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Dev. Policy and Practice

by

Peter Mollinga

DPP Working Paper No 24

In Conjunction with the Department of Irrigation
and Soil and Water Conservation,
Wageningen Agricultural University, the Netherlar

Development Policy and Practice Research Group

Faculty of Technology

The Open University

August 1992

Protective Irrigation in South India
Deadlock or Development

by

Peter Mollinga

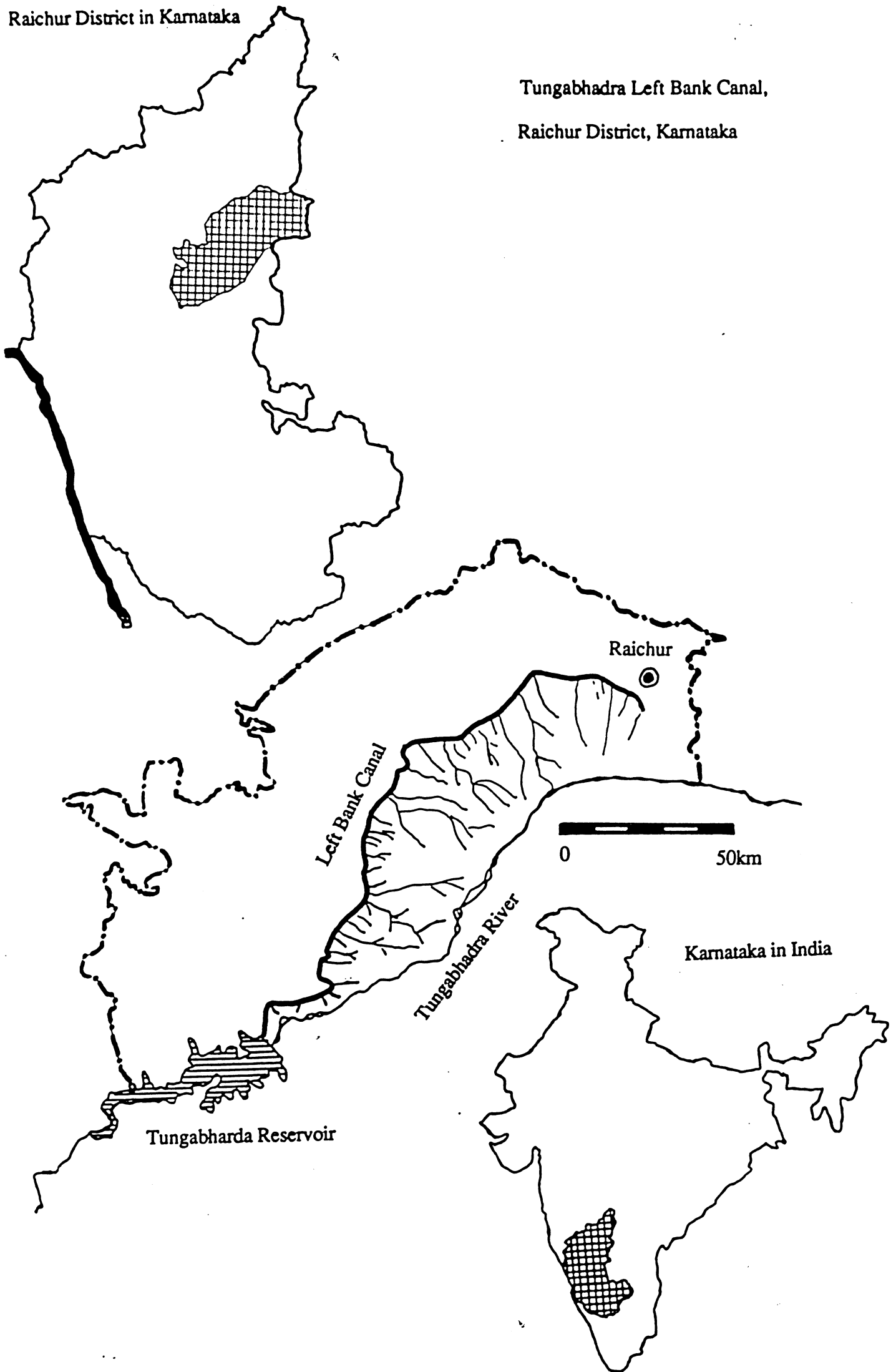
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Contents		Page
1	Introduction	1
2	The Phenomenon of Protective Irrigation	3
2.1	Protective irrigation as a colonial concept	3
2.4	Protective irrigation after independence	5
2.3	Three dimensions of protective irrigation	7
2.4	The contradiction of protective irrigation in operation	9
3	The Tungabhadra Left Bank Canal System	10
3.1	Tungabhadra Project as a protective irrigation system	11
3.2	From design to practice	14
3.3	Deadlock	19
4	Ways Out Of The Protective Deadlock	21
4.1	Implementing protective irrigation as planned	21
4.2	Transformation into productive schemes	22
4.3	Combining protective and productive objectives	24
5	Deadlock or Development?	26
5.1	The case for protective irrigation	26
5.2	One step further	30
6	Conclusion	35
	References	36

Raichur District in Karnataka

Tungabhadra Left Bank Canal,
Raichur District, Karnataka



Raichur

Left Bank Canal

Tungabhadra River

0 50km

Karnataka in India

Tungabhadra Reservoir

Protective Irrigation in South India Deadlock or development ?

by Peter P. Mollinga*

1. Introduction

The late Krishna Bharadwaj has left those who study irrigation development in India with a great task. She concludes her review of the economic literature on Indian irrigation by stating that

More research needs to be done on the interaction between the irrigation technology and the social relations in a region, i.e. on the impact that irrigation has (or may have) on the conditions of production and accumulation of the different categories of users and the implications this has on the dynamics of the development of the region as a whole. (Bharadwaj, 1990:51)

Her summary evaluation of the mainstream economic literature is that it works from a "technological perspective which treats irrigation as a 'technological' input in production" without placing "these 'technological' considerations of costs and benefits (...) within the context of socio-economic relations and conditions of production and exchange of the user community." (p.50-51, see also p.30)

Considering the richness and volume of the political economy literature on Indian agriculture, it is indeed remarkable that a 'production relations approach' as Bharadwaj calls it, is virtually non-existent with regard to irrigation¹. Students of the agrarian question have traditionally focussed on land tenure, labour relations and credit, but very little on the social relationships around and structuring properties of irrigation water. That is notwithstanding Ishikawa's early argument about irrigation as a leading input

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¹ This was truer in 1985 when Bharadwaj wrote her review than in 1992. Though small, there is a literature that can be said to fall under this heading. Strongly political economically flavoured examples include Boyce (1987), Jairath (1984, 1985, 1986), Ramamurthy (1988) and Gorter (nd, 1989). More sociological examples are Wade (1988) and Sengupta (1991). Apart from these analyses of contemporary irrigation, there is some historical work on irrigation development, including Whitcombe (1972, 1983), Stone (1984), Wallach (1984, 1985) and Attwood (1987). 'Normal' analyses of agrarian development in irrigated areas are more plentiful, and include (focussing on South India) Harriss (1982), Pandian (1990), Athreya et al (1990), several contributions in Bhattacharya et al, (eds) (1991) and van Schendel (1991).

(Ishikawa, 1967) and Wittfogel's even earlier sweeping analysis of hydraulic societies (Wittfogel, 1957). Another body of scholarly work on irrigation, the irrigation water management literature, in which India is a major case, has also failed to produce a 'production relations approach' to the question of the utilisation of irrigation water². Without further discussing the merits and demerits of these different literatures, the research of which this paper is the first product, takes as its inspiration Bharadwaj's call to investigate the social relationships in which the users and managers of irrigation systems operate.

This paper discusses one instance of Indian irrigation, the phenomenon of protective irrigation, particularly in South India. The concept of protective irrigation emerged in the context of British colonial rule of the Indian subcontinent in the 19th century. Protective irrigation systems were those large scale canal irrigation systems that were not primarily constructed as profitable investments, that is as productive systems, but as famine relief works to secure social stability. Low rates of return on invested capital were accepted. Technically and agronomically protective irrigation implied and implies canal systems spreading available irrigation water thinly over as large an area and as many farmers or villages as possible to protect them against the failure of their food crops in low rainfall years. Protective irrigation systems are thus found in drought prone areas, where water is the crucial input for securing agricultural production.

Very few protective systems were constructed under British rule. It was only after independence in 1947 that this type of irrigation development was undertaken on a large scale by the Indian government, as an element of its broader agricultural development policy which strongly emphasised increasing food production. A large number of protective schemes were constructed in the drought prone areas of South India. One of these schemes is the focus of this paper: the Tungabhadra Left Bank Canal (LBC) large scale irrigation system on the Tungabhadra river in Karnataka.

A general feature of protective irrigation systems in operation is that irrigation water is spread much less thinly or equally than it is supposed to be. In fact, irrigation water is concentrated on the fields of only a fraction of the producers. These producers do not grow the traditional food crops sorghum and millet, which require little water, but prefer to cultivate more profitable cash crops like rice and sugarcane, which happen to consume a lot of water. This unequal distribution of water is known in the irrigation literature as the head end-tail end problem: the unequal spread of water, and thereby

²For a comprehensive review of this literature, see Chambers (1988). It is not the subject of Bharadwaj's review.

economic benefits, favouring producers close to the water source at the heads of canals, over the producers further away from the water source at the tails of the canals. The Tungabhadra LBC system is a typical example of this problem.

