in these responses may be simply a result of respondents telling me what they think I want to hear. It is, therefore, vitally important to triangulate such findings and openly report any discordance between results obtained via different methods. It is also essential to thoroughly read the literature – especially studies conducted by Indonesian researchers – and identify any areas of overlap, agreement or discordance with their findings, and entertain the possibility that my presence could have contributed to any discrepancies.

Confirmation bias is a major hazard of qualitative research (Schumm, 2021), which is likely exacerbated in cross-cultural, cross-language research such as this. It is easy to be drawn to data when a respondent says something that fits neatly with an existing theory and overlooks discrepant data. Confirmation bias is not limited to existing theory and preconceptions – the lure of the novel, exciting or potentially *publishable* finding is strong. It is important to resist the temptation to draw upon findings and data which are most likely to have *impact* rather than those which best represent the data. There are several examples of this which occurred during my research. One such case is a handful of respondents mentioning the members of mafia/gangs operating informal taxation, and even roadblocks, on fertilisers and other agricultural chemical inputs. Upon reading the transcripts of interviews, I was excited by the parallels with a recent paper by Li (2018). It was only when further searches of the database failed to reveal mentions of this, and after a follow-up interview with one of my team members that I realised (a) the data I had did not adequately capture the complexity of the situation and (b) to do so would require focused research on this topic, not brief asides mentioned in the context of discussing other topics. Reflecting now on my thrill of having potentially discovered a "gem" within my data is useful to notice the extent to which my excitement reveals my bias and serves as a reminder to notice when such feelings occur and re-evaluate whether the data itself speaks to this issue.

E.12 Research Team Recruitment and Training

The research team consisted of one experienced researcher with whom I had collaborated with on a previous CIFOR-led research project, as well as four team members who were recent graduates in forestry or biology from one of the universities in Pontianak. All of the team originated from West Kalimantan, with three out of five of the team originating from Kapuas

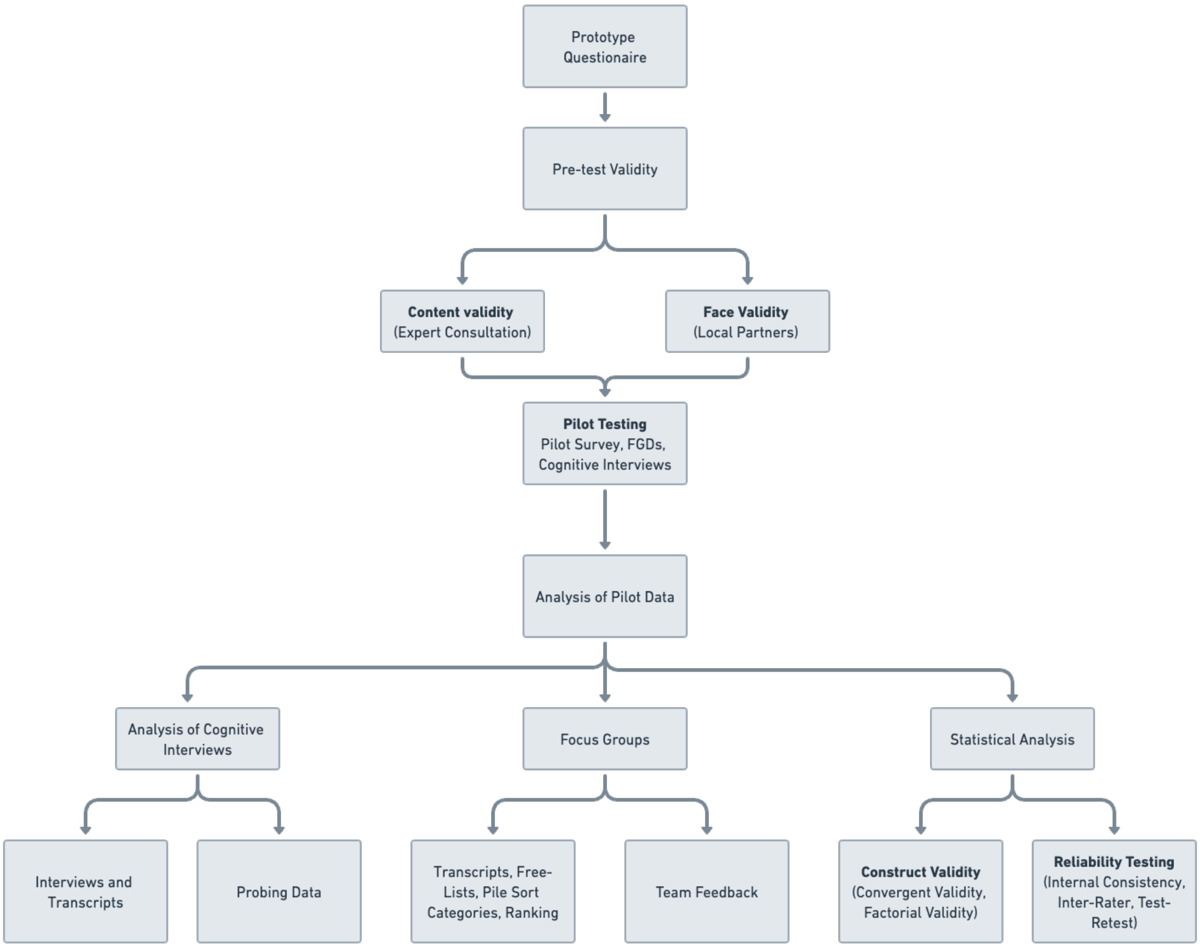
Hulu. Four of the team members were Dayak, while one was Malay. All fieldwork was conducted in Indonesian, although Dayak team members would occasionally speak to village residents in Dayak languages and dialects when interviews or surveys were not being conducted[6].

The importance of training teams in mixed-methods research has been emphasised by several researchers (e.g. Molyneux et al., 2009). Training not only ensures that researchers and research assistants are well-versed in a range of research methods and methodologies but can also build motivation and confidence. Likewise, training, if done right, is a way of including research assistants as active collaborators in the research (Molyneux et al., 2009; Stevano and Deane, 2017), with their knowledge and experience contributing to research design through feedback anticipation of potential issues with the research approach.

Team training was carried out in Pontianak over three days, beginning with familiarisation with the aims and approaches, as well as familiarisation with the methods. Training was provided on all of the techniques used, with different team members sharing their various experiences of fieldwork. Each of the methods used in the survey was discussed, and role-play exercises were conducted to practice the surveys and interview approaches. The team were also provided with a methods manual I authored outlining each of the methods along with some common scenarios. In-field training was conducted during the pilot stage of the study (in villages not included in the main sample) overseen by myself and my research assistant who sat in during interviews and ran nightly de-briefing and training sessions based on our observations. I also analysed survey data to test statistically whether the enumerator conducting the survey had any influence and was unable to detect any bias.

E.13 Pre-Fieldwork Method Development and Pilot Testing

Figure E-5: Questionnaire Design Process



Testing construct validity consists of consultation on the content and design of the questionnaire with a selection of experts in the field. The theoretical scope, measurement approach and survey instrument was reviewed by experts in the field. These consisted mainly of experienced researchers for or visiting the CIFOR campus in Bogor. The experts were asked to review the survey materials for scope, accuracy and validity. Reviewers are asked to assess the survey instrument fits with established theory and is capable of producing the data required for analysis. They were asked to make modifications to

[6] See Appendix E.11 for a discussion of benefits and drawbacks of this.

the survey where needed and input on potential measurement and statistical issues. The modified survey instruments were then translated into Indonesian by a native Indonesian speaker with knowledge of the research field and study location. The phrasing and language used in the translated version were then discussed during the training workshop with the team members to identify any miss-translations or confusing wording, and the surveys were modified accordingly. We also discussed the survey informally with local partner organisations to obtain feedback on whether items made sense in the local context and to pre-empt any potential issues or misunderstandings which might arise

Pilot Survey

The next stage of the process was to assess the survey tools for validity and reliability in the context of the survey. To do this a variety of pre-testing techniques were employed to inform changes to the questionnaire. The pre-testing of the survey was designed to identify any missing but necessary questions, identify missing options and problematic phrasing and to assess whether the survey was well matched for the respondents (i.e.ẇhether respondents are able and willing to answer the questions). Pre-testing consisted of three techniques: (1) Cogitative interviewing; (2) Focus group discussions and; (3) Statistical testing of items.

Cognitive interviewing aims to evaluate how well a respondent comprehends the survey questions. Willis (2004) describes the three main objectives of cognitive interviewing as assessing the respondent's comprehension of the question (what is being asked), the respondent's understanding of the terms used in the question, and the way in which the respondent retrieves of information from memory, makes decisions and formulates the response.

In total, 24 cognitive interviews were conducted. Two main techniques were used for the cognitive interviewing process. Firstly, respondents were asked to "think aloud" (i.e.ḋescribe their reasoning behind answering questions). This process was useful for both open and closed questions. For example, for open questions, respondents externalised some of the assumptions they are making about what the questioner is asking. These were used to rephrase questions or ensure that the questionnaire preamble clarified any confusion respondents may have. For closed questions – especially those involving calculations – the responses were used to break down questions into smaller sub-sections from which to calculate desired values.

The second approach used in cognitive interviewing was probing. While probing is a powerful technique that allows feedback that is quick and specific to the needs of the researcher, it is limited by the foresight of the researcher in designing the probes (Willis, 2004). I therefore limited the use of probing to specific instances where I wanted to check the way in which respondents calculated certain answers – for example, answers which required the calculation quantities ot the of conversion between units.

One of the objectives of this research was to explore new methods and metrics for measuring food environments in rural contexts in LMICs, as there is a lack of available survey instruments for these contexts (see Section 5.4.3). I initially set out to create a set of new scales which could be used to measure specific aspects of the respondent's lives. These aspects (e.g. time pressure) are latent constructs – i.e.u̇nobservable characteristics whose presence is inferred by other observable characteristics. Developing scales for measuring latent constructs is a widely used process in disciplines such as psychology, where the characteristic of interest to the researcher can not be measured directly. Scale development for measuring latent constructs begins with item generation (creating plausible questions which may reflect the latent characteristic) followed by item evaluation and item reduction (DeVilles, 2011).

The pilot stage, therefore, contained multiple questions which aimed to tap into similar properties (which also made the questionnaire long and repetitive). By using factor analysis of the pilot data the degree of association and correlation between items (which indicates if the measure the same thing or not) and the strength of the relationship between a question and the construct (the factor loading) could be tested. This allowed me to reduce the length of the survey by including only the questions that best predicted the property of interest. Additionally, it identified poorly constructed concepts and domains which consisted of two or more latent properties.

Following pre-testing, the statistical analysis of the pilot survey and responses and cognitive interviewing transcripts, the survey was redesigned for implementation in the field. In particular, problematic issues about the relevance of the questions were identified from the FGDs, problematic categories or definitions were identified from the FGDs, unclear, ambiguous use of terms and language was identified from the cognitive interviewing and the questionnaire was reduced in length through the use of factor analysis.

E.14 A Note on Recall Periods

While shorter recall periods are generally more accurate, they are also more likely to lose important seasonal variation. Additionally, with large sample sizes and small research teams they may introduce systematic bias.As Bell et al. (2019) describe, the danger is that "respondents near the beginning of a survey campaign could be utterly incomparable to that of the respondents visited toward the end, some weeks, or even months later". To this end the Inter-Agency and Expert Group on Food Security, Agricultural and Rural Statistics (IAEG) recommends either (a) conducting multiple (typically 2) visits for each household over a period of 12 months or (b) splitting the sample into sub-samples that can be into sub-samples (e.g. quarterly sub-samples) (IAEG-AG, 2018). The latter can be achieved by "randomizing the order in which village clusters are visited" (Bell et al., 2019). The former approach, while perhaps theoretically desirable should be "considered carefully" (IAEG-AG, 2018) due to the increased expense logistically complications as well as the risk that it may increase the burden upon respondents and thus the accuracy of data collected. The latter approach, however, also introduces logistical and training complications as well as introducing "spurious between-subjects variation that could limit the kinds of analysis possible" (Bell et al., 2019).

The tension between capturing seasonal variations and avoiding the pitfalls of introducing bias and error was prominent in the design of my survey approach. I was constrained also by logistical constraints – neither having sufficient resources and teams large enough to conduct simultaneous research in multiple villages, nor being able to complete all the surveys within a short period of time. Thus, I combined two approaches. The first approach was that similar to recommendation (b) produced by the IAEG above[7] to ensure sub-samples in each season were included so that the analysis and results could, where necessary, be aggregated by season. While a full-village cluster randomisation would have been logistically impossible due to the time, expense and resources needed for travel, I adopted a compromise approach of alternating between oil palm and non-oil palm village clusters throughout the fieldwork periodd, ensuring that for each month and each season, there was data from both sites. The second approach I selected was that of selecting different recall periods for different types of questions and topics based upon the likelihood that an event was memorable.

E.15 Reflections on Ethics

Of particular concern to me is a conflict between respecting the anonymity of respondents and reporting apparent malpractice (as reported by village residents) on conducted by oil palm companies. I am cognizant, in the words of Lancaster (2017), that "the decision not to disclose particular information is a political choice which may have implications for maintaining or perpetuating troubling power dynamics".

Prior to starting research, I had decided to anonymise quotes from individuals but also to not reveal which villages these individual respondents were from. I felt (and still do) that these steps were necessary to ensure the safety of research participants – especially considering that it is not always clear to outside researchers what information may be contentious. This does, however, come at a cost to the quality of research as well as introducing other ethical dilemmas.

Without revealing here the details of the issue in question, I was informed of certain practices by a particular company to have adversely affected the livelihoods of a group of local people and appeared to be (without verifying the information myself) a clear breach of an agreement made between a company and a community. In this case, a company unilaterally changed the contractual arrangements they had agreed with communities and did so after several years of operation – resulting in significant, unexpected adverse impacts upon local income and livelihoods. These changes were made (again apparently - I have not verified this information) without consultation with local communities – or at least without consultation with many of them who reported it to me.

The specifics of this case are highly relevant to my research findings – and more generally to studies on the welfare impacts of oil palm. However, discussing them is not possible without revealing information which would allow the villages (and by implication respondents) to be identified. There is an ethical dilemma in this particular case. Firstly, there is the general consequence of researchers not exposing such practices – which may lead to the erroneous interpretation that such things do not occur, or at least that they are rare (or more likely that they are reported on only by environmental NGOs with grievances against oil palm companies). Secondly, there is the specific case of whether my raising of the issue could change anything – i.e. cause a reversal or change in company policy, compensation given to affected parties, sanctions taken against the company by the government, policies put into place to prevent it happening again.

On the first issue, I feel that aggregate consequences of researchers not reporting such issues may be significant - and more neutral voices other than campaigning NGOs are required to expose such malpractice. I am therefore, uneasy that ethical considerations will mean that I do not publicise this malpractice. On the second issue, I am more reassured. It is highly unlikely that my intervention would have any effect in the form of compensation to affected parties or changes in company policies. It should also be noted that affected parties may well have other channels through which to air grievances and complaints – although without a thorough investigation it would not be possible to say whether such processes work or protect complainants from retaliation.

While, for the above reasons, I am uneasy with my decision, I justify not releasing this information on the following grounds: (1) Retaliation against informants in possible - both from the company and local elites who may have made agreements with the company; (2) While respondents volunteered this information, I did not seek to further investigate or clarify (for the reasons stated in 5.6). I am therefore, likely to have an incomplete picture of the whole situation; (3) I was neither asked not asked not to raise this issue with anyone. The information was also volunteered mainly (although not entirely) outside of the context of formal interviews or surveys in social situations; (4) The issues that emerged fell outside of the scope of my research I outlined to respondents and participants as part of the FPIC process. Respondents may have answered differently, or refused or withdrawn consent if they knew I was focusing on this topic.

Given these concerns, I feel that the raising of these issues should be the focus of separate targeted research. This research would be better able to triangulate between multiple respondents and perspectives and act in good faith with participants whose consent has been obtained for the purposes of research on that topic. It is also a topic of research for which foreign researchers are least suited to. Though uneasy with my decision, I console myself that there are many active Indonesian researchers working in general topic today. In the few years following my fieldwork period, there have several excellent recent reports published on similar violations of promises and trust in both the academic (e.g. Yuliani et al., 2020) and non-academic, advocacy-based literature (e.g. Berenschot et al., 2021; Gecko Project, 2022a). While I have not seen reports

[7] The specific recommendation was published in 2018 after my fieldwork, however, the approach I took was discussed as options in various discussion of the dilemma, e.g. in Smith et al. (2014)

of this specific issue, research is increasingly uncovering the disparity between promised contractual agreements and the arrangements which occur in practice.

E.16 Comparison of Methods for Controlling the False Discovery Rate

Throughout the thesis, I compare the two sites using t-tests and z-tests of proportions on many occasions, often comparing many variables at once. Below is a brief comparison of the Bonferroni with alternative, less conservative methods for controlling for multiple comparisons along with a side-by-side comparison using data from this thesis in Table E.4. The distinction between different methods is based on whether you are controlling for False Discovery Rate (FDR) or the Family Wise Error Rate (FWER). The former is the expected proportion of false positives among all comparisons, i.e. the proportion of incorrect rejections of the null hypothesis. The latter is the probability of at least one of the comparisons being a false positive.

