6 PERFORMANCE OF PROTECTIVE IRRIGATION SYSTEMS

In view of the above, one could expect that if part of the farmers would succeed in taking more water than according to the protective principles, this would leave less for other farmers in the system and head-tail differences would be created. It would therefore be useful to have field information on the actual performance of protective systems, to assess if this is so. Data on actual intensities and actual water use, which should then be compared with the design values, could give a first impression. The problem, however, is that very little field information on these issues is available.

In reviews of irrigation in India and Pakistan it is frequently pointed out that the average yields attained are much lower than in other countries and that the large scale irrigation schemes are performing poorly. Paddy yields average 2.5 t/ha in India and 1.7 t/ha in Pakistan, while, for example, they are 5.5 t/ha in China and 4.1 t/ha in Indonesia (GoP/WAPDA, 1990; World Bank, 1991). The label "poor performance" is attached to most of the schemes because it is alleged that water is poorly distributed both spatially and temporally, water charges are too low and hence do not cover working expenses of management and maintenance, cost recovery is weak, scheme maintenance is deplorable, structures are frequently demolished or tampered with by farmers, on-farm water application is poor and farmers are notorious over-irrigators if they can get water. However, the empirical base of these observations is very limited, as very few in-depth studies of irrigation water management practices have been conducted. Moreover, the above sketched poor performance analysis is diagnostic in nature and belittles the benefits that irrigation has brought.

No doubt there are problems in irrigation in India and Pakistan and improvements are necessary. The basis for any improvements, however, should be a profound understanding of the protective irrigation concept and a thorough analysis of current irrigation water management practices. In the following it is attempted to give an overview of the performance of protective irrigation, drawing on the available literature. We concentrate on the performance of the irrigation system and more specifically on water supply performance and not on the agricultural performance. Thus, our main concern is actual irrigation water management practices.

6.1 Northwest India and Pakistan

Generally in India it is said that water distribution problems typically occur in the Southern part of the country, but not in the North. The warabandi system is often claimed to be a success (most recently by Berkoff, 1991). Northwest India is heralded for having achieved a good fit between agro-climatic and socio-economic conditions and the irrigation schemes and for showing good to excellent irrigation management performance. It is said that, in large parts of Punjab and Haryana, high intensities and

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1) Warabandi was considered to be so successful by irrigation policy makers, that it was exported wholesale to the South in the 1980's, to be implemented by the Command Area Development Authorities. This effort largely failed, see for instance Jurriëns et al. (1989) and Reddy (1989). This is not surprising, where Wade (1982) already labelled it as "planning by slogan".
good yields are realized, in spite of the low design intensities and high duties. The average irrigated cereal yield in Punjab is 3t/ha, which is the highest in India (World Bank, 1991).

Although irrigation in Northwest India is claimed to be successful, little empirical evidence exists for this. Recently there has been an increase in rice cultivation in the canal systems in the north. It is difficult to imagine that rice farmers have reduced their cultivated area proportionally to the higher water demand of rice. One of the few documented examples is the work done by Tyagi (1993) on the Haryana part of the Bhakra system. Based on field measurements it was concluded that:

- The average relative water supply RWS (ratio of actual supply to crop water requirements) on 5 watercourses varied in the rainy season from 0.72 in the head regions to 0.58 in the tail regions and in the dry season from 0.65 to 0.50 respectively;
- Accordingly, IQR values (interquartile ratio, being an indication of inequity) along watercourses varied between 1.5 and 2.5, showing that on the average, upstream ends received about twice as much water as tail-end reaches;

That the relative water supply ratio is less than one is not surprising for protective irrigation schemes. The differences between head and tail are important however. Unfortunately, no intensity figures were given and no information was collected on command areas larger than the watercourse commands, so that nothing is known on realized intensities and water use on entire distributaries and along main canals.

For Adampur and Gohana distributaries in Bhakra and West Yamuna Systems, Tyagi and Mishra (1990) mention recorded seasonal average RWS values of 0.28 and 0.36 respectively. One other figure is from the Gohana area on the Bhalaut distributary on the West Yamuna Canal system (de Jong and Datta, 1994), where the average annual irrigation intensity over five recent years was 72% against a design intensity of 62%. It must be added, however, that this is largely due to a widespread additional use of private tubewells. And moreover, during field visits considerable head-tail differences were observed and problems of waterlogging and salinization are increasing.

