CHAPTER 1

Potential for the Poor

ABSTRACT

Canal irrigation provides livelihoods for hundreds of millions of people in developing countries. In parts of South Asia, where it has been a massive thrust in rural and national development, extensive irrigation networks co-exist with the greatest concentration of rural poverty in the world.

Production and livelihoods are linked, but, for poverty alleviation in the mid-1980s, partly because of food surpluses, the generation and support of livelihoods is a higher priority than production *per se*. Key questions concern who gains and who loses from irrigation. Generally, the poor stand to gain from better managed canal irrigation—in employment and income, in security against impoverishment, in less outmigration, and in quality of life. In South Asia about 68 per cent of the irrigation is in India and 26 per cent in Pakistan, and over half the irrigation in the subcontinent is from dual managed canal systems, controlled by official irrigation staff in their upper parts and by farmers lower down. Performance in these systems has often been disappointing in areas irrigated, in waterlogging, in the multiple deprivation of tailends, and in yields. Evidence suggests that groundwater generally produces about twice as much per net irrigated hectare as canal irrigation. The potential for better livelihoods for the poor from improved management of canal irrigation systems appears high.

THE CONTEXT

Canal irrigation is a direct source of livelihood for hundreds of millions of the rural poor of the third world and it could be for tens, perhaps hundreds, of millions more. In countries as diverse as China, Egypt, Indonesia, Mexico, Philippines, Sudan and Thailand, to name but some, it is a major part of the rural and national economy; and in these and in many other countries, potential for further irrigation development has been identified. In the context of canal irrigation and rural poverty, however, South Asia stands out, combining vast canal irrigation development and potential with the greatest concentration of rural poverty in the world. There are other regions like the Sahel and the Horn of Africa which are struck by famine, violence or economic disaster and where the plight of the poor is dramatically awful. But these are mostly areas with low irrigation potential. There is nowhere outside South Asia where so many, so close together, are so deeply deprived, in regions with such extensive canal irrigation.

The scale of rural poverty in South Asia is daunting. The 1986 population of the five largest countries of the South Asian subcontinent—Bangladesh, India, Nepal, Pakistan, and Sri Lanka—was over one billion. Of these, more than three-quarters were rural. The five countries ranked among the 28 in the world with the lowest per capita income. In those countries (Bangladesh, India and Sri Lanka) for which figures were available, the poorest two-fifths of the population were much worse off than the average, with less than one-fifth of the income (WDR 1986: 226). Poverty and deprivation in these countries are, moreover, mainly rural. Urban poverty is more visible, but in scale, rural poverty affects several times more people. In India in 1983–4, for example, some 225 million rural people were below the poverty line, compared with only 50 million urban (GOI 1985: 4). In sum, in the mid-1980s, close to half the people in the rural areas of the subcontinent had to survive in conditions and at levels of living below any reasonable definition of human decency. The challenge, was, and will remain, to generate adequate, secure and decent livelihoods both for those who already lack them, and for the much larger rural populations of the future, including the 100 million more rural inhabitants estimated by the year 2000.

To meet the challenge of rural poverty, the Governments of South Asia have launched many programmes. Without these, things might have been much worse. India, in particular, has mounted a succession of bold and large-scale attempts to help poor people directly, including the Integrated Rural Development Programme (IRDP). But the sums spent on irrigation development have been and remain higher than those on direct poverty alleviation programmes of this sort. Even in the Indian Seventh Plan, with its strong anti-poverty and rural development thrust, more was

Table 1.1. GNP per caput and population—five South Asian countries

	1 GNP Per capita 1984 US$	2 Rank position among 128 countries (1=low)	3 Population mid-1984 (millions)	4 Population estimated in 2,000 (millions)	5 % Population rural 1984	6 (3×5) Rural population mid 1984 (millions)
Bangladesh	130	2	98.1	141	82	80.4
India	260	15	749.2	994	75	561.9
Nepal	160	6	16.1	24	93	14.6
Pakistan	380	28	92.4	138	71	65.6
Sri Lanka	360	26	15.9	21	79	12.6
Totals/ average	—	—	971.7	1313	76	735.1

Source: WDR 1986: 180, 228, 240.

allocated for major and medium canal irrigation (Rs 11, 556 crores or about $11.6 billion) than for all rural development programmes together (Rs 9,074 crores or about $9.1 billion of which the IRDP was Rs 3,473 crores or about $3.5 billion). The IRDP has been evaluated for the numbers of households it enables to rise above the poverty line (e.g. PEO 1985; Rath 1985). But despite its historically and currently higher levels of investment, the same criterion has not normally been applied to canal irrigation.

This then is the starting point for this book: to examine canal irrigation from an anti-poverty point of view. In doing this, and throughout, most of the evidence comes from South Asia, especially India and Sri Lanka, but much of the analysis and many of the lessons apply more widely.

Production and Livelihoods

A first step is to examine some of the anti-poverty effects of irrigation. Two complementary views are possible here, one based on production, and one on livelihoods. There are also two major levels of analysis: the national or regional economy, and the household.

The part played by irrigation in agricultural production in South Asia needs no emphasis. It is responsible for 55 per cent of food production in India and some 80 per cent in Pakistan (Rangeley 1985). Moreover, irrigation is normally seen as the major source of future increases in production. A widely quoted study by the International Food Policy Research Institute (Oram *et al.* 1979) calculated future production and demand for food. From a baseline of production in 1974-6, the study made projections to 1990. Of the increased food production during the 15-year period for the five largest South Asian countries, 81 per cent was anticipated from irrigation (compare sub-Saharan Africa with only 4.5 per cent), with the highest proportions in Pakistan (89 per cent) and India (83 per cent). In the event, national policies have indeed given high priority to extending and intensifying irrigation and irrigation has been largely responsible for the achievement by the mid-1980s of near or complete self-sufficiency or surpluses of food in Pakistan, India and Sri Lanka.

In several ways, increased agricultural production can diminish rural poverty. At the level of the national economy, it can be part of the engine of growth; it can substitute for imports and generate exports, whether of food or of non-food agricultural produce; and it can reduce the costs of foodgrain procurement. At the level of the poor household, it usually reduces food prices and makes it easier especially for the urban poor to obtain food. It also usually generates additional employment and incomes for the poor, both directly through employment in agriculture, and related activities like input supply, processing and marketing, and indirectly through multiplier effects as incomes are spent, generating more employment and incomes. Studies, especially those of IFPRI (the International Food Policy Research Institute) have sought to measure these indirect effects (e.g. IFPRI 1984, 1985) and, while there are methodological debates over detail, they confirm that increased production generates substantial indirect benefits.

The strength of these points makes it easy to accept production as the objective of irrigation, and to assume that more production is the best criterion of achievement in combatting poverty. Production is also attractive for other reasons. It is a simple concept. It is relatively easy to measure. Production statistics are available and accessible to academic analysts and planners. Those who prefer a physical view of development,[1] explaining poverty in terms of population, environment and other physical factors, find the mathematics of food and population a convenient and straightforward mode of analysis. Production, moreover, is a technical matter demanding technical innovations and actions. In evaluating performance of any agricultural project, and of many agricultural experiments, it is the natural unit of output and benefit. It is also a single idea, meeting the common desire for one objective rather than several.

There are, however, three qualifications to be made to assumptions that increased production is of automatic benefit to the poor.

The first concerns food surpluses. While world food surpluses persist, domestic surpluses can be a liability, either deteriorating in stores at high cost, or having to be dumped on the world market, also at high cost for the subsidies required, and with adverse effects on the national economy and so on the poor.

The second qualification concerns technology and direct benefits. Shifts to more capital-intensive and less labour-intensive farming through mechanisation and the like, tend to be found with larger and better-off farmers, who thereby gain, more than with smaller and less well-off farmers, who thereby do not gain, or lose, if prices drop for the food they sell. Those shifts also reduce the ratio of employment generated to additional production, a ratio which appears to be in long-term decline.

The third qualification follows from these two. A common view has been that hunger occurs because of shortage of food: producing more food so that more is available is essential to stave off hunger. Thus, for example, the first heading of a paper on comprehensive evaluation of the impact of irrigation on development is 'The role of irrigation in meeting world food needs', and the paper starts 'World food production is rising steadily. To improve nutritional standards among the world's poor and to feed the world's rapidly growing population, food production must continue to expand' (USAID 1980:1). Now obviously food supplies have to match or exceed demand if people are not to go hungry. But this line of thinking can mislead at both national and household levels.

At the national level, in South Asia, food is available and likely to remain so. India, Pakistan and Sri Lanka are, in the mid-1980s, either self-sufficient or in surplus for foodgrains, and total production continues to increase. Even Bangladesh, which is in deficit, has achieved substantial national food security: food aid, buffer stocks, and timely interventions ensured that the disaster conditions of 1984, so similar to those of 1974, did not lead to a similar famine (Clay 1985). In India, effective administration, a free press and an open political system are a guarantee against any major regional food shortages. For all countries, the glut of grain on the world market in the mid-1980s has made it easier than before to buy food to make up any deficit. Short of unforeseen calamities, national food security seems assured, even without self-sufficiency.