Generally speaking, the FWER is used when a false-positive of any particular comparison would be problematic and the FRD is used when the focus is on the overall set of comparisons and a degree of false positives for individual comparisons can be tolerated. In this thesis I have used the most conservative methods for controlling for multiple comparisons for all tables – the Bonferroni correction which controls for the This is likely overly conservative in places resulting in non-significant results. However, the approach is used because (a) it is the most widely used correction in this sort of literature and (b) by minimising false discoveries I ensure that my research presents a conservative analysis and thus do not over-state findings.

Bonferroni is the most conservative correction method, working by adjusting the significance threshold through division by the number of tests, N. The formula for Bonferroni is given by:

$$\alpha_{\text{adjusted}} = \frac{\alpha}{N}$$

The next most conservative method is the Holm method, which is calculated by first ranking the p-values from smallest to largest and using the rank and the number of comparisons to adjust the significance threshold. The formula for Holm is:

$$\alpha_{\text{adjusted},i} = \frac{\alpha}{N - i + 1}$$

where i represents the rank of the p-value.

A less conservative method is the Benjamini-Hochberg procedure for controlling the False Discovery Rate (FDR). It adjusts the significance threshold in a similar though modified way to the Holm method by first ranking p-values. The formula for the Benjamini-Hochberg procedure under independence (the most relevant for my research) is:

$$\alpha_{\text{adjusted},i} = \frac{i \cdot \alpha}{N}$$

Finally, a slightly more conservative method for controlling the FDR is the Benjamini–Yekutieli method which uses 1/rank instead of the rank. The formula for Benjamini–Yekutieli is:

$$\alpha_{\text{adjusted},i} = \frac{i \cdot \alpha}{N \cdot C(N)}$$

where $C(N)$ is the sum of the reciprocals from 1 to N.

Table E.4: Comparison of Methods to Control for False Discovery Rate and Family Wise Error

Table shows significance at the < 0.05 level

	Forest		**Oil Palm**		**Uncorrected**		**Holm**		**Benjamini Hochberg**		**Benjamini–Yekutieli**	
Variable	**Mean**	**SD**	**Mean**	**SD**	**p-value**	**sig.**	**adj. p-value**	**sig.**	**adj. p-value**	**adj. p-value**	**adj. p-value**	**sig.**
var_a	6.2	5.8	3.3	1.4	0.0000	***	0.0036	***	0.0036	***	0.0036	***
var_b	4.8	6.4	2.6	2	0.0010	***	0.0042	***	0.0107	***	0.0012	***
var_c	4.3	3.4	2.2	1.3	0.0010	***	0.0046	***	0.0143	***	0.0009	***
var_d	4.6	5.4	3	3.2	0.0080	***	0.0050		0.0179	***	0.0007	
var_e	5.4	5.1	2.2	1	0.0080	***	0.0056		0.0214	***	0.0006	
var_f	4.2	6.4	1.5	1	0.0100	***	0.0063		0.0250	***	0.0005	
var_g	2.8	1.6	2.1	0.9	0.0220	***	0.0071		0.0286	***	0.0004	
var_h	3.3	1.8	2.3	1	0.0560		0.0083		0.0321		0.0004	
var_i	0.8	1.8	0.5	1.2	0.1090		0.0100		0.0357		0.0004	
var_j	0.3	1.9	0	0	0.2050		0.0125		0.0393		0.0003	
k	3.6	12.5	1.8	9.6	0.2300		0.0167		0.0429		0.0003	
var_l	4.5	5.7	6.6	14.3	0.2490		0.0250		0.0464		0.0003	
var_m	3.3	1.6	2.3	0.6	0.2980		0.0500		0.0500		0.0003	

Appendix F: Supplementary Information for Chapter 6

F.1 Historical Upriver – Down River Axis

The coastal regions of Borneo have been integrated into global markets since pre-industrial times. Coastal communities were both staging posts on trade-routes to and from China, as well as centres of trade themselves, exporting gold, diamonds, camphor, and NTFPs including tortoise shells, hornbill ivory, rhinoceros horn, birds nests, spices among many others (Broek, 1962). Evidence for trade in some NTFPs dates back as early the first century CE, with trading networks extending as far as China, India and The Persian Gulf (Sellato, 2002). Archaeological evidence suggests Chinese and Indian-influenced centers of trade date back to as early as the 6th Century (Broek, 1962). However, historically *upriver* groups remained practically autonomous, even if theoretically ruled by coastal sultanates, while those furthest upstream were exempt even from paying tribute (Sellato, 2001). Likewise, the numerous kingdoms and empires which claimed control over parts of Borneo[1] tended only to exert control over the coastal populations who operated as middle-men for tradable resources from the interior

Dove (2011b) explains the importance of such coastal kingdoms thus:

> *The historic power of native, coastal kingdoms like Banjar was explicitly based on their ability to veil the wealth of the interior from the eyes of outsiders, thus enabling them to act as middlemen in the trade of everything from pepper to bird-of-paradise feathers.* Dove (2011b, p35)

Citing Alfred Russel Wallace's accounts (1869) of his *difficulties* of collecting specimens directly from those living in the interior of Borneo, Dove explains:

> *Such contact would have undermined the long-established authority of the coastal natives, which was based on ensuring that no one but them had such access to the interior peoples.*
> Dove (2011b, p262)

The interior of Borneo has often been beyond the effective political control of coastal coastal kingdoms and sultanates, and even latterly, colonial powers (Wadley, 2001). Indeed, prior to the establishment of the Raj of Sarawak[2] in 1841, Dutch maps of the the interior were lacking basic geographical information (Irwin, 1955). Upriver communities in the interior of Borneo had largely been ignored by Dutch colonialists until 1846. Irwin (1955) describes how the Dutch maintained control through vassal kingdoms and sultanates, maintaining power without direct control by setting different groups and regimes against one another. Only two dutch expeditions had ever ventured up the Kapuas River, and there was no Dutch presence anywhere as far upstream at Kapuas Hulu[3], until the late 1850s and 1860s (Wadley, 2001).

F.2 History of the "Borderland"

> Hills along the border are easily crossed and pose no physical barrier. Besides the main border roads such as the one between Nanga Badau (Indonesia) and Lubok Antu (Sarawak) (which locals have used for centuries), there are estimated to be more than 50 small back-roads, or "jalan tikus" (mouse paths), leading into Sarawak. . . .the sheer size and amount of traffic have made locals rename these cross-border routes as "jalan gajah" (elephant paths). Eilenberg (2012),P.19

[1]Pre-Dutch colonialism, numerous kingdoms and sultanates have controlled parts or all of the coastal areas of Borneo, often with local kingdoms acting as vassal states for larger empires including the Hindu-Buddhist Majapahit Empire (centered around Java), the Chinese Ming Dynasty and the pre-Islamic Sulu empire (centred around modern-day Phillipines).

[2]Also known as the Brooke State or State of Sarawak, this independent state was was run independently from the British Empire until 1946 by the British Brooke family following land concessions obtained from the Sultan of Brunei for mercenary aid in suppressing a local rebellion. The origins and history of this regime are complex but fascinating. Wadley (2001), based upon personal communication with historical John Walker, states that the Raja or Sarawak should be considered a colonial power, despite it clearly not resembling the colonial model prevalent elsewhere at the time. While it was a dynastic monarchy, it integrated a greater level of local participation than other colonial powers and (arguably) existed with a greater (if only partial) degree of local consent than other colonial powers. This is a highly contentious and complex issue. For further reading see Runciman Runciman (2011) and Walker Walker (2001, 2020). Additionally, for an earlier (extremely dated but fascinating) overview of the period see Irwin (1955).

[3]Wadley (2001) draws a wide range of source material including primary material from Dutch archives showing that prior to 1841 only two Dutch expeditions had been sent up the Kapuas River (1822 & 1823), and that Dutch maps were based entirely on these. A post existed for a brief period in Sintang, but was withdrawn by 1826. There is little evidence of long-term contact further upstream until after the establishment of the Brooke State, after which the Dutch sent representatives upstream in 1847, 1854 and 1855 to renew contracts with local kingdoms (created in 1823).

The contemporary land border between Indonesia and Malaysia that separates Kapuas Hulu from the Malaysian province of Sarawak originates from these conflicts' attempts to entrench colonial power in Borneo (Wadley and Eilenberg, 2005). Following the establishment of the Raj of Sarawak, Dutch Colonial authorities, began to dedicate more resources and attention to the area, and ensure control of local kingdoms, which had previously operated with almost complete autonomy (Wadley, 2001). Wadley (2001) provides an excellent account of the relations and tensions between Dutch colonialists the newly formed Raj of Sarawak and the founder of the Raj of Sarawak James Brooke during the period 1841-1886. The account describes how the founding of the Raj of Sarawak threatened Dutch colonialists in multiple ways: militarily (through potential territorial expansion, supporting local uprising, and/or selling of firearms), economically (through stimulating cross-border trade, facilitating smuggling and/or undercutting Dutch prices via Malay trading settlements across the border).

The border became a source of frustration to colonial powers due to the continued movement of the local Iban population across the border while refusing to pay taxes and end headhunting practices[4] (Wadley, 2001). A major stated aim of the Brooke State was to end the practice of headhunting, while simultaneously offering protection (in return for taxes) for other local groups from Iban raids (Walker, 2001, 2020; Runciman, 2011). Lack of effective political control also meant that the Iban had evaded paying taxes to the Dutch and Raj authorities[5] which considered the area their possession (Wadley, 2001; Pringle, 2010). While they had different approaches[6], both sides used violent means to subjugate border populations and bring them under the control of the state.

The borders solidified by the Dutch and Brooke colonial regimes, re-emerged as sites of conflict following Indonesian independence in 1949 and the incorporation of the State of Sarawak into the Federation of Malaya (leading to the establishment of Malaysia) in 1963. During the 1960s, President Sukarno embarked upon armed conflict with the newly formed state of Malaysia (known as *Konfrontasi*) over the incorporation of Sarawak into Malaysia. These conflicts were exacerbated by cold-war tensions, with Sukarno (known to have increasing associations with communist organisations and countries) directly supporting and training communist volunteer rebels who were fighting against the British state, as well as implicitly allowing them sanctuary over the border in West Kalimantan[7] (Fowler, 2006; Eilenberg, 2012).

Following the ousting of Sukarno and establishing the New Order Regime, geo-political tensions were eased due to President Suharto's more pro-western stance. However, the border remained heavily militarised. As part of the new regime's anti-communist stance, the Indonesian military targeted communist rebels in West Kalimantan, as well as locals supporting them were targeted by the Indonesian military. While most local Iban remained neutral, some locals aided the military in purging communists and communist sympathisers from the areas. A "select few" leaders of these groups were later rewarded with forest concessions by the military to *form the base of the border elite* (Eilenberg, 2012), which dominates today. The New Order regime pursued twin objectives of increasing economic and national security controls in the border area. In 1967, on the grounds of *national security considerations* an Indonesian military-owned company (PT Yamaker) was granted logging rights to a concession covering over one million hectares along the Indonesia-Malaysia border (HWC, 2006; Obidzinski et al., 2007). The military, however, lacked both the capital and technical knowledge to conduct logging operations, so it relied instead on wealthy investors and contractors, including Chinese businessmen from Pontianak and Malaysian Timber companies (despite having a publicly facing anti-Chinese and anti-Malaysian stance) (Wadley and Eilenberg, 2005).

During the *Reformasi* (reform era) which followed the fall of Suharto, significant powers were decentralised, allowing provincial and district governments new powers, among them, the power to issue logging concessions (Moeliono and Limberg, 2012). In Kapuas Hulu, *Bupati* (heads of District Government[8]) primarily used their new powers to issue licences to local co-operatives, working in collaboration with Malaysian timber entrepreneurs (Wadley and Eilenberg, 2005). Connections with Malaysian timber entrepreneurs *(tukei)* , as well as infrastructure and logistics, resulted in vast quantities of timber – both legal and illegal – being transported across the Border to Sarawak through a vast network of small roads (Obidzinski et al., 2007).

The increasing dominance of Malaysian entrepreneurs in the timber industry in Kapuas Hulu led to concerns at the national level of undue Malaysian influence over the region, leading to increased national-level state control over the industry (Eilenberg, 2012; Hasudungan, 2018). Additionally, the rapid expansion of oil palm estates in Malaysia during the 1990s, led to concerns among officials that the relative under-development of Kapuas Hulu relative to Sarawak could lead eventually to Malaysian expansion (Hasudungan, 2018), as well large numbers of Indonesians working illegally as oil palm labourers in Malaysia (Potter, 2009).

National policymakers, therefore, saw the need to for rapid economic development along the border region, able to secure the border, raise living standards for border communities and absorb the labour of returning migrants from Sarawak (Cramb, 2007; Hasudungan, 2018). In the early-to-mid 2000s, the national government announced a number of strategies and plans for the border regions, re-defining them as the nation's front yard (*halaman depand*) (Eilenberg, 2012). The plans involved the creation of a new *plantation corridor* along the entire 200km border with Malaysia, justified partially on border security grounds (despite involving Malaysian investors as some of the main investors) (Potter, 2009; Eilenberg, 2012).

Despite the national strategy to use oil palm plantations along the border, conflict between branches and levels of govern-

[4] In fact, the Brooke State ultimately explicitly sanctioned headhunting by Iban mercenaries against other Iban.

[5] as well as to the Sultanate of Brunei.

[6] Wadley (2001), The Dutch used local "auxiliary" troops consisting of non-Iban groups with historical grievances with the Iban such as Kantu Dayaks and Kapuas Malays under the command of rotating Dutch officers (rotated to as to ensure distancing from populations). The Brooke State had a policy that "only Dayaks can kill Dayaks" and used Iban mercenaries, both to control and punish resisting Iban groups, but also to provide a "sanctioned" outlet for headhunting, raiding and plunder. The Dutch established border posts and territorial control over the border more effectively and earlier than the Brooke State which aimed to control the area politically but was less concerned about physically occupying border territory.

[7] Requiring Commonwealth forces to make territorial incursions into Indonesia in order to pursue rebels.

[8] The term *bupati* originates from Dutch colonial times. The literal translation is "regent" but are analogous to a mayor. The *bupati* is a directly elected political position with wide-ranging executive powers.

ment, as well as opposition from local, and transnational NGOs as well as some local groups delayed oil palm development (Potter, 2009). The earliest oil palm development in Kapuas Hulu began in 2001 in Silat Hilir Large scale Oil palm development began in 2001 in Silat hilir, partiality in response to security concerns (Shantiko et al., 2013) – but was considered too far from the border by local government officials (Hasudungan, 2018). Additionally, vast areas of forest were cleared (logged) with the justification of oil palm development which failed to materialise (Potter, 2009). In 2011, Kapuas Hulu was included as one of eight regions included in the *Grand Design* (Bappenas, 2011), a 15 year plan for economic development along the border. This coincided with presidential regulation aiming to scale up economic growth in border regions, driven in large part by the development of agricultural plantation (Eilenberg, 2014)

F.3 Swidden and Sawah

Respondents generally distinguished between dry swidden (*ladang kering*) and rain-fed wet swidden (*ladang sawah*). The former is traditional swidden growing upland varieties of dry rice. The latter is rain-fed wet rice production cultivated on land likely to flood for part of the year (i.e., lowland land in naturally occurring dips and hollows). While respondents referred generally to "*ladang sawah*" as a catch-all phrase for wet rice production, sawah rice in fact exists on a continuum from "wet swiddens" or "natural sawah" (often referred to as "*padi paya*") to "complex sawah" ("*padi sawah*")[9]. Wet swiddens can be a transitional stage towards complex sawah depending local soil conditions. The term "lading sawah" differs from the meaning of "sawah" in Java and other parts of Indonesia where it refers to irrigated wet paddy rice. No rice production was irrigated in either site. Unlike wet rice, rice grown in *ladang sawah* tended to be flooded for only around 2 months of the growing cycle. Rice varieties planted are primarily local indigenous cultivars in both types of farming. The same varieties could be planted in either type of field, but some types were considered better adapted for particular fields types.