Sometimes, more detailed figures are given, as for instance in Kundu (1990), but information is insufficient to compare actual results with design and thus to analyze the above questions. It was measured for instance that supply to outlets on a distributary varied from 80% of design on the canal head to 50% on its tail, but design duties are not given. Also, irrigation intensities for different minors on some distributaries are given as varying between 50-90% (head) to 25-45% (tail), but the definition is not clear and design intensities are not given. In any case, the detailed results show that the design operational targets are certainly not realized. Whatever may be the case, these figures do not give the impression of unqualified success.

Yet, a number of factors may indeed result in fewer problems and better performance in the Northwest, factors which are not valid for all other parts of the country. One factor is the system of rotation in the main system, which makes it difficult for the farmers to interfere with the "automatic" distribution by the proportional outlet structures on the distributary. Another element is that in many cases, over the years, extra water has been made available by additional pumping of
groundwater from wells. Tubewells have individualized water management; when canal water is falling short, additional pumping can cope with the situation, rice can be grown and higher intensities can be achieved than according to design. Moreover, in some of these areas over the past decades, the groundwater level has risen considerably (from more than 20 m to less than 1-2 m within 30-40 years), to such extent that crops draw part of their water from groundwater by capillary rise. Thus, there are cases where canal water caters for only half or less of the total crop consumption.29

Concerning the performance of protective irrigation in Pakistan much more is known. Although the irrigation schemes are of the same type as in Northwest India, they are claimed to be unsuccessful (e.g. Merrey, 1986b; Bandaragoda and Badruddin, 1992; World Bank, 1994). Most studies draw attention to the low productivity of protective irrigation in Pakistan, by pointing out that the average yield for rice is 1.7 t/ha and for wheat 2.5 t/ha. However, as Bhatti et al. (1991) rightly caution, it can be questioned whether yields in Pakistan should be expressed in terms of yield per unit area. In protective irrigation systems water, and not land, is the constraining factor. If yields are expressed in terms of yield per unit of water it transpires that Pakistan’s irrigation systems are not performing so badly, and that average wheat yields lie in the order of 7 kg/mm of water (Bhatti et al., 1991). In India, average yields per unit of water for all crops was found to vary between 2.2 kg/mm of water in Andhra Pradesh and 4.8 kg/mm of water in Uttar Pradesh, with a mean of 3.2 kg/mm of water (Dhawan, 1988). Unfortunately, figures from other countries were not available, making comparison impossible.

Detailed studies of main system management in Pakistan are still few in number, and have mainly been conducted by the International Irrigation Management Institute (e.g. Bhutta et al., 1991; Vander Velde, 1991; Bhutta and Vander Velde, 1992; Kuper and Kijne, 1992). At the most general level it was found that the annual relative water supply ratio (RWS) in most command areas is below one (ranging from 0.47 to 0.70 for six selected command areas), which is to be expected in protective irrigation schemes (Bandaragoda and Badruddin, 1992). Studies on existing water distribution in selected distributaries of the Lower Chenab Canal system (Punjab, CCA of 1,200,000 ha) by Vander Velde (1991), Bhutta et al. (1991) and Bhutta and Vander Velde (1992) reveal that discharges at the head of distributaries greatly vary and that water distribution among the outlets is highly inequitable, with head-end outlets taking three to six times more than their design discharge. As a result, large areas in the tails of distributaries receive very little of no water. They attribute the highly inequitable water distribution to outlet tampering (the enlarging of outlets by farmers), frequent distributary operation at less than 70% full supply level, installation of illegal outlets and the changed canal dimensions due to deferred maintenance.