At the household level, the question is much less food availability than entitlements (the ability to command food by growing, buying, or otherwise obtaining it). Even with national self-sufficiency in food and national food security, poverty and underconsumption of food, to use a euphemism, persist on a vast scale in South Asia. As Amartya Sen (1981, 1983) has demonstrated, it is often not decline in food availability which causes people to starve, but loss of entitlements. The millions of deaths of the Great Bengal Famine of 1943-4 resulted less from lack of food—food was there—than from the inability of many suddenly impoverished people to obtain it. Whatever may have been the case in the past, the problem of poverty in South Asia at least is not now a problem of production, or of food availability: it is a problem of who produces the food and of who has power to obtain it.

In this connection, production-thinking, which sees production as a sufficient end in itself, contrasts with livelihood-thinking, which sees production as a means of enhancing the well-being and livelihoods especially of the poorer people (Table 1.2). With livelihood-thinking, irrigation is assessed in terms of the adequate and secure livelihoods it generates and sustains, putting antipoverty effects, and people, before production *per se*. An adequate and secure livelihood can be defined here as a level of assets and stocks and flows of food and cash which provide for year-round physical and social well-being for the household and protec-

Table 1.2. Production-thinking and livelihood-thinking contrasted

	Production-thinking	Livelihood-thinking
Starts with	Production	Poor people
Problem seen as	Increasing production	Increasing entitlements, especially incomes and purchasing power, or ability to grow and retain food
Objective for irrigation	Increasing amount and stability of foodgrain production	Increasing amount and stability of days worked, wages, and food grown by the poor
Key analytical concept	Productivity of scarce resources (water, land . . .)	Livelihood—intensity of scarce resources (water, land . . .)
Benefits assessed as	Higher production especially for procurement and the market	More and better livelihoods with more food and income commanded by the poor

tion against impoverishment. This applies to all members of a household and especially to those, usually women, who are most deprived.

In contrast with production-thinking, livelihood-thinking has been little applied to irrigation. Arguments for improving the performance of canal irrigation systems are couched in production terms. Conventional cost-benefit analysis, in its simpler forms, is concerned with the value of production rather than employment or income distribution. Of 24 papers contributed to the *Indian Journal of Agricultural Economics* issue on the socio-economic impact of irrigation projects (IJAE 1984), few dealt with employment. Appraisals for irrigation projects also estimate production rather than employment or livelihoods to be generated. Production-thinking has been dominant and widely accepted, and until recently there has been little need to find other justifications for irrigation investment or improving irrigation performance. Yet, while food surpluses persist, the general economic case for additional production is weakened. Moreover, in India a major shift has already taken place in rural development from programmes which stressed community development and agricultural production to programmes targeted to the poor. Livelihood-thinking is close to the mainstream of large-scale administered programmes designed to provide direct benefits to target groups of the under-privileged—small and marginal farmers, landless labourers, members of the weaker and vulnerable sections, women, the seasonally unemployed, and poor people generally. Applied to irrigation, livelihood-thinking raises a new set of questions.

Some of these concern secondary benefits from better livelihoods. These are easy to underestimate. First, poor households spend high proportions of their additional income on goods produced locally, whether food, consumer goods, or assets like furniture, thereby generating additional employment and livelihoods for others. Secondly, new livelihoods which withdraw labour from the casual labour market help other poor people: the balance of demand and supply shifts in the labour market and wages are higher than they would have been. Third, adequate and secure livelihoods in rural areas reduce migration to other rural areas and to towns. This restrains the pressure on urban slums where otherwise new entrants would add to the overload on housing, services and jobs.

It is, however, with the direct benefits of irrigation in terms of better livelihoods, which in turn generate these secondary benefits, that we are most concerned. Livelihood-thinking leads logically to the aim of enabling the rural environment, economy and society to provide niches for and to sustain more households at acceptable levels of living. As the case for irrigation becomes less based on arguments for production *per se*, and more on livelihoods generated and sustained, questions are raised about how irrigation can enable the poor to lose less and gain more.

Who Gains, Who Loses?

Priority to livelihoods directs attention to the key questions of who gains and who loses from irrigation, setting the answers against the

Table 1.3. Indirect gains and losses to the land-poor from irrigation

Type of gain	Who gains	Under what conditions
1. Increase in employment in construction of irrigation projects	Male and female agricultural labourers	Labour-intensive construction
2. Increase in number of days of employment, and levelling off of peaks in agricultural employment	Male and female agricultural labourers	Irrigation-induced agricultural intensification
3. Increase in wage rates for agricultural labour	Male and female agricultural labourers	Irrigation-induced agricultural intensification; no surplus labour to restrain wage rises
4. Growth in non-farm employment	Male and female agricultural labourers	Irrigation-induced agricultural intensification
5. Return migration	Male and female agricultural labourers	Irrigation-induced agricultural intensification
6. Lower food prices	All sections of rural society but particularly the poor (who spend a disproportionate percentage of their income on food)	Payment in cash rather than kind
7. Non-agricultural uses of water, including uses that improve health	Those located close to major canals and distributaries	Year-round irrigation, with access by villagers to canals or groundwater

Type of loss	Who loses	Under what conditions
1. Increase in land prices	Marginal farmers bought out. Landless tenants displaced	Actual or anticipated irrigation-induced agricultural intensification
2. Market competition between irrigated and rainfed farmers	Marginal rainfed farmers	Irrigation-induced agricultural intensification
3. Displacement due to irrigation construction	Those displaced from reservoir sites, etc.	Inadequate compensation
4. Increased unpaid work-loads for women	Women	
5. Increase in water-borne diseases	Particularly agricultural workers	Presence of endemic water-borne diseases; lack of preventative health measures
6. Labour displacement	Agricultural workers displaced by mechanical threshing, herbicides, etc.	Adverse effects of irrigation-induced mechanisation outweigh benefits of productivity
7. Waterlogging and salinity	Small farmers, share-croppers displaced by induced waterlogging and salinity	Irrigation-induced water-logging and salinity

Source: Adapted from Silliman and Lenton 1985 : 8.

counter-factual—what would have happened without irrigation. Much of the literature on the impact of irrigation on poor people has been reviewed by Silliman and Lenton (1985). They concern themselves with the 'land-poor' whom they define to include those who own no land, those who operate no land, and those whose major source of income is from agricultural wage employment. This includes many marginal and small farmers whose holdings are too meagre to produce enough food and income and who periodically join the labour force. The land-poor could also be described as households whose access to land and water does not assure them an adequate and secure livelihood.

Irrigation generally has different impacts on different people in different conditions, with both gains and losses. Small and marginal farmers can gain from irrigation in obvious direct ways. Some of the indirect gains and losses of the land-poor are less obvious and are summarised in Table 1.3.

For any irrigation project, however large or small, a balance sheet of gains and losses might come out positive or negative.[2] Losers are easy to overlook. Often they shift out of sight, migrate, or even die. Losses can take many forms. Marginal farmers can be pushed off land or bought out at low prices by speculators, and so lose the direct benefits of irrigation. Women can be burdened with increased unpaid work as happened with increased livestock responsibilities on the Bhima Project in Maharashtra (IFAD 1984). Water-borne diseases can increase, especially malaria. Sometimes labour is displaced by mechanical threshing or herbicides which are introduced and adopted along with irrigation. If irrigation fails, through waterlogging, salinity or flooding, then small farmers and labourers suffer along with others. Most seriously of all are likely to be the indirect effects of surpluses of foodgrains and other crops produced under irrigation on rainfed farmers who depend on selling the same crops for cash. For countries with sustained food surpluses and downward pressures on foodgrain prices, this may be a major hidden disbenefit of increased production from irrigation, though offset by gains to poor consumers.

Many of the losers are those displaced by reservoirs, canals, or other construction associated with canal irrigation projects (CSE 1985). After reservoirs have been constructed oustees are easy to overlook. Evaluations of canal irrigation projects concentrate geographically in command areas rather than in dam catchments where some of those displaced may remain; and often oustees disperse and are hard to find. They may, though, be numerous. An example is the Bhima Project. The Mid-Term Evaluation Report on Bhima reads favourably on many counts but it notes that

> Some people have also been hurt by the project. The Bhima Reservoir inundated 29,000 ha and some 57,000 people from fifty-one villages had to be relocated due to the submergence. The relocation programme has been a very bitter experience for some people. It is a sad commentary that . . . four years after completion, thirteen more vil-

lages where people are to be resettled are still not ready for occupation. (IFAD 1984: 23)

As here, any evaluation has to be concerned with a balance sheet of net livelihood and well-being effects, offsetting losses of livelihood and well-being against gains. With canal irrigation, the hidden losses can be so large that livelihood analysis might indicate that many projects should not have been undertaken in the past or should not be undertaken in the future.

Gains in Livelihoods

The main livelihood gains for the rural poor from irrigation can be summarised under four headings: employment and income; security against impoverishment; migration; and quality of life.

employment and income

Empirical studies again and again confirm that reliable and adequate irrigation directly raises employment: for example, increases in days worked per hectare with irrigation compared with rainfed conditions, are reported to have been 61 per cent on the Dantiwada Canal Irrigation Project in Gujarat (Patel and Patel 1984), more than 100 per cent under Kakatiya Canal of Sriramasagar Project in Andhra Pradesh (Adinarayana 1984), 135 per cent in a village under the Damodar Valley Canals in West Bengal (Ghosh 1984), and 150 per cent in Ferozepur, Punjab (Mehra 1976). Silliman and Lenton (1985), reviewing empirical evidence from 45 micro studies, 25 of them from India, found that, with few exceptions, they confirmed a positive relationship between irrigation and employment, while indicating that much of irrigation's potential to increase yields and cropping intensities had not been realised. Most studies reviewed concluded that cropping intensity had the greatest employment impact. One study (Mehra 1976) which, exceptionally, disaggregated the employment effects of irrigation and of HYVs, found the contribution of irrigation to employment to be greater than that of HYVs.