> *"It is much better to sawah. Like before to give an example, because the fields move around the trees are so big, so we cut down and we burn it down then we clear it, then we will straighten it. For the sawah you do not need to clear. You can do it all with a hoe. Straight after hoeing you plant, it is not like this with moving around"*
>
> **Quote F-1:** (OP_Vill4_KI_F)

Dry swidden was the dominant form of rice production in both sites. As definitions of sawah varied too widely between villages, I am unable to provide a quantitative estimate of the frequency of *ladang sawah* and *ladang kering.* While data was collected on this in both the farm survey and the wider DFC survey, I am not sufficiently confident the survey question was interpreted the same way in every village. I can, however, augment the findings with my own observation that *ladang sawah*, though more widely practiced in the OP site, was a small minority of rice fields in both sites. The few households in the forest site who had experimented with sawah production, either individually or as part of government trials, gave up due to the cost of agricultural inputs, which they saw as an unnecessary expense when swidden did not require it. Those in the swidden area generally did not desire to switch to *ladang sawah* for this reason – along with the fact that rice from swidden was said to taste better and be healthier due to the lack of chemicals. This view was not universal, however, with some respondents reporting that a lower cost of chemical inputs would encourage them to make the switch. In these cases, the appeal of sawah was its routine maintenance, seen as a less complicated and more predictable form of agriculture requiring only a regular small amount of time weekly. Despite this, for the most part, residents in the forest site had no strong desire to switch to *ladang sawah.* While only a minority of farmers had made the full switch to *ladang sawah* in the OP site, there was little evidence that those who had made the switch regretted the move. *Ladang sawah* was seen as more compatible with their livelihoods, primarily due to the time constraints of oil palm labour

Sawah was said to only be possible on good quality soils with the aid of fertilisers – but many respondents stated that suitable land was not easily available. In one FOR village, villagers who had trialed *sawah* had eventually abandoned it due to poor results (Quote F-2)

> *"You can't [sawah] here, the soil has already been fertilised and you still can't"*
>
> **Quote F-2:** (FOR_Vill4_FGD_M)

While many households in both sites were moving away from traditional upland, long-fallow swidden – the practice was seen as linked with tradition. Swidden remained highly important in swidden culture, with many respondents emphasising that changes were made only out of necessity. For example, as one respondent put the recent decision to use chemical inputs that were not traditionally used:

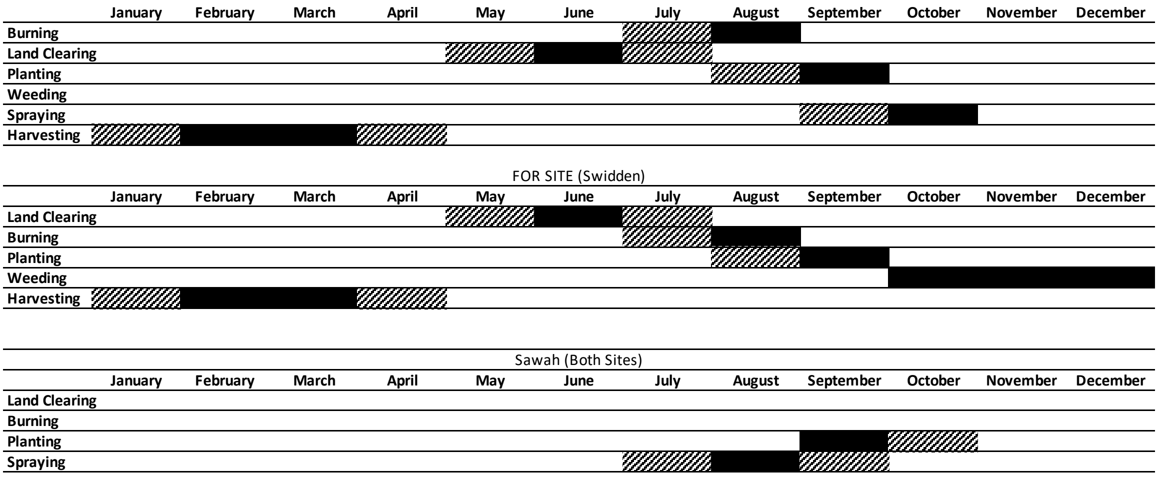
> *"[swidden] is a tradition of the people here from generation to generation...it's the work of our great grandfathers... Whether we like it or not, this is our production [system]. Whether we like it or not, this what it is for us. But this is what we want for the rice fields – to not use our hands, but use tools like this [chemicals] because we are so tired"*
>
> **Quote F-3:** (OP_Vill1_KI_F)

F.4 Swidden Calendars and Seasonal Cycles

> *"Last year we start clearing [the ladang] in June, after one or two months and it's been burned in August we planted rice. The rice planting season, it's called 'nugal' by people here. Once 'nugal'*

[9]For more details see Padoch (1985); Padoch et al. (1998); Potter (2015))

Figure F-1: Swidden Season



> *was finished in the month October it was sprayed, around February it was harvesting, the rice was starting to come out, so we didn't buy rice, we already had the harvest from the fields. There are people who sometimes buy a little, but for a few months at a time like that, but not much, just up to the harvest again"*
>
> **Quote F-4:** (OP_Vill_FGD_KI_F)

Quote F-4 above describes a typical seasonal cycle for swidden farmers in the OP site. While the exact timings of each activity vary from year-to year and by location, Figure F-1 shows the months during which different activities are typically carried out in swidden cultivation as well as sawah, based upon focus group data. The main differences between sites are absence of weeding during the months October-December in the OP site, replaced instead by the spraying of chemical inputs. Low-level maintenance did occur during these months in the OP site, but were not considered a major seasonal activity. Figure F-1 also demonstrates the perceived advantage of sawah cultivation over swidden cultivation. Two main advantages were perceived by respondents cultivating sawah. The first was the shorter time between plating and harvesting, which averaged just 4 months compared with 6 months under swidden. The second advantage was the perceived low level of labour input outside of the spraying, planting and harvest times. As one respondent who cultivated sawah fields in the OP site stated:

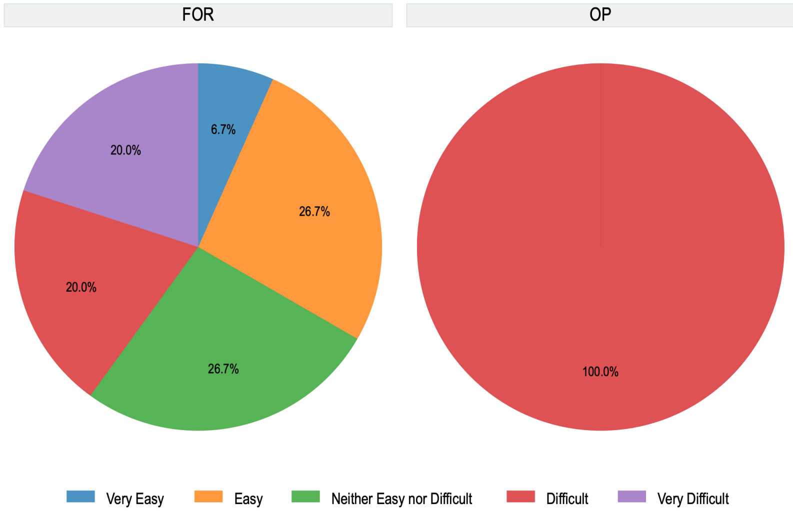
> *"...sawah is not too tiring, caring for it is easier and faster. For example, in August we spray, in in September we are planting, the rest is just waiting for the results. If it was a ladang. you have to cut down, then clear, then drill, then clean etc. that's the problem"*
>
> **Quote F-5:** (OP_Vill3_KI_F)

F.5 Description of Government Programmes

KIP (Kartu Indonesia Pintar) Literally "Indonesia Smart Card", the programme provides financial assistance to students from poor families covering school fees, books, and other related expenses. **KIS (Kartu Indonesia Sehat):** Literally "Indonesia Health Card", the programme is a subsidised health insurance program ensuring access to public health facilities (and some private facilities). Levels of subsidies are dependent on household income. **PKH (Program Keluarga Harapan):** Literally "Family Hope Programme", the programme is is a conditional cash transfer program targeted at the most vulnerable households. Cash transfers are conditional on families meeting certain health and education requirements, such as children's attendence at school and obtaining vaccinations.

F.6 Perceived Road Quality During Wet Season

Figure F-2: Perceived Road Quality During Wet Season



F.7 Diversity of Livelihood Strategies and Approaches

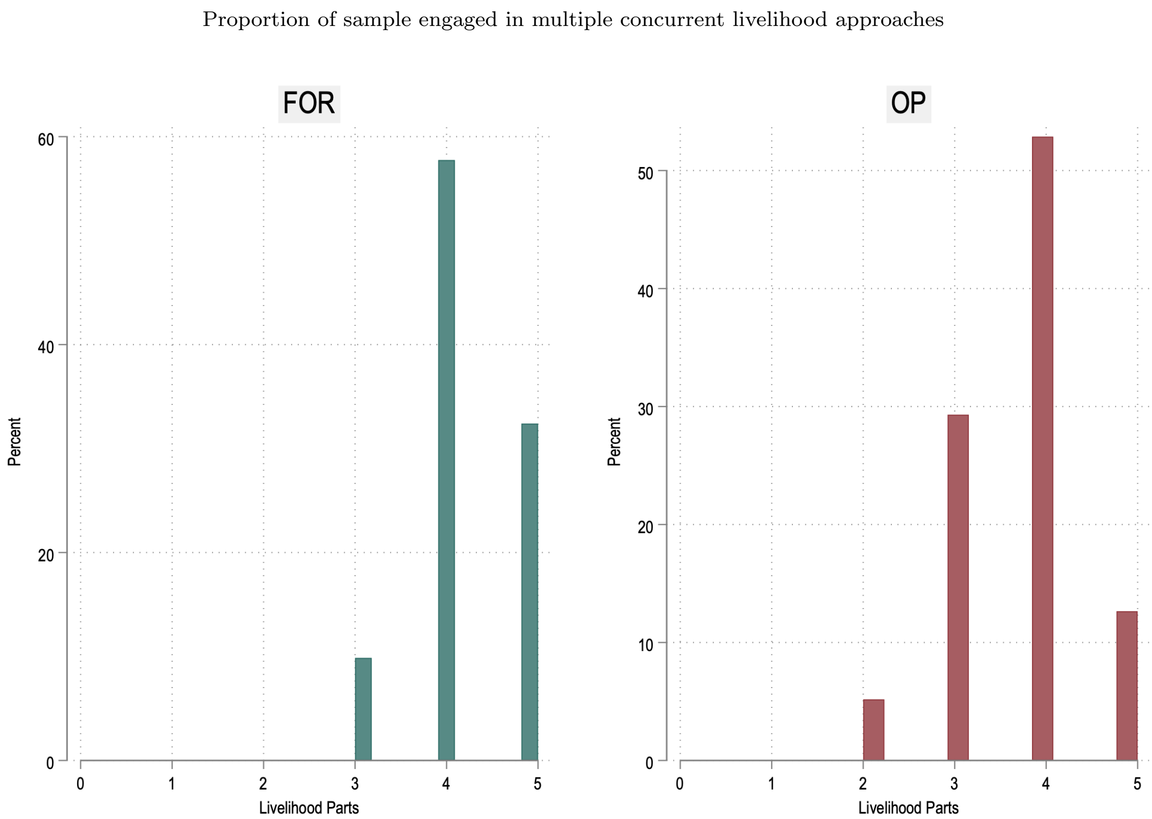
While the individual components which make up each source differ by site, the strategies are remarkably similar. As shown in Table 6.6, livelihood strategies can be categorised into 5 approaches:

1. Diversified subsistence farming system consisting at least two types of fields:
   (a) Rice production centred around a modified swidden cultivation (with or without vegetable production)
   (b) Other food (predominantly fruit and vegetable) via home garden and/or extensive poly-crop (usually agro-forestry) based system
2. One or more commercialised cash crops (e.g. rubber, pepper, kratom)
3. Supplementation of subsistence foods (and/or income) with foods from wild and forest sources
4. Income from waged labour or other off-farm income sources
5. Supplemental (relatively minor) income from home-based business such as home-front shops (*warung*), handicrafts or (in OP site) plasma scheme revenue

Figure F-3 shows the distribution of households and the number of livelihood approaches they adopt using the five-level categorisation described above. The figure indicates a shift in the distribution to the left of the graph in the OP site – as evidenced by a slight statistical difference in the mean number of livelihood approaches (FOR=3.73, OP=4.22, p=0.00). However, rather than than creating total specialisation in oil palm and oil palm-related off-farm labour, livelihoods in the OP site remain surprisingly diverse. Far fewer households in the OP site have adopted all five of the approaches, yet over half of households in both sites adopt four approaches.

The main difference between the sites is not the diversity of livelihood approaches but the degree of emphasis/dependence on particular parts and the nature of the constituent livelihood strategies. For example, in the OP site, swidden rice cultivation was more heavily modified than in the FOR site and produced foods with lower quantities of rice sufficient for fewer months of the year. Farming households in the OP site were more likely to rely solely on homegardens as an additional source of subsistence food production, while households in the FOR site were more likely to have a wide range of extensive forms of agroforestry and poly-culture fields. Likewise, oil-palm-adopting in the OP site has not resulted in an abandonment of rubber – but a replacement of rubber with pepper cultivation (though many households still retain infrequently used rubber fields). Surprisingly, engagement in some wild and forest-based activities is comparable between sites. While participation in and the frequency of hunting is lower in the OP site, and *gaharu* seeking is no longer an activity, participation in fishing and the acquisition of wild edible plants is extremely high in both sites. In the OP site, there is a far greater emphasis on employment and off-farm waged labour, though households in the FOR site also engage in these activities periodically as needed or when opportunities arise.

Figure F-3: Concurrent Livelihood Approaches



Average number of livelihood approaches and proportion of households engaged in each of the five approaches

Variable	**FOR**	**sd/se**†	**OP**	**sd/se**†	**p-value**
Average Number of Approaches:	4.23	0.05	3.73	0.06	0.00
Proportion of HHs Participating in Livelihood Approach					
Subsistence Agriculture	1.00	0.00	0.90	0.00	0.00***
Rice Fields	0.99	0.01	0.80	0.01	0.00***
Other Subsistence Fields	0.96	0.02	0.73	0.02	0.00***
Cash-Crops	0.92	0.02	0.65	0.02	0.00***
Wild and Forest Resources	1.00	0.00	0.99	0.00	0.20
Waged Labour (Formal and Informal)	0.91	0.02	1.00	0.02	0.00***
Supplementary Income	0.40	0.04	0.20	0.04	0.00***
Number of Livelihood Approaches					
Two	-	-	0.05	0.00	0.01***
Three	0.10	0.03	0.29	0.03	0.00***
Four	0.58	0.04	0.53	0.04	0.39
Five	0.32	0.04	0.13	0.04	0.00***

Notes: Significance levels have been corrected for multiple comparisons using Bonferroni correction. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. †Unless otherwise stated, t-tests have been used for continual variables and z-tests of proportions for binary variables.

Appendix G: Supplementary Information for Chapter 7

G.1 Sensitivity Analysis of Weighting of Primary and Secondary Activities

Individuals in the FOR site made up 45.4% of the sample with the remaining 54.4% coming from the OP site. In the OP site, participants were predominantly women (58%) while in the FOR site, men and women were equally represented. On average, women in the OP site were younger than women in the FOR site and significantly better educated. While there are no differences in the land endowments, households in the OP sites are wealthier and tend to be smaller, with fewer younger and older members.