29 At the same time, however, the higher water use in upstream parts and particularly canal seepage lead to increasing waterlogging and salinization in such areas. In many areas there is now a delicate equilibrium between groundwater being high enough to provide extra water to the crop by capillary rise and low enough for the maintenance of an acceptable salt balance. The present danger is that when better drainage is implemented, this may lower the water table to such extent that canal water, which is insufficient already, would have to take a greater share in meeting the crop needs. According to Pakistan officials, this happened already in some systems after introduction of drainage, leading to increased conflicts over water and head-tail differences.
Concerning irrigation water management at tertiary level there is a small, although growing, body of literature which focuses on warabandi in practice (e.g. Lowdermilk, Clyma and Early, 1975; Merrey, 1983, 1986a, 1986b, 1986c, 1990; Franks, 1986; Freeman and Shinn, 1989; Garces and Bandaragoda, 1991; Beekker, 1993; Halsema, van and Wester, 1994). In general, these studies point out the disparities between the warabandi concept and warabandi in practice and suggest that unequal distribution of water is a prominent feature of the system.

The study by Lowdermilk, Clyma and Early (1975) is, to our knowledge, the first study that was conducted on tertiary level irrigation water management. One of their remarkable findings is that in the chak they studied, 86 percent of the cultivators reported trading their warabandi turns, although the trading of turns is illegal under warabandi. According to them trading mainly occurs between relatives. This is significant because the rigidity of the warabandi concept is apparently circumvented, through trading, in practice. A prime example of a fine anthropological study of an irrigation village is Merrey’s (1983, 1986a, 1986b, 1986c). He gives a detailed description of one chak and goes into changes in the watercourse route and the warabandi roster that have occurred. Although the warabandi roster had been changed several times between 1961 and 1977, the roster of turns was losing its legitimacy at the time of his fieldwork (1977-1978). According to Merrey this was the result of land fragmentation, land transfers and conflicts between cultivators. He concludes that the formal rotation schedule is impractical and that informal cooperation, i.e. the trading and sharing of water, is needed between cultivators.

Freeman and Shinn (1989) recently reported on irrigation water management at tertiary level. Their primary focus was on the degree of water control by farmers in the Niazbeg system. They conclude that the location of the farm is the dominant factor in determining which farmers have the greatest water control. Their study revealed that farmers located at the tail of the system received less water than their counterparts at the head of the system, independent of land owned or cultivated, education, or caste affiliation. For six outlets, the actual water supply was compared with the sanctioned water supply over one season. The head-end outlets received 171% and 156% of their sanctioned water supply, whilst the tail-end outlets received 73% and 54%. This locational bias existed among and within watercourses. Although the relationship between location and farmer water control was strong, their data also revealed that warabandi provides poor water control for all farmers on the Niazbeg system. They indicate that, although the exchange of warabandi turns is strictly prohibited, many farmers in their study area (35%) trade water turns to gain more water control. Besides that, farmers reported that the biggest problem encountered in water distribution was controlling the behaviour of influential landlords, who often appropriate water out of their turn. (Freeman and Shinn 1989)

Another class of studies, which discusses irrigation water management practices indirectly, points out that water distribution under warabandi is inherently inequitable, because seepage losses in the watercourse are not taken into account in the preparation of the warabandi schedule (Chaudry and Young, 1990; Sharma and Oad, 1990; Latif and Sarwar, 1994). Lowdermilk et al. (1978) report that seepage losses in watercourses
range from 33% to 63% for the forty watercourses they studied (with an average of 47%). Thus, the tail-end farmers of a specific chak in theory receive about half of the amount of water that head-end farmers do, under official warabandi schedules.

The conclusions reached by the different studies on warabandi in practice are neatly summarized by Garces and Bandaragoda (1991)\(^3\), who state that field observations clearly indicate that warabandi as understood in its traditional "image" no longer exists and that in fact there is already a de facto move in Pakistan towards (full) irrigation of actually planted crops, not hindered by time/area distribution rules. They indicate that unauthorized outlets exist, authorized outlets have been enlarged, distributaries are obstructed with cross-bunds, farmers’ turns are influenced by large landowners, farmers take water out of turn (steal water) and trade and/or sell their water turns, and equity is no longer a shared value among officials, farmers and politicians. Most of the authors that have written on warabandi in Pakistan come to the conclusion that warabandi in practice is far from ideal.

"Most studies emphasize the poor performance of warabandi systems, both in terms of adequacy, reliability, and equity of water deliveries, and in terms of agricultural production. Warabandi is said to be too inflexible to match crop-water requirements; various factors at the main canal level reduce its reliability; and factors at the watercourse level such as high losses from the channels reduce the equity of water supply."