Irrigation, increased irrigation, higher cropping intensities, and associated changes in cropping patterns, all affect different groups in different ways. For small and marginal farmers, irrigation means more productive work on their land, and increased intensities mean productive work on more days of the year. Some who went out to work for others before irrigation came, or before cropping intensity increased, cease to do so, and may hire in labour at peak times. Production and income are generally higher and more stable.

For landless labourers, irrigation means work on more days of the year especially where there is a second or third irrigation season. A comparison of an irrigated village and a largely unirrigated village in West Bengal by M.G. Ghosh (1984, n.d.) shows how sharp the contrast can be for labourers. Ghosh notes that in the irrigated area there was virtually no dead season, and also that a large number of migrant labourers came in for the peak periods. The implied differences in livelihood for labourers in these two villages are stark, and the value of irrigation can be surmised as

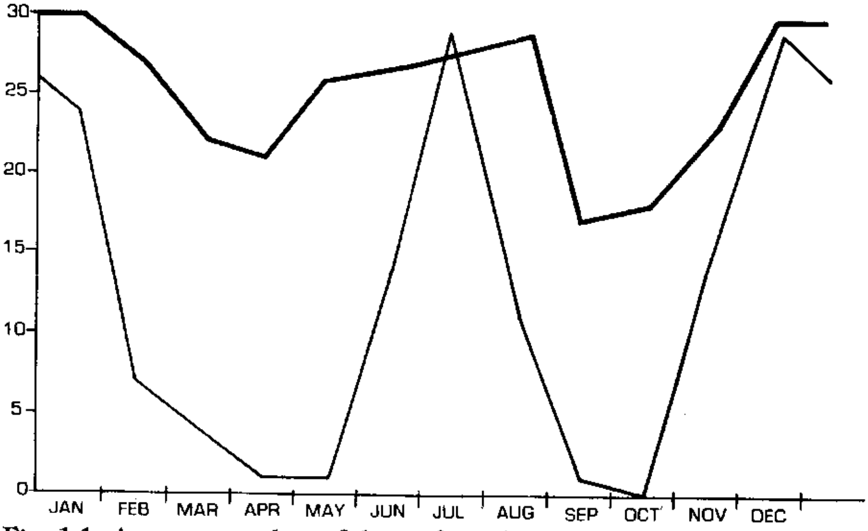

Fig. 1.1. Average number of days of employment of adult male casual labourers as agricultural work in two West Bengal villages. (Source: Ghosh 1985)
— an irrigated village in Burdwan District
– an unirrigated village in Bankura District.

not just work and income, but the relative assurance and continuity of that work to provide regular income without gaps. This contrasts with conditions in the largely unirrigated village where the negligible agricultural employment over two three-month periods in the year must have meant either seeking other low-paid local work, or migration, or serious deprivation, or some combination of these. Put differently, the value to labourers of filling in the dead seasons exceeds the value of extra work at the peaks. It seems likely, if this example is typical, that irrigation intensities which fill in dead seasons might often lift labourers above any livelihood line, enabling them to achieve a minimum adequacy and security of livelihood. Through its reliability and the continuity of employment generated, high intensities of irrigation will thus also be livelihood-intensive.

This will be more so if daily wages rise. Wages may generally tend to be higher where there is a continuous demand for labour. In Bangladesh, in those places where an additional (boro) irrigated season of rice had been introduced, most groups of a voluntary agency (PROSHIKA) reported higher wage rates not just for the irrigation season but for other seasons as well (Wood 1985: 24). Wages also tend to be high when there is a sharp peak in labour demand. With a continuous demand for labour throughout the year resulting from irrigation, employers may wish to take on semi-permanent or permanent labour. Wage levels are subject to many forces, subtle and not so subtle, and may not always rise with irrigation. But the normal condition is probably that with irrigation in two or more seasons daily wages do rise, and it is probably almost universal that total annual earnings of all but the most indebted and exploited labourers will be larger.

These tendencies are confirmed by a study in the Philippines (Dozina *et al.*, 1978) which compared conditions before and after rehabilitation of a communal irrigation scheme. Labourers with no land in the system contributed labour to the rehabilitation in the expectation of more dry-season employment with the greater irrigation intensity. After rehabilitation, gross value added per farm rose 146 per cent, but the landowners' share rose least—by 133 per cent, and the hired labourers' share most—by 180 per cent. It would be dangerous to generalise from one case in the Philippines, but this does indicate not only that labourers can gain substantially, but also that in some conditions they can be the group that gains proportionately most even though not absolutely most.

security against impoverishment

Livelihoods are much more than just employment and incomes. An adequate and secure livelihood includes protection against impoverishment. This aspect of irrigation has been largely overlooked. By providing employment and incomes which are not just more in quantity, but more reliable and spaced over more of the year, vulnerability is reduced. The need for dependent relations with moneylenders and employers is likely to be less. The dangers of having to dispose of assets, and in particular to sell land to buy food or meet debts, are likely to be diminished. For Bangladesh, Michael Howes (1985: 114) has described how irrigation by poor families with handpumps arrests the slide to landlessness. Reliable irrigation can provide a strong shield against further impoverishment, restraining and diminishing indebtedness, and weakening or eliminating the contingency so feared by poor households of bad seasons or times of year when they run out of cash and food, and have to become indebted or dispose of assets.

migration

Irrigation can have two good effects on migration: stopping previous out-migration; and attracting in-migration. Of these the first is less conspicuous and less well documented. But it is probably common that when new irrigation is spread over two or three seasons each year, landless people who before had to go elsewhere for part of the year, no longer have to do so. This avoids the anguish and misery entailed by family splitting, if some, often the weak, young and very old have to be left behind; the risks to property left behind; and the hasseles, humiliations, uncertainties and privations of seeking and performing work as migrant labourers. It also permits a more stable and settled existence.

Another benefit is better access to services, especially education. The Bhima project evaluation observed that

> One point made by several landless labourers was that, before irrigation, they had to move from one place to another searching for jobs. Thus, they could educate only one son, who was left initially with relatives, and in a few cases in hostels. Daughters invariably

> moved with parents from place to place, and thus were never sent to school.
>
> With the introduction of irrigation, employment opportunities near the villages have increased significantly. Now they stay in one village and find work within the village itself or neighbouring areas. Because of this stability, for the first time, they are sending their daughters to school. (IFAD 1984 : 29)

Yet female education is not one of the justifications normally put forward for year-round irrigation.

In-migration is widespread. Much is seasonal, as with the lakhs of people who move from Eastern UP and Bihar annually for work in Punjab and Haryana in the rabi season. Much also is semi-permanent or permanent. Of 12 villages surveyed in North Arcot District, the largest intercensal (1961-71) increase in the Harijan population, most of whom were landless, was in precisely that village which during the period developed the most intensive year-round irrigation-based cultivation (Chambers and Harriss 1977). Two other studies, each comparing an irrigated with an unirrigated village, show the expected pattern. In Karnataka, the irrigated village, Wangala, attracted permanent settlement by landless families, but not the unirrigated village (Epstein 1973: 80-1). Near the Haryana-Rajasthan border, an irrigated village attracted in-migrants for year-long labour contracts but an unirrigated village reversed the process (Groenfeldt 1984). Irrigation is more often associated with labour shortages than is commonly recognised.

In-migration of seasonal labour for work on irrigation has both negative and positive effects. It can contribute to the immiseration of locally resident landless labour, as with the Halpatis in South Gujarat who have to compete with a stream of migrants and 'find themselves entrapped in a process of acute pauperisation in an area enjoying accelerated economic growth from irrigation' (Breman 1985: 345-6). There is also the factor that labourers who migrate are abandoning the fight for better conditions in their villages of origin. But, offsetting these negative aspects, the migration-linked benefits of irrigation are easily undervalued. Indirect positive effects on other poor people are usually neglected. Assessing these entails thinking about the counterfactual, what would have happened without the migration or countermigration effects of irrigation. Two sets of such indirect benefits are likely. First, in areas from which outmigrants are drawn by irrigation, poor people who remain will benefit from reduced competition for work, and should stand to gain from more days worked and higher daily wages. Second, poor people in areas to which migrants would have come had irrigation not restrained them, will similarly gain. A well-managed irrigation project, by attracting and retaining labour, can thus have good effects on others at a considerable distance.

When these effects are considered, the net benefits of irrigation are seen to be greater than with a narrower and more conventional evaluation.

quality of life

Many aspects, both tangible and intangible, of the quality of life are affected by irrigation. On the debit side of any balance sheet are waterborne and water-related diseases, and effects of flooding, water-logging and salinity where these result from irrigation. Other effects are symptoms of prosperity but may be experienced negatively, like more unpaid work for women (in animal husbandry, in cooking for labourers, in work in the fields) and the spread of dowry and higher dowry prices (Agarwal 1981).