Table G.1: Sensitivity Analysis of Weighting of Primary and Secondary Activities

	Weighting 0.5		**Weighting 0.8**			
	Mean	**SD**	**Mean**	**SD**	**t**	**p-value**
Ratio off-farm	0.19	0.15	0.19	0.15	-0.09	0.92
Ratio forest and agriculture	0.09	0.12	0.09	0.12	0.03	0.97
Ratio of reproductive activities	0.13	0.10	0.13	0.10	0.09	0.92
Ratio personal and leisure	0.25	0.07	0.25	0.07	-0.01	0.99
Ratio sleep	0.34	0.04	0.34	0.04	0.03	0.97

Notes: Sensitivity analysis showing differences in ratios between weighting concurrent primary and secondary activities as 50% each and as 80% primary and 20% secondary

G.2 Supplementary Tables from Quantitative Analysis

Table G.2: Individual characteristics

	Men					**Women**				
	FOR		**OP**			**FOR**		**OP**		
	Mean	**sd**	**Mean**	**sd**	**Diff.**	**Mean**	**sd**	**Mean**	**sd**	**Diff.**
Age (years)	31.0	4.68	29.9	5.81	1.07	29.3	5.12	27.7	5.57	1.60*
Primary education (%)	0.49	0.50	0.67	0.47	-0.18*	0.48	0.50	0.76	0.43	-0.29***
Middle school education (%)	0.30	0.46	0.19	0.39	0.11	0.19	0.39	0.10	0.30	0.09*
High school education (%)	0.22	0.41	0.14	0.35	0.07	0.33	0.47	0.14	0.35	0.19***
High Season (%)	0.65	0.48	0.67	0.47	-0.02	0.49	0.50	0.61	0.49	-0.12

* Significance: $p < 0.1$; $p < 0.05$; Significance: $p < 0.01$

Table G.3: Household characteristics

	FOR	**sd**	**OP**	**sd**	**Difference**
Demographic:					
Female	0.58	0.49	0.50	0.50	0.08*
Children <14yrs	2.51	1.12	2.27	1.14	0.24**
Children 14-18yrs	1.52	1.15	1.42	1.02	0.10
Adults >60yrs	0.28	0.57	0.16	0.44	0.12***
Socio-Economic:					
Female employment	0.44	0.50	0.89	0.32	-0.45***
Land area	1.66	1.93	1.29	4.17	0.38
Asset Index	-0.73	1.27	0.82	1.68	-1.55***

Significance: * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$

Table G.4: Marginal effects of covariates on time shares in activities

	Wage Work	**Agriculture and Forest**	**Reproductive Labour**	**Personal and Leisure**	**Sleep**
Female	-0.067***	-0.026***	0.123***	-0.026***	-0.003
	(0.011)	(0.008)	(0.008)	(0.006)	(0.004)
Oil palm	0.119***	-0.094***	0.007	-0.015	-0.016***
	(0.014)	(0.015)	(0.008)	(0.009)	(0.006)
Female employment	0.135***	-0.018*	-0.048***	-0.056***	-0.013***
	(0.013)	(0.010)	(0.008)	(0.008)	(0.005)
Age	0.001	0.000	-0.002**	0.000	0.000
	(0.001)	(0.001)	(0.001)	(0.001)	(0.000)
Middle school edu.	-0.013	0.008	0.005	0.006	-0.005
	(0.013)	(0.011)	(0.010)	(0.009)	(0.005)
High school edu.	-0.004	0.003	0.001	-0.003	0.003
	(0.012)	(0.009)	(0.009)	(0.007)	(0.004)
High season	-0.001	0.004	0.010	-0.023***	0.009**
	(0.009)	(0.008)	(0.007)	(0.007)	(0.004)
Wealth (asset index)	0.002	-0.006**	0.000	0.002	0.002*
	(0.003)	(0.003)	(0.002)	(0.002)	(0.001)
Children <14yrs	-0.003	0.003	0.003	-0.000	-0.002
	(0.005)	(0.004)	(0.003)	(0.003)	(0.002)
Children 14-18yrs	-0.000	-0.012***	0.008**	0.002	0.002
	(0.005)	(0.004)	(0.004)	(0.003)	(0.002)
Adults >60yrs	0.006	0.000	0.004	-0.014**	0.004
	(0.010)	(0.008)	(0.007)	(0.006)	(0.003)
Land area (log)	0.001	0.005	-0.002	-0.005	0.001
	(0.005)	(0.004)	(0.003)	(0.004)	(0.002)
Hired labour	0.005	0.008	-0.002	0.000	-0.011
	(0.013)	(0.014)	(0.011)	(0.012)	(0.007)
Fertilizer	-0.000	-0.011	0.001	0.003	0.007
	(0.015)	(0.018)	(0.013)	(0.012)	(0.008)
Pesticide	0.023	-0.017	-0.021**	0.005	0.009
	(0.014)	(0.014)	(0.010)	(0.010)	(0.006)
Herbicide	-0.010	0.008	-0.009	0.028***	-0.017***
	(0.013)	(0.010)	(0.008)	(0.007)	(0.005)
No rice	0.009	0.017	0.005	-0.018	-0.013*
	(0.013)	(0.017)	(0.011)	(0.012)	(0.008)
Grows rubber	-0.030***	0.023**	0.012	-0.006	0.001
	(0.011)	(0.010)	(0.008)	(0.008)	(0.005)
Grows pepper	-0.014	0.019	0.003	-0.008	0.000
	(0.013)	(0.019)	(0.011)	(0.010)	(0.007)
Chi-squared	1308.44***				
BIC	1748.543				
AIC	1417.883				
N	603				

Note: Fractional Multinomial Logit model. Robust standard errors clustered at household level. *** denotes statistical significance at 1

G.3 Comparison of Model with Alternative Specifications

As indicated in Section 7.3.2, our model clustered standard errors at the household level based upon a theoretical and methodological justification. However, the data is hierarchical with households nested in villages. It is therefore possible that unobserved village-level effects are influencing the findings. There are several potential approaches of addressing this problem. For example, standard errors could be clustered at both village and household levels. Alternatively, a mixed-effects model could be used to account for the hierarchical nature of the data structure. Unfortunately, neither of these options are possible using the available statistical packages for fractional multinomial regression which do not currently allow for clustering of standard errors at multiple levels nor mixed-models. While they are available for other types of regression, fractional multinomial models are inherently superior for the purposes of time allocation (Picchioni et al., 2020) as shares of time spent on different activities highly dependent and their analysis as a share allows for the accounting of inherent trade-offs between time allocated to different activities.

Since multi-level clustering of standard errors and mixed-effects models are not currently possible with fractional multinomial regression, an alternative approach is to run a fixed effects model - which in this context of cross-sectional observational data consists of dummy variables included for each of the villages. This approach may address omitted variable bias at the village level, but also has significant drawbacks. In the context of our data, there is perfect multi-collinearity between villages and oil palm (as villages are either OP or not OP) which prevents the model from converging in the full data set. To adopt this approach it is therefore necessary to split data set into two (OP and FOR) and run the model separately for each without the OP interaction term. This approach is less desirable both because interactions between OP and gender are the primary outcome of interest, and because it reduces the sample size significantly — and thus reduces the overall power of the analysis.

Indications of Village-Level Clustering

To determine whether a hierarchical linear model is necessary it is necessary to calculate the proportion of the variance in the outcome variable that can be attributed to the grouping variable (Lee, 2000). I therefore calculated the Intraclass Correlation Coefficient (ICC) to determine the proportion of varience in the outcome variables that can be attributed to the village level (see table G.5). Lee (2000) states that ICC values below 0.1 can be considered “trivial” and that only when correlations are above 0.1 should hierarchical linear models be considered. The results table X indicate that the correlations are in extremely low for all outcome variables and only one of the six correlations is greater than the 0.1 threshold – and only then only marginally. It is reasonable to conclude therefore that within village clustering has a relatively minor effect and therefore there is no need for a mixed-effects model.

Table G.5: Intraclass Correlation Coefficient (ICC) for Village Level

Time Shares	**FOR**	**OP**
Employment	0.112	0.097
Own-Production	0.000	0.027
Reproductive	0.028	0.000

Comparisons of Model Fit

While the fixed-effects models are less desirable, for the sake of comparison, model fits are compared are in Table G.6. The fixed-effect model was run for both the OP and FOR sample and compared with the random effects model in each case. In neither sample is the model is significantly improved by inclusion of village dummy variables. For both the FOR and the OP samples, the fixed-effects models have (very slightly) lower log-likelihood scores/values, but higher AIC and BIC scores. AIC scores and BIC scores are calculated from log-likelihood scores, but adjusted from model complexity. Whereas LL scores focus solely on model fit, AIC and BIC also introduce a penalty for model complexity — trading off model fit and parsimony. When LL are higher, but both AIC and BIC are lower, this is generally an indicator of over-fitting of the data in the more complex model, with the more parsimonious model likely to be the preferred model. This is likely a result of the fact that there are a high number of villages in the overall sample.

As discussed in Section 7.3.2, there are sound theoretical reasons to cluster standard errors at the household rather than the village level. However, for the sake of comparison, model fit indicators are also included in Table G.6 of both methods, which indicates a similar overall fit of both approaches.

Table G.6: Comparison of Model Fit Indicators

Model Name	AIC	BIC	Log-likelihood
Fixed and Random Effects for Split Sample Models:			
OP0 No Dummies	870,379	1110,918	-367,19
OP0 With Dummies	903,7164	1218,539	-362,858
OP1 No Dummies	987,2875	1239,371	-425,644
OP1 With Dummies	1091,324	1543,592	-423,662
Full Sample Models with Different Levels of SE Clustering:			
All Data Household Cluster	1744,102	2072,344	-796,051
All Data Village Cluster	1648,102	1769,033	-796,051

Sensitivity Analysis of Alternate Specifications

As discussed in Section 7.3.2, there are sound theoretical reasons to cluster standard errors at the household rather than the village level. Indicators of model fit discussed above in G.3 also indicate that clustering at the village level does not improve model fit. One final analysis of robustness is to conduct a sensitivity analysis to determine whether the different specifications change the overall results and conclusions of the analysis. Table G.7 shoes the marginal effects coefficients, standard errors and significance levels of the models with clustering of standard errors at the household and village level. The results show that the level does not substantially alter the interpretation of the model. The consistency in coefficients and significance levels across clustering methods suggests that the findings are generally robust to the choice of clustering level[1]. Only one of the main variables of interest are altered in terms of significance – and then only marginally, and without altering the interpretation of the model. All other variables of interest remain similarly significant. The stability of the model under both specifications indicates that the findings are robust, and not highly sensitive to the level at which standard errors are clustered.

[1] Changes in Significance levels between model specifications are indicated by bold font. In rare cases, coefficients have also changed. This is likely due to dropped observations by the stata model as a result of co-linearity between clusters. This applies only in the case of one or two control variables and not to any of the primary variables of interest.

Table G.7: Sensitivity Analysis for Marginal Effects Coefficients

	Wage Work		**Agriculture and Forest**		**Reproductive Labour**		**Personal and Leisure**		**Sleep**	
	HH	**VILL**	**HH**	**VILL**	**HH**	**VILL**	**HH**	**VILL**	**HH**	**VILL**
Female	-0.067***	-0.067***	-0.026***	-0.026***	0.122***	0.123***	-0.026***	-0.026***	-0.003	-0.003
	(0.012)	(0.011)	(0.006)	(0.008)	(0.008)	(0.008)	(0.006)	(0.006)	(0.004)	(0.004)
Oil Palm	0.109***	0.119***	-0.087***	-0.094***	0.003	0.007	-0.009	-0.015	**-0.016****	**-0.016*****
	(0.013)	(0.014)	(0.016)	(0.015)	(0.011)	(0.008)	(0.010)	(0.009)	(0.006)	(0.006)
Fem. Emp.	0.146***	0.135***	-0.018	-0.018*	-0.049***	-0.048***	-0.060***	-0.056***	-0.019***	-0.013***
	(0.012)	(0.013)	(0.012)	(0.010)	(0.006)	(0.008)	(0.012)	(0.008)	(0.007)	(0.005)
Age	0.000	0.001	0.001	0.000	-0.002**	-0.002**	0.000	0.000	0.000	0.000
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.000)	(0.000)
Mid. Sch..	-0.016	-0.013	0.009	0.008	-0.001	0.005	0.008	0.006	-0.000	-0.005
	(0.012)	(0.013)	(0.014)	(0.011)	(0.008)	(0.010)	(0.010)	(0.009)	(0.005)	(0.005)
High Sch..	-0.011	-0.004	0.007	0.003	0.001	0.001	-0.004	-0.003	**0.007***	**0.003**
	(0.012)	(0.012)	(0.007)	(0.009)	(0.011)	(0.009)	(0.008)	(0.007)	(0.004)	(0.004)
High Season	0.004	-0.001	0.004	0.004	0.011	0.010	-0.026***	-0.023***	**0.007***	**0.009****
	(0.009)	(0.009)	(0.009)	(0.008)	(0.009)	(0.007)	(0.007)	(0.007)	(0.004)	(0.004)
Wealth	0.003	0.002	-0.008**	-0.006**	0.001	0.000	0.002	0.002	0.002	0.002*
	(0.004)	(0.003)	(0.004)	(0.003)	(0.003)	(0.002)	(0.003)	(0.002)	(0.002)	(0.001)
Children 14	-0.003	-0.003	0.002	0.003	0.003	0.003	-0.001	-0.000	-0.002	-0.002
	(0.004)	(0.005)	(0.005)	(0.004)	(0.004)	(0.003)	(0.003)	(0.003)	(0.002)	(0.002)
Chidren 14-18	0.002	-0.000	-0.013***	-0.012***	0.008**	0.008**	0.002	0.002	0.001	0.002
	(0.003)	(0.005)	(0.004)	(0.004)	(0.004)	(0.004)	(0.003)	(0.003)	(0.002)	(0.002)
Adults 60	0.004	0.006	-0.003	0.000	0.007	0.004	**-0.013***	**-0.014****	0.005	0.004
	(0.011)	(0.010)	(0.011)	(0.008)	(0.005)	(0.007)	(0.007)	(0.006)	(0.004)	(0.003)
Land Area (log)	0.003	0.001	0.005	0.005	-0.003	-0.002	-0.004	-0.005	-0.001	0.001
	(0.005)	(0.005)	(0.005)	(0.004)	(0.003)	(0.003)	(0.003)	(0.004)	(0.002)	(0.002)
Hired Labour	0.002	0.005	0.004	0.008	0.003	-0.002	-0.001	0.000	-0.008	-0.011
	(0.015)	(0.013)	(0.016)	(0.014)	(0.011)	(0.011)	(0.012)	(0.012)	(0.006)	(0.007)
Fertilizer	-0.006	-0.010	0.010	0.008	**-0.014***	**-0.009**	0.027***	0.028***	-0.018***	-0.017***
	(0.011)	(0.013)	(0.011)	(0.010)	(0.008)	(0.008)	(0.007)	(0.007)	(0.005)	(0.005)
Pesticide	0.022	0.023	-0.020	-0.017	-0.020**	-0.021**	0.005	0.005	0.012**	0.009
	(0.015)	(0.014)	(0.014)	(0.014)	(0.009)	(0.010)	(0.009)	(0.010)	(0.005)	(0.006)
Herbicide	-0.001	-0.000	-0.012	-0.011	0.000	0.001	0.004	0.003	0.008*	0.007
	(0.017)	(0.015)	(0.017)	(0.018)	(0.017)	(0.013)	(0.013)	(0.012)	(0.004)	(0.008)
No Rice	0.006	0.009	0.018	0.017	0.002	0.005	-0.015	-0.018	**-0.010**	**-0.013***
	(0.013)	(0.013)	(0.015)	(0.017)	(0.010)	(0.011)	(0.010)	(0.012)	(0.011)	(0.008)
Grows Rubber	**-0.030****	**-0.030*****	**0.025*****	**0.023****	0.010	0.012	-0.006	-0.006	0.001	0.001
	(0.013)	(0.011)	(0.009)	(0.010)	(0.009)	(0.008)	(0.009)	(0.008)	(0.004)	(0.005)
Grows Pepper	-0.020**	-0.014	0.021	0.019	0.005	0.003	-0.007	-0.008	0.002	0.000
	(0.009)	(0.013)	(0.017)	(0.019)	(0.012)	(0.011)	(0.011)	(0.010)	(0.007)	(0.007)

G.4 Joint Display Table

Table G.8: Joint Display Table for Time Allocation Study

Quantitative Findings	Qualitative Findings: FOR	Qualitative Findings: OP	Mixed Methods Inferences
Time Scarcity & Time Poverty			
Time Poverty: OP Site: Women > Men FOR site: Women ≈ Men Women: OP > FOR **Sleep, Rest & Leisure:** OP: Women < OP Men < FOR Men < FOR Women	• Women consider themselves busy and have numerous techniques and strategies for managing time scarcity • Women and men both perceive time scarcity to be periodical and occasional • Both men and women have a rest day outside of peak swidden labour periods	• Women complain of extreme fatigue and chronic time scarcity • Neither men nor women have a rest day	**Confirming** • Both qual. and quant. evidence suggest that time scarcity is both more prevalent and more severe among women in OP site **Expanding** • Difference time scarcity between sites is likely significantly underestimated due to men and women working 7 days a week in OP site while in the FOR site both have rest days for most of the year • Qual. evidence shows the extent to which women feel the burden of time scarcity
Gendered Allocation of Labour			
Time Spent in Own-Production[1] Men: OP < Women Women OP < FOR OP: Men ≈ Women FOR: Men < Women **Time Spent in Waged Work[1]** OP: Men Women FOR: Men > Women Men: OP >FOR Women: OP > FOR	• Women and men engage in vegetable gardening, but primary role is for women • Men's role as food providers focused on hunting, fishing and collection of heavy WEPs such as roots and palm hearts • Limited opportunities for men and women to engage in off-farm labour • If households hire agricultural workers to aid with swidden, typically men and women are hired as a couple • Most common, regular source of income is rubber – collected and sold jointly by men and women	• Loss of men's role in food acquisition through reduced hunting and fishing • As men's available time is limited, households prioritise its use for activities that are perceived as physically demanding or requiring technical knowledge of chemicals • Men's time in waged labour increased due to longer contractual hours in plantation labour, as well as more opportunities for overtime off-farm work	**Expanding** • In relative terms, women in OP take on a greater share of household on-farm labour. However, in absolute terms, women's time in on-farm labour is reduced. • In relative terms, women in OP participate less than husbands in off-farm labour is reduced compared to men's. However, in absolute terms, women spend more time in income generating activities than prior to oil palm. • The quant. study alone would disguise the extent to which women take on additional on-farm roles. The qual. study alone would disguise the extent to which women's on-farm labour has been reduced in absolute terms.