The paper describes the situation in the Tungabhadra LBC scheme as one of a deadlock. This refers to the (1) impasse in the efforts to translate the concept of protective irrigation into a working technology, (2) to the failure to organise water distribution in a manner that curbs large scale rice cultivation, and (3) to the end of the economic boom that the region experienced over the last 30 years. It is suggested that a potential for further agricultural growth is present in the existence of high yielding irrigated dry cash crops, which can compete with wet cash crops in profitability and consume less water. A change to an irrigated dry cropping pattern would spread the available irrigation water over a larger area. However, the change sought is not 'just' a change in cropping pattern, but a change in the whole farming system and its institutional environment. Bringing it about therefore requires a comprehensive and sustained effort. In this way, the benefits of irrigation could also be spread in a more equitable manner, that is over a larger number of producers. However, the changes in the social relations of production that may accompany a new cycle of agricultural growth, particularly changes in land ownership, may undermine the equity effects of a more protective mode of water distribution. This raises questions about the connection of water rights and land rights, and the form of local level organisation for water distribution.

2. The Phenomenon of Protective Irrigation

2.1 Protective irrigation as a colonial concept

British colonial involvement in India's irrigation development from the beginning of the 19th century to independence in 1947 was informed by the following set of objectives (Stone, 1984:8-9).

- 1) The spread of commercial crops, or more generally, modernisation of agricultural production.
- 2) The collection of land revenue; a higher tax was charged on irrigated land than on non-irrigated land.
- 3) Famine protection, that is securing a baseline level of food production.
- 4) The maintenance of political security and social stability.

These objectives are mutually reinforcing in several ways. For example protection against famine directly affects political security and social stability³. Both revenue collection and famine protection imply a logic of area maximisation: reaching as many villages or farmers as possible. The spread of commercial crops can, in particular circumstances, have positive protective effects by stimulating the production of food and fodder (Attwood, 1987:356-9). The set of imperial objectives was however also fraught with contradictions. The colonial interest to maximise revenue extraction had inherent destabilising effects and undermined the security of the livelihood of many peasant households. The same can be said about modernisation strategies, which were strongly biased towards larger farmers (Whitcombe, 1972). Furthermore, the occurrence of famines was at least partly the result of colonial policy itself⁴. Summarising and simplifying, British colonial involvement in irrigation was geared to revenue collection and cash crop production. Its main problem was securing the continuity of the colonial regime, threatened by famines and social instability.

These tensions in irrigation policy came to express themselves in the definition of two different types of irrigation towards the end of the 19th century. After the Mutiny, or first civil war of 1857-8, the Crown took over rule of the colony from the East India Company. In the period 1858-66 a financially disastrous attempt was made at irrigation development by private companies (Atchi Reddy, 1990). The Crown had to buy these companies out and take over the responsibility for irrigation development. Something that could effectively be called an irrigation policy started to emerge, and in this policy the protective function of irrigation became more articulated. For example in 1867 several changes were made in the technical concept of large scale irrigation in order to improve its protective qualities. But the most important change took place after the Indian Famine Commission, appointed after a series of severe famines, reported in 1880. A distinction was made between *productive* and *protective* systems. The definition was a simple one. Systems which yielded a rate of return on invested capital above the interest rate plus running costs were called *productive*, systems with a lower rate of return were called *protective* (for further discussion see Stone, 1984 and Bharadwaj, 1990). Protective systems were those systems that were constructed not primarily for direct financial benefits for the colonial state or investors, but they were meant in the first place as famine relief works⁵. On the recommendation of the Famine

³ The latter can however also refer to the settling of "unruly tribes" (Stone, 1984:9). And after the British gained control over Punjab in 1849 irrigation development was also an "employment measure to absorb and placate the new idle, sturdy soldiers of the former Sikh army." (Jairath, 1984: 23-24)

⁴ A recent contribution to the debate on famines in India is McAlpin (1983).

⁵ The systems were famine relief programmes in two senses. Firstly, they were constructed as "food for work" programmes. This policy was introduced in 1878 in the Bombay Presidency. It was meant

Commission a Famine Fund was created. Half, and later all, of the revenues of this fund were to be used for the construction of protective irrigation systems.

Until the turn of the century and the Report of the Indian Irrigation Commission 1901-3 (again appointed after a series of famines) very little headway was made with the construction of protective irrigation systems. Between 1878-9 and 1900-1 the area irrigated by large scale productive works expanded from 4.6 to 10.9 million acres, while the area covered by protective systems lay below 0.4 million acres (Stone, 1984:27). In the period 1912-13 to 1945-6 protective irrigation comprised between 14% and 33% of the total irrigation budget and thus becomes a more serious affair. Most protective systems were constructed in the inland areas of the Bombay and Madras Presidencies where drought and famines hit hard and where very little investment in irrigation had occurred before 1880. A major reason for the lower profitability of irrigation systems in these regions was that their construction costs were considerably higher. Topographically the terrain is much more difficult than the vast plains of Northern India and delta regions of present Andhra Pradesh and Tamil Nadu where British irrigation development started. A second reason for high constructions costs is that the systems in Bombay and Madras require the building of reservoirs because the rivers are not perennial, in contrast to the north.

2.2 Protective irrigation after independence

It is not uncommon to stress the continuity of irrigation policy before and after independence. There are certainly continuities in form. To give three examples: strong government involvement in irrigation development continues, the administrative structure of the Irrigation Department seems to have remained unaltered since it was established in the 19th century, and the technical designs of large scale systems before and after independence are quite similar. Furthermore, agricultural modernisation and social (food) security are central objectives of post-independence agricultural and irrigation policy as well.

Notwithstanding these similarities in form, irrigation policy is now embedded in a very different state and society than before independence. No general analysis of the Indian state will be attempted here⁶. For the purposes of this paper it is sufficient to note that we are dealing with a state assuming large responsibilities in development planning,

to reduce the costs of famine relief in drought areas by making available labour productive. The second sense in which protective irrigation systems were famine relief programmes is that they were supposed to bring irrigation water to large number of farmers and prevent the failure of their crops in drought years (see Wallach, 1985).

⁶ For an introduction to the debate on the Indian state see Rudolph and Rudolph (1987, 1988) and Byres (1988).

with a constituency based system of parliamentary democracy governing over very scarce resources, with blurred lines of separation between the polity and the administration, and a political discourse dominated by rabidly populist ideologies⁷. As a result post-independence irrigation policy has quite a different context and content than colonial irrigation policy. Ramamurthy succinctly puts the point as follows.

In the contemporary context, while the policy is still justified using the rhetoric of 'protection' and socialist planning (sharing benefits as widely as possible), longer canals also provide an opportunity to maximise the number of constituencies that [politicians] have favoured. (1988:19)

In other words, because politicians have to be responsive to the needs of their constituencies, the outcome of political decision making tends towards spreading resources, including water resources. A push towards protective irrigation is, at least at the ideological and policy level, inherent to the working of the political system. An example is the history of the Hemavathy irrigation system in Karnataka. This was originally conceived as an intensively irrigated or productive system for rice cultivation around 1970. As a result of the effective pressure of downstream constituencies the area planned to be irrigated multiplied by 4 to 5 times in the course of 10 to 15 years, while the available amount of irrigation water remained constant⁸.

A last point to be noted in this respect is that the words productive and protective irrigation have to a considerable extent disappeared from irrigation policy discourse, and have been replaced by more neutral classifications like irrigated dry, wet and garden irrigation⁹. This disappearance from debate of the concept does not, however, imply that the *issue* of protective irrigation has disappeared from the political arena, especially not in the drought prone areas of South India.

⁷ A point not discussed in this paper is how revenue collection, or in more general terms surplus extraction by the state, has been transformed in the post-independence period, and how this affects irrigation policy and practice. I refer to the discussion of this issue in Ramamurthy (1988) and Wade (1982 and 1985).

⁸ Personal communication B.K. Narayan.

⁹ One informant suggested this was because of the discrepancy between stated objectives and actual practice of protective irrigation, that is the problem of unfulfilled promises. Another reason may be that when taken out of the colonial frame of reference they become confusing concepts because they stop being exclusive.

2.3 Three dimensions of protective irrigation

Looking at the content of the concept of protective irrigation in more detail reveals that it has three interrelated dimensions: a technical, an organisational and a socio-economic (see table 1 for a summary)¹⁰.

In a *technical* sense protective irrigation means spreading a certain amount of water over as large an area as possible. It means distributing a limited amount of water to all water users, enough to prevent crop failure when no rain falls, but not enough to meet crop water requirements for maximum yields. Protective irrigation requires an extended canal system. The systems are designed as supply-oriented systems, mostly on the basis of water distribution proportional to land size. Agronomically, protective irrigation concentrates on the cultivation of low water demanding 'irrigated dry' food crops, like sorghum and millet, which were the traditional food crops in the regions to be protected.

In an *organisational* sense protective irrigation means planned scarcity of water. For distributing limited amounts of water over a large number of people, a sophisticated system of organisational arrangements has to be devised that makes farmers accept less water than is needed for the full growth of their crops, so that other farmers can also have water. Different solutions to this problem are possible. One is strict rotation of irrigation water among users on a time basis, which is the essence of the *warabandi* system in use in Northwest India. Another solution is minimising organisational requirements by making the system a continuous flow system with fixed proportional division structures at all division points. As the cultivation of irrigated dry food crops is central to protective irrigation policy, protective irrigation implies the prescription of the cropping pattern by the government management, and institutional arrangements to implement this prescription of land use.

