National Seminar

on

WATER MANAGEMENT—THE KEY TO DEVELOPING AGRICULTURE

held under the auspices of Indian National Science Academy, New Delhi, 28-30 April 1986

Edited by

J S KANWAR

Published for Indian National Science Academy

AGRICOLE PUBLISHING ACADEMY

IRRIGATION AGAINST RURAL POVERTY

*R Chambers**

Abstract

Benefits from irrigation are normally thought of in terms of production, but with foodgrain surpluses this is less of a priority. The anti poverty and livelihood effects of irrigation have been neglected but are more important. Benefits from irrigation can be assessed in terms of its livelihood-intensity – the numbers of households enabled by irrigation to gain adequate and secure livelihoods. Some lose from irrigation, but the gains of labourers and irrigation intensity can be considerable – in amount, stability and seasonal spread of employment and income; in reduced vulnerability to impoverishment; in less need to migrate; and in a better quality of life.

The livelihood-intensity of canal irrigation can be raised through water distribution reform, water rights reform, and land rights reform.

The livelihood-intensity of small-scale irrigation can be raised through better power supplies, improved pumping efficiency, "saturation" within pumping capacity above good aquifers, modifying tarrifs and spacing regulations to make more water available cheaper to buyers, developing small-scale lift technology, organization for water-sharing, and the principle of water rights to people instead of to land.

Implications include thinking in livelihood terms in planning; research on neglected aspects of impacts of irrigation and different approaches to irrigation; and priorities in policies and practice, including irrigation development in areas where poor people are concentrated. As a weapon against poverty, irrigation has been undersold. Where feasible, well-implemented irrigation development is probably the single most promising short and long-term weapon against poverty/means of reducing poverty.

Definitions

In this paper:

'livelihood' refers to income, assets, and well-being. An adequate and secure livelihood is a level of assets and of stocks and flows of food and cash which provide for year-round physical and social well being for a house-

*The Institute of Development Studies, University of Sussex, Brighton BN1 9 RE, England.

hold and protection against impoverishment. (There are also other aspects of wellbeing that are not covered by the concept of livelihood).

'livelihood-intensity' refers to the degree to which households who previously lacked adequate and secure livelihoods are enabled to gain them.

'marginal and small' refers to farms from 0-1 ha and 1-2 ha, respectively. Rainfed marginal and small farmers are often land-poor and resource-poor but a "marginal" or "small farm" family with good irrigation may be neither 'land-poor' nor 'resource-poor'.

'land-poor', following Silliman and Lenton (1985), includes those who own no land, those who operate no land, those whose major source of income is derived from agricultural wage employment. A close alternative expression is 'landless and near-landless'.

'resource-poor' refers to farm families whose land and water does not assure them an adequate and secure livelihood. This includes many marginal and small farmers, and many rainfed farmers with more than 2 ha.

Production Thinking

It is common for the benefits from irrigation to be thought of in terms of production. The belief that the purpose of irrigation is production is so widespread and deeply rooted that it can be described as production thinking, and as part of normal professionalism in the physical and biological sciences and in much economics.

There are analytical justifications for production thinking; and professional and personal explanations for its prevalence.

The main analytical justification for production thinking is the rationale for increasing the volume and stability of foodgrain production. For long this has been a preoccupation, with the aim of national self-sufficiency and a comfortable buffer stock. The green revolution strategy to boost production was largely based on irrigation. Backing this strategy, at least in the popular mind, was the belief that producing more food was necessary and might be sufficient to overcome hunger. Further support came from the argument that increases in the volume of production have secondary benefits in employment. Studies by IFPRI (the International Food

Policy Research Institute) of the Muda irrigation project in Malaysia and jointly with the Tamil Nadu Agricultural University of parts of North Arcot District in Tamil Nadu have sought to measure such induced benefits (*e g* IFPRI, 1985 : 28). Thinking and studies such as these serve to support taking production as a convenient and plausible proxy for benefits from irrigation in general.

Production thinking is also seductive for professional and personal reasons. Those predisposed to a physical view of development, explaining poverty in terms of population, environment and other physical factors, find the mathematics of food and population easy to grasp and attractive to accept. Production appears politically neutral, a technical matter demanding technical innovations and actions. Production statistics are available and accessible to academics and planners, ready to be analysed and presented in tables. Foodgrain production is relatively measurable and provides easily remembered targets and performance, season by season and year by year. In evaluating performance of any agricultural or irrigation project, production seems a natural and convenient unit of benefit. It is, above all, a single measure, meeting the common human need for one simple objective, not several. Production, or its derivative the value of production, are obvious, easy indicators of benefits from irrigation.