Notes: [1] Own-Production both forest and agricultural activities. < and > refer to statistically significant differences. No statistically significant difference is indicated by ≈ *Table continued on Page 369*

Quantitative Findings	Qualitative Findings: FOR	Qualitative Findings: OP	Mixed Meth
Gendered Labour as Cause and Consequence of Agrarian Change			
Swidden Changes[2] Fallow Lengths: OP < FOR Field Distance: OP < FOR Chemical use: OP > FOR **Cash-Crop Changes**[2] Rubber: OP < FOR Pepper: OP > FOR	• Reducing time spent in swidden agriculture is mostly not gendered. The aim is to free up time for rubber cultivation, which is a joint household activity. • However, free-ing up time for men was a concern when said men were periodically employed as migrant oil-palm labourers in Malaysia (though men would usually return home for peak swidden labour periods and/or hire additional labour to help women)	• Reducing time spent in swidden agriculture explicitly gendered and is a major motivation for enacting changes • The aim is to free-up time for the household, but to maximise men's time in plantation labour.	**Conf** • Qual. helps to explai sults showing a range

Notes: [2] Changes are documented in Chapter 6. < and > refer to statistically significant differences. No statistically significant difference is indicated by ≈

Appendix H:
Supplementary Information for Chapter 8

H.1 Supplementary Information for Food Systems Methods

Types of Quantitative Metrics Used

Table H.1 below shows the types of quantitative measures and metrics used in the study as well the data used to calculate them. The metrics are categorised into established (i.e validated/widely used and accepted), emerging (proposed but untested/validated metrics found in literature and established = widely used in literature. Additionally, metrics which have not been used in their original form but have been adapted for this specific purpose and study location are indicated.

Triangulation of Availability and Price Data

Combining different incomplete sources of data where sources vary in their likely accuracy or reliability requires the use of a transparent process to select certain sources of data over others. I employ a "stepwise hierarchical approach" to data collection similar to that used by Ambikapathi et al. (2018) in the context of economic health models. The stepwise approach aims to reconcile three aims: (1) Selecting data likely to be most accurate (2) Selecting data that is the most representative, and (3) Selecting data that provides the necessary outcome variables of interest while minimising conversions of units which may introduce bias.

Selecting the most accurate data requires preferentially selecting directly observed or measured data over reported data where both sources are available. Selecting the most representative data requires consideration of the village context. When data is otherwise equivalent, data from within the village itself (or from the closest source to the village) was preferred. Likewise, foods found in their most commonly found form or source were preferred.

Reconciling Conflicting Price Data

Determining village-level prices required triangulating data from multiple sources. In cases where there was no consensus between sources on food prices, I followed a hierarchical selection process which prioritised prices based upon direct observation, prices confirmed by multiple sources, as well as data expressed in kilograms or easily convertible units. It is possible that this biases the data prices of foods found in village shops – though foods sold in village shops generally are not available from multiple sources. However, any such biases should apply consistently across the whole data set, and thus, price comparisons between sites would remain valid.

Measures of Market Diversity and Prices

In Chapter 8, I compare the diversity of markets and food availability at the village level using different variants of a MLDS. Several attempts have been made to adapt individual and household metrics for the purpose of monitoring and comparing market-level food availability and diversity (Pingali and Ricketts, 2014). However, as yet, no validated method for estimating the market-level diversity of foods for sale has yet been produced (Chege et al., 2021; Data4Diets, 2023). The need for such a measure, however well understood. As Pingali and Ricketts (2014) state:

> While the HDDS can identify a particular household's economic access to dietary diversity, it does little to capture the quality and diversity available in the local food supply. Especially for micronutrient- and protein-dense foods (specifically vegetables, fruit, dairy, and meat products), a market-level dietary diversity score (MLDS) can illuminate why households may be deficient in dietary quality and suggest where interventions need to be made.... In short, the MLDS contributes to an accurate understanding of local market supply and offers the ability to better target interventions for improving the supply of dietary diversity.

While still classified as an "emerging indicator", a MLDS based upon the 12-food groups[1] of the HDDS is becoming the main indicator of market availability (Ambikapathi et al., 2019; Chege et al., 2021; Data4Diets, 2023). Similarly to the HDDS which measures household food security (access to foods) rather than dietary quality, the MLDS measures whether market foods provide access to a sufficient variety of different food groups. In other words, it is an indicator of whether food availability at the market level is likely to be a constraint on food security and nutrition in a particular context.

[1] See Appendix H.1

Table H.1: Quantitative Metrics Used

Metric	Measure Of	Metric Type	Data Used
Agricultural Food Sub-System			
Farm Diversity			
FSDI	Diversity	Author	Farm Survey
FSDI-F	Diversity	Author	Farm Survey
Production Diversity			
Crop Count	Diversity	Established	Farm Survey
FGs	Diversity	Established	Farm Survey
Field Diversity			
Relative Field Diversity (RFD)	Diversity	Author	Farm Survey
Wild Food Food Sub-System			
Ownership of Agrobiodiverse Fields	Food Environment	Author	Farm Survey
Proximity to Wild Food Habitats	Food Environment		
Collection Time of Wild Foods:			
- Perceived	Food Environment	Author	Qualitative Triangulation
- Actual	Food Environment	Author	Recall Surveys
Collection Time of Wild Foods	Food Environment	Author	Recall Surveys
Acquisition Events:			
% opportunistic	Acquisition	Author	
Locations WF acquisitions	Acquisition	Author	Recall Surveys
Perceived Abundance WF	Availability	Author	Participatory FGDs
Intention and Use of WFs	Acquisition	Established	Recall Surveys
Market Food Sub-System			
Proximity and Distance	Food Environment	Established	
Mobile Vendor Visitation Frequency	Food Environment	Author	
No. Establishments Selling	Food Environment	Established	
No. Intra-Village Traders Selling	Food Environment	Author	
Weekly Sub-District Level Markets			
No. varieties of Food (within FGs)	Diversity	Established	DFC Data
Average Prices of Foods (within FGs)	Prices	Established	DFC Data
Local-Market Sources			
Market-Level Diversity Score (MLDS)	Diversity	Emerging	
No. varieties of Food (within FGs)	Diversity	Established*	
Nutritionally Important FGs	Diversity	Established*	
Proportion of Locally Produced Entering Local Market System	Food Environment	Author	Recall Surveys
Hyper-Local Trade			
Market-Level Diversity Score (MLDS)	Diversity	Emerging*	
No. varieties of Food (within FGs)	Diversity	Established*	
Market Prices			
Average Market Prices	Prices	Established	
Minimum Market Prices	Prices	Established	
Relative Price of Hyper-Local Food	Prices	Author	
All-Source Village Level Food System			
VLDS			
Village-Level Diversity Score (MLDS)	Diversity	Emerging*	
Nutritionally Important FGs	Diversity	Author*	All-Source Village Inventory
Total food variety by FG	Diversity	Established*	All-Source Village Inventory
All-Source Average Price	Prices		All-Source Village Inventory
All-Source Minimum Price	Prices		All-Source Village Inventory
Perceived Availability by Source	Food Environment	Author	PDM
Diversity of Food Sources by FG	Food Environment	Author	All-Source Village Inventory
Food Sources of Commonly Consumed Foods	Food Environment	Author	All-Source Village Inventory
Contributions of Sources to FG availability	Food Environment	Author	All-Source Village Inventory

Notes: *Data Sources:* Recall surveys are included in both the women's, men's and farm (part of men's) surveys for both agricultural and wild food acquisitions. Women's survey contains 30-day and 7-day recalls of all food acquisitions. Men's survey contains 30-day recall of wild food acquisitions. Farm surveys contain 30-day and 12-month recalls of agricultural products produced and harvested. *Metric Types:* * Indicates that metric is adapted for new purpose/context; Author = created by Author; Emerging = Proposed but untested/validated metrics found in literature; Established = widely used in literature. See for instance Jones (2017a); Verger et al. (2017, 2019)

My use of the MLDS deviates from its standard use in two ways. Firstly, while I am interested in market access to foods as a pre-condition of food security and nutrition, my focus is more on differences in the availability of healthy and unhealthy food groups. Secondly, I am interested primarily in food availability at the village level (i.e. whether there is access to foods from any source within the village system). The justification for this is that almost all agricultural and wild foods are traded in the FOR site.

Dietary and Market Diversity Indicators

Table H.2: Standard Metrics for Food Security and Nutrition

Food Groups Included in Different Metrics and Measures

	Household Dietary Diversity Score	**Dietary Diversity for Children**	**Minimum Dietary Diversity for Women**
1	Cereals	Grains, roots, and tubers	Grains, roots, and tubers
2	White Roots, Tubers, Plantains	Legumes, nuts, and seeds	Pulses (beans, peas, and lentils)
3	Vegetables	Dairy products	Nuts and seeds
4	Fruits	Flesh foods (meat, poultry etc.)	Dairy products
5	Meat	Eggs	Meat, poultry, and fish
6	Eggs	Vitamin A-rich fruits and vegetables	Eggs
7	Fish and Other Sea Food	Other fruits and vegetables	Dark green leafy vegetables
8	Legumes, Nuts, and Seeds	-	Other vitamin A-rich fruits and vegetables
9	Milk and Milk Products	-	Other vegetables
10	Oils and Fats	-	Other fruits
11	Sugars and Sweets	-	-
12	Spices, Condiments, and Beverages	-	-

Village-Level Diversity Score

To measure food availability at the village level, I adapt the MLDS discussed above by including all sources of foods from markets and non-market sources to create a VLDS. Like the MLDS, the VLDS is not an indicator of nutritional quality – but of the overall health and functioning of the food system.

Comparison of Market Diversity Indicators

The figures indicates that at the overall food-system level, both food systems are comparable regardless of the metric used

H.2 Processed Foods

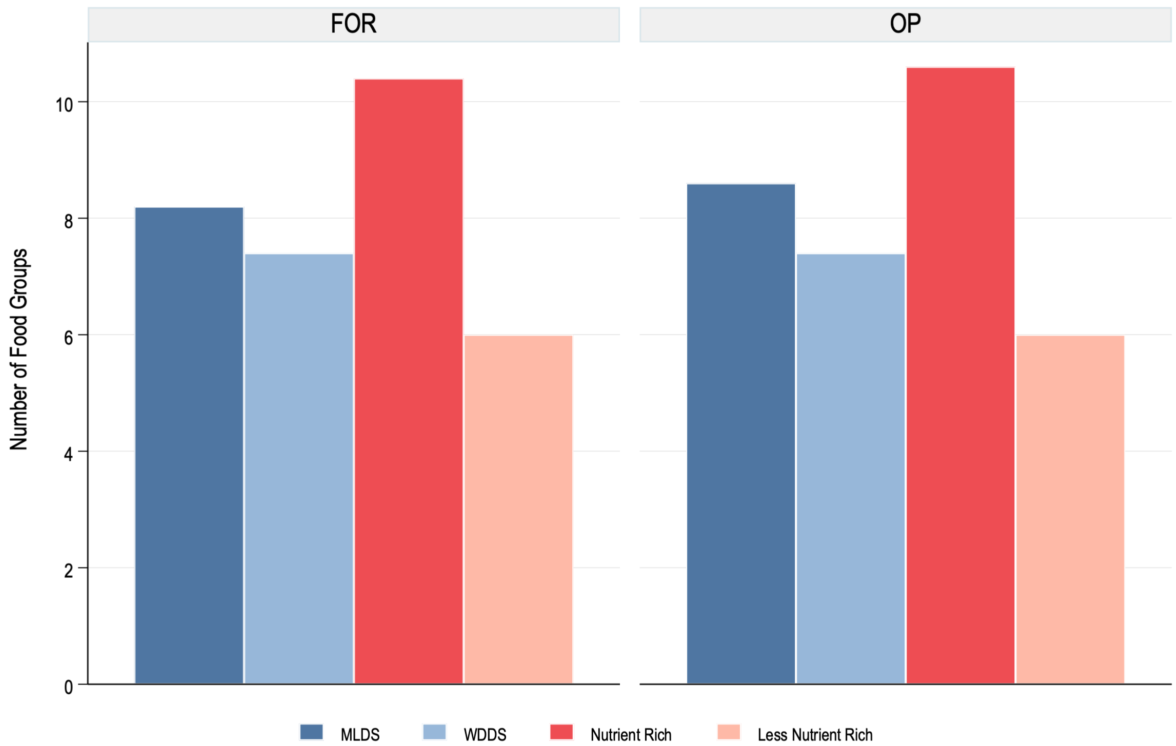
Novel Metrics and Indicators

(a) Farm-System Diversity Indices

In Chapters 6 and 8, I propose the use of a novel metric to complement other indices of farm-level production diversity. The metric shows the number of types of arable production systems that exist within a household's farm, with two versions: the FSDI and the FSDI-F for all field types and fields which produce edible crops respectively. For instance, a household with a swidden field, a mixed-agroforestry field, and a pepper field would have a farm diversity index of three and a food-producing farm diversity index of two. In cases where there is some ambiguity over food production, for example, rubber gardens which can be monocultures or can be mixed agroforests with food-producing plants, fields are classified as food-producing if the household has obtained any food crops from this land in the preceding 12 months.

I propose the use of these measures in addition to a conventional crop diversity count to control for agrobiodiversity. The reduction in the number of different production systems resulting from increased opportunity costs of land was one of the main drivers of food system change resulting from oil palm. The FSDI therefore represents to some extent the degree of specialisation of farms, as more marginal types of extensive agriculture are squeezed out of existence by changing economic incentives. The FSDI has several potential uses. Firstly, at least in the context of this study, the FSDI would be a fairly accurate proxy for relative exposure and access to agrobiodiversity. Secondly, with an increased focus on food systems

Figure H-1: Comparison of Food Availability at Using Different Metrics



resilience, it is likely that farming households or communities with a low FSDI would weather shocks more easily – being more likely to have have fallback alternatives when faced with economic shocks (such as price shocks) or other food system shocks.

There are several potential advantages of focusing on the number of different production systems within a farming household's livelihood are as follows rather than (or as well as) on the diversity of crops produced which are the basis of existing production diversity metrics. Firstly, measures of production diversity are notoriously poor at accounting for agrobiodiversity(Sibhatu and Qaim, 2018a; Sibhatu et al., 2015b), which may be important contributors to diets yet missed in farm surveys. Secondly, distinguishing between cultivated and semi-cultivated crops is difficult and requires significant time and expertise to distinguish and thus impractical for large surveys. These proposed metrics do not require collecting such data – only whether or not a field produces any edible foods (cultivated or uncultivated). Thirdly, it is possible to construct the metric using data routinely collected as part of farm surveys and living standard surveys. The only potential question to add is the collection of edible foods from fields which contain no crops planted within the past 12 months (e.g. fallows) which can be done quickly.

(b) Relative Diversity of Fields

While most field types produce a range of different crop types, some field types are significantly more diverse than others. To compare the contribution of fields towards farm-level production diversity, I calculate the relative diversity of each field type in terms of each food group, calculated using the formula:

$$\text{Relative Diversity}_{i,FG} = \left(\frac{v_{i,FG}}{V_{FG}}\right) \times 100 \tag{H.1}$$

Where $v_{i,FG}$ is the average number of varieties of the food group FG in field i and V_{FG} is the sum of average varieties of the food group FG across all fields.

Figure H-2: Disaggregation of Ultra-Processed Foods (NOVA Group 4)

See Figure 8-13

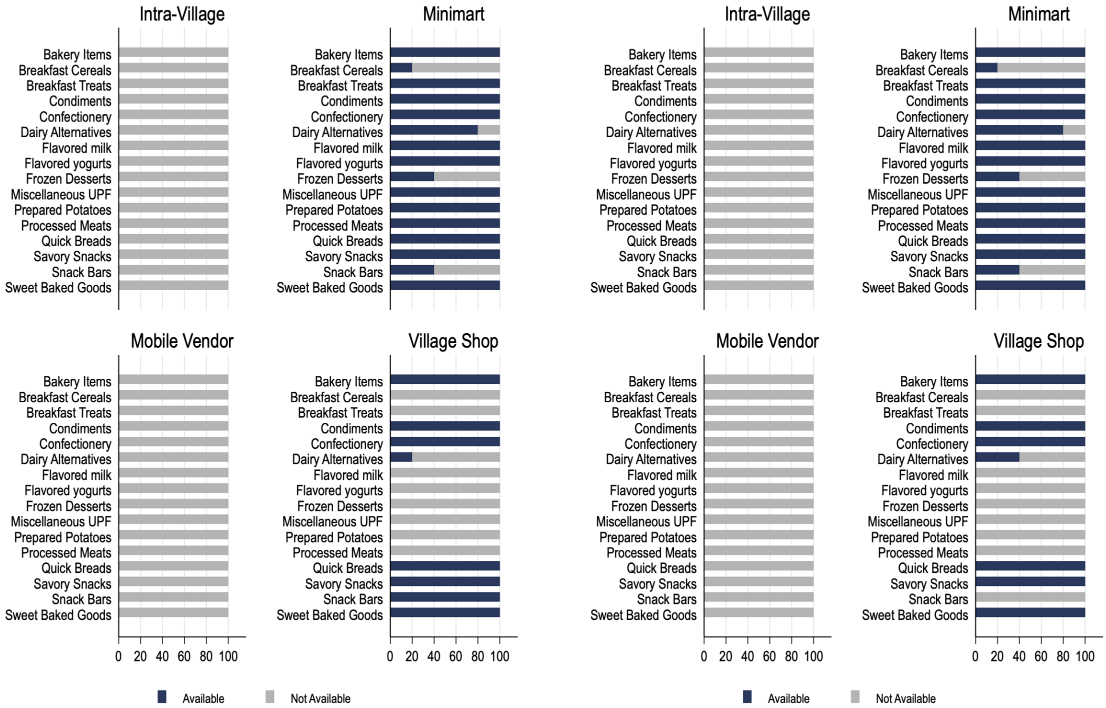


Table H.3: Comparison of Prices Locally Produced and Non-Locally Produced Foods

Discount Relative to Market Foods Originating Outside the Village

	Outside Origin (Average Discount (%))	
Local Origin	**Wild**	**Agricultural**
Vegetables:		
Wild	-	30-100
Agricultural	50-60	-
Meat:		
Wild	70-150	10-20
Agricultural	5-10	-

Notes: Prices of local origin foods are prices reported for intra-village peer-to-peer trade. Prices of foods from outside origin are predominantly (though not exclusively) from mobile vendors. Note that foods sold from outside origin and foods sold within the village are not always the same varieties. This table, therefore, shows average discount rates for like-for-like equivalents (e.g. different types of DGLVs) – except for wild meat, which are the same varieties.