In a *socio-economic* sense protective irrigation means the maximisation of returns per unit of water instead of per unit of land (as in productive irrigation), and thereby maximising total social benefits (see section 5 for a detailed argument). Protective irrigation is considered an important instrument for poverty alleviation because it spreads benefits. Because irrigated dry food crops have tended to be relatively low priced and low yielding, the concept of protective irrigation in a political economic sense means the constitution of an agrarian structure based on a large number of

¹⁰ To my knowledge the concepts of protective and productive irrigation have never been spelt out in detail, and my description therefore is a combination of its observable characteristics and implicit assumptions, and open for discussion and improvement. It should also be noted that the category productive irrigation very much has the meaning of 'all other irrigation'.

farmers, many of them small ones, producing not particularly remunerative crops for the market and for subsistence, and to a large extent making use of family labour. While before independence 'protective farmers' were seen as subsistence producers, after independence the image became one of petty commodity producers. It is my view that what is sometimes called a peasant mode of production is implicit in the concept of protective irrigation¹¹.

Table 1: The concepts protective and productive irrigation

Protective irrigation	Productive irrigation
Technical	Technical
- spreading water	- concentrating water
- supply less than full water requirement of crop	- supply full water requirement of crop
- supply proportionate to size of landholding	- supply depends on crop
- supply oriented design	- demand oriented design
- cultivation of 'dry' food crops	- cultivation of 'wet' cash crops
- high canal length per unit discharge (extended system)	- low canal length per unit discharge (dense system)
Organisational	Organisational
- planned scarcity of water	- planned optimisation of water availability
- prescribed water management with constant discharges	- demand oriented water management with varying discharges
- prescription of cropping pattern by the government	- no prescription of cropping pattern

¹¹ The category 'peasant mode of production' originally derives from Chayanov (1987), and has been hotly discussed also in the Indian debate on the agrarian question (see for example Banaji, 1976 and 1977a and b), a debate I will leave aside in this paper. However, it should be made clear that I am not defending peasant mode of production as a useful analytic category. My argument is only that it is constitutive part of protective irrigation as a concept. Even when peasant mode of production is a theoretically flawed, analytically useless and politically misleading category, it still has ideological force and informs policies with real effects.

Socio-economic	
- maximise returns per unit of water	- maximise returns per unit of land
- spreading benefits	- concentrating benefits
- poverty alleviation important objective	- growth of private farms main objective
- form of production: dominance of family labour and large subsistence component	- form of production: dominance of wage labour and highly market oriented

2.4 The contradiction of protective irrigation in operation

The implementation of the concept of protective irrigation has run into serious difficulties both in the colonial period and after independence. Much to the surprise of the colonial government farmers showed very little interest in the irrigation water made available by the protective systems. In the Nira Left Bank Canal system in present Maharashtra the area irrigated varied between 16% and 46% of the potential in a decade with serious and frequent famines (Attwood, 1987:345). One of the numerous cases reported by Wallach is the Kurnool-Cuddapah canal in present Andhra Pradesh. It was built around 1860. In 1882 it irrigated a mere 5% of the planned 118,000 hectares. In 1920 this had risen to only 30 % (Wallach, 1985:163).

The reason for this lack of interest was that in years with around average rainfall irrigating indigenous food crops was not an attractive economic proposition. The responsiveness of these crops to improved water supply was very low above a certain, rather low, threshold level. Furthermore, in many places the soils were *black cotton soils*. These are very moisture retentive and rainfall was therefore used efficiently. At the same time these soils were very sensitive to excess water: there was danger of waterlogging and salinisation. Excess water might also cause excessive growth of weeds, requiring extra labour, a scarce resource in these thinly populated areas¹². It was only in years of complete rainfall failure that farmers turned to irrigating their food crops. In years with around average rainfall the extra costs of irrigation, in time and money, didn't weigh up to the extra returns.

The colonial government responded in different ways. One response was to further expand the systems to increase chances for selling irrigation water. Another response

¹² Up to the present day many local farmers in the Tungabhadra LBC are reluctant to irrigate black cotton soils for the last two reasons.

was to allow head end farmers to grow water intensive crops like rice and sugarcane. These were also the crops that were traditionally irrigated intensively in small acreages under tanks. This second response developed into a general pattern¹³: rice and sugarcane at the head ends, very limited or no irrigated cultivation at the tail ends.

After independence large scale irrigation systems in drought prone areas continued to be designed and constructed on the basis of the principles of protective irrigation. A similar pattern of actual use emerged: head end farmers appropriating irrigation water for the growth of water intensive cash crops, creating shortages for tail end farmers¹⁴. A factor contributing to the development of such a pattern is that large scale systems are constructed in phases going from the upstream to the downstream end. In the first phase when the reservoir and the first part of the canals are finished, a lot of water is available for a small area. It is hard to deny farmers the cultivation of water intensive crops in these circumstances, especially when there is, as there was in the 1960s, a food shortage and a national policy to increase food production. I will not embark upon an analysis of the head end-tail end problem and the strategies implemented during the last few decades to do something about it, because it is the most extensively discussed subject in the irrigation water management literature¹⁵. The efforts that have been undertaken to remedy the problem have generally been unsuccessful, a fact that is now widely recognised.

To summarise, the problem of protective irrigation 'on the ground' is that farmers don't cooperate. The contradiction underlying this situation is between, on one hand, a government strategy aiming to spread water thinly to maximise output per unit of water and thereby maximise aggregate social benefits, and, on the other, individual farmers, particularly those at the head ends of the system, who try to appropriate and concentrate irrigation water to maximise production per unit of land and thereby maximise their individual benefits. This tension will be illustrated and elaborated by discussing the Tungabhadra Left Bank Canal case.

3. The Tungabhadra Left Bank Canal Irrigation System

The Tungabhadra river is a tributary to the Krishna river, the second largest river in South India. The first plans to use the Tungabhadra waters for large scale irrigation

¹³ Except where no market infrastructure and/or labour was available, as was the case in the Kurnool-Cuddapah canal.

¹⁴ The lack of interest in irrigation gradually disappeared as farmers saw the possibility of intensive wet cultivation and improved irrigated dry crops slowly became available.

¹⁵ See footnote 2

development were made in 1860 by Sir Arthur Cotton, then in charge of irrigation development in Madras Presidency. The plans went through several rounds of postponement and alteration (Tungabhadra Board, 1959). Reasons for postponement included the failure of the Kurnool-Cuddapah canal located downstream on the Krishna river, and problems in reaching agreement among the governments involved¹⁶. It was only in February 1945 that the Tungabhadra Project, the major irrigation scheme on the Tungabhadra river, was inaugurated as a joint venture of the governments of Hyderabad and Madras. After changes in the boundaries and names of the States after independence, the Tungabhadra Project became the joint undertaking of Karnataka and Andhra Pradesh. The project is primarily intended for irrigation, but power is also generated at the dam and at canal drops. The first water was released in 1953. The Tungabhadra Board, headed by representatives of both States and the Central Government, has been created to manage the reservoir, that is to decide on the division of water over the two States and over different canals. Four canals are fed from the reservoir, two on the left bank and two on the right bank of the river. This paper focusses on the biggest of the two canals on the left bank, the Left Bank Canal, covering a planned irrigated area of 243,900 ha. The whole project covers a planned irrigated area of 527,749 ha of which approximately 70% lies in Karnataka and 30 % in Andhra Pradesh. The Left Bank Canal is wholly situated in Raichur District, Karnataka (CADA/TBP, 1987).

3.1 Tungabhadra Project as a protective irrigation system

The districts covered by the Tungabhadra Project (Raichur, Bellary, Anantapur, Kurnool and Cuddapah) are chronic drought prone areas that, in the past, were frequently stricken by severe famines (*Mysore State Gazetteer*, 1970). Rainfall averages about 600 mm and is erratic; almost all of it falls in the rainy season between June and October. A large part of the region is covered by black cotton soils. Sorghum and millet were the prevalent staple food crops before the start of the project. Indigenous irrigation, including the famous Vijayanagar canals, covered only relatively small areas near the river bed. Tanks and wells were scarce for geophysical reasons. This inland area was far removed from commercial and political centres. These characteristics and the presence of a virtually untapped river made the region particularly suited for the construction of a large scale protective irrigation system in the eyes of both pre- and post-independence governments.

¹⁶ At this time the Tungabhadra river bordered and passed through the Bombay and Madras Presidencies and the Hyderabad and Mysore Princely States, which made the sharing of the waters a complicated affair.

The planned 243,900 ha on the left bank are fed by the 227 km long Left Bank Canal (LBC). 87 distributaries start from the LBC, and units of on average 40-60 ha draw water from the distributaries and sub-distributaries through gated pipe outlets¹⁷. Within pipe outlets there are water courses, field channels and drains. Down to pipe outlet level the system has been designed as a supply oriented system with continuous and constant flow. Water needs for every pipe outlet were calculated on the basis of the cropping pattern set by the government (the localisation pattern, see below). This water need is supplied in a continuous (day and night) and constant (over the growing season) manner. The pipe outlets have slide gates that can be regulated. The target discharge is based on the localisation pattern for each pipe outlet. Water levels in the distributaries and main canal are controlled by discharge only; there are no cross regulators¹⁸. Within pipe outlets water distribution is left to the farmers.

This design is supposed to be easy in terms of operation. Once all the inlets to the distributaries and all gates to the pipe outlets are adjusted at the right level at the beginning of the cropping season, water distribution down to pipe outlet level requires no further intervention by the Irrigation Department managers of the system because of constant flow over the season.

A second important design characteristic is the quantity of water planned to go to the fields, that is, what is considered to be the water requirement of the crop. Part of the design is the *localisation* pattern which is a strong form of land use planning. It means that the cropping pattern is prescribed by the government management up to the unit of the survey number (usually having a size of several acres). Particular survey numbers are localised for the irrigation of particular crops in a particular season. The protective nature of the Tungabhadra scheme is most evident in this localisation pattern. In table 2 it can be seen that only in the kharif season (June-October) is the cultivation of rice allowed, and not in the rabi season (September-January). Light crops, mainly sorghum and millet, constitute the bulk of the planned irrigated area in both kharif and rabi. Among the perennial crops cotton is dominant. No seasonal crops are planned to be grown in the summer season (January-May).