On the credit side, employment and income effects dominate. Secondary effects may also be very important. Labourers' hassle is likely to diminish and labour relations may be transformed, with a shift in the balance of power towards the labourers. For example, without irrigation a family with a rainfed marginal farm may have had to depend partly on going out daily for wage labour in the uncertain hope of getting work. With irrigation, they need to go out less, to go less far, and to spend less time and suffer less stress travelling, searching and supplicating for work. Labour relations can then change from begging to bargaining; employers may even actively look for labourers. Again, less family splitting through migration, better housing through more permanent residence, less vulnerability to impoverishment and indebtedness in a bad monsoon year, more education for children—these are among the benefits of irrigation which can be guessed at but which social scientists in their surveys have rarely if ever sought and captured.

Better known are the non-agricultural uses of irrigation water—for washing clothes, personal hygiene, and drinking (Yoder 1981; Small 1983). One benefit which has not attracted the attention it deserves is where rising water tables relieve women's work lifting water from wells.

In sum, where good irrigation is provided, and especially where intensities are high, the poor are likely to benefit on balance, and sometimes substantially. There are always twists and subtleties, and much more needs to be known. But any observer can confirm or question these points for any irrigation system or part of it by asking labourers and small farmers their views and experiences. My own findings have been consistent: labourers welcome irrigation, and some say they wish water supplies were better so that irrigation could generate even more work and wages.[3]

All this discussion assumes that when irrigation comes, landholdings remain unchanged: large farmers remain large farmers, small remain small, and the landless remain landless. Although irrigated land ceilings in India are lower than non-irrigated, in practice, little land is acquired from land reform when canal irrigation comes to an area: the many methods of evasion are well known and skilfully executed. In Sri Lanka and many parts of Africa in contrast, land under new canal irrigation is often acquired by the state and parcelled out to settlers in equal-sized holdings. Given the sharp rise in land values and incomes with irrigation, the inequity of normal Indian practice is little short of spectacular. Thus, although the landless and small farmers are made better off than before by canal irrigation, absolute wealth and income differentials are accentuated. The greatest potential for creating livelihoods from canal irrigation is not the reforms advocated in the rest of this book, but the redistribution of the irrigated land. In India, however, that appears politically improbable at present on any scale. While that remains so, the next best option is to seek other, more realistic, ways in which the poor, small farmers and tailenders can gain.

In that spirit of realism, this book is concerned with changes which look politically feasible; and in line with evident priorities of the poor themselves, it is more concerned with the generation of livelihoods from irrigation than with production *per se*. Some of the discussion will be couched conventionally in terms of production because of the nature of the statistics, the parts of causal chains which are being considered, and the often positive relationships between production and livelihoods. But this must not obscure the main purpose of improved performance, that poor people shall be better off, nor the potential of irrigation as a direct weapon to enable people who are deprived to command more food and income.

Canal Irrigation in South Asia

The next step is to distinguish the main types of irrigation in South Asia and their orders of magnitude.

Three types of irrigation organisation are evident:

Dual managed canal systems	: usually larger river diversion or reservoir-based gravity irrigation systems with a dual management, in which the upper parts of the systems are managed mainly by a staff recruited, paid and disciplined by an external organisation, and the lower parts are managed by irrigators.
Communals	: usually smaller river diversion or reservoir-based gravity irrigation systems managed by irrigators and/or by servants or employees recruited, paid and disciplined by irrigators.
Lift irrigation	: where water is pumped up before distribution. Groundwater is the most common source, but water is also lifted from reservoirs, canals, drains and other sources.

Comparing the size of these types between countries is complicated by different national classifications using the terms 'major', 'medium' and 'minor'. In India, major canal irrigation is that with a culturable command area (CCA) of over 10,000 hectares, medium is over 2,000 hectares but less than 10,000, and minor is less than 2,000. In Sri Lanka, in contrast, there is no medium irrigation and the divide between major and minor is at 80 hectares. Thus much major irrigation in Sri Lanka would be minor in India, and vice versa. Nor does the major-minor divide based on size necessarily coincide with the organisational distinction between dual management and communals which defines the scope of this book. For, although much of what follows applies, *mutatis mutandis*, to communals, our concern is primarily with dual managed systems, where irrigation staff and irrigators manage different spheres.

Nor are the statistics anything but unreliable. In an earlier outline for this book I set aside a chapter for sorting out irrigation definitions and statistics. Heroic patience and several lifetimes were evidently needed. Both were beyond me. Had I not backed off, this book would never have been written. I shall use statistics throughout, but the reader is asked to take them with judiciously liberal doses of salt. Usually the best that can be said is that they indicate orders of magnitude.

With that caveat, it is striking that areas reported irrigated in the five South Asian countries give (to the nearest whole number) 68 per cent in India, 26 per cent in Pakistan, 3 per cent in Bangladesh, and only one per cent in each of Sri Lanka and Nepal (Table 1.4).

Table 1.4. Area reported irrigated in five South Asian countries

	(thousand hectares) 1974-6	1984	1984 proportion of total percentage for five countries
Bangladesh	1,355	1,920	3.3
India	33,590	39,700	68.3
Nepal	232	640	1.1
Pakistan	13,601	15,320	26.4
Sri Lanka	480	550	0.9
Totals	49,258	58,130	100.0

Source: FAO Production Yearbook Vol. 39, 1985 : 59.
Notes: 'Data on irrigation relate to areas purposely provided with water, including land flooded by river water for crop production or pasture improvement, whether this area is irrigated several times or only once during the year stated' (ibid: 3). Sri Lanka data refer to irrigated rice only.

Table 1.5 separates out areas reported by type of irrigation in India and Pakistan with their 95 per cent of the total.

The addition of Bangladesh (mainly lift irrigation), Nepal (mainly communals) and Sri Lanka (dual managed canals and communals roughly equal) would shift the balance of these figures slightly away from dual managed canal irrigation, as would the fast rate of groundwater development in India since 1983-4. For South Asia as a whole in the mid-1980s, very rough orders of magnitude for irrigation potential created by irrigation type are perhaps communals 7 per cent, groundwater 36 per cent, and dual managed canal 57 per cent. Two-thirds of that dual managed canal irrigation is in India, and most of the remainder in Pakistan in conditions similar to Northwest India.

For India the significance of canal irrigation can also be indicated by the growth of potential created and the future potential remaining. Table 1.6 shows the expansion from the start of the First Five-Year Plan in 1951. In 1985-6 the proportions of ultimate potential which had been created were 68 per cent for groundwater, 61 per cent for minor surface,

Table 1.5 Irrigation potential created by type of irrigation: indications of orders of magnitude for India and Pakistan (million hectares)

	India 1985-6 target	Pakistan mid-1980s	Dual managed canal	Communal	Lift irrigation	Percentage of total rounded
Major and medium canal (CCA 2,000 ha)	31.1	14.0	45.1	-	-	52
Minor surface gravity (CCA 2,000 ha)	9.2	1.8	6.1	4.9	-	13
Lift irrigation (mainly groundwater)	27.2	3.0	-	-	30.2	35
Totals	67.5	18.8	51.2	4.9	30.2	—
Percentages (rounded)	78	22	59	6	35	—

Notes: This table is based on scattered and disparate data, and judgements made by a number of well-informed sources. The data have many limitations, including imprecise definition of what the hectares reported for Pakistan represent, possible double-counting between lift irrigation and the other categories, and problems of definition and estimation as between dual managed and communal. The purpose of the table is not to present definitive statistics, but to give a sense of provisional orders of magnitude for different types of irrigation.

For definitions of dual managed canal, communal, and lift irrigation see page 16.

Minor surface gravity irrigation is divided between dual managed and communal in the ratio 3 : 2 for India and 1 : 2 for Pakistan.

Table 1.6. Irrigation expansion and potential in India (million hectares)

	Major and medium (CCA >2,000 ha)		Minor		
	Potential created	Utilisation reported	Surface CCA < 2,000 ha	Groundwater	Total reported utilised
1950-1	9.7	9.7	6.4	6.5	22.6
1985-6 (target)	31.1	25.9	9.2	27.2	62.3
Ultimate potential	58	58	15	40	113
Percentage of potential achieved by 1985-6 (target)	54	45	61	68	55

Sources: MOIP 1972; GOI 1976; and Ministry of Agriculture and Irrigation, Central Water Commission and Central Groundwater Board. All figures are gross, not net.

and only 54 per cent for major and medium canal, with only 45 per cent of the ultimate major and medium canal potential utilised.

Canal irrigation in India has to be understood in a historical perspective. Before 1947, most canal irrigation was by river diversion, though with notable exceptions like the Mettur Dam in South India. During the plan periods, a prodigious expansion took place, most of it in storage reservoirs. The rate of increase in gross storage capacity was spectacular, rising 14-fold in 32 years, from 1.4 million hectare-metres (mha m) in 1951 to 19.7 mha m by 1983 (B. Sinha 1983: 1-21). In the 30 years 1951-80, 640 reservoir projects were completed. Including all types of canals, the potential reported created under canal irrigation was over three times that at the start of the First Plan.

The Seventh Five-Year Plan initiated a new phase of completion, consolidation and utilisation. Priority was given to completing unfinished projects, with priority to those benefiting tribal areas, drought-prone areas and areas with a sizeable scheduled caste population. Also, new starts were restricted to such areas. The highest priority was given to the utilisation of existing irrigation potential, and exploration and exploitation of groundwater was put on a priority basis (GOI 1985 : II : 71). Attention was shifted from new construction towards making better use of the phenomenal investments and expanded potential from the earlier plan periods.