(Merrey 1990:12)

A major drawback of the studies discussed above is that, although the link between main system management and tertiary unit water management is often mentioned in passing, this link is not explicitly explored. Nonetheless, they give an impression of how the drawbacks of the warabandi concept are overcome in the field. It can be concluded that cultivators undertake a range of activities to increase the water supply to their chak and to circumvent the rigidity of the warabandi concept. The trading of water (irrigation turns) is most important among these. In all, the studies cited above create the impression that an equitable water distribution, as envisioned under protective irrigation, is not realized in the field.

6.2 South India

In the interior South, the localization approach has largely been ineffective. In this region, there has been an enormous increase in the cultivation of rice, cotton and -to a smaller extent- sugarcane and the government has not been able to stop or control this. For various reasons, additional use of groundwater hardly occurs, and fine-tuning depends fully on the operation of the canal system and the gated outlets.

\(^3\) Their observations are primarily based on research conducted by IIM in the Lower Swat Canal and the Chasma Right Bank Canal systems, both in NWFP. Nonetheless, based on the works mentioned above, it can be stated that these observations generally hold true for all of Pakistan.
An example is from Tungabhadra (Left Bank) in Karnataka. Here, it was concluded, based on field measurements (Jurriëns and Landstra, 1989), that:

- Crop water requirements were much higher than unit supplies according to the duties.
- The actual water use (in average 1/s.ha for the actually irrigated areas) was also more than according to the duties and in line with the actual crop water requirements;
- Head-tail differences were considerable, along the main canal, along distributaries and within chaks; this was the result of the fact that upstream farmers were able to take approximately the water they needed, leaving little or nothing for downstream reaches;
- As a result, overall realized irrigation intensities were less than target. However, on the upstream reaches they were much higher than target, because of irrigation in two seasons, instead of in one season, according to the objectives.

All land in the Tungabhadra Left Bank Canal has been localized, but administrative and legal control of the crops grown is virtually absent. Rice is grown on large areas, also where not localized. The situation is aggravated by the policy of the National Government to promote more productive and "modernized" agriculture, supported by all necessary programs on crop research, inputs, pesticides, processing and marketing, subsidy policies and related training and extension. Thus in many schemes one can observe a simultaneous strive for productive irrigation in protective schemes, with still the initial limited amount of water (and often less, where reservoirs are silting up). In addition, politicians in tail areas or areas not benefitting from irrigation at all, are often pushing hard to get their area included in the irrigation system which is already too large. In this connection Mollinga (1992) talks about a "deadlock", in which "capable actors on all sides" (farmers, officials, politicians) are trapped in the continuous conflict between protective (design) and productive irrigation (which is the actual practice in part of the system). Basically, it is a redistribution problem whereby meeting the rightful wishes of tail-enders would mean pruning the long-established privileges of head-enders. A solution to this problem is hampered by the existing balance of forces between the parties involved.

Similar observations were made during field visits to or from field reports from other schemes in Karnataka, Andhra Pradesh and Tamil Nadu. Generally, problems were less when more water was available and the scheme was of a less protective nature. One example of the latter is the Bhadra system in Karnataka. [4]

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[4] This scheme was selected for the World Bank supported National Water Management Project (NWMP), which aims to improve the performance of protective irrigation systems. The claim that the NWMP management intervention was successful has to be looked at with some care. It is doubtful whether this system is a real protective system. There is abundant water available in the reservoir and in fact the limited capacity of the main canal was the major problem. Annual intensities of 165%, with widespread paddy, were already realized before NWMP interventions. For discussion, see Kuiper (1993).
6.3 Central India

Not much is known about the actual performance of irrigation schemes in Central India. High level officials usually state that due to shejpali and the block system everything is running perfectly. However, the observation made by Wade still holds true. "I suggest that the Maharashtra method of water accounting may have much to recommend it. To be more confident, however, we need studies of how the method works in practice. The same applies more generally: improvements in canal administration will be more successful if based on knowledge of how canals are administered in practice. The 'in practice' is important, for there are several generalised accounts of how canal administration is designed to work in principle in different parts of India. What is lacking in these accounts is an interest in the divergence between principle and practice (...)." (Wade, 1976:1438-1439, emphasis in the original)

Unfortunately, after nearly twenty years, accounts treating the divergence between principle and practice are still hardly available.