¹⁷ These units of irrigated area are themselves usually called pipe outlet or P.O., after their inlet structure. In North India they are called *chak* and in irrigation engineering tertiary unit.

¹⁸ The drop structures in distributaries partially function as water level control devices (Jurriëns et al., 1988:23). The regulators in the main canal are shutters used to close sections of the canal, for example in case of breaches.

Table 2: Localisation pattern of Tungabhadra Left Bank Canal and crop water allowances and requirements

Crop	Localised area (ha)			Duty (acres/ cusec)	Allowance (l/s.ha)	Full requirement (l/s.ha)
	Kharif Perennial Rabi					
Rice	21,100	-	-	65	1.08	1.00
Light Crops	89,3000	-	88,800	175/140	0.40/0.50	0.70/0.80
Sugarcane	-	8,400	-	90	0.78	1.00
Cotton	-	30,000	-	140	0.50	0.75
Garden Crops	-	6,3000	-	115	0.61	0.80
Total	110,400 (45%)	44,700 (18%)	88,800 (37%)			

(Source: Jurriëns et al., 1988:25-26, tables 1 and 2; slightly adapted)

Also given in the table is the *duty* (at the distributary head) which is the area (in acres) planned to be irrigated with one cusec (cubic foot per second) continuous flow. *Allowance* is the inverse of duty, expressed in liters per second per hectare. Division of localised area by duty gives the design discharge, on which the canal design is based. In the last column the full water requirements of the crops are given¹⁹. Comparison of this column with the allowance column reveals another feature of localisation, namely that the water requirement of crops was not defined as the crop water requirements for full growth, but as a percentage thereof. This percentage ranges between 40 and 70% (see also Jurriëns and Ramaiah, 1989:37, table 2). A feature of localisation that can not readily be derived from the table is that every particular piece of land is only irrigated for one crop per year, that is no double cropping takes place (cropping intensity is 100%). Together this amounts to spreading water over a large area.

The organisational and socio-economic dimension are implied in the foregoing. With regard to water distribution the principles are low intensity management and a clear separation of government and farmers domains. Apart from proper construction, the realisation of this mode of water distribution presupposes effective implementation of the localisation pattern. There is a system of policing the localisation pattern. Two terms

¹⁹ These were calculated following FAO guidelines; the figures are seasonal, not peak requirements.

are in use here: violation of cropping pattern (VCP) meaning cultivation of different crops than localised, and unauthorised irrigation (UI) meaning the irrigation of non-localised areas. These two infringements become evident with the estimation of land revenue, which depends on the crop grown and whether the land is irrigated or not. Fines have been set for them. The Irrigation Department makes the tax and fine estimates. The Revenue Department is supposed to collect them. The Irrigation Department has the legal possibility to file a civil or criminal court case against violating farmers. There are also procedures through which farmers can request changes in the localisation pattern.

Given the fact that insufficient water is available for the full growth of crops, and given the fact that returns on grains like sorghum and millet are generally low because of low prices, the socio-economic implication of the foregoing is a type of agricultural production characterised by relatively low-key peasant production of mainly food grains, with a large subsistence component, and a limited amount of cash crop cultivation.

3.2 From design to practice

The practice of protective irrigation in the Tungabhadra LBC system is very far removed from the concept just described, in all three dimensions. The crux of the protective approach the localisation pattern is that it has very little meaning as an instrument for land use planning. Farmers follow their own preferences in crop choice, and irrigate land that is irrigable, disregarding localisation. What they prefer to grow when water is available are crops like rice, sugarcane and cotton. When farmers grow sorghum and millet, it is because there is not enough water available to grow something else. Rice alone covered between 19 %and 43% of the total localised area in the years 1977-78 to 1991-92, with an average of 29%. The area localised for rice is just under 10% of the total²⁰. These figures suggest to which extent a relatively small groups of farmers are able to appropriate water above their protective share. The resulting head-tail differences are found at all levels: among distributaries on the main canal, among pipe outlets on the distributaries, and among farmers within pipe outlets (Groenhuijzen and Noordman, 1992; Jurriëns and Ramaiah, 1989; Ramamurthy, 1984; field data). This results in the underutilisation of the potential irrigated area. Official estimates of utilisation rates are around 70%, but these may in practice be lower. Furthermore, at

²⁰ As the actually cultivated area is lower than the total localised area, and because much of the rice cultivation is double cropping, these figures underestimate the dominance of rice and rice farmers. Figures have been taken from the Tungabhadra Command Area Development Authority Annual Report 1986-87, and from the yearly reports of the Agricultural Department in Raichur District.

least 15,000 ha of the LBC area²¹ is seriously salt affected as a result of intensive irrigation in the head ends (Rao and Sundar, 1984).

At this stage of the research the social processes underlying this state of affairs can only be described in a general and qualitative manner²². Notwithstanding the fact that the actual overall water distribution pattern is approximately the same every year the process that produces this pattern is one of intense lobbying, negotiation and struggle. The efforts to secure a sufficient flow into the main canal are well documented in newspaper reports. The struggle around this particular issue, between farmers and the system management, centres on the opening and closing dates of the main canal, that is the length of the irrigation season. For perennial crops like sugarcane and for double cropping of rice it is important to keep the canal open as long as possible, though it is supposed to be closed for 2 months in April and May. Another point of struggle is the recent decision to close the canal in November/December for several weeks as well, to discourage double cropping of rice and to save water. Decisions on closure dates are taken by the Irrigation Consultative Committee, a body chaired by the Command Area Development Authority (CADA, see below). Members are government officials, notably from the Irrigation Department, and the local members of parliament.²³ Methods of farmer action to press their demands include road blocks, strikes, surrounding of Irrigation Department officials' houses and occasionally physical harassment, as well as marches to the dam and sit-ins. Protests are voiced through members of parliament and other public figures. When conflicts escalate Cabinet ministers may be called upon to mediate, and ban-orders for the dam area may be issued.

At the lower level of the distributaries farmers press their case for (more) water in similar ways. They guard their own and others' pipe outlets and sub-distributary offtakes, and in some cases even the distributary offtake itself, to keep the water flowing in their direction, particularly at night. They also manipulate pipe outlet gates

²¹ More precisely, some areas are over-utilised, that is irrigated in both seasons, and some areas are underutilised, that is irrigated in no season. For a discussion of the concept of underutilisation, see Mitra (1986).

²² The paper was written before fieldwork in the canal system started, but could only be finalised towards the end of it. The following paragraphs, and section 5, have been adapted on the basis of recently gathered field data, without however attempting any detailed presentation of these data.

²³ Both MPs (members of the national parliament) and MLAs (members of the legislative assembly, the state parliament) can be involved, though MLAs play the dominant role.

themselves, sometimes resulting in their complete destruction²⁴, or convince the gangman (the Irrigation Department official responsible for adjusting the gates) to raise their own gates and/or lower other ones. Farmers also put and remove canal blockages. Apart from this farmers file court cases against the government. These activities can be individual as well as collective. Problems regularly increase to the extent that visits to the Irrigation Department offices are deemed necessary, sometimes followed by spot inspections of officials. In serious cases local and regional leaders, particular the local MLAs, are engaged to resolve conflicts. Guarding and manipulation can and is done by everyone, but the actual interaction with government officials and politicians is mostly taken care of by local leaders, who, more often than not, are the head end farmers of their particular locality (though they may be tail end farmers compared to other localities on the canal). One practice that is fairly common in the Irrigation Department is to appoint extra gangmen hailing from tail end villages in the tense periods of the season. Night patrolling by Irrigation Department staff is common practice.

An interesting and crucial feature of the Tungabhadra LBC system is the settlement of large numbers of migrant farmers from the coastal districts of Andhra Pradesh (Kallur, 1988; Swamy, 1988). These farmers came from a densely populated area with intensively irrigated and highly commercialised agriculture, particularly rice cultivation (Upadhyaya, 1988). Land prices were extremely high and holdings small and fragmented. Selling one acre in their home area provided the resources to buy around four acres and sometimes more in the Tungabhadra scheme²⁵. The coming of these migrant farmers meant the influx of experienced agricultural entrepreneurs into a region with mainly subsistence oriented farmers almost completely unfamiliar with irrigation, and maybe more importantly, a region where most farmers lacked the means to make the necessary investments to start irrigated agriculture. The migrants took the region by surprise, and established a farming system based on intensive cultivation of particularly rice, but also cotton and sugarcane. Farm work was to a large extent performed by wage labour, with the farmer in a managerial role²⁶. The LBC area thus experienced a rapid expansion of typically capitalist farming, which was started by the migrant

²⁴ Apart from damaging structures, farmers also construct or realign field channels in their pipe outlets, construct pick-ups from the natural drains and install pumpsets on the banks of the river and natural drains.

²⁵ At least initially, around 1960 (Nagaraju, 1989). Most migrant farmers migrated in the 1950's and 1960's. When land prices started to rise migration slowed down, but continues to the present day.

²⁶ It is interesting to note that initially there was a shortage of labour in the area. The Karnataka government went as far as to set up a programme for the migration of labourers to this area from other parts of Karnataka (Tungabhadra Board, 1959).

farmers, but was followed after some time by the head and middle reach local farmers (see Venkata Reddy, 1979 on the latter issue).

Was anything done by the government to curb the rice based capitalist expansionism, possible through unrightful appropriation of water? Yes, there was. At the policy level the protective approach was never abandoned. On the contrary, several committees appointed to look into the situation in the Tungabhadra scheme recommended that the localisation pattern should be made even more protective (Rao and Sundar, 1984)²⁷. However, as already mentioned, localisation has proven to be a very weak policy instrument. The collection rate of taxes and fines is low, and court cases are rarely decided in favour of the government. Still, localisation provides tail end farmers with a rightful claim to water, and as such is an important, though not always effective, political resource to them.