It is fitting here to pay tribute to the labourers and others who did the work on the dams and canals, and to the engineers who designed them and supervised construction. There were many defects, and it is easy, and nowadays commonplace, to criticise irrigation engineers for their preoccupation with structures, their fixation on the reinforced concrete beam and so on, and their neglect of management; to condemn gigantism and grandiose projects; and to point to evidence of corruption. Many of these criticisms are justified and will be examined and elaborated on in this book; but they should not obscure the achievement that, in the decades which followed India's independence, massive structures and vast irrigation potential were created and that so many worked hard and well to achieve this.

Performance

The structures are a fact; they exist. But unfortunately it is easier to design and construct than to operate and maintain. The early 1980s were marked, in South Asia and elsewhere, by increased awareness of the poor performance of canal irrigation systems. Much of this originated in economic and political considerations. Enormous investments by governments and aid agencies had been based on misleading appraisals and cost-benefit calculations. Problems included delays in construction, faulty construction, cost overruns and in India the gap between potential declared created and potential utilised with full facilities to enable water to reach fields (Pant 1982; PAC 1983). At Independence irrigation works in India as a whole covered their maintenance and interest costs but by the early 1980s they were running at a loss of over 400 crores rupees ($400 million) per annum (PAC 1983 : 130) rising by the mid 1980s to an estimate of some 800 crores ($800 million) per annum (Vohra 1986: 2). All these and other problems received increasing attention. At the same time, research and analysis in the early 1980s exposed more and more deficiencies in the operation and management of canal irrigation systems, especially those constructed in the previous three decades, and provided details of dismal performance.

Ideally, poor performance could be expressed in terms of employment and livelihoods not realised. Such data are not available, so other figures, which are rough proxies, must be taken. These are areas irrigated as proportions of area planned to be irrigated; waterlogging; tailend deprivation; and yields.

area irrigated

For projects constructed during the plan periods in India it may be a universal experience that the area irrigated has been less than planned in the project proposals and design. There is, of course, a danger that failures and shortfalls are reported but successes not. All the same, in every case for which I have evidence, achievement has been short of plan. The Rajasthan Canal when receiving two-thirds of its water in the early 1980s was irrigating only one-third of the land intended (Roberto Lenton, personal communication quoting C.C. Patel). In Uttar Pradesh in 1980-1, irrigation potential utilised on the Sarda Sahayak Project was reported to be only 38 per cent of the potential created of 1,410,000 hectares (Swaminathan 1982: 96). In Bihar, the Kosi Canal, with a planned gross area to be irrigated of 74,000 hectares, was reported to have irrigated only 18 per cent of this on average in the years 1971 to 1976 (Pant 1981: 17 and 118). Even when the target was reduced to make it more realistic, only 31 per cent of the newly planned area was irrigated. In Andhra Pradesh, utilisation reported as a percentage of the ultimate potential planned was, in 1980-1, 88 per cent for the K.C. Canal, 81 for the Tungabhadra High Level Canal, 78 for the Tungabhadra Low Level Canal, 65 for Kaddam, 60 for the Rajolibanda Diversion Scheme, 42 for Nagarjunasagar Left Bank Canal and 37 for Nagarjunasagar Right Bank Canal, and 17 for Sriramasagar Project (Ali 1982: 46-7). In Gujarat a study of the Mahi-Kadana project conducted by the Water Technology Centre, Delhi, reported an irrigation intensity in 1980-1 of 55 per cent, compared with 131 per cent proposed by the Government of Gujarat (WTC 1983: 356). In Tamil Nadu on the Perambikulam Aliyar Project over the period 1976 to 1981, the area irrigated averaged only 47 per cent of the area planned (Sivanappan *et al.* 1984: 125). In Madhya Pradesh the Tawa Project cannot escape mention. Even though its reputation for having reduced production through waterlogging is not justified, it has the dubious distinction of being most commonly cited as a disaster.

Nor are these problems limited to India. In Sri Lanka, the Uda Walawe Project was, in the mid-1970s, irrigating only about one-quarter of the area planned. But there is little to be gained from extending the list. Whatever the reasons, performance in area actually irrigated has fallen far short of that projected. Millions of hectares planned to receive canal irrigation water have not received it.

waterlogging

Waterlogging has been widely reported, especially in the head reaches of relatively new canal irrigation commands. In Pakistan it is a major national problem. In India, it is also reportedly widespread. On the Tungabhadra project in Karnataka, commissioned in 1953, a survey in 1983 found 33,000 ha severely affected by waterlogging and salinity, increasing at the rate of 6,000 ha annually. Production was reported to be zero on about 20,000 ha and the cultivators had been forced to abandon their lands (Abrol 1985: 7). In parts of Haryana where the waters of the Bhakra canal were delivered in 1963, the rising water table created a problem of salinisation which became more serious each year. The rising water table in the command of the Mahi-Kadana project in Gujarat had, by 1983, been responsible for patches of salinity which gave cause for concern; a groundwater study revealed an annual rise of about one metre (WTC 1983: 199) which promised extensive problems in a few years. In 1983, it was reported that following extension of the Sarda Sahayak Project in Uttar Pradesh, an expenditure of Rs 384 crores (Rs 384 $\times 10^7$) had added 4 lakh (400,000) hectares of irrigated area but with a loss of 5 lakh (500,000) hectares of irrigated area to waterlogging, a net loss of 1 lakh (100,000) hectares and a net negative effect of the Project on food production (MOA 1984: 51). There can be no question but, that on many projects in Pakistan and India, at mid-1980s levels of management and infrastructure, waterlogging is a serious and threatening problem.

Some caution is needed, however, with high figures repeatedly quoted for waterlogging, and the manner in which waterlogging is automatically attributed to canal irrigation. India's 6 million hectares waterlogged is repeatedly cited, but is based on estimates some of which originate in 1972 or earlier; and not all the 6 million is the result of canal irrigation.[4] Whatever the truth, the fact remains that through canal irrigation a total of lakhs and perhaps of millions of hectares have been lost to cultivation or have had their productivity seriously diminished by waterlogging, with or without salinity. The losses of livelihoods and production resulting, and the effects of distress migration from areas affected, are one extreme manifestation of poor canal irrigation performance.

tailend deprivation

The deprivation of tailends is notorious, and is confirmed again and again. As a result of research a much clearer view of this is possible in the mid-1980s than a decade earlier. Tailends of main canals, branch canals, distributaries, minors, and field water courses all suffer. Sometimes it is from excess water from flooding or seepage. More often it is from receiving too little water, unpredictably, and late, if indeed water is received at all.

Deprivation takes many forms and is reflected in various indicators including water supply, irrigation intensity, crops grown, cultivation practices, yields and incomes.

Tailend deprivation of water supply and low irrigation intensities are often acute on relatively new projects. In 1981 it was reported that, in the new Sarda Sahayak command area, farmers at the top-end got five irrigations while farmers in the lower reaches hardly got one (Ali 1983: 96). On the Ghatampur Distributary of the Ramganga Project, the intensity of irrigation as a percentage of that designed was recorded over four years to average 155 per cent for the Kisarwal (headreach) minor and only 22 per cent for the Bairampur (tailreach) minor, besides being more stable and reliable (157, 150, 166, 148) in the head minor than in the tail (46, 43, 0, 0). On minors in the Hirakud Project, it was found that 70 per cent of the water went to the head halves with only 30 per cent to the tail halves. On the Pardhiapali subminor, the headreach irrigation intensity was 93 per cent, but only 46 and 24 in the tail, reflecting water supplies which were 137, 84 and 22 per cent respectively of the flows planned (Naik 1981: 5).

Tailend deprivation in water supply and intensities is also found on much older projects. The old Sarda canal was designed for 32 per cent annual irrigation but, over time, the intensity in the upper reaches went up to 42 per cent while in the lower reaches it was only 19 per cent (Rathi 1983: 27). Or again, on the Left Salawa Distributary on the Upper Ganga Canal, annual irrigation cropping intensity was found to be 119 per cent at the head, 72 in the middle and 68 at the tail. Even on the northwest Indian warabandi systems, which have a reputation for equity, a careful study found that cropping intensity (gross area irrigated as a proportion of the CCA of a chak) was lower in the lower reaches of the distributary (Malhotra *et al.* 1984a: 79). Tailend deprivation in canal irrigation water deliveries is found in all the evidence examined. It is either universal, or almost universal.

This deprivation is reflected in the crops grown, cultivation practices, yields and incomes. Higher valued and more water-intensive crops tend to be concentrated in headreaches. Sugarcane in the north and west of India, and paddy in the south and east, often show this pattern. On one distributary on the Upper Ganga in North India, sugarcane intensity was found to be 44 per cent at the head and only 10 per cent at the tail (Padhi and Suryavanshi 1982: 26). In South India, unplanned cultivation of paddy in headreaches on land zoned for irrigated dry crops (i.e. other than paddy) is widespread. Although there are exceptions, as when tailenders invest in groundwater, headenders generally grow more profitable crops and use more inputs, while tailenders grow less profitable and less risky crops, and apply fewer inputs such as fertilisers.