Table H.4: Fictionalised Examples to Show Calculation of FSDI and FSDI-F

Farm Name	**Field Types**	**FSDI**	**FSDI-F**
Farm A	Rubber, Vegetable Garden, Pepper	3	2
Farm B	Kratom, Mixed Garden, Oil Palm	3	2
Farm C	Swidden, Fallow, Gaharu	3	2
Farm D	Forest Garden, Homegarden, Pepper, Oil Palm	4	2
Farm E	Mixed Garden, Fallow, Homegarden, Pepper, Gaharu	5	3

Table H.5: Ten Item Consumer Basket of Processed and Packaged Foods

No.	Product (and preferred variety*)	Number Sampled
1	Instant noodles (Indomie)	2
2	Instant Noodles (Pop Mie)	2
3	Crisps / Potato Rings	1
4	Packet Seasoning	1
5	Roasted Peanuts	1
6	Wafer Rolls	1
7	Powdered Drink (Pop Ice)	1
8	Coca-Cola/Sprite	1
9	Kecup Manis (ABC)	1
10	Krupuk (unbranded)	1
11	Large Biscuits (Tim Tam / Slai O'Lai)	1
12	Small Chocolate Bar (Beng Beng)	1

Discussed in Section 8.3.4; *If available

Table H.6: Livestock Ownership

Variable	Forest	(sd/se)†	OP	(sd/se)†	p-value
Livestock Ownership (Prep. HHs):					
Any	0.81	0.03	0.65	0.03	0.00**
Chicken	0.75	0.03	0.58	0.03	0.00***
Cow	0.08	0.02	0.00	0.02	0.00***
Duck	0.03	0.01	0.03	0.01	0.95
Fish	0.08	0.02	0.04	0.02	0.18
Pig	0.49	0.04	0.38	0.04	0.03
Number of Animals (#):					
No. Types	1.42	0.94	1.01	0.94	0.00***
Chicken	8.57	9.05	5.22	9.05	0.00***
Duck	0.09	0.75	0.09	0.75	0.99
Pig	1.07	1.36	0.93	1.36	0.37
Cow‡	0.23	0.92	0.00	0.92	0.00***

Note: Table shows comparisons between OP and FOR sites. Significance levels have been corrected for multiple comparisons using Bonferroni correction. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. †Unless otherwise stated, t-tests have been used for continual variables and z-tests of proportions for binary variables. ‡Indicated continuous variables which violate the assumption of normality (because of zero ownership) and have been tested instead using non-parametric the Mann-Whitney U test (Wilcoxon rank-sum test).

Figure H-3: Examples of Food Producing Fields

(a) Mixed gardens *(kebun campuran)*

(b) Mixed gardens *(kebun campuran)*

(c) Mixed gardens *(kebun campuran)*

(d) Home gardens *(perkarangan)*

(e) Home gardens *(perkarangan)*

(f) Home gardens *(perkarangan)*

Photos (a),(b) and (c) show mixed-gardens (kebun campuran); Photos (d), (e) and (f) show home gardens (perkarangan). Source: Author

H.3 Further Description of Other Field Types

(a) Homegardens

> *"Usually every day we will take something [from the homegarden], whether it's vegetables or spices or medicinal plants that are there. Every day we will take it but maybe we will take a different food. For example, usually in the homegarden there are sweet potato leaves, there are types of fruit. The fruits that are usually planted in the yard are kedondong, guava and for spices: turmeric and lemongrass. Spices and can be used for medicinal plants... We take it every day depending on our needs... If for example we want vegetables, we will take vegetables today, if tomorrow we need spices we will take spices for tomorrow, like that"*

Quote H-1: (OP_Vill2_FGD_KI_F)

(b) Forest Gardens (*Tembawang*)

Tembawangs are a type of forest garden consisting of fruit trees surrounded by wild forest. The position of tembawang were known collectively – although they may often be indistinguishable from forests to non-locals. Key indicators were a concentration of fruit trees such as Durian. When discussing tembawang many respondents were keen to emphasise that, while the area was part of the forest, the land was privately owned (Quote H-2). However, respondents distinguished between those privately owned and those owned privately but collectively with other members of the extended family owned via inheritance (Quote H-3).

> *"The land belongs to each person, and people who do not own land cannot use it"*

Quote H-2: (FOR_Vill1_FGD_KI_F)

> *"So the system of people here is like this, when it comes to tembawang, tembawang really belong to individual people. But there is also something called tembawang that belongs to the family. This means that if we are all siblings and our parents have one tembawang which is quite large, where it is planted with fruits and all that kind of stuff, then are lots of [shared owners] there"*

Quote H-3: (OP_Vill_FGD_KI_F)

However, use was not entirely limited by ownership. Respondents in some sites stated that others were free to collect fruits if they obtained permission.

> *"The tembawang is privately owned and can only be taken by private individuals and if someone else wants to take it they have to ask the owner"*

Quote H-4: (OP_Vill_FGD_KI_F)

In some cases, especially where tembawang were very old– being seen as collectively owned by the whole community

> *"...usually only descendants can take it, sometimes everyone can... but if it belongs to the ancestors, now, the tembawang is not distributed to their children and grandchildren, but whoever wants it, it belongs to the community"*

Quote H-5: (FOR_Vill3_FGD_KI_F)

Complex local customary laws governed the ownership and use of tembawang that are shared among many families, which require the consent and sharing of fruits obtained with descendent families (Quote H-6). In other villages, respondents stated there were different rules for obtaining fallen fruits (Quote H-7), and for eating fruits in situ vs harvesting for consumption elsewhere

> *"Of course there are rules as well, civil rules that govern it. For example, if the durian tree bears fruit, or whatever tree, you can eat it right there. Or, so long as all families are represented, many people can go there to pick the fruit and distribute it later. You can share if you distribute it to*

all the respective families... if it belongs to the family, the joint family, we really must tell all the family that tomorrow we might want to harvest, let's be together. At least one person from one family head must participate"

Quote H-6: (FOR_Vill1_FGD_KI_F)

"All the people here can [collect fruit from it]. For example, if it's a durian fruit, if it falls, it can picked up by whoever get's it first. But you can not climb"

Quote H-7: (OP_Vill2_FGD_KI_F)

(c) Mixed Agroforestry Garden

Photos H-3a, H-3b and H-3c show a variety of mixed gardens *(kebun campuran).* The term is used to describe a form of food producing agriculture which semi-cultivated, low maintenance and consists primarily of perennial edible plants. Mixed gardens are primarily agroforests, dominated by fruit trees such a bananas, rambutans, guavas, durians, alongside perennial vegetables such as cassava leaves, forest ferns, young bamboo.

H.4 Kratom

Kratom *(Mitragyna speciosa)* leaves produce opioid-like and stimulant-like effects. At the time of conducting fieldwork, the legality of Kratom as a crop and as a drug for sale and export was ambiguous. Numerous farmers expressed to me a desire for clarity, seeing clearly the economic benefits to those who grew it, but fearing that the crop may be banned in the future and unwilling to invest significantly in its production. Few farmers had extensive gardens, but many households owned one or more trees and local factories for processing leaves existed in the region. The tree appears to grow easily with little chemical or labour input. While the farm survey captured those who had kratom gardens (i.e. fields) the prevalence of tree ownership is likely to be dramatically higher as many households had planted one or two trees – often next to their house.

Global demand for kratom had increased dramatically following widely shared social media posts and comments by influencers in the U.S.A. stating that it is effective at treating opioid withdrawal symptoms and thus could be used to combat the opioid epidemic. This narrative was mingled with conspiracy-adjacent views that kratom was not legalised because it is a non-pharmaceutical natural alternative. At the time of my fieldwork, there were few rigorous public health assessments, and the debate over the potential risks and benefits was ongoing. In 2021 a World Health Organisation (WHO) advised against a critical review but recommended that its use and effects be kept under surveillance (WHO, 2021).

The crop is scheduled to be made illegal in Indonesia in 2024, intended to give time to farmers to switch crops (Tambun, 2021). In the author's opinion and personal observation, Kratom production in Kapuas Hulu is/was a potentially lucrative export crop which – if grown responsibly in agroforestry configurations – could bring significant economic benefits to the region without many of the downsides associated with oil palm expansion.

H.5 Types of Wild Food Environments

Forest Environments

There are numerous types of forest environments which provide foods, which vary in terms of their remoteness, and the foods they provide. Respondents in focus groups defined categories of forest according to local custom. While there was not universal agreement, the types of forests were similar between villages. These included Wild Forest (*Rimba*); Protected Forest (Usually *Hutan Lindung*); Secondary Forest and (*Hutan Sekonder).*

Fallow and Semi-Cultivated Environments

Fallow and semi-cultivated environments include swidden fallows (*bekas ladang*), forest gardens (*tembawang*), rubber gardens (*kebun karet*) as well as wild and semi-cultivated fruit trees that appear on farms. In addition, agrobiodiversity in the form of naturally growing edible weeds and other plants found within agricultural fields are included. Table H.7 shows a local classification derived from focus group discussions of fallow types along with the types of foods available in each system. The types of foods grown in fallow systems have similar properties (Quote H-8)

"The types of plants that grow there [in fallow fields] are plants that do not need regular maintenance, and we know when we can take them, for example, sweet potato leaves, they have thick and tall leaves and tall stems, for example, if the terong asam [acidic aubergine]: if it produces fruit it, is ready, if it only has the stems and the leaf is not ready to be taken, but if there is already fruit, we take the fruit. It is the same case with chilli – if it bears fruit, we can take the fruit. Otherwise, leave it."

Quote H-8: (FOR_Vill1_FGD_F)

Table H.7: Types of Fallows and Foods Produced

Name	Description	Example Foods Produced
Damum	General term covering different types of fallows in former rice fields	Cassava & Sweet Potato (roots & leaves); Condiment Vegetables and Spices (e.g. ginger, lemon grass); Grounduts (peanuts); Wild edible ferns
Perukoh / Osau	One year old fallow. Still contains some crops such as chilli, sweet potatoes, alongside small shrub regeneration	Cassava & Sweet Potato (roots & leaves); Condiment Vegetables and Spices (e.g. ginger, lemon grass); Legumes (e.g. green beans, peanuts)
Dijab / Pansap	1-2 year old fallow. Larger shrubs and small trees. Field crops may remain such as sweet potato & cassava alongside tree-crops such as bananas	Cassava & Sweet Potato (roots & leaves); Condiment Vegetables and Spices (e.g. ginger, lemon grass), Fruits (e.g. Banana), Wild edible ferns
Pengeyang	3-9 year old fallow. Larger shrubs and small trees.	Roots and Shoots (cassava, sweet potato, palm-hearts, bamboo), Mushrooms, Wild edible ferns, Fruits
Pengerang Tuai	15-20 year fallow with large trees. May be indistinguishable by non-locals from secondary forest	Roots and Shoots (cassava, sweet potato, palm-hearts, bamboo), Mushrooms, Wild edible ferns, Fruits

Note: Fallow classifications are derived from multiple Focus Group Discussions. Local names and classifications vary from village to village. Where possible, the most general terms have been used. The table is intended to reflect a general characterisation and is not a universal fallow classification system.

Village Surroundings

"Cempedak fruit is in season now, isn't it...this is easy to get around here, it can be behind the house or in the forests it's so easy to get"

Quote H-9: (OP_Vill2_FGD_F)

Village surroundings contained many types of foods which could be obtained quickly and conveniently for immediate cooking and consumption. As most villages were located close to rivers, village surroundings also included the rivers, tributaries and banks alongside spaces in and around houses and the edges of roads. Among the most cited wild foods in the village surroundings were wild edible ferns – of which there were many varieties – which grew around the home and at the edges of roads.

Fruit trees were also commonly found among the village surroundings (Quote H-9). A greater proportion of households in the OP site stated that they owned a fruit-producing tree near the home and within the village surroundings (FOR=32.5%, OP=52.6%, p=0.00). For households who owned such trees, the average number of trees owned was around three per household, with no significant difference between sites (p=0.96). However, there was a weekly significant difference in the type of ownership of these trees, with households on the OP site more likely to be co-own trees with other households (FOR=1.9%, OP=13.9, p=0.02). Thus, the difference in overall ownership rates between sites may be partially explained by the fact that trees are more likely to be owned by more than one household in the OP site.

Fishing was conducted for a variety of reasons, including to obtain food for household consumption, to generate cash income via intra-village trade or as a hobby. Often, the reason for going fishing was a combination of all three. Riverbanks were seen as a good location from which to obtain wild Green Leafy Vegetables (GLVs), in particular several species of edible ferns. The water level of many rivers also fluctuated considerably, increasing dramatically in the few hours following intense rain within the watershed and leaving behind rocky shores/beaches during dryer periods. These river's shores were also a rich source of wild foods – with foods such as frogs, snails, crabs, and turtles being obtained from these locations (often by children).

H.6 Fruit Trees

Another important source of agrobiodiversity are fruit trees, the ownership of which are compared in Table H.8. Data on fruit trees was collected as part of the farm survey conducted with men (who often are not those collecting fruits). While respondents were given a range of options for ownership for each set of trees (individual private ownership, household private ownership, shared ownership with other households, ownership as part of an organised group/cooperative, or collective/traditional ownership with Hamlet, village or customary *adat* rules), the ownership question was asked after the question on tree ownership. Respondents were not prompted for ownership, access or usage rights to wild fruit trees in general (which is a modification which should be made in future surveys of a similar nature). However, data on within the field and near-home fruit trees are likely to be accurate.

A greater proportion of households in the OP site stated that they owned a fruit-producing tree near to the home and within the village surroundings (FOR=32.5%, OP=52.6%, p=0.00). For households who owned such trees, the average number of trees owned was around three per household, with no significant difference between sites (p=0.96). However, there was a weekly significant difference in the type of ownership of these trees, with households on the OP site more likely to co-own trees with other households (FOR=1.9%, OP=13.9%, p=0.02). Thus, the difference in overall ownership rates between sites may be partially explained by the fact that trees are more likely to be owned by more than one household in the OP site.

Table H.8: Locations of Fruit Trees

% of households with fruit trees in location

Location	**FOR**	**sd**	**OP**	**sd**	**p-value**
Any Location	32.3	4.0	54.5	4.0	0.000***
Around Home	1.0	14.0	1.6	1.4	0.000***
Fallow Land†	2.8	1.0	0.8	1.0	0.209
Ladang†	7.6	2.0	2.3	2.0	0.087
Rubber Garden†	36.40	5.0	30.4	7.0	0.478

Notes: † Proportion of households who own these field types who also have fruit trees in these fields.

H.7 Wild Food Locations

Figure H-4 shows the time it takes to walk from the village to collect food in different food groups. Figure H-4a shows average distances across all foods in the food group and uses the village as the starting point. The graph, therefore, shows the approximate relative distance of the most abundant sources of wild foods – not necessarily the location of time to collect for the most common, not most convenient wild foods and does not account for the respondent's activity space[2] (i.e. if the respondent collects wild foods from a location already closer to the source of foods). The average distance, however, may be misleading in contexts where there are large numbers of wild foods, some of which may be collected infrequently. Figure H-4b therefore shows the average minimum time for food groups (averaged across focus groups).