More interesting are the concrete efforts of the irrigation administration to change existing water distribution practices. Generally speaking, interventions in irrigation water management in India have had a strong technical bias (see Chambers, 1988). A well known example of this is the CAD (Command Area Development) programme started in the 1970s. This theoretically had a strong organisational component, the formation of water users associations and the introduction of a *warabandi* rotation system, but in practice strongly focussed on technical interventions like the construction and lining of (field) channels and levelling (see Ali, 1984; Pant, 1981; Wade, 1980). This approach is also present in the Tungabhadra LBC. For example recent efforts to introduce the *warabandi* rotation system in several pipe outlets in distributary 36 by CADA²⁸ have in practice been reduced to the construction of division boxes (Jurriëns et al., 1989)²⁹. Re-lining of the main canal by the Irrigation Department is another major physical intervention, and the most recent initiative is the plan to build a balancing reservoir in the tail end of the main canal.

But organisational interventions have also been undertaken. For at least 20 years a variety of rotation systems have been introduced in distributaries, particularly in the longer ones, as a response to problems between head end and tail end farmers. Though

²⁷ This supports the point made in section 2 that there is a push towards protective irrigation at the policy level.

²⁸ Command Area Development Authorities were established as an element of the CAD programme. They were meant to coordinate all activities of the different departments in an irrigation system. In practice CADA is active downstream of the pipe outlet to the tertiary unit, and the Irrigation Department upstream of the pipe outlet in the main system.

²⁹ In 1991-2 CADA started a new programme to establish Water Users Cooperative Societies.

sometimes the introduction of rotation systems may have increased water supply to the tails, practically speaking they are the stabilisation of a particular pattern of inequality in water distribution. More than increasing total water supply to tail enders, the rotation increases predictability and reliability of flows. Within many pipe outlets and in some sub-distributaries farmers have implemented their own, sometimes very sophisticated but not necessarily equitable, rotation systems. In 1982 CADA ordained rotation over distributaries in the main canal which has in recent years been implemented with some success in the tail end part of the main canal but remains to be implemented in the head end. In 1988 the Irrigation Department succeeded for the first time in closing the main canal in November/December against strong opposition of farmers, and this has now become common practice, though the length of the closure period is still subject to negotiation.

The relation between the irrigation administration and the head end farmers is not a simple good guys-bad guys opposition. The Irrigation Department is subject to pressure from different sides and at different levels. Because government officials strongly depend on politicians, particularly MLAs, for transfers and for the allocation of budgets, the managers of the system are not in a position to disregard farmers' demands for irrigation water voiced through these politicians³⁰. As the pressures are multiple, originating from head end as well as tail end locations, water management in practice requires constant adjusting of gate levels, particularly at times of severe water scarcity, in response to the balance and force of the exerted pressure. The present pattern of water distribution shows that head end farmers carry most weight³¹. Though many engineers in the Irrigation Department feel they are at the mercy of politicians, some try to turn the tables and use the dependence of the MLA on his voters to their own advantage. Officials sometimes mobilise farmers to make the MLA engage in finding more permanent solutions for water distribution problems than the ad hoc issuing of orders for increasing or decreasing water releases in particular places.

The direct pressure of farmers on the scheme management is partly mediated by the latter exacting an extra payment for water releases from farmers. This practice creates vested interests in unequal water distribution not only among farmers, but also within the bureaucracy. It is however difficult to judge the extent and importance of this 'water market'. I would hypothesise that political mediation increasingly takes precedence over

³⁰ For a detailed analysis of politicians-officials relations in a neighbouring state, see Wade (1982).

³¹ In fact, to some extent, those who are able to wield enough political influence become 'head end' farmers independent of the geographical location of their land. This point will not be elaborated in this paper.

direct financial dealings. The logic of this could be that the former is more longer term and reliable than the latter.

Another aspect of the operation of the irrigation administration is the tension between 'field staff' and 'office staff'. The instructions issued by the office staff have to be translated into workable water management by the field staff. Those on the higher echelons regularly instruct their field staff to simply 'convince the farmers' of the necessity of particular measures, like strict implementation of rotation systems, disregarding the complexities and contradictions of the work on the canals.

To conclude, the interaction of farmers, officials and politicians regarding water distribution is a social process, with knowledgeable and capable actors on all three sides. Although the outcome of the interaction is pre-structured by the nature of the political system and the agrarian economy, it is not fixed and unchangeable, but a continuously negotiated balance of forces.

3.3 Deadlock

The present predicament of the Tungabhadra LBC can be described as a deadlock. This condition is most evident in the organisational dimension. In a positive interpretation there is growing pressure from tail end farmers to bring about changes in water distribution; the tail enders are increasingly capable of translating their rightful claim to water into political manoeuvring. The intense activity of the present CADA chairman, a politician from the tail end area of the main canal, to implement rotation systems more rigorously can be seen as an example of this. But this does not hide the fact that this type of effort fails to confront the heart of the matter: changing the existing cropping pattern means substantially reducing the area cultivated with rice. Though there is some scope for reducing canal water losses, reusing drainage water and making field irrigation more efficient, the basic problem is crop choice. When asked, most people answer to the question 'how to convince farmers to stop growing rice?' that it is impossible. They then elaborate by listing the advantages of growing rice. Irrigation is easy, apart from transplanting and harvesting it requires little labour. Yields are good and stable. Prices are stable and the market is assured. It produces fodder. It is an important food item, and so forth. Rice is the rock wrecking all ships that sail to change the mode of water distribution.

On the technical front all is also not well. There are, however, points of progress, like the prevention of breaches by re-lining the main canal, most of the distributary canals are in a poor state of maintenance, which according to the engineers in the system, reduces the flow to the tail ends. More important however is the state of the pipe outlet

gates. These are the technical heart of the system, as their operation determines how much water goes where. The government management is unable to translate the protective irrigation intention into a working technology, as is evident in the places where the outlets have been demolished. But it is also the case where they are working. Apart from being a device that enables government officials to regulate water flows, the pipe outlet gate offers the same opportunity to farmers, as it is fairly easy to copy the keys necessary for operating it. The adjustable gated outlets can be seen as a convenient compromise that allows the government to regulate flows when it is present, and farmers when the officials are not present. More than water flows, these structures regulate conflicts. In this way they help to reproduce the existing pattern of water distribution.

In the socio-economic domain the deadlock or impasse is less evident, but still there. The introduction of irrigation in a semi-arid area can be seen as a form of colonisation (see also Attwood, 1985:66-67). Though the LBC did not come to an uninhabited and uncultivated region, the increase in land productivity through irrigation was so dramatic that effectively 'new land' was created³². Another aspect of the colonisation was the anticipation of this rise in productivity by the prospective migrants and their consequent occupation of large tracts under the canal. But the land frontier, which is in fact a water frontier, is in sight. Land development for irrigation seems to have reached the point of a zero sum game, and further concentration of water for 'wet' cultivation is prevented by the already mentioned increasing tail end pressure. Water availability is actually decreasing as a result of the sedimentation of the Tungabhadra reservoir (Satyanarayana and Srivastava, 1989). The problem is exacerbated by the circumstance that many migrant farmer families, which settled as small nuclear families with no or few children, have grown and reached the point of 'property division', reducing the average land holding size³³. This creates a problem for further agricultural growth, to which farmers have responded in different ways. The installation of irrigation pumpsets on the river bank and along natural drains, the main response, can only partially solve the problem as the area covered is limited. Some farmers are considering moving or have already moved to newly constructed schemes like the nearby Upper Krishna Project, to repeat the cycle. There is some scope for increasing yields and productivity through improving agricultural practices, but this should not be exaggerated as present yields are often quite impressive and farmers are actively chasing technological innovation already. A further aspect of the deadlock is that most of the agricultural surplus seems

³² The construction of canals and (levelling) of the fields has also radically changed the visual appearance of the landscape.

³³ For the local farming community this is obviously a more continuous process.

to have been invested in fertiliser cum moneylending cum commission agent enterprises³⁴, and in rice, cotton and oil mills. These activities directly depend on the volume of agricultural production; if production doesn't expand, business also stagnates. In short: the boom is over.

The reason for labelling this technical, organisational and socio-economic impasse as a deadlock, is that the balance of forces among the three parties involved - farmers, the administration and politicians - prevents the implementation of a more protective mode of water distribution. Despite the fact that a more protective mode of irrigation would increase total agricultural production and might start a new phase of growth. Apart from an equity argument for protective irrigation, there is also a growth argument supporting it.

4. WAYS OUT OF THE DEADLOCK

Theoretically there are three ways out of a situation of protective deadlock.

- 1) Go for protective irrigation, that is: implement the protective mode of water distribution as originally planned, giving tailenders their due.
- 2) Go for productive irrigation and abandon protective objectives; abolish constraints on the cropping pattern and water use and bet on the head end farmers.
- 3) Combine protective and productive objectives.