Yields almost always decline from head to tail, though a few exceptions can be found where they are higher in the middle reaches (especially where there is waterlogging near the head) or where groundwater is used extensively in tailends. On the Gal Oya Left Bank in Sri Lanka, paddy yields were found to decline from 40 bushels per acre on head distributary channels to 33 on middles and 26 on tails, and yield closely correlated with indices of water availability and water problems stated by farmers (Murray-Rust *et al.* 1984: 92, 99). Another set of studies in Sri Lanka found head and tail yields of paddy in bushels per acre to be respectively 52 and 38 on Uda Walawe, 65 and 58 on Kaudulla (which has a relatively abundant water supply), and 83 and 62 on Padaviya (Moore *et al.* 1983 Table 1). The fullest data known are from paddy yield crop cutting measurements from the Mahanadi Reservoir Project in kharif 1980. These showed gradations according to head, middle and tail positions respectively on canals, distributaries, minors and outlets. Yields were found to decline from 1,935 kg/ha at the quadruple head location, to 350 kg/ha at the quadruple tail location (Lenton 1984a: 63-4 citing WAPCOS 1981 pers. comm. Sinchai Bhavan, Raipur).

Incomes and returns to labour evidently decline from head to tail more sharply than yields. On the Left Main Canal of the Gambhiri Project, an economic study of a headreach and tailreach minor gave figures for wheat shown in Table 1.7.

Table 1.7. Yields and incomes on a headreach and a tailreach minor, Gambhiri Project

	Yield per bigha in in kg	Net income Rs per 100 kg	Net income per ha
Thikaria (headreach) Minor	622	142	881
Rithola (tailreach) Minor	350	41	144
Tail : head ratio	0.56	0.29	0.16

Source: WMSP 1983a: 225.

Overall, the study concluded that incomes of headreach minor farmers were more than six times those of tailreach minor farmers (ibid.: 281). Even more remarkably, a study on the Gal Oya Project in Sri Lanka found a marked but not excessive gradient of yields from head to tail, but a sharp difference in net returns to family labour which were in all cases negative in the tails (Table 1.8).

Table 1.8. Net returns per family labour day by canal location, Gal Oya Project

	Uhana-Mandur sub-system		Left bank main channel		Gonagolla channel	
	Top	Tail	Top	Tail	Top	Tail
Average yield bushels per acre (four seasons)	53	33	48	33	45	37
Rs per acre cost of production per bushel	35	53	30	53	29	55
Net returns per family labour day	+27	−48	+28	−11	+44	−8

Source: Moore *et al.* 1983, Table 2, citing ARTI 1982.

The negative returns to family labour in the tails do not necessarily mean production at a loss, but rather that the returns to family labour were substantially lower than the going wage rate at which family labour was costed. Nevertheless the fact that incomes and returns to labour decline so much more sharply than yields shows how easy it is to underperceive tail end deprivation.

Nor is tailend deprivation limited to water, agriculture and incomes. In the Dry Zone of Sri Lanka it is also linked with inferior access to government services, transport, and information and with relative political powerlessness (Moore *et al.* 1983). The tensions and uncertainties over water supplies also have other bad effects. Water shortages and uncertainties give rise to quarrels: on the Lower Bhavani system in Tamil Nadu, it was found over three years that disputes were nearly four times as common in the tail as in the head (Palanisami 1983: 120). For farmers, to be a tailender is to live at a permanent disadvantage with high risks involved in farming decisions. For landless labourers, tailends provide less work and less assured work. The deprivations of tailends are multiple, affect all of the poor, and keep people poor.

Estimates of the scale of tailend deprivation can only be approximate. Definitions are difficult. Quite often tailend deprivation is mitigated by groundwater exploitation—for those who can afford a pump and tube or well, or who can buy water from neighbours; and the groundwater may be recharged by the canals. However, after extensive field visits to canal irrigation projects in India, Henry Hart estimated (1978: A-126) that between 10 and 30 per cent of their CCAs suffered from 'unavailability... of a supply of water adequate in amount and timeliness to sustain normal yields of recommended crops'. In the light of the empirical evidence cited above in this section, even the upper limit of this estimate may be optimistic. The scale is daunting. My own guess is that between a quarter and two-fifths of the potential declared utilised in India, roughly between 6 and 10 million hectares, suffers from recognisable and damaging tailend deprivation; and that this is socially far more serious than the more visible problem of waterlogging.

average yields

A fourth measure of poor performance is average yields. In the words of India's Sixth Five-Year Plan (GOI 1981 : 149):

> Irrigated land should yield at least 4 to 5 tonnes of grains per hectare per year. However, at present it is hardly 1.7 tonnes on average. Actual yield levels are lower than the levels of 4 to 5 tonnes achieved in National Demonstrations and by experiments in water management projects where appropriate water management and other cultural practices were maintained at optimum levels.

The Gambhiri Project provides an illustration of how much lower yields can be than the potential. In 1980–1 wheat yields were only just over half those on the experimental farm (1,850 kg ha^{-1} compared with 3,500) while those for gram were less than one-fifth (490 kg ha^{-1} compared with 2,500) (WMSP 1983a: 15).

A striking analysis has been carried out by B.D. Dhawan (1986). For Punjab, Haryana, Andhra Pradesh and Tamil Nadu, he has calculated foodgrain yields per net and gross irrigated hectare by irrigation source and at different points in time. Table 1.9 presents the results.

Table 1.9. Average foodgrain yields per unirrigated hectare and per net irrigated hectare by irrigation source in four Indian States

		Unirrigated	Groundwater	Canal	Tank
Punjab	77-9	1.08	5.46	3.24	-
	63-5	0.75	3.06	1.18	-
	50-1	0.37	1.75	0.94	-
Haryana	76-7 and 78-9	0.38	5.74	2.39	-
Andhra Pradesh	77-9	0.42	5.69	3.43	1.96
	57-9	0.47	3.11	2.27	1.35
Tamil Nadu	77-9	0.49	6.53	2.60	2.33
	64-6	0.61	4.00	2.14	2.08
	56-68	0.66	3.78	1.69	1.86

Source: Dhawan 1986 : 17 which also gives standard errors, R^2s, etc.
Figures here have been rounded to two decimal points from three in the original.

By subtracting unirrigated yields from irrigated, Dhawan then presents 'output impact', that is, the difference in yield attributable to irrigation (Table 1.10).

Table 1.10. Output impact of groundwater, canals and tanks, 1977-9

	Tons of food grain per net irrigated hectare additional to rainfed yield		
	Groundwater	Canals	Tanks
Punjab	4.4	2.1	-
Haryana	5.3[1]	2.0	-
Andhra Pradesh	5.2	2.9	1.5
Tamil Nadu	6.0	2.1	1.8

Source: Dhawan 1986: 11 and 13.
Notes: 1. The groundwater impact for Haryana is higher than Punjab partly because unirrigated yields are lower. Haryana figures are for 1976-7 and 1978-9.

For the purposes of comparison, net irrigated hectares are better than gross because net yields are higher when intensities are higher, and intensities themselves reflect management. The figures suggest that land receiving groundwater irrigation produces each year roughly twice as much additional foodgrains per hectare as land receiving canal irrigation. Water used has not been measured. Had the yields been per unit of water, the comparison would have favoured groundwater even more sharply.

These four States are among those with higher yields under irrigation. Punjab and Haryana both have the warabandi system (see pp. 92-9) for canal water distribution, in contrast with the rest of India, and much of Tamil Nadu's canal irrigation is relatively mature and well managed. All India figures, were they available, would give lower yields.

Potential

When performance is so poor, potential seems vast. Some caution is in order, however. Performance is poor partly when compared with projections made at the time of planning and design; and these were often unrealistically optimistic. Frequently, they were made to achieve the desired internal rates of return and to placate political interests demanding water in more places. Quite often, water supply was planned to places which could not be served.

All the same, it is widely believed that the scope for better performance is large. In the words of a report of the Water Technology Centre, Delhi 'There is a vast scope for increasing the efficiency of on-going projects and future ones' (WTC 1983: 357). Calculations for Pakistan concluded that improvements in management together with some fairly modest physical improvements would save water which over 13 million ha of irrigated land in Pakistan would be equivalent to the water available from three Tarbela dams (Bottrall 1981a: 24 citing PSASR 1976 pp. 32, 50, 55-6). Following a review of irrigation in Bangladesh, India, Nepal, Pakistan and Thailand, Jack Keller wrote (1982: 6) that 'for many projects we visited the irrigated land is less than 50 per cent of the land that could potentially be irrigated with the available water supply'.

For India, David Seckler speculated in 1981 about the extent of 'capacity utilisation', defined as the amount of effectively irrigated land which can be obtained from existing supplies of water at the headgates of irrigation systems, with good management of the water through the farm level, and with economically justifiable improvements in physical distribution facilities. He considered that three-quarters of the systems in India operated in these terms at about 25 per cent of their capacity, and that of the 30 million hectares of canal irrigation potential created only some 11 million were effectively irrigated, a figure which could be increased to about 21 million (Seckler 1981: 8, 10). Bearing in mind the fairly good standards of irrigation in parts of the large deltas of India, Seckler's estimate of area effectively irrigated in 1981 may be low. My own estimate in 1983 was 14 to 15 million hectares. But such figures are imprecise, not least in the absence of a definition of 'effective'. An alternative concept is 'significant irrigation', defined as irrigation responsible for a 50 per cent or more rise in the value of agricultural production or for risk reduced so that cultivation practices change, compared with the condition without canal irrigation supplies. My estimate would be that canal irrigation in India in 1986 supplied perhaps half of the area of potential created with significant irrigation, and that this could be raised to perhaps three-quarters, that is from some 16 million hectares to some 24 million hectares.