It seems that in Maharashtra the protective objectives have been undermined by the widespread cultivation of sugar cane, a water intensive crop, because of the related established interests. The sugar cane boom started in the first decades of the twentieth century and continues till today (Attwood, 1993). Dhamdhere (1983) mentions that in the Mula irrigation scheme (irrigated area of 30,000 ha) 10 to 20% of the command area is under sugar cane, while only 4% was sanctioned. He indicates that farmers request water for seasonal crops under the shejpali system but use it for growing sugar cane and that they also illegally draw water for irrigating sugar cane. Besides the widespread cultivation of sugarcane and improved varieties of other crops has also led to an increase in the demand for water. As a result the block system is slowly disintegrating and making way for temporary sanctions and cultivators steal water to irrigate areas not sanctioned. (Gandhi and Inamdar, 1983)

The lack of studies on actual irrigation water management practices in Central India has not deterred irrigation experts from claiming that there are substantial performance problems. They state that the management of the shejpali system has often proven difficult, due to the stresses of different cropping patterns, unpredictable rainfall, variable topography and soils, weak designs and inadequate seasonal planning (World Bank, 1991). The breakages of structures by frustrated farmers and large head-end tail-end differences both in chaks and in schemes are said to be common problems. It is suggested in the National Water Policy that the shejpali system should be abandoned because it entails considerable management problems and water inefficiencies (IPTRID, 1993). The empirical basis on which these statements are based is unclear and could not be traced in the literature.
6.4 Northeast India

Irrigation schemes in Bihar are said to be performing very badly and are claimed to be the least productive of India (Berkoff, 1991). Yields and irrigation intensity are low (average crop yield in Bihar is 1.4 t/ha), and the difference between rainfed and irrigated yields is often small (World Bank, 1991). Problems frequently mentioned in the literature are; extensive cultivation of paddy in the head of the schemes, tail-ends largely unirrigated, extensive damage to physical structures and continual farmer interference with water distribution in the main system through the cross-bundling of distributaries, cuts in the canals and the placement of illegal outlets. Thus, providing protective irrigation during dry periods for the kharif crop encounters major difficulties and during rabi is nearly impossible. (Roy, 1990; Sihna and Srivastava, 1990; Berkoff, 1991; World Bank, 1991) For example, on the Dumraon Branch Canal of the Sone Canal system (Bihar) farmers are not sure of irrigation water and hence head-enders interfere with the canal system and draw much more water than needed. This has deprived the farmers of the tail-ends of their due share of water (Dwivedi, 1994). The regular cross-bundling of the distributaries in the upper reaches have caused a severe scarcity of water in the tail-end reaches. Also, there are a large number of unauthorized cuts in the distributaries.

According to Berkoff (1991) the poor performance of the Northeastern schemes can be attributed to several factors, of which the level of rainfall is the most important. He argues that under conditions of higher rainfall (from central Uttar Pradesh eastwards) all farmers, hoping for sufficient rainfall, plant their entire land to a kharif crop. As a result, when a dry interval occurs during the monsoon, all farmers need irrigation water on their entire parcels to avoid crop failure. This leads to tremendous stress in the irrigation schemes because head-enders take (much) more water than they are entitled to thereby depriving tail-enders of their water. Conflicts arise and breakages by farmers of irrigation structures are common. Thus rainfed crops and wide variations in demand result in an unstable, uncertain system with endemic farmer intervention. (Berkoff, 1991)

This contrasts with the situation in Northwest India, which is the most productive agricultural region of India. Because of the much lower levels of rainfall farmers plan on irrigation water as their regular water source. They limit water-sensitive crops to perhaps 20-30% of each farm, with the balance under scratch crops, fodder or fallow. (Berkoff, 1991)