H.8 Market Food Environment and Vendor Products and Properties

Further Description of market foods environments outlined in Section 8.6.1, Page 8.6.1

Village Shops

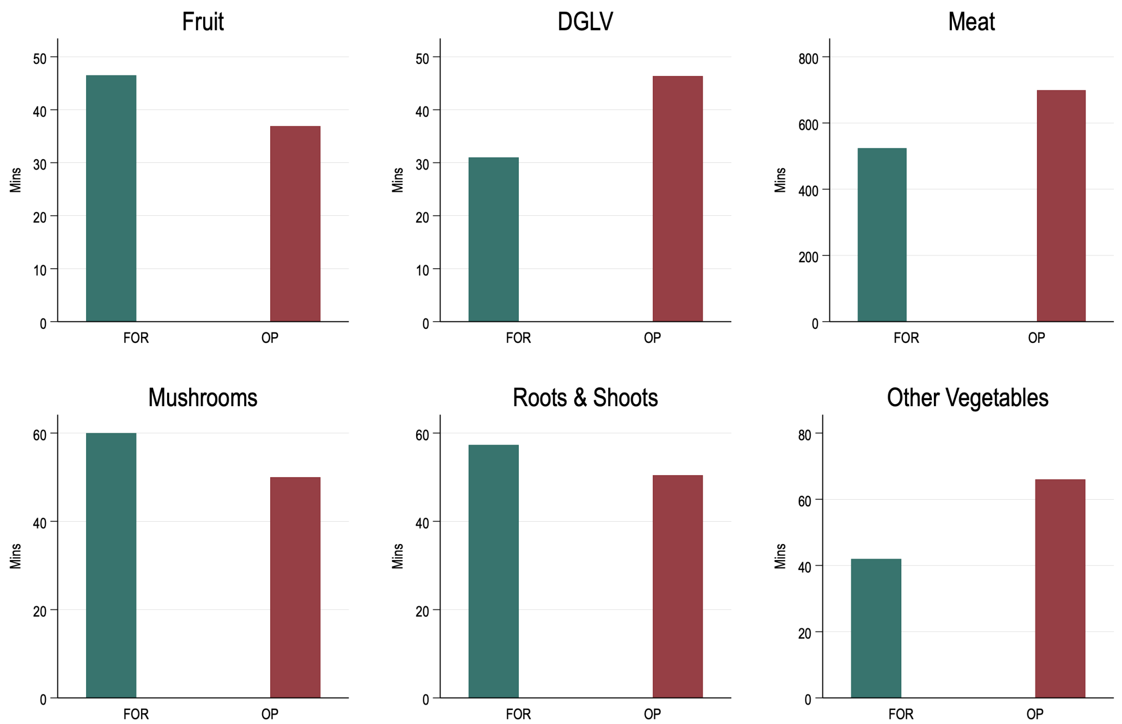
Village shops in both sites mostly consisted of converted front rooms of homes, or wooden extensions built onto the front of homes. While the number of village shops remained similar, larger shops were more common in the OP site than the FOR site. No full-time professional sellers of food existed in either site with all shops being side business intended to generate supplemental revenue. In both sites it was common for village shops to be closed for part, or even most of the day while family members were working. Shops belonging to households with small children where the mother stayed at home for much of the day, or village officials who received income from salaries were more likely to be open but these were also closed when family members had things to do elsewhere.

[2]These factors are discussed in the chapter in women's food choice (Chapter 9

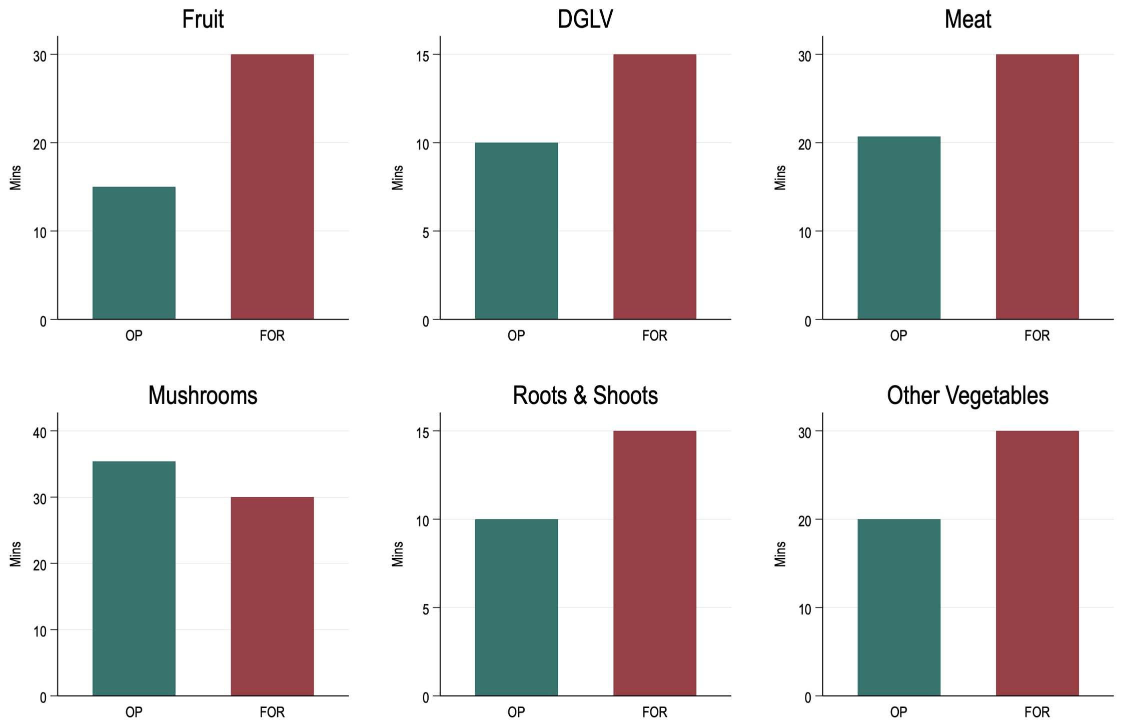
Figure H-4: Distance to Wild Food Sources

Average estimated distance (mins walking) from home to site of wild food collection

(a) Average Time



(b) Minimum Time



Notes: Estimated time walking from village to collect food averaged by food group and site. Data is obtained from free-listing exercises in FGDs in FOR (n=5) and OP (n=5) villages

Opening a small shop in the front of one's house was typically the first investment made by those who received a financial windfall but was not seen as providing sufficient income to abandon other work. Financial windfalls occurred in the FOR site from time to time as a result of successful *gaharu* expeditions or through men returning from migrant oil palm labour, either elsewhere in Kapuas Hulu, or across the border in Malaysia where wages are higher. In the OP site, shop owners were likely to have accumulated sufficient capital to open the shops through side businesses or by working in more lucrative positions for oil palm companies (e.g. supervisory work, office work). Restocking shops from larger markers or small towns was carried out infrequently, typically bundled with other reasons to visit these locations, due to high transaction costs and opportunity costs of labour. As such, small shops tended to focus on less-perishable foods – particularly staple foods and packaged processed foods.

Mobile Vendors

clean

While almost all villages were frequented by at least one mobile vendor a week, villages in the OP site were visited on average almost twice as frequently – the though frequency of visitations varied considerably in both sites. There was a considerable variation between OP sites in terms of accessibility. For many OP villages in the OP site accessing villages by motorised transport remained difficult – despite having new roads built by oil palm companies. The building of such roads (most often made from compacted earth rather than asphalt) did not necessarily improve upon the previous condition of the roads as the new roads also experienced significant heavy traffic of heavy oil palm trucks and could result in degraded and pot-holed roads that may become impassably slippery during parts of the wet season.

Mobile vendors were considered essential for ensuring food availability. However, their frequency, time of day of arrival and the foods on offer were considered unpredictable. The degree to which respondents felt they could rely on mobile vendors to provide foods varied greatly by village in both the forest and OP sites.

Mobile vendors were seen to prioritise those villages with the most demand and income, optimising the foods they sold, the villages they sold them in accordingly. Additionally, mobile vendors were said to adjust their routes to ensure they arrived at high demand villages at the optimal time when most customers would be around and when they would want to purchase these foods, as well as optimising the routes taken to reach these villages to pass through the most profitable villages on the way. As such, villages close to high-demand villages or situated on roads or at junctions where mobile vendors pass through on their way to high-demand villages had a significant number of different mobile vendors passing through, selling different products, throughout the day. In contrast, villages not en route to other villages may be visited only once every few days by mobile vendors.

Node Villages

While most interactions with retail food environments occurred within village boundaries, an extended food environment existed consisting of neighbouring villages and local markets. Villages situated at busy junctions were qualitatively different from villages less well connected. At busy junctions in the OP site it was common to find settlements (often not officially villages) consisting of two to three shops providing a range of services including mechanics, hostel accommodation for truck drivers, cooked and prepared foods, as well as multi-purpose shops selling food and non-food items. To encompass these connected villages as well cross-road settlements I will use the term "node settlements" to reflect their connectivity and their function as serving both passing traffic as well as the surrounding villages.

Oil palm villages were more likely to be adjacent (<10 minutes by motorbike) to a larger shop or group or retail hub (group of small shops) in a neighbouring node settlement. In the FOR site, these node village shops could be characterised as independent mini-marts offering non-perishable foods available to purchase in small quantities as well as in bulk for reduced prices as well as non-food household goods (e.g. plastic goods). In the OP site these villages also served non-resident passers-by (e.g., truck drivers) as well as migrant oil palm labourers housed in barracks with few facilities. Unlike village shops (which were run as economic enterprises on the side), node village shops operated as businesses offering multiple services often including over-night accommodation, cafe/bar/restaurant areas offering cooked food, mechanic services and non-food products such as car parts, and non-food domestic goods. From a food systems perspective they also offered different foods to village shops. Most noticeably, these shops were intermediaries for non-perishable market-foods – especially those purchased in bulk (e.g., rice). In the OP site, node village shops also often contained large chest freezers containing frozen meat, especially chicken (often said to be imported from Malaysia). In a few cases, node village shops were also linked to local aquaculture production selling freshwater fish cultivated in ponds. Generally speaking, node settlements were considered to be cheaper than village shops

Intra-Village Trade

Intra-village trade in foods was practised in both sites and consisted of the sale and purchase of foods for cash, as well exchanges of foods between households and reciprocal gift giving whereby surplus foods (either wild or crops) were given to friends and kin relations with an unspoken expectation of a reciprocal gift (often a different food) for which other households may have an excess at an unspecified time in the future. A significant difference in food availability between the sites can be explained by the degree of intra-village trade and reciprocal or non-reciprocal gift-giving. KIs were asked to name the number of village residents[3] from whom they could "often or usually" obtain different foods from. On average, respondents in forest villages knew more people who acted as informal traders for food and barter, indicating that informal intra-village

[3]Non-professional traders. Residents who obtained food for sale, gift or exchange from their own production or from wild or semi-cultivated sources

trade within the forest villages was higher. The results indicate that options to obtain food via- intra-village trade are more widespread in the FOR site compared with the OP site. In the OP site, very little intra-village trade occurred – and the small amount that did occur was almost exclusively limited to agricultural products, with very little trade in wild fish or meat.

Trade in widely available foods such as edible ferns and other green leafy vegetables was negligible – as it was simply too easy to collect them. Foods such as wild meat, fish however, were more likely to require deliberate harvesting and thus were traded mire often. Likewise, WEPs which were encountered opportunistically, but which provided more food than was needed for one family (such as palm hearts) were commonly given away, exchanged or sold to friends or neighbours. Intra-village trade and gift-giving was also a strategy for coping for temporary abundance in foods resulting from seasonal cycles. For example, fruits were ripe and ready for harvest (either wild or agricultural), fruit trees would typically produce more than a household could consumed. Excess fruits therefore were sold or given to friends and neighbours (only commercial valuable fruits such as Durian were sold outside the village). In giving gifts, or regularly exchanging foods for which a household had excess, households also improved their access to foods year-round.

Temporary and Pay-Day Markets

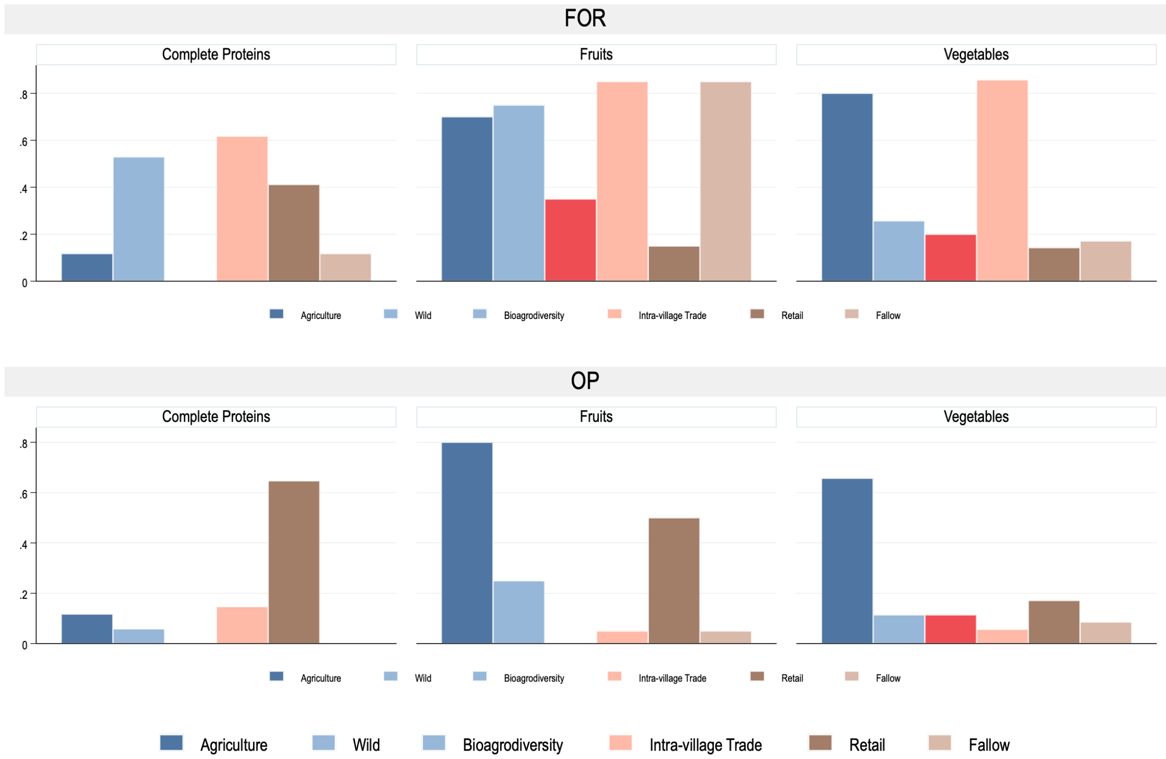
Informal temporary markets were a common feature of both sites, often taking place weekly in a node village. In both sites, markets consisted of local farmers from surrounding villages as well as traders selling produce produced in the wider region. The markets however differed by site in the degree to which mobile traders dominated the markets. In the OP site, temporary weekly markets consisted mainly of larger-scale mobile vendors using pick-up trucks combined with smaller scale traders on motorbikes. In the OP site, temporary markets also popped up in other places than node villages including nearby oil palm company offices on days when workers were handed pay. Such markets as well as selling food produce, would also prepare cooked foods as well as non-food produce such as household goods

H.9 Commonly Consumed Food Groups

Exhaustive lists of foods may bias data towards wild foods – as there are often significant numbers of wild foods which are theoretically available, but rarely consumed. I, therefore, examine the sources from which the most commonly consumed foods in each site can be obtained. Figure H-5 shows the proportion of the most consumed foods within each food group which are available from each source (note that many foods can be obtained from more than one source). Several features of the graphs are noticeable. Firstly, intra-village trade is significantly more important in contributing to availability in the FOR site compared with the OP site. Almost all fruits and vegetables which are available from wild and agricultural sources in the FOR site are also traded via intra-village trade. Secondly, food retail is much more important in the OP site than in the FOR site for fruits and complete proteins. Thirdly, fallow lands contribute more towards availability for all food groups in the FOR site than the OP site – but especially for fruits, where over 80% of the commonly consumed fruits can be obtained from fallow lands.