The potential for livelihoods can be understood not just in terms of area irrigated, but also yields and reduced tailend deprivation. With an adequate, convenient, predictable and timely water supply most farmers will adopt high-yielding practices. Improved water supplies could then lead to a doubling or more of yields. The mathematics are simple and dramatic: if the significantly irrigated area from canals in India could be raised by a half (from 16 to 24 million hectares), and yields doubled (to bring them into line with lift irrigation), then production from canal irrigation would triple. The direct and indirect livelihood effects of providing significant irrigation to a further 8 million hectares on existing projects, of doubling per hectare yields, and above all of reducing multiple tailend deprivations, would be enormous. Even if much less were achieved, the enduring impact could benefit crores of poor people, whether as small farmers, agricultural labourers, or others with livelihoods generated through the resulting prosperity.

Whether such potentials can ever be realised, and if so how, is much of the concern of this book. In the real world of canal system management there are many constraints. It is one thing to accept that it is physically feasible, or could be made physically feasible, to supply irrigation water to larger areas, to raise yields, and to generate new and better livelihoods. It is quite another to do this in practice. Canal irrigation systems are huge, inert and deteriorating complexities, trapped in physical forms and by set routines and entrenched interests which lock them into low performance.

The thesis of the book is that many past attempts to improve performance have failed because of defective analysis. In the past, studies and recommendations for canal irrigation have been dominated by the normal professionalism of the irrigation professions, especially irrigation engineering and agronomy. Irrigation engineering is a highly developed disciplinary and professional specialisation with a well-defined body of concepts and concerns. Agronomy has well-developed procedures for water-related research, and much is known about plant water requirements and crop yield responses to water. But neither is at all equipped, nor have irrigation engineers or agronomists often been inclined, to look far beyond their disciplinary boundaries. Yet commonsense suggests that any realistic agenda for reform should be based upon an understanding of irrigation systems as wholes, including their several domains, dimensions and linkages.

Notes

[1]For an elaboration of contrasts between physical and social views of development, see Chambers 1983a : 35-40.

[2]Normal economic thinking divides costs and benefits into direct and indirect. For recent economic approaches and analysis see Carruthers and Clark 1981. There is considerable debate and uncertainty about the indirect or secondary benefits of irrigation (see e.g. ibid. 171-2). The livelihood thinking followed here diverges from normal economic thinking especially in setting a higher value on complete year-round sources of work, food and income for households.

[3]Visiting a village in North Arcot District in Tamil Nadu, I asked some Harijan women how they felt about electricity connected to their huts through a Government scheme. They replied not about those domestic supplies, but with impassioned condemnation of the erratic and inadequate supplies to their employers' pumpsets as a result of which there was less irrigation, and for them less work and earnings.

[4]I know of no more recent estimate than the 6 million hectares of the National Agricultural Commission (GOI 1976 : Vol. V: 224). The NAC relied heavily on the Report of the Irrigation Commission (MOIP 1972). The State reported by the Irrigation Commission to have the largest waterlogged area was West Bengal with 1.85 million hectares, almost one-third of the national total. Much of this may have originated from flooding rather than canal irrigation, since in 1977-8 the net canal irrigated area in West Bengal was only 0.96 million hectares (ETSSIEc 1984 : 39).

References

The following abbreviations are used:

ARTI	Agrarian Research and Training Institute, P.O. Box 2522, Colombo 7, Sri Lanka
CBIP	Central Board for Irrigation and Power, Malcha Marg, New Delhi 110021, India
Cornell University	Cornell University, Ithaca, NT 14853, USA
Ford Foundation, Delhi	Ford Foundation, 55 Lodi Estate, New Delhi 110003 India
IDS, Sussex	Institute of Development Studies, University of Sussex, Brighton BN1 9RE, UK
IIMI	International Irrigation Management Institute, Digana Village, near Kandy, Sri Lanka
IRRI	International Rice Research Institute, P.O. Box 933, Manila, Philippines
ODI	Overseas Development Institute, Regents College, Regents Park, London NW1 4NS, UK
WRDTC	Water Resources Development Centre, University of Roorkee, Roorkee, U.P., India
WTC	Water Technology Centre, Indian Agricultural Research Institute, New Delhi 110012, India
World Bank	World Bank, 1818 H Street NW, Washington DC 20433, USA

Abrol, I.P., 1985, 'Salinity and Food Production in the Indian Sub-Continent', paper to the International Conference on Food and Water, Texas A and M University, College Station, texas, 26-30 May

Adinarayana, S., 1984, 'Impact of irrigation on employment, farm productivity and income under Kakatiya Canal of Sriramsagar Project in Andhra Pradesh', *Indian Journal of Agricultural Economics*, Vol. 39, No. 3, p. 543.

Agarwal, Bina, 1981, 'Water Resources Development and Rural Women', typescript, New Delhi

Ali, Syed Hashim (Chairman), 1982, *Report of the Commission for Irrigation Utilisation*, 2 vols, Government of Andhra Pradesh, Hyderabad, November

Ali, Syed Hashim, 1983, 'Water Scarcity and the Role of Operation and Maintenance: Adminstration and Farmers' Organisations', in K.K. Singh, ed., *Utilisation of Canal Waters*, pp. 40-7

ARTI, 1982, *1980 Yearbook for Sri Lanka Water Management Research: initial analysis of pre-rehabilitation situation in Left Bank Gal Oya*, ARTI, Colombo

Bottrall, Anthony, 1981a, *Comparative Study of the Management and Organization of Irrigation Projects*, World Bank Staff Working paper No. 458, World Bank, Washington, May

Breman, Jan, 1985, *Of Peasants, Migrants and Paupers: Rural Labour Circulation and Capitalist Production in West India*, Oxford University Press, Delhi

Carruthers, Ian and Colin Clark, 1981, *The Economics of Irrigation*, Liverpool University Press

Chambers, Robert and John Harriss, 1977, 'Comparing Twelve South Indian Villages' in B.H. Farmer ed., *Green Revolution?*, pp. 301-22.

Chambers, Robert, 1983a, *Rural Development: Putting the Last First*, Longman, Harlow, UK

Clay, Edward, 1985, 'Floods in Bangladesh 1974 and 1984: From Famine to Food Crisis Management', *Food Policy*, Vol. 10 (3), August

CSE, 1985, *The State of India's Environment 1984-85: The Second Citizen's Report* Centre for Science and Development, 95 Nehru Place, New Delhi 110019

Dhawan, B.D., 1986, 'Output Impact According to Main Irrigation Sources: Empirical Evidence from Four Selected States', paper to Seminar on Water Management — The Key to Development of Agriculture, New Delhi 28-30 April 1986, Indian National Science Academy, New Delhi 110002

Dozina, G. Jr, M. Kikuchi and Y. Hayami, 1978, 'Mobilising resources for irrigation development: a communal system in Central Luzon, Philippines', in IRRI, *Irrigation Policy and Management in Southeast Asia*, pp. 135-42

Epstein, Scarlett, 1973, *South India: Yesterday, Today and Tomorrow*, Macmillan, London and Basingstoke

ETSSIE c. 1984 *The Economic Times Statistical Survey of the Indian Economy*, Vikas Publishing House, New Delhi

Ghosh, M.G. n.d. 'Impact of New Technology on Income and Employment Study—a case study in a Bengal village', typescript, Agro-Economic Research Centre, Viswa-Bharati, Santiniketan

Ghosh, M.G., 1984, 'Impact of Irrigation on Income and Employment—a case study in a Bengal village', *Indian Journal of Agricultural Economics*, Vol. 39, No. 3, July-August,

GOI, 1976, *Report of the National Commission on Agriculture 1976*, Government of India, Ministry of Agriculture and Irrigation, New Delhi

GOI, 1981, *Sixth Five-Year Plan 1980-85*, Planning Commission, Government of India

GOI, 1985, *Seventh Five-Year Plan 1985-90*, Vols. I and II, Planning Commission, Government of India, October

Groenfeldt, David, 1984, 'Change, Persistence, and the Impact of Irrigation: a controlled comparison of two northwest Indian villages', PhD thesis, University of Arizona

Hart, Henry, 1978, 'Anarchy, Paternalism or Collective Responsibility under the Canals?', *Economic and Political Weekly*, Review of Agriculture, pp. A125-34

Howes, Michael, 1985, *Whose Water? An Investigation of the Consequences of Alternative Approaches to Small Scale Irrigation in Bangladesh*, Bangladesh Institute of Development Studies, Motijheel Commercial Area, Dhaka-2, Bangladesh

IFAD, 1984, *Mid-Term Evaluation Report: Bhima Command Area Development Project, India*, International Fund for Agricultural Development, 107 via del Serafico 00142 Rome

IFPRI, 1984, *IFPRI Report 1984*, International Food Policy Research Institute, 1776 Massachusetts Avenue NW, Washington DC 20036

IFPRI, 1985, *IFPRI Report 1985*, International Food Policy Research Institute, 1776 Massachusetts Avenue NW, Washington DC, 20036

IJAE 1984, *Indian Journal of Agricultural Economics* Vol. 39, No. 3, July-August, Socio-economic impact of irrigation projects, pp. 491-561

Lenton, Roberto, 1984a, 'A Note on Monitoring Productivity and Equity in Irrigation Systems', in Niranjan Pant, ed., *Productivity and Equity in Irrigation Systems*, pp. 51-65