The limitations of the analytical basis of production thinking are clearer now than in the past. It is now better recognised than ever, especially following the work of Sen (1981, 1983), that production and food availability do not ensure consumption by the poor : whether they can consume depends on their entitlements—their ability to command food by growing, purchasing or otherwise obtaining it; and starvation can coexist with food stocks, as it did in the Great Bengal famine. Moreover, India's (mid-1986) foodgrain reserve of some 24 million tons, and the probability that this will be maintained if not increased exposes further attempts to raise foodgrain production to hard economic questions, given costs of storage, the food glut on the world market, and the costs of high producer prices guaranteed by Government. The problem of poverty is even less a problem of production now than it was in

the past. It is more a problem of who produces, where production takes place, and who has the means to purchase or otherwise command food. Any irrigation policy to increase foodgrain production selectively by prosperous farmers in relatively prosperous surplus areas, like Haryana and Punjab, can be questioned now on both equity and economic grounds.

This undermining of the production argument for irrigation weakens the conventional case for irrigation as a major component of development strategy, but production thinking is so entrenched and automatic that it will remain strong long after its original rationale has eroded.

Livelihood Thinking

Because production thinking has been dominant and widely accepted, there has been little need to find other justifications for irrigation. Yet, especially in India, there is another mainstream of thinking about development which starts not with production but people. More than any other country, India has persevered with large-scale administered programmes designed to provide direct benefits to target groups of the underprivileged-small and marginal farmers, landless labourers, members of the weaker and vulnerable sections, women, the seasonally unemployed, and poor people generally. The Integrated Rural Development Programme (IRDP) and the National Rural Employment Programme (NREP) and their forerunners probably have no equivalent in scale anywhere else in the world.

The analysis underlying this other mainstream can be described as livelihood thinking. Earlier programmes of rural development stressed community development and agricultural production. But with livelihood-thinking, attention shifts away from community action and away from production, and focuses on the household and its sustenance at an adequate and secure level of living. An adequate and secure livelihood can be defined here as a level of assets and of stocks and flows of food and cash which provide for year-round physical and social well-being for the household and protection against impoverishment. This applies to all members of the household and especially those,

usually women, who are most deprived. The IRDP and its predecessors have sought to enable poor households to gain better livelihoods through providing them with credit and productive assets, and the IRDP in particular is judged by the numbers of households believed to have been raised above the poverty line.

The poverty line is not the same as a livelihood line. The poverty line can be measured, at least in principle, and is defined in terms of flows of income or consumption. A livelihood line would include assets and security against impoverishment, and has not to my knowledge been developed as an operational concept. Nevertheless, adequate and secure livelihoods are probably closer to what poor people want and seek than being above a poverty line (Chambers, 1985 : 84-87).

The diminished importance of production per se, and the priority of poverty reduction, make it timely to apply livelihood thinking to irrigation. If irrigation can enable many poor people to improve their condition and gain adequate and secure livelihoods for themselves, it can be justified in terms of the same objectives as programmes like the IRDP and NREP. For certain target groups at least, it will often be a more feasible and cost-effective approach.

The contrast between the two normative paradigms or ways of thinking about irrigation can be presented as two parallel lists as given on page 726.

To my knowledge, livelihood thinking has been little applied to irrigation. Arguments for improving the performance of canal irrigation systems are usually couched in production terms. OF 24 papers contributed to the Indian Journal of Agricultural Economics on the socio-economic impact of irrigation projects in 1984 few dealt with employment, let alone with livelihoods. Conventional social cost-benefit analysis, in its simpler forms, is concerned with the value of production rather than employment or income distribution. Appraisal for an irrigation project estimates production; it does not necessarily estimate the project's net carrying capacity for households with adequate and secure livelihoods. Nor has the criterion applied to the IRDP as an anti-

Production Thinking and Livelihood Thinking About Irrigation

	Production thinking	*Livelihood thinking*
Starts with	Food	Poor people
Problem seen as	Food production and availability	Entitlements, especially incomes and purchasing power, or ability to grow and retain food
Objective for irrigation	Increase amount and stability of foodgrain production	Increase 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
Units of benefit are	—technical —physical —easy to measure	—political —social —hard to measure
Attraction of way of thinking to normal professionals	High	Low

poverty programme, of numbers enabled to rise above the poverty line, been much applied to irrigation development.