"Stability in the west and instability in the centre and east reflect the impact of rainfall (...). If irrigation supplies do not meet full farm requirements, and rainfall is sufficient to support a reasonable crop, then rainfed crops will occupy the balance (non-irrigated) area since farmers must plan to use all their scarce land. If rainfall is insufficient to support a rainfed crop, then of course the balance (non-irrigated) land will be left fallow. It is this, more than anything else, which underlies the poor performance in the centre and the east, and the relative success in the west." (Berkoff, 1991:76)
7 DISCUSSION

The general impression is that in many protective schemes yields on actually irrigated lands are often quite good, but the problem is that many farmers have been deprived from irrigation for many years and that there is, every year again, a constant struggle for water with much unrest in the area, continuous conflicts between farmers and the Irrigation Department and between farmers mutually, regular political upheaval and increasing demands for improvement of the situation. Yet, the result of the above situation may well be that the total scheme production is about the magnitude initially envisaged, because some of the farmers realize high yields per unit area, instead of less production per unit area by more farmers. This is the reason that one can read about good yields and productions in Indian irrigation, while at the same time all kinds of irrigation management problems are observed. Precise figures on this issue are not known. Research would be useful.

It seems evident that more information on protective irrigation should be collected, both on initial design and on performance. To get a first impression, the list of Chapter 4 could be used as a starting point, whereby actual results should be compared with design data. The present lack of material on water control concepts, water delivery schedules, water allocation concepts and actual irrigation management practices and their interrelationships makes it difficult to evaluate protective irrigation. Moreover, it impedes a substantive discussion on the merits of extensive (i.e. protective) irrigation versus intensive (i.e. productive) irrigation and on which water delivery concept (proportional delivery versus volumetric delivery) is to be preferred in conditions of water scarcity.

The present problems encountered in the performance of protective irrigation illustrate one conclusion of this paper: first, before embarking on developing any new remedial measures, a decision has to be taken on the future objective of the irrigation systems. More specifically, detailed attention must be given to water availability and to whether water scarcity by design should be maintained or not. Basically, there are two options:
1) Abandon the protective objectives, and implement productive irrigation in (part of) the command area.
2) Achieve the initial protective objectives through new technical, managerial and socio-economic strategies.

We briefly discuss both options.

7.1 Shifting to Productive Irrigation

Regarding the first option, this is what has basically happened in the Nira Left Bank Canal case described by Attwood (1993). He argues that the economic spin-off effects of intensive sugar cane cultivation (creation of employment, processing industry, services etc.) compensate the inequity effects in agricultural production. Illustrative in this respect also is the fact that some years ago the Tungabhadra system won the second price in the national competition for production, while at the same time this scheme has
a reputation for severe head-tail problems and regular social and political upheavals. Officially, these schemes are still protective, but in practice part of their command area is used for productive irrigation (pockets of prosperity) while the remainder receives little or no water. This state of affairs appears to apply to most of the protective irrigation systems in India and Pakistan.

Burns (1993) proposes to formalize this situation by dividing the irrigation systems in a core and an marginal area. The core area will be sure to receive water, making productive irrigation possible, the marginal area only when there is a surplus. He sees this as the only way to control "rent seeking" behaviour, which, in his view, is the principal undermining force of good irrigation management. Another form of shifting to productive irrigation would be an inter-seasonal or over-year rotation whereby every season or year part of the system will be completely excluded from irrigation. The question is whether the situation on the ground should be officially recognized and sanctioned or whether efforts should be undertaken to restore protective irrigation. This is an important issue for debate, and involves political choices on the type of agrarian change one wishes to support, but as of now there is too little empirical data to support such a discussion.

The shift away from protective irrigation is also occurring in Pakistan, but in a different sense. Current government policy is to modernize selected irrigation schemes and to substantially increase their water allowance, water availability permitting. This policy is based on the thought that the mismatch between irrigation water supplies and crop water requirements inherent to protective irrigation is a major constraint adversely affecting the performance of Pakistan’s irrigation schemes. The approach adopted at policy level to date has been a cautious one. The National Commission on Agriculture recommended that pilot studies be executed first before the whole of Pakistan’s irrigation sector switches to productive irrigation. (Bandaragoda and Badruddin, 1992)

To make productive irrigation possible in Pakistan the existing infrastructure would have to be completely remodelled and major changes would have to be made in the management sphere. In short, it is a complete redefinition of the concept of irrigation. To effectuate the shift to productive irrigation, several schemes, such as the Lower Swat Canal (LSC) system in NWFP, have been modernized with the objective of creating a productive irrigation scheme with an on-request, arranged water delivery schedule. An important element of the remodelling exercise has been the increase in water allowances. In the case of the LSC, the water allowance at the outlet rose from 6.15 to 11.0 cusecs/1,000 acres (0.44 and 0.78 l/s.ha) (Bandaragoda and Badruddin, 1992).