4.1 Implementing protective irrigation as planned

The first option, implementing protective irrigation as planned, is the official objective of present intervention in water management in protective irrigation schemes in South India. To my knowledge there are no examples of the government management of these schemes having achieved this objective. Considering the present political climate with larger, head end farmers in a powerful position, this option seems to be quite unrealistic. One policy measure popular in recent debate is making water more expensive to stimulate its economic use, including the establishment of 'water markets'. As the present water rates are low compared to the costs of other inputs, and rice cultivation is quite profitable as well as having many other advantages. Water price increases would have to be very substantial to induce a change away from rice

³⁴ These shops give fertiliser (and pesticides and seeds) on credit on the condition that farmers sell their produce through the shop. Farmers can also take money loans in these shops.

cultivation. As the strength of the Indian farmers movement lies exactly in influencing government policy on price and tax issues (see Nadkarni, 1987), higher pricing of water does not seem to have a bright future. A standard recommendation for implementing protective irrigation as planned is stricter laws, or stricter adherence to the existing laws, and more policing of water distribution on the canals (see for example GOK/PD, 1976 and CADA/TBP, 1979). This advice also seems quite unrealistic. It is difficult to see how a 'law and order' approach could work in a system where farmers can circumvent convictions for even the simplest offences by mobilising their political representatives. Continued adherence to the original concept of protective irrigation is thus a blind alley.

4.2 Transformation into productive schemes

The second option of transforming protective schemes into productive ones has, in the past, been successfully implemented. I am referring here to the introduction of the block system of water distribution in protective and other systems in the Bombay Presidency in the beginning of this century³⁵. This area experienced severe droughts and famines in the second half of the 19th century, but the few protective irrigation systems that had been constructed were heavily underutilised for the reasons outlined in section 2. By the end of the century less than one third of the potential was irrigated. The percentage of net revenue on capital outlay on the Nira Left Bank Canal was as low as 0.11%. At the same time the colonial government had to spend large sums on famine relief. Reviewing this situation the Indian Irrigation Commission (1901-3) recommended both the construction of more protective systems and the introduction of a different system of water distribution: the *block system*. The concept of the block system was based on an indigenous system of water distribution in minor irrigation. Blocks were physically more or less homogeneous pieces of agricultural land in a village, of which all farmers had a piece. One fourth of the block was reserved for intensive irrigation of crops like sugarcane, the remainder was reserved for irrigated dry crops. The 'wet quarter' rotated over the whole block. As all farmers had land in the block, though not necessarily equal amounts, they were all able to participate in heavy irrigation of sugarcane at least once every 4 years. Around 1904 this concept was introduced in large scale irrigation. Creating blocks with all farmers from a village having land in it, required reallocation of land. This was tried but proved to be impossible to implement. Blocks were therefore allocated to individual farmers. Farmers were allowed to cultivate one third of the block with sugarcane, the remainder

³⁵ The literature used to write this section is Attwood (1977, 1985, 1987 and 1988), Choksey (1945 and 1955), Gadgil and Kanetkar (1960), Khursale and Gandhi (1969), Maijer (1988:98-101), Mitra (1987) and Wallach (1985).

with irrigated dry crops. Water supply to the blocks was guaranteed for a period of six years by the government³⁶. This combination of a commercial crop and a secured water supply made investment in irrigation interesting for farmers. It allowed the government to sell more water, increase irrigated area and thereby its revenues. The system was a success. Sugarcane cultivation grew explosively, and in its wake so did the cultivation of irrigated food grains³⁷. On the whole the regions where the block system was introduced became more prosperous: both cash crop production and food crop production increased and employment was created.

In equity terms the picture was less rosy. The blocks were not distributed proportionally over different categories of farmers because small farmers didn't have the capital to cultivate the minimum of half an acre of sugarcane. Also no cane blocks were allocated downstream of a particular point of the main canal. Apart from that, the introduction of sugarcane blocks amounted to a contraction of the potentially irrigated area effectively writing off part of the system. The individualisation of the blocks strongly reduced the usefulness of the block system as an instrument for achieving an equitable water distribution, and in the long run seems to have watered down its protective objectives completely in the sugarcane areas³⁸. Whatever the original protective intentions of the block system may have been, with hindsight it is clear that the change in the mode of water distribution was an important trigger for the intensive and expansive capitalist pattern of agricultural development that emerged in this region during this century.³⁹

It is unclear why the block system has not been introduced in other parts of South India. Now in 1992, the block system does not seem to be a way out of the protective deadlock in the Tungabhadra LBC. The situation in Maharashtra 85 years ago was one in which a surplus of unused water was available. In the Tungabhadra system all water is used. In its individualised form the block system would mean the reduction of intensively irrigated acreage for the head end farmers and can therefore hardly be an attractive proposition for them. The block system on a village basis would run into

³⁶ In fact the block system was more complicated. The six year cane block was the most important block, but there were/are other blocks as well: only for irrigated dry crops, for fruit trees etc.

³⁷ One reason for this is that sugarcane cultivation implied increased use of bullock power, which requires fodder. Indigenous food grains produce excellent fodder apart from grain.

³⁸ Personal communication Alex Bolding and Kees van Straaten.

³⁹ The development of the region took another leap forward when in 1932 a protective tariff was introduced for sugarcane. As a response sugar factories were established by both urban private capital and cooperatively by farmers. The resulting boom involved a process of gradual industrialisation of sugarcane production around sugar factories with a high incidence of (seasonally migrating) wage labour in production and the diversification of activities by the sugar agro-industries.

similar problems. The head end villages would have to reduce their wet areas without any compensation. In the present circumstances introduction of the block system would be a variation on the present approach to intervention.⁴⁰

The process that actually occurred in Maharashtra, abandoning protective objectives and going for full fledged productive development, is another possibility. Such a step could be legitimised by arguing that intensive capitalist development brings greater overall prosperity than a more extensive, broad based type implied by the protective approach. The argument would be that more surplus is generated, more wage labour employment created, more diversification of economic (industrial) activities takes place, and as a result less poverty occurs (Attwood, 1987, 1988). Whether the argument holds depends on a great many contextual factors. Additionally apart from the quantitative question of the poverty rate, there is also the qualitative question of the type of development one wishes to promote, in this case the type of capitalist development, which is essentially a political question. However, in the Tungabhadra case the option of changing to a fully productive system based on rice, sugarcane and perhaps cotton, is not feasible considering the existing claim of tailenders and the modus operandi of the political system. Productive irrigation on the basis of the presently popular cash crops thus also seems not to be a possibility.

4.3 Combining protective and productive objectives

The historical example of canal irrigation development in Punjab can serve as an example of the third way out of the protective deadlock: combining protective and productive objectives.⁴¹ In fact in Punjab a deadlock never occurred, instead the two types of irrigation were successfully combined from the beginning. Large scale irrigation systems in Punjab are designed as protective systems with cropping intensities sometimes as low as 62% in the *Bhakra* system. The systems constructed from the 1850's, but mostly from the beginning of this century, spread water over vast areas and were extremely profitable for the British colonial government. A set of factors explains this situation. An important feature of canal irrigation in Punjab is that, to a large extent, it developed as the colonisation of previously waste and barren terrain. This meant that relatively large consolidated holdings could be created, and that settlers

⁴⁰ A different type of block system was tried in distributary 40 of the Tungabhadra LBC. In this system pipe outlets were made into blocks in which in a particular season all farmers could grow only either rice, or sugarcane or irrigated dry crops (GOK/TBP, 1976). According to one engineer working in the distributary at the time the implementation had to be abandoned within a week because of farmers' opposition.

⁴¹ The literature used for writing this section is Dhawan (1988), Ghose (1979), Jairath (1984), Malhotra (1982), Malhotra et al. (1984), Reidinger (1974), Stone (1984) and Whitcombe (1983).

could be selected. In their settlement policy the British distinguished capitalists, yeomen and peasants, expecting the most of and favouring the former with larger grants of land. Colonisation also meant that expansion of cultivated area could keep up with population increase. A last factor is the relatively easy topographical situation in Punjab, compared with, for example, the Tungabhadra basin.

But what is it about the irrigation system and farming itself that facilitated the combination of protective and productive objectives? The two important points in this respect are the *warabandi* system of water distribution and the cultivation of wheat as the main crop. *Warabandi* is a system of rotational water distribution over distributaries combined with allocation of water to farmers on a weekly basis. The share of water of a farmer, expressed in irrigation time, is proportional to the size of holding. Farmers are only able to irrigate part of their holding, around one third, with their share of the canal water.⁴² Though the implementation of the *warabandi* system was by no means perfect, it still seems to have done a reasonable job in spreading the water thinly compared to the South Indian situation. The second important point about protective irrigation in Punjab was that the main crop grown, wheat, is both a food crop and a remunerative cash crop (most of the time), while its water consumption is relatively low.⁴³ Furthermore, from the beginning of the 20th century crop selection and breeding activities were undertaken for wheat.

Given the foregoing it is perhaps not surprising that Punjab's agrarian structure was characterised by stability in the period 1900-1960. In contrast to many other regions of India the percentage of the agricultural work force that were agricultural labourers did not increase and was stable around 12% in this period. Between 1925 and 1960 the (skewed) distribution of operated area changed very little. The percentage of operated area under tenancy decreased. The growth of land productivity was steady but not spectacular and bigger than the growth of population. Growth, both in terms of productivity and of cultivated area, ensured structural stability of Punjab agriculture. The picture is one of a growing but not extremely dynamic economy of commercial peasant farming. This is probably the closest the *practice* of protective irrigation ever came to the *concept* of protective irrigation.⁴⁴

42 The origins of the *warabandi* system are not clear to me.

43 Although wheat was originally not a local food crop, these were sorghum and millet, it soon became part of the diet.

44 The protective nature of the Punjab systems was of course relative considering the the possibility of unequal water distribution even under *warabandi*, particularly within the pipe outlets, and the way land was distributed to begin with.