Who Gains and Who Loses

In their paper 'Irrigation and the Land-Poor', Silliman and Lenton (1985) review much of the literature concerning the impact of irrigation on poor people. They define the 'land-poor' to include

(i) those who own no land

(ii) those who operate no land

(iii) those whose major source of income is derived from agricultural wage employment.

They note that this definition includes many marginal and small farmers whose holdings are too meagre to produce enough food and income and who periodically join the labour force. In this paper the term 'resource-poor' will also be used, to describe households whose access to land and water does not assure them an adequate and secure livelihood.

Irrigation has different impacts on different people in different conditions, with both gainers and losers. Silliman and Lenton's summary of gainers and losers among the land-poor is presented in Table 1.

For any irrigation project, however large or small, a balance sheet of gains and losses might come out positive or negative. 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 (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 serious of all, and

TABLE 1

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 % 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 landprices	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 workloads for women	Women	
5	Increase in water-borne diseases	Particularly agricultural workers	Presence of endemic water-borne diseases; lack of preventive health measures
6	Labour displacement	Agricultural workers displaced by mechanical threshing, herbicides, etc.	Adverse effects of irrigation-induced mechanization outweigh benefits of increased productivity
7	Waterlogging and salinity	Small farmers, sharecroppers displaced by induced waterlogging and salinity	Irrigation induced waterlogging and salinity

deserving a major study, 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 their cash incomes. 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. After reservoirs have been constructed, though, oustees are easy to miss. Evaluations of canal irrigation projects concentrate geographically in command areas rather than in dam catchments where some of those displaced may be; and often they disperse and are hard to find. An example is the Bhima Project in Maharashtra. The Mid-Term Evaluation Report on Bhima (IFAD 1984) reads favourably on many counts but it notes (*Ibid* 23) 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 villages where people are to be resettled are still not ready for occupation.'

As here, any evaluation has to be concerned with a balance sheet of net livelihood and wellbeing effects, offsetting losses of livelihood and wellbeing against gains. With canal irrigation, the hidden losses can be so large that livelihood analysis would indicate that some projects should never be undertaken.

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,

—quality of life.

(*i*) *Employment and income*

Empirical studies again and again confirm that reliable and adequate irrigation 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 realized. 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 irrrigated village and a largely unirrigated villages in West Bengal by Ghosh (1984, 1985) 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.

TABLE 2

Average Number of Days of Employment of Adult Male Casual Labourers on Agricultural Work by Month, in Two West Bengal Villages

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Irrigated village in Burdwan District	30	27	22	21	26	27	28	29	17	18	23	30	298
Largely unirrigated village in Bankura District	24	7	4	1	1	14	29	11	1	—	14	29	135

Source: Ghosh, 1985

The implied differences in livelihood for labourers in these two village are stark, and the value of irrigation can be surmised as 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 and 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 are thus also livelihood-intensive.

This will be more so if daily wages rise. Wages tend to be higher where there is a continuous demand for labour (Chambers and Harriss, 1977). In Bangladesh, in those places where an additional (boro) irrigated season of rice has been introduced, most groups of a voluntary agency (PROSHIKA) report 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 Phillippines (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.[1] It would be dangerous to generalise from one case in the Philippines, but this does indicate not only that labourers can gain very substantially, but also that in some conditions they can be the group that gains proportionately most.

(*ii*) *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 less. The dangers of having to dispose of assets, and in particular to sell land to buy food or meet debts, are diminished. For Bangladesh, Howes (1985) 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.

---

1 The details are Factor

	1972 (US $)	1974 (US $)	Change from 1972 to 1974
Gross value added per farm	89	219	146
Distribution of added gross value among			
Landowners	43	100	133
Farm operators	26	63	142
Hired labour	20	56	180

(Dozina *et al* 1978 : 142)

(iii) 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 irrigation comes for two or three seasons, landless people who before had to go elsewhere for part of the year, no longer have to do so. The effects on the quality of life of a family are hard to judge, but casual meetings indicate that the greater stability and more settled life are very welcome. Another effect 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).

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. 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. 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). Near the Haryana-Rajasthan border, an irrigated village attracted in-migrants for year-long labour contracts but an unirrigated village reversed the process. 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 pauperization' in an area enjoying accelerated economic growth from irrigation (Breman, 1985). 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 counter migration 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. An irrigation project, or extensive groundwater development, 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.

(*iv*) *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 water-borne diseases, and effects of flooding, waterlogging 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. Labourer's 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 irrrigation 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 lessstress travelling, seaching andsupplicating 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 the reduction in women's work of rising water tables so that they have to lift well water less far.