Malhotra, S.P., S.K. Raheja, and David Seckler, 1984a, 'Performance Monitoring in the Warabandi System of Irrigation Management', in Niranjan Pant, ed., *Productivity and Equity in Irrigation Systems*, pp. 69-83

Mehra, S., 1976, 'Some aspects of labour use in Indian agriculture', *Indian Journal of Agricultural Economics*

MOA, 1984, *Report of the Task Force on Increasing Agricultural Productivity in the Command Areas of Irrigation Systems.* (The Mukerji Report), Ministry of Agriculture, Government of India

MOIP, 1972, *Report of the Irrigation Commission 1972*, Ministry of Irrigation and Power, New Delhi

Moore, M.P., F. Abeyratne, R. Amarakoon and J. Farrington, 1983, 'Space and the Generation of Socio-economic Inequality on Sri Lanka's Irrigation Schemes', *Marga*, Vol. 7, No. 1, pp. 1-32

Murray-Rust, Hammond, Nancy St Julien, Mark Svendsen, Norman Uphoff, M.L. Wickramasinghe, C.M. Wijayaratne, 1984, 'Productivity and Eauity in Gal Oya Left Bank: A Sri Lankan Irrigation System', in N. Pant, ed., *Productivity and Equity in Irrigation Systems*, pp. 85-124

Naik, B., 1981, 'Evolution of an Approach for OFF and ON farm Development and Their Operation', *Wamana*, 1, 3, July, pp. 2-5

Oram, Peter, Juan Zapata, George Alibaruho and Shymal Roy, 1979, *Investment and Input Requirements for Accelerating Food Production in Low-Income Countries by 1990*, Research Report 10, International Food Policy Research Institute, Washington, September

PAC, 1983, *Planning Process and Monitoring Mechanism with Reference to Irrigation Projects*, Ministry of Planning (Planning Commission), Hundred and Forty-First Report, Public Accounts Committee (1982-3), Lok Sabha Secretariat, New Delhi, April

Padhi, G.N. and A.R. Suryavanshi, 1982, 'Evaluation of Water Distribution Method of Left Salawa Distributary of Upper Ganga Canal System', in IWRS *Workshop on Water Distribution Practices*, pp. 1-21

Palanisami, K., 1983, 'Problems of Water Distribution and Management at Outlet Level—A Case of Lower Bhavani Project, Coimbatore District, South India', in K.K. Singh, ed., *Utilization of Canal Waters*, pp. 114-20

Pant, Niranjan, 1981, *Some Aspects of Irrigation Administration (A Case Study of Kosi Project)*, Naya Prokash, Calcutta-6

Pant, Niranjan, 1982, 'Major and Medium Irrigation Projects: analysis of cost escalation and delay in completion', *Economic and Political Weekly*, 26 Review of Agriculture June, pp. A34-A43

Patel, Arun S. and Haribhai F. Patel, 1984, 'Economic impact and efficiency of water use—a case study of Dantiwada Canal Irrigation Project in Gujarat', *Indian Journal of Agricultural Economics*, Vol. 39, No. 3, p. 538

PEO, 1985, *Evaluation Report on Integrated Rural Development Programme*, Programme Evaluation Organisation, Planning Commission, Government of India, New Delhi, May

PSASR, 1976, *Pakistan Special Agriculture Sector Review Vol. III: Annex on Water Management*, January (cited by Bottrall 1981: 24)

Rangeley, W. Robert, 1985, 'Irrigation and Drainage in the World', paper for the International Conference on Food and Water, Texas A and M University, May 26-30

Rath, Nilakantha, 1985, 'Garibi Hatao: Can IRDP Do It?' *Economic and Political Weekly*, 20, 6, 9 February, pp. 238-46

Rathi, B.D., 1983, 'Operation of the Canal System and Field Requirement: Uttar Pradesh', in K.K. Singh, ed., *Utilization of Canal Waters*, pp. 26-30

Seckler, David, 1981, 'The New Era of Irrigation Management in India', Ford Foundation, New Delhi, January

Sen, Amartya, 1981, *Poverty and Famines: An Essay on Entitlement and Deprivation*, Clarendon Press, Oxford

Sen, Amartya, 1983, 'How is India Doing?' *Mainstream*, Republic Day

Silliman, Jael and Roberto Lenton, 1985, 'Irrigation and the Land-Poor', paper for the International Conference on Food and Water, Texas A and M University, College Station, Texas, May 27-30

Sivanappan, R.K., P. Kandaswamy and K.V. Selvaraj, 1984, 'Water Management Practices in Parambikulam Aliyar Project Command area, Tamil Nadu', in *National Symposium on Strategies for Irrigation Development*, February 23-5, 1984, Water Resources Studies Programme, Bihar College of Engineering, Patna, Manglik Prakashau, Sahavenpur, Vol. III, pp. 121-30

Small, Leslie E., 1983, *Irrigation and Human Welfare: a workshop report*, International Agricultural and Food Program, Cook College, Rutgers University, New Brunswick, New Jersey

Swaminathan, M.S., 1982, *Science and Integrated Rural Development*, Concept Publishing Company, New Delhi

USAID, 1980, *The Impact of Irrigation on Development: Issues for a Comprehensive Evaluation Study*, AID Program Evaluation Discussion Paper No. 9, Office of Evaluation, Agency for International Development, Washington, DC

Vohra, B.B., 1986, 'Management of Natural Resources: Urgent Need for Fresh Thinking', Delhi, August

WAPCOS 1981, Madhya Pradesh Composite Irrigation Project Outlet Studies — Kharif 1980, Summary Report, mimeo, Water and Power Consultancy Services (India) Ltd, Raipur, 9 February, 1981

WDR 1986, *World Development Report 1986*, World Bank 1818 H Street N.W., Washington DC 20433

WMSP 1983a, *Diagnostic Analysis of Farm Irrigation Systems on the Gambhiri Irrigation Project, Rajasthan, India*, Water Management Synthesis Report 17, University Services Center, Colorado State University, Fort Collins, Colorado, August (by W. Clyma, S.R. Katariya, L.J. Nelson, S.P. Tomar, J.M. Reddy, S.K. Bakliwal, M.I. Haider, U.R. Mehta, M.K. Lowdermilk, W.R. Laitos, and R.R. Mehta)

Wood, Geoffrey D., 1985, 'Negotiations between water-sellers and water-users: the landless irrigation service in Bangladesh', paper to the Development Studies Association Conference, University of Bath, Claverton, Bath, UK

WTC, 1983, *Resource Analysis and Plan for Efficient Water Management: A Case Study of Mahi Right Bank Canal Command Area, Gujarat*, WTC, New Delhi

Yoder, Robert, 1981, Non-Agricultural Uses of Irrigation Systems: Past Experience and Implications for Planning and Design, prepared for the Agricultural Development Council, Inc., Rural Development Committee, Cornell University, Ithaca, May

Abbreviations

AE	Assistant Engineer (junior to an Executive Engineer)
CADA(s)	Command Area Development Authority(ies)
CAD	Command Area Development and the Command Area Development Programme
CCA	Culturable Commanded Area
CE	Chief Engineer (senior to a Superintending Engineer)
CWC	Central Water Commission (India)
DIY	Do It Yourself
EE	Executive Engineer (junior to a Superintending Engineer, senior to an Assistant Engineer)
ET	Evapotranspiration
FJM	Farmer Joint Management
GOI	Government of India
HBP	Hasdeo Bango Project, Madhya Pradesh
IAS	Indian Administrative Service
ICID	International Commission on Irrigation and Drainage
ID	Irrigated Dry, meaning zoned for irrigation for non-paddy crops, (as opposed to Irrigated Wet) (South India)
IFAD	International Fund for Agricultural Development
IIMI	The International Irrigation Management Institute, with its headquarters at Digana, near Kandy, Sri Lanka
IRDP	Integrated Rural Development Programme (India)
IRRI	International Rice Research Institute, Philippines
IW	Irrigated Wet, meaning zoned for paddy (as opposed to Irrigated Dry) (South India)
IWM	Integrated Water Management, a programme in Andhra Pradesh integrating water management above and below the outlet
LTRIS	Lower Talavera River Irrigation System (Philippines)
M and E	Monitoring and Evaluation
MLA	Member of Legislative Assembly
MRB	Mahi Right Bank, a command area in Gujarat
MRP	Mahanadi River Project, Madhya Pradesh
MSM	Main system management
NIA	National Irrigation Administration, Philippines
NWMP	National Water Management Project (India)

O and M	Operation and Maintenance (occasionally also Organisation and Management)
OFD	on-farm development
PENRIS	Penaranda River Irrigation System (Philippines)
PWD	Public Works Department
RWS	Rotational water supply (similar to warabandi)
SCO	Systematic canal operation (India)
SE	Superintending Engineer (junior to a Chief Engineer and senior to an Executive Engineer)
t/ha	Tonnes per hectare
USAID	United States Agency for International Development
WAPCOS	Water and Power Consultancy Services (Delhi)
WAPDA	Water and Power Development Authority (Pakistan)
WDR	World Development Report, published annually by the World Bank
WMSP	Water Management Synthesis Project, funded by USAID
WTC	The Water Technology Centre at the Indian Agricultural Research Institute, Delhi
WUA	Water Users' Association (especially in Taiwan)