With the Green Revolution starting in the 1960s the protective nature of the Punjab irrigation systems was undermined. With the new high yielding varieties tubewells were introduced in large numbers as irrigation at the right moment and in the right quantity was very important for the cultivation of the new high yielding seeds. Tubewells can improve the control of water supply substantially because mostly they are operated individually. Tubewells made canal irrigation less important, or rather gave it a different meaning. An important function of canal irrigation now was the replenishment of groundwater. The loss of interest of tubewell farmers in canal irrigation meant that it became more difficult to keep the *warabandi* system going because, for example, they were less motivated to do the necessary maintenance of canals. Furthermore, tubewells were distributed very unevenly over different categories of farmers, which was one element of the process of increasing polarisation of agrarian relations since the mid-1960s.⁴⁵

The pre-1960 situation of protective irrigation in Punjab is not a simple model for the Tungabhadra LBC case. We are dealing with a quite different set of social relationships now and, as a matter of fact, efforts to introduce wheat as well as *warabandi* in the Tungabhadra LBC have failed. The Punjab case nevertheless contains an important clue for the Tungabhadra and other South Indian cases: the cultivation of a remunerative irrigated dry crop. In recent debate about the future of South Indian protective irrigation this idea is a central one, as will be discussed in the next section. Furthermore, in the Tungabhadra case there need to be no fear of the undermining effect of tubewells, that is the individualisation of access to water, as the prospects for well irrigation are, as already mentioned, very poor.

5. DEADLOCK OR DEVELOPMENT?

5.1 The case for protective irrigation

The contention that in dry areas a protective/extensive mode of irrigation yields higher total social benefits than a productive/intensive mode of irrigation has remained unsubstantiated in the preceding sections. The argument underlying this contention goes as follows. In dry areas like the Tungabhadra basin, water is not just a scarce resource, but there are definite absolute limits to its availability, while irrigable land is abundant. In such a case, in order to maximise aggregate output, the output per unit of water should be maximised. This is what protective irrigation proposes to do. Whether

⁴⁵ The Green revolution in Punjab is a nice example of interrelated technical (high yielding varieties, tubewells), organisational (individualisation, deterioration of *warabandi*) and socio-economic (from commercial-peasant to capitalist production) change.

maximum aggregate output translates into maximum aggregate income depends on the prices and cost of cultivation of the different crops grown under these different water regimes. In recent years several publications have appeared that show that this is indeed the case. I refer here to the debate on irrigation policy in Maharashtra, and the work of economists of the Gokhale Institute of Politics and Economics in Pune in particular.

In 1979 the 'Committee to study the introduction of eight-monthly supply of water on the irrigation projects in Maharashtra' submitted an interim report that contained radical proposals to reduce the sugarcane area in large scale irrigation systems in this state. The report showed that Maharashtra's water resources were extremely meagre. In the dry tracts no more than 25-35% of cultivable area could have been irrigated under the existent cropping pattern (GOM, 1979:10, table 3). The committee calculated that with extensive irrigation, that is stopping sugarcane cultivation, this could be around 60% of the cultivable area (p.23). The committee also quoted the gross income per acre inch and per rupee worth of irrigation water as calculated by the Maharashtra State Irrigation Commission in 1962. Part of these figures are reproduced here.

Table 3: Estimated gross income of different irrigated crops (Maharashtra, 1962)

Crop	Gross income per acre inch of water (Rs.)	Gross income per rupee worth of water (Rs.)
Rice	6.73	6.33
Sugarcane	10.89	9.32
Kharif sorghum	23.08	21.98
Rabi sorghum	11.54	9.78
Millet	21.54	23.40
Wheat	12.18	10.32
Groundnut	34.19	33.96
Ordinary cotton	21.15	20.15
Long staple cotton	15.38	12.72

(Source: GOM(1962) cited in GOM (1979:29); slightly adapted)

The 1979 committee made its own calculation for a particular project in Maharashtra.

Table 4: Net value of produce of different irrigated crops (Maharashtra, 1977)

Crop	Net value of produce per acre (Rs.)	Net value of produce per acre-inch of water (Rs.)
Sugarcane	1774.51	8.17
Light perennials	1001.58	8.71
Long staple cotton	1028.69	16.87
Two seasonals (chillies)	3911.51	105.69
Kharif groundnut	785.0	44.68
Wheat	209.0	8.85
Rabi sorghum	798.0	45.06
Summer maize and vegetables	715.0	20.69

(Source: GOM (1979:32); slightly adapted)

These two tables show that the income and output per unit of water was considerably higher for irrigated dry crops like groundnut and rabi sorghum, than for wet crops like sugarcane and rice. In fact, none of the irrigated dry crops gave lower income or output per unit water than sugarcane and rice. A similar defence of protective irrigation was developed in the 1980s. Rath and Mitra (1989) give the following table, based on data for 1978-79 in two systems in Western Maharashtra.

Table 5: Economics of alternative crops in terms of net income per unit (Mcf.) of water (Western Maharashtra, 1978-9)

Crop	Per acre water requirements in acre-inches	Area that can be irrigated per Mcft. ^a of water (acres)	Net value of produce per Mcft. of water (Rs.)
Sugarcane	175	1.60	2336
Hybrid sorghum	15	18.40	6955

Millet	20	13.80	2139
Groundnut (kharif)	24	11.50	5980
Sorghum	22	12.50	3650
Wheat	31	9.20	3606
Pulses and beans	18	15.30	2295
Cotton (summer)	42	6.60	4059

a) 1Mct. = 1 million cubic feet

(Source: Rath and Mitra (1989:65); slightly adapted)

This table shows the same difference between irrigated dry and wet crops. Groundnut, sorghum and cotton gave the highest returns per unit of water. The second column of the table gives an idea of the spread of water that can be achieved with different crops. Rath and Mitra also made calculations for different crop combinations that show that the value of produce per unit of water is between 2.1 and 2.7 times as high as that of sugarcane. Rath and Mitra bring in another interesting element, namely that the total labour requirement of protective irrigation for most crops is much higher than for sugarcane.

Table 6: Total number of labour days required by the individual crops that can be irrigated with one Mct. of water (Western Maharashtra 1978-9)

Crop	Total labour days	Crop	Total labour days
Sugarcane	217-240	Wheat (HYV, rabi)	331
Millet (hybrid, kharif)	552	Wheat (local, rabi)	276
Groundnut (HYV, kharif)	518	Onion (rabi)	689
Groundnut (local, kharif)	345	Pulses and beans (local)	337
Cotton (HYV, kharif)	805	Onion (summer)	590
Maize (local, kharif)	414	Maize (summer)	230
Sorghum (hybrid, kharif)	736	Cotton (HYV, summer)	524

Sorghum (local, rabi)	313	Groundnut (summer)	344
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(Source: Rath and Mitra (1989:87); slightly adapted)

It follows clearly from these tables that a number of dry crops give substantially higher returns per unit of water than wet crops like sugarcane and rice, and the case for protective irrigation maximising total social benefits thus seems to be a strong one.⁴⁶ In addition, it seems to create employment.

What do the advocates of dry irrigation propose in terms of water management? The GOM (1979) committee report did not get a warm reception in the Maharashtra polity, in which the sugarcane lobby is very influential. Particularly problematic was the idea to bring the change in cropping pattern and irrigated area about by closing the canals for 4 months.⁴⁷ This not only implied relegating sugarcane cultivation to tubewell irrigation but also meant the possible creation of a drinking water problem as a result of wells running dry. The report never got beyond the interim phase.

Rath and Mitra's proposal for a different mode of water distribution is less radical than that of the earlier committee. They do not explicitly propose to close the canal for a certain period of time but only argue for rotational water supply delivering fixed amounts of water to farmers. Rath and Mitra correctly note that "equitable distribution of water requires control over the volume of water supplied to farmers" (1989:123), but this is exactly what the government is incapable of doing at the moment. It is not clear to me that the technical interventions Rath and Mitra propose, including measurement of water at the pipe outlet, are sufficient to enable the government to exercise this control in the future. Furthermore, table 4 illustrates the difference in value of produce per acre of wet and irrigated dry crops when we compare for example sugarcane with groundnut and sorghum. Which farmer is prepared to reduce his income by more than 50%?

5.2 One step further

Are we then back to square one? Not quite. Recently the reasoning has been taken one step further in the philosophy underlying the National Water Management Project (NWMP) and accompanying activities. The NWMP is a programme for the improvement of main system management in large scale irrigation in South India, in

⁴⁶ Dhawan (1989) has criticised Rath and Mitra's analysis and also complemented it by including other regions of India in his analysis. Though Dhawan's calculations yield less pronounced differences between wet and irrigated dry crops, on the whole they corroborate the thesis that protective irrigation gives higher returns per unit of water in dry areas.

⁴⁷ It was also proposed to abandon the block system and to replace it with volumetric or time delivery of water to farmers in amounts that could irrigate 25% of their holding. Small holdings below 2.5 acres were given more water for irrigation of the whole holding.

existence since 1987 and funded by the World Bank (Berkoff, 1988). *Technically*, in the NWMP approach, the most downstream point of government control of water distribution is the head of the distributary. Downstream of this point 'automatic' proportional division by means of fixed (non-adjustable) structures should take place. The *organisational* element of the programme is lower intensity management, as implied in the foregoing, and abandoning the localisation pattern.⁴⁸ It wants to leave to farmers to decide what crops they want to grow, and gives up on trying to directly control farmers' production processes. The fixed amount of water supplied to an outlet is not sufficient to grow wet crops on all the area under the outlet. For changing the present pattern of wet cultivation to irrigated dry cropping, stronghanded government action is considered necessary in the initial phase.⁴⁹ But the underlying *socio-economic* logic of the NWMP is that the new irrigated dry cropping pattern will be more profitable for individual farmers, and that they will turn to irrigated dry farming once they have experienced its profitability. A senior official of the programme claims that farmers will be able to double their income if they change from double cropping of rice to a cotton/maize sequence.⁵⁰ This is possible because of the existence of high yielding irrigated dry cash crops with attractive prices.