Livelihood-intensity in Canal Irrigation

Applying livelihood thinking to canal irrigation, the criterion of efficiency in water use is its livelihood-intensity. The objective becomes to maximize the adequate and secure livelihoods sustained by a project. This can be done by three types of reform—of canal water distribution; of water rights; and of land rights.

(*i*) *Water distribution reform*

On most canal irrigation systems too much water is supplied to the head reaches, and too little is supplied in an untimely and un-

predictable manner to the tails. Tails suffer multiple deprivation (Moore *et al*, 1983). Although transmission losses can be an offsetting factor, on most canal irrigation systems there is scope for issuing less water more predictably to headreach farmers, and sending more water, also more predictably, to the tails. Much management is still based on continuous flow run-of-the-river thinking appropriate to the large and older systems of north India, but less appropriate for the reservoir systems, the capacity of which has been increased so phenomenally, 14-fold between 1951 and 1983 (Sinha, 1983 : 1-21). Water which runs to waste at night (Chambers, 1986) or leads to waterlogging, or runs out in drains, can be feasibly saved and used to increase irrigation intensities and so generate more and better year-round livelihoods.

(*ii*) *Water rights reform*

The almost universal convention under canal irrigation in India is that rights to water are proportional to land holding. This means that small farmers gain much less than large farmers from state investment in irrigation. This principle of proportionality has been increasingly challenged. At the July 1982 Workshop on Water Distribution Practices at Roorkee it was separately questioned by H V Dhamdhere, S P Malhotra, and Bharat Singh. At the November 1983 National Workshop on Irrigation Scheduling at WALMI, Aurangabad, S N Lele (1984) asked whether the scarce water owned by society would not be allocated in slabs, with very small land holders getting proportionally higher water allocations with respect to their holding and major land holders getting smaller quotas. In one case, on the West Banas Project in Rajasthan, it has been reported that the amount of water supplied to each farmer is only enough to irrigate 5 acres (Bottrall, 1981 : citing Charan n d), but this arrangement is exceptional. Yet wide adoption of this principle where water is scarce could lead to much more equitable and more livelihood-intensive use of water.

(*iii*) *Land rights reform*

In theory, the lower land ceilings for irrigated land release land for distribution when new irrigation comes to an area. In practice, evasions of this provision are common. This does not mean,

however, that the lower ceilings are useless. The existence of rules to benefit the very poor can help them, even if the provision is partly or largely subverted by the less poor.

An example can illustrate the difficulties. In Wangala, an irrigated village in Karnataka, Scheduled Castes had a right to purchase newly irrigated land at a low price. Malla, who belonged to a Scheduled Caste, was advanced Rs 1,000 by his Peasant Master to buy 1¼ acres, worth over Rs 4,000 at market rates. The Peasant master took 1 acre, for the Rs 1,000, but Malla got ¼ acre of wetland for no cost. Others gained from similar arran ements. Scarlett Epstein concludes that 'In their eyes these land deals enable them to raise their heads once more, though they do not know for how long' (Epstein, 1973). The Peasant Master gained disproportionately, but Malla did get something towards a better livelihood. Renewed programmes to enforce land ceilings when irrigation comes to an area even if partly subverted, can thus do something to improve the livelihoods of the land-poor.

Livelihood-intensity in Small-Scale Irrigation

As in canal irrigation, livelihood-intensity in small-scale irrigation can be enhanced through employment for labourers, and production by marginal and small farmers. These effects can result from

—increasing irrigation intensity

—increasing the amount and reliability of water sold to marginal and small farmers

—reducing the cost of water sales to marginal and small farmers

—enabling the land-poor to lift their own water

—enabling the land-poor to combine and share water

—allocating water rights to people rather than land

These in turn lead to benefits in total income, in reliability of income, in spread of income flows round the year filling in dead periods, in security against impoverishment including land sales,

in reduced out-migration, in more in-migration, and in improved quality of life.

Many measures can increase the livelihood-intensity of small-scale irrigation, both gravity and lift, but seven will be mentioned here. The first two—better power supply; and improved pumping efficiency—are well-known and important for the scale of their potential. The others 'saturation'; tariffs and spacing policies; small scale lift technology; small irrigator organization; and water rights to people—are less well recognised and vary in the potential scale of their impact.