Figure H-5: Food Sources for Commonly Consumed Foods

Locations from which commonly consumed foods can be acquired

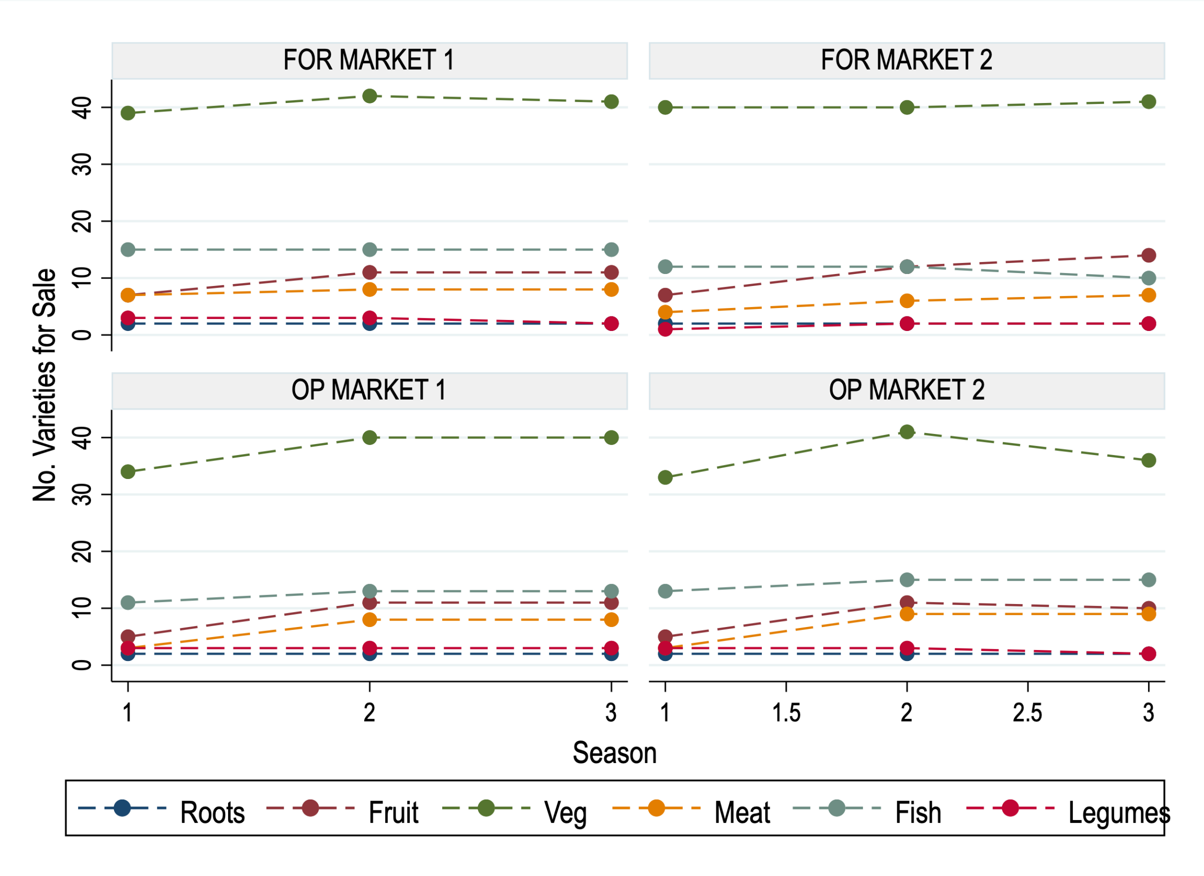


H.10 Price and Availability Data from Temporary Markets

Market Diversity

Figure H-6: Market Diversity Scores in Sub-District Markets

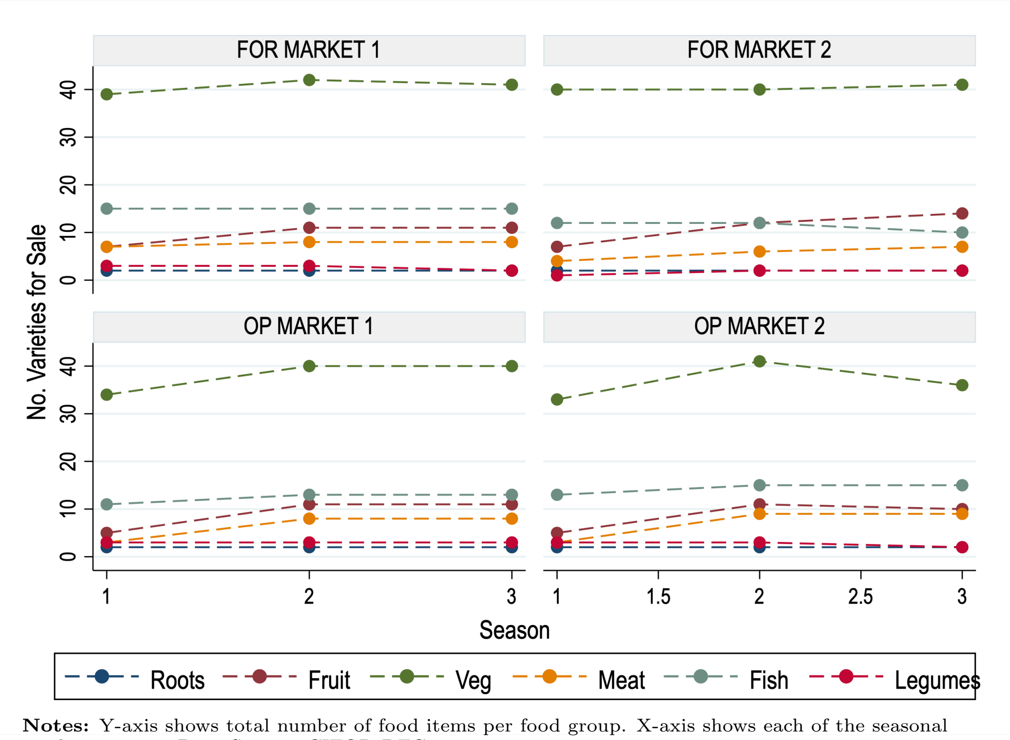
MLDS by Sub-District Market and Season



Data Source: CIFOR DFC project.

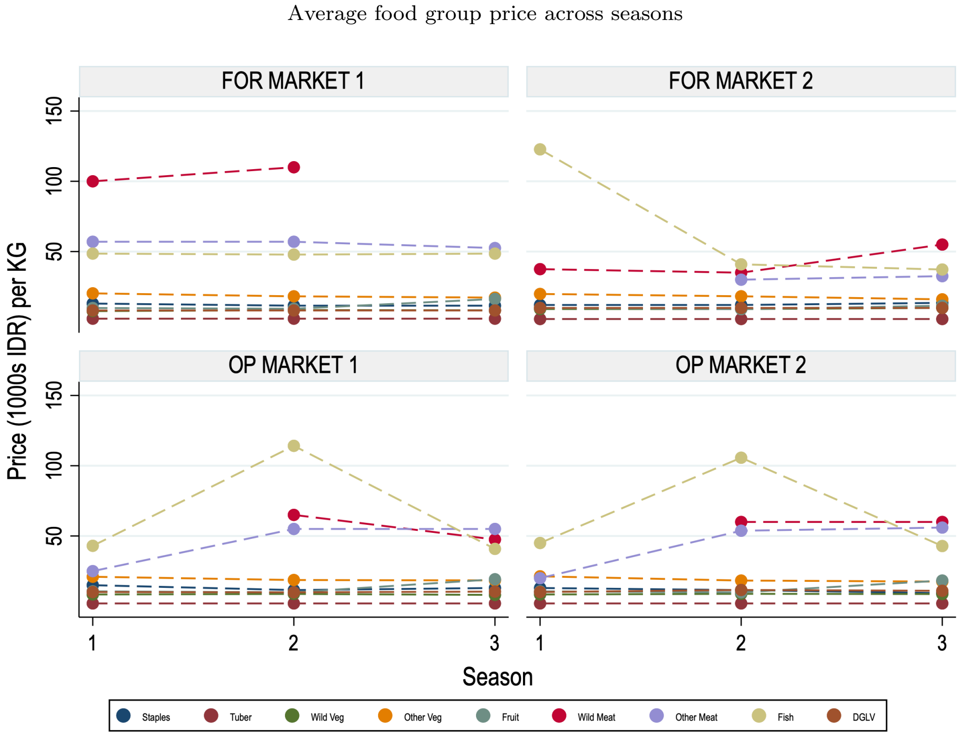
Seasonal Price and Availability in Temporary Markets

Figure H-7: Seasonal Food Availability from Temporary Markets



Notes: Y-axis shows total number of food items per food group. X-axis shows each of the seasonal market surveys. Data Source: CIFOR DFC project.

Figure H-8: Seasonal Price Data from Temporary Markets



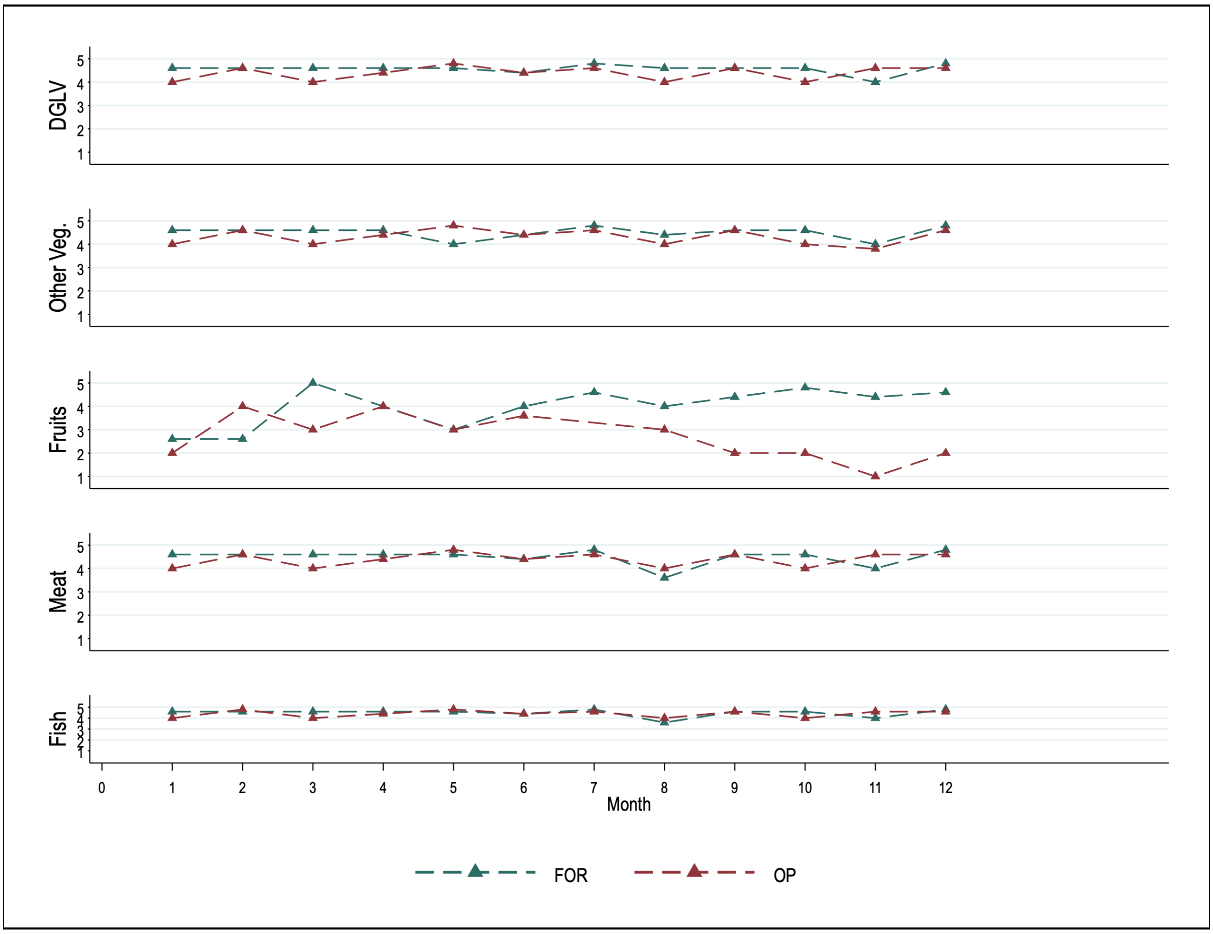
Notes: Y-axis shows total number of food items per food group. X-axis shows each of the seasonal market surveys. Data Source: CIFOR DFC project

H.11 Perceived Seasonal Fluctuations in Food Availability at the Village-Level

While I did not collect seasonal data for food availability, focus group discussions did contain discussions of seasonal fluctuations in food availability. Additionally, in each of the case study villages, participatory seasonal calendars of food availability were produced using Labelled Magnitude Scales (LMS).

Figure H-9: Perceived Seasonal Availability of Food Groups

Perceived Seasonal Availability Using Labelled Magnitude Scale (LMS)



Notes: Perceived availability is relative and derived from participatory charts of perceived food availability based on FGDs with women in case study villages.

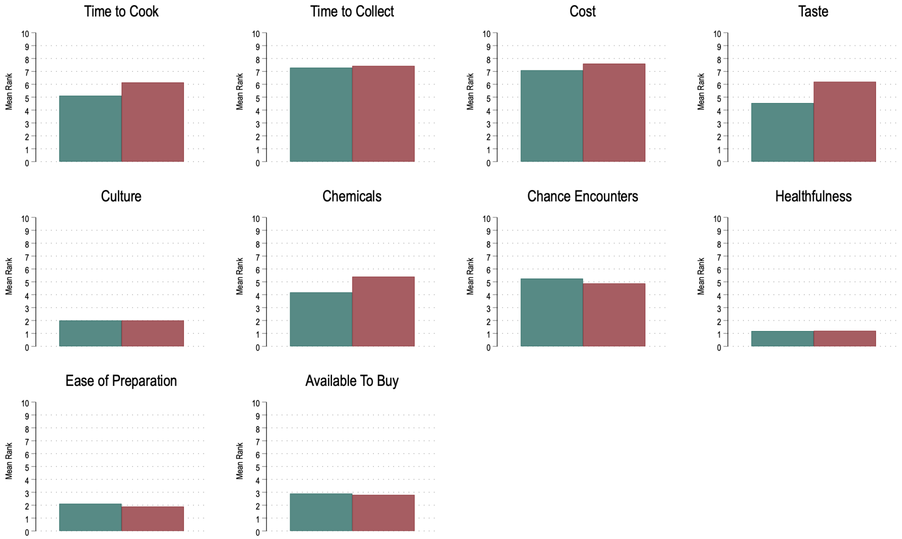
Appendix I:
Supplementary Information for Chapter 9

I.1 Food Choice Priorities

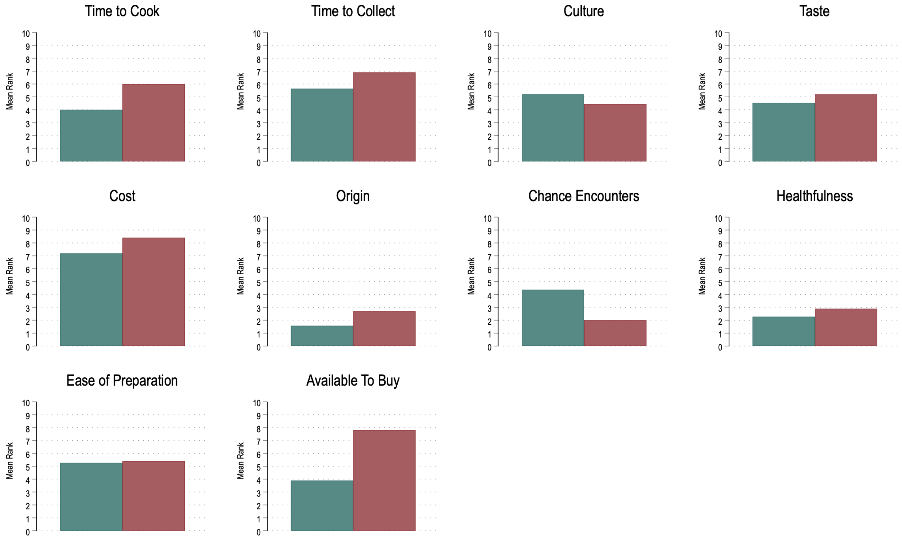
Figure 11-1 shows the average ranked importance of each food choice motivation in each site for the top ten ranked motivations from FGDs.

Figure 11-1: Women's Food Choice Priorities

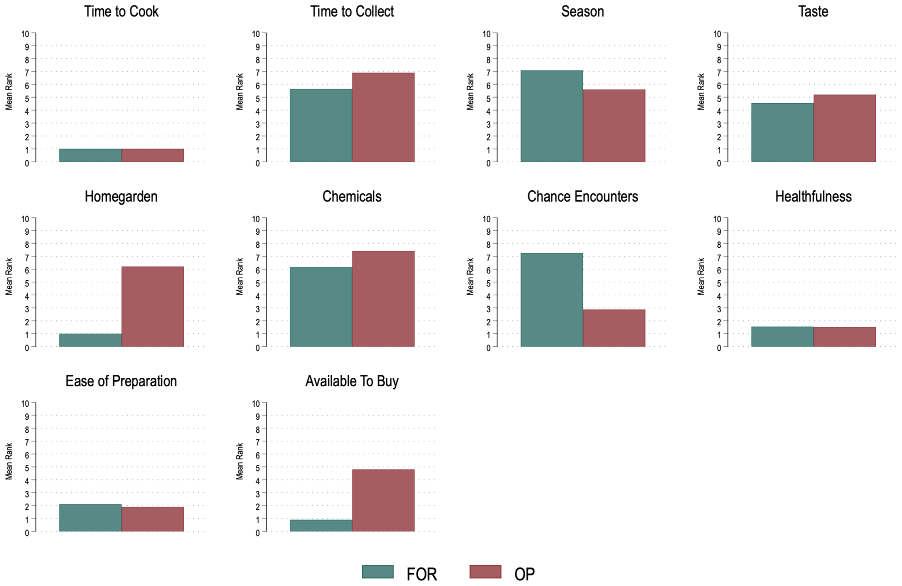
(a) General Food Groups



(b) Protein Rich Foods



(c) Vegetables



Legend