At present, the LSC is still operated as a supply based, protective irrigation scheme. That it is still operated on the basis of full supply levels is to a large extent the result of engrained practice and the lack of a detailed operating schedule. Yet, seeing as there are only two cross regulators in the main canal and no escape structures in the distributaries the only option the ID has is to run the system at full supply level. Thus, the lack of appropriate infrastructure also impedes productive irrigation water management in the LSC in the sense that varying crop water requirements can be met. Water use in the LSC is very inefficient at present, because it is operated at full
capacity throughout the year while this is only necessary in one month of the year, and it will probably aggravate existing drainage problems. As a result, the productivity of water and overall system performance are depressed and the benefits from the substantial investments made in the LSC system are only partially being attained.

It may be argued that shifting to productive irrigation is not feasible in India or Pakistan, both politically and technically. For example, in South India localization has formally created water rights, also for tail-enders who receive no water at present. The existence of these rights is a form of political capital both for tail-enders and their political representatives, that will not easily be relinquished. Making unequal distribution official would, we predict, at least in Karnataka, create a political furor of the first order. One might also argue that accepting the present pattern of unequal water distribution is a morally unacceptable approach of "betting on the strong". In Pakistan, there is simply not enough water to remodel all the irrigation schemes. Thus, in the Punjab, which at present is already using its surface water to the full extent\(^1\), introducing productive irrigation would entail a substantial reduction of the command area. Once again, it is to be strongly doubted whether this is politically feasible.

7.2 Achieving Protective Irrigation Through New Strategies

With regard to the second option, restoring protective irrigation as planned, many people will argue that this will no longer be possible. And indeed, some of the assumptions of protective irrigation, particularly that of subsistence food production, have become very unrealistic now. However, new approaches might be tried to go at least some way towards achieving a more protective distribution of water.

First of all, one should try to make more water available, for instance by re-use of drainage water or additional use of groundwater. If this is not possible, both technical and managerial measures could be thought of. Canal lining, canal rotation, proportional outlets, introduction of warabandi and training of farmers are most frequently advocated. Also, balancing reservoirs in the main system could be useful, but there have to be suitable sites. Considering past experience it is doubtful whether these commonly advocated measures are sufficient to solve the existing problems (Jurriëns, 1993).

A complete package of more systematic management, with clear and consistent pre-season planning and operational guidelines, communications, etc. could be of some help; provided it starts with not trying to irrigate much more than the area which is normally irrigated. And moreover, a more precise legislation and effective prosecution of violators should go along with that. In the organizational field the main option seems to be the organization of tail-end water users to exert pressure on irrigation department officials and head-end farmers to release more water. Some NGO's are undertaking such efforts, and, it seems, with some success (ISARD, 1992).

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\(^1\) Under the Water Apportionment Accord of 1991, Punjab has the right to 68.80 Bd\(^3\) water annually. With flood water included its share is 75.03 Bd\(^3\). Between 1976 and 1985 the mean annual diversion of Punjab was 66.25 Bd\(^3\). (Sufi, Ahmad and Zuberi, 1993)
DISCUSSION

The main opportunities may, however, lie in the agricultural sphere. Price and market policy are not usually considered to be relevant for water management, but the discussion above suggest they may be. Favourable prices and good market accessibility for "light" crops may influence farmers' crop choice away from water intensive crops, and thereby automatically have a spreading effect on water distribution. One candidate in this respect is sunflower, which has been a remunerative cash crop over the past years, and requires little irrigation. The liberalization of the Indian economy may also have an impact. Liberalising the market for sugar and sugarcane for example could in the long run make sugarcane a less economically attractive crop than it is now. However, these changes are not easily brought about, and particularly in the case of rice, there are other considerations than economic returns for the cultivation of crops as well.