In the Tungabhadra LBC the possibility of gaining a higher income by cultivating irrigated dry crops also seems to exist, though the crops are different. Over the last few years sunflower has become a popular crop because of its attractive prices and low cost of cultivation. The sunflower area tripled from 1988-89 to 1991-92, while the price per quintal rose from Rs.573 in 1988-89 to Rs.981 in 1990-91.⁵¹ Rice prices were stable in this period. With prices per quintal around Rs.1000 in 1991-2, the cost of cultivation between 1000 and 2000 Rs. per acre and yields of 6 quintals per acre certainly possible, sunflower can now compete with rice in terms of profitability.⁵² However,

⁴⁸ There is an interesting historical parallel here with the colonial period. In the second half of the 19th century the British tried to extend their control of water distribution to lower levels of the system, but encountered many problems. They decided to withdraw and make distribution below the distributary head 'automatic' (Stone, 1984:chapter 6). The CAD programme of the 1970s and the NWMP are also an example of extension and withdrawal.

⁴⁹ For example, in the Bhadra project in Kamataka the NWMP will try to reduce the area under double rice cultivation with 20.000 ha. from one year to the other.

⁵⁰ Interview, 29.11.89. It was mentioned that a double rice crop would give the farmer an income of about Rs.11,000-12,000, while the cotton/maize sequence would give Rs.24,000 per hectare.

⁵¹ The prices are weighed averages of monthly average prices in the Raichur regulated market.

⁵² This calculation was made for me by a senior official of the Agricultural Department in Raichur District. Cotton is even more competitive with the 1991-2 prices.

the increase in sunflower area has not happened at the cost of rice, but at the cost of irrigated dry grain crops, notably sorghum (see table 7).

Table 7: Irrigated crops grown under Tungabhadra Project in Raichur District, 1988-89 to 1991-92

Crop		1988-89	1989-90	1990-91	1991-92
Sunflower	ha	18,718	29,759	46,822	57,555
	% TCA	8.3	14.3	20.8	23.4
Irrigated dry grains a)	ha	57,573	58,411	40,055	28,923
	% TCA	25.4	28.1	17.8	11.8
Rice	ha	84,399	65,440	78,055	103,554
	% TCA	37.2	31.5	34.7	42.2
Cotton	ha	23,663	22,706	15,295	18,623
	% TCA	10.4	10.9	6.8	7.6
Sugarcane	ha	850	853	2,430	1,585
	% TCA	0.4	0.4	1.1	0.6
Groundnut	ha	35,763	22,009	35,247	30,241
	% TCA	15.8	10.6	15.7	12.3
Pulses and beans	ha	3,533	5,844	4,372	4,107
	% TCA	1.6	2.8	1.9	1.7
Other crops	ha	2,214	2,934	2,519	918
	% TCA	1.0	1.4	1.1	0.4
Total cultivated area	ha	226,713	207,956	224,795	245,506
	% TCA	100	100	100	100

a) Sorghum, millet, wheat and maize

(Source: yearly reports Agricultural Department Raichur District)

The recent history of the sunflower crop suggests that farmers' crop choice is indeed influenced by the financial profitability of the crop, but it also suggests that crop choice is influenced by more than financial profit alone. Some of the advantages of rice have already been mentioned, and these point to many disadvantages of the remunerative irrigated dry crops. The disadvantages and problems in the cultivation of irrigated dry crops are of a diverse nature.

- (i) The remunerative irrigated dry crops of the moment, sunflower and groundnut, and cotton as a semi-dry crop, happen to be non-food crops. Neither do they produce fodder. The shift from sorghum to sunflower during the last years has already caused a fodder shortage in Raichur district.
- (ii) One reason why sunflower has become so popular is that the cost of cultivation is comparatively low. But that of groundnut, and particularly that of cotton is high, which means that a farmer has to be able to invest large sums at the start

of the season. The prices of oilseeds, and even more of cotton, are very unstable. Furthermore, the market infrastructure for irrigated dry crops is not well developed in the rice areas.

- (iii) Cotton is very sensitive to pests and diseases. A sunflower crop may be lost when untimely rain washes the pollen away. The groundnut crop needs irrigation just before harvesting it, to soften the soil. In the rabi season this can be a problem.
- (iv) A farmer who wants to change from rice to an irrigated dry crop encounters the problem that in most cases his rice field is surrounded by other rice fields, and if he is the only one who changes, his sunflower, groundnut or cotton will drown in the seepage water from his neighbours' fields. Also for rice cultivation he has levelled his field to become a flat 'zero level' basin. Cultivating irrigated dry crops in black cotton soil basins in the rainy season is hazardous because crops may drown through lack of drainage. The irrigated dry crops should preferably be cultivated on ridges with a gradient, but when a farmer wants to alternate irrigated dry crops with rice this becomes problematic.
- (v) Not all farmers may be happy with the employment created by the irrigated dry crops, particularly small farmers who also work as wage labourers.⁵³ For many farmers the cultivation of irrigated dry crops would imply acquiring new skills and knowledge, and possibly changing the organisation of farm labour, as the labour demands of these crops are different in type and timing.

The foregoing analysis should make clear that an eventual change from cultivating rice to cultivating irrigated dry crops is not 'just' a change in cropping pattern, but amounts to a change of the whole farming system, involving farming technology, organisation and economics. Although there seems to be a potential for increasing agricultural production and income through the cultivation of irrigated dry crops, the shift away from rice will not happen overnight. It requires a sustained effort on terrains as different as crop research, water management and price policy. In the present political climate it also means going against powerful vested interests in the rice and sugarcane sectors.

The last pitfall is perhaps of an even bigger magnitude. The implementation of the changes just described would certainly 'release expansionary forces', to use Stone's

⁵³ It is interesting to note that sunflower is presently cultivated by many farmers as if it were sorghum or millet, that is, in an extensive manner. This reduces yield (for example because planting distances are not observed) but it saves labour.

phrase. And expansionary forces generally lead to changes in the agrarian structure. In the first round of expansion in the Tungabhadra LBC many small farmers sold their land because they didn't foresee the potential of irrigated agriculture, or didn't have the resources to make use of it. One important reason for the latter was indebtedness. The migrant farmers and big farmers offered prices the small ones could not refuse. With bitterness they now tell how they work on their own land as daily wage labourers. In a second round of expansion, a similar process might occur, which would make the 'spreading of benefits' a hollow phrase. The phrase 'equal' or 'equitable distribution' of water, which is part of the protective irrigation discourse, is somewhat misleading as long as water rights remain linked to land rights and land remains distributed in an unequal fashion as it is now, let alone when land distribution becomes even more skewed. Chambers makes the point as well.

The greatest potential for creating livelihoods from canal irrigation is not the reforms [in water management] advocated in the rest of this book, but the redistribution of the irrigated land. (1988:16)

However, land reform is not a very prominent issue on the Indian political agenda, and to my knowledge the separation of land rights and water rights is unheard of in large scale canal irrigation.⁵⁴ This point makes clear that changes in water distribution can only solve part of the equity problem, but at the same time it may be argued that it is an important entry for change, as it is on the political agenda.

With regard to bringing about changes in water distribution and making it more equitable, some have rested their hopes in local level organisation of water distribution by Water Users Associations, Water Users Cooperative Societies, or whatever name these organisations may be given. Apart from the fact that very few of these organisations actually exist in India, particularly in Karnataka, it should be kept in mind that local management in no way automatically implies equitable and democratic management, as the present local influence on canal management suggests. In the Tungabhadra LBC the 'real tailenders', that is those farmers who receive no or hardly any water and who, practically speaking have a rainfed farming system carry little political weight and are, as yet, unorganised. Increasing pressure from the tail end in most cases actually means increasing pressure from the headenders in the tail. This should, however, not discourage us too much. The Tungabhadra LBC also provides an example of a successful Water Users Cooperative Society in the tail end of a middle reach distributary. This example shows the potential of collective organisation at the local level. To go back to where I started, this is one of the reasons why we should not

⁵⁴ Though rare, it is not unheard of in other types of irrigation.

be satisfied with the existing 'technical' approach to irrigation economics and irrigation water management, and irrigation engineering for that matter, and why Bharadwaj's 'production relations approach' is called for. To quote her review once again

Research needs also to be done to investigate and evolve methods of co-operative management of irrigation (...) suitable to the social needs of the community. (Bharadwaj, 1990:51)

6. CONCLUSION

1. The Tungabhadra case suggests that to solve water management problems, that is to reduce the disproportionate appropriation of irrigation water by head end farmers, indirect measures such as agricultural price and marketing policies are more appropriate at present than the traditional direct approach of 'educating' farmers and officials, and interventions in (the organisation of) water distribution itself. Some socio-economic 'space' is needed to successfully implement technical and organisational changes.
2. There is no future in trying to implement the protective mode of water distribution as originally conceived. The present situation with politically and economically powerful head end farmers requires the development of alternative approaches that deal with the farmer's desire to maximise his individual income. Also, the idea that protection should primarily be achieved through the cultivation of irrigated dry *food* crops should be abandoned. These do not now offer the possibility to resolve the contradiction of maximising aggregate and individual benefits, but irrigated *non-food* crops, particularly oilseeds, have this potential.
3. The shift from a wet to an irrigated dry mode of farming and water distribution implies a radical change in the farming system and its institutional environment. It is therefore more of a medium or long term endeavour than a short term project.
4. The achievement of a more protective mode of water distribution in the manner suggested in this paper, can contribute to a more equitable pattern of agricultural growth, but it is by no means a full answer to the equity question. Two issues that present themselves in this regard are (i) the connection of water rights and land rights, and (ii) the form of local level organisation for water distribution. This suggests that the problem of unequal water distribution can not be reduced

to either of its three dimensions, technical, organisational or socio-economic, but that it is a problem of development in the full sense of the word.

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