(*i*) *Power supply*

The link between power supply in rabi and summer, and employment and incomes is close. Rabi and summer irrigation have special-significance to the land-poor because of the heavy costs of a dead season, or of unreliable electricity supplies which limit irrigated area and hence employment.[2] A good power supply to areas with pumpsets and groundwater in second and third seasons can be very livelihood-intensive for the poor.

(*ii*) *Pumping efficiency*

The low efficiency of many pumpsets is well known. In three blocks in Allahabad District, the average efficiency of electric motor installations was found to be 27 per cent, and of diesel engines 9 per cent, compared to the 50 per cent normally assumed (Saxena *et al*, 1983 : 403,407). In Punjab a similar study of electric pumpsets found efficiencies between 26 and 58 per cent (Khepar *et al*, 1983 : 412). Apart from the major gains from proper matching of prime movers, pumps, well design and lift height, the authors report potential for increased efficiency through very small expenditures, for example, replacing elbows with bends : the Punjab study concluded that efficiency could be improved by about 14 per cent

2 An anecdote makes the point. In a Tamil Nadu village, Harijan women were asked how they liked the electricity which a Government Programme had Installed in their huts. They replied vociferously not about this domestic supply, but about the unreliable supplies to their employers' pumpsets which limited their work and income.

with expenditures of only Rs 30 to Rs 100 per tubewell (*ibid* : 418). Especially where power is limiting to area irrigated, the direct employment and livelihood effects of a 14 per cent increase in pumping efficiency for all tubewells would be very large indeed. It has been estimated (Sanghal, 1983) that if an average private tubewell in U P pumps water for 5 hectares, 2 of these hectares usually belong to adjoining farmers to whom water is sold. At the margin, a much higher proportion of the extra water pumped with improved efficiency would be sold, to the benefit of neighbours who are likely to be poorer. The Institute of Cooperative Management, Ahmedabad has effected improvements to 1600 electric pumpsets and installations reducing power consumption by 20-50 per cent (Shah, 1985). An advisory service, where one does not exist, to enable and encourage farmers to make minor investments to improve efficiency, would appear likely to pay off handsomely in improved livelihoods especially for water purchasers.

The livelihood-intensity of improved power supply and of technical advice can be expected to vary by region. In well developed areas like Punjab and Haryana with higher levels of mechanization and other economies of scale, the net livelihood effects might be less than in, say, eastern U P and Bihar. There, higher intensities of irrigation would deter migration by providing more employment in rabi where poor people are. This, however, might be for lower wages. The issues are important but not simple. The questions raised here by livelihood-thinking could be answered by empirical research.

(*iii*) *'Saturation'*

With 'saturation' livelihood-intensity is sought by fully developing the potential of an aquifer, and thus generating a favourable buyers' market for water. With a saturation strategy, areas with good groundwater recharge, such as parts of Gonda District, else where in eastern U P, and North Bihar would be, as some already are, 'saturated' with tubes and pumpsets so that overcapacity prevails. In such conditions, especially if land is flat and has not been consolidated, the same small farmer may be both seller of water on one plot, and buyer on another, and may also have a

choice of whom to buy water from. Prices for water will be low, and access good for marginal and small farmers (Chambers and Joshi, 1983).

(*iv*) *Tariffs, spacing and water markets*

In an important paper, Shah (1985) has analyzed water markets in different states.[3] In 1983 and 1984, groundwater sale prices in Punjab, Haryana and UP were generally in the range of Rs 4—Rs 8 per hour. In the same period in parts of Gujarat water from 5 to 7.5 H P pumpsets cost between Rs 15 and Rs 20 per hour, or roughly three times as much. Shah attributes the differences to various factors, including competition from public tubewells which keep prices down in Punjab, Haryana and U P but he most emphasizes well spacing and tariff policy. Well spacing in Gujarat gives those who first instal wells localized monopolies for water sale : where geologically feasible, easing the regulations would weaken these monopolies. More significantly, Shah argues that the fixed tariff per horsepower per year in North India makes the marginal cost of pumping water close to zero, encouraging farmers to sell cheaply, whereas, the pro rata charging system of Gujarat means that the water has a cost to the seller, and requires and encourages higher prices.

Shah recommends adoption of the fixed tariff in Gujarat. His analysis indicates that protecting the Gujarat Electricity Board's profits from its sale of power to agriculture denies the resource-poor farmers of Gujarat the opportunity to increase their incomes by several times as much as GEB's profits. He emphasizes that the buyers of water are mainly the resource-poor. In other words, the fixed tariff policy is livelihood-intensive.

(*v*) *Small-scale lift technology*

There is a power gap between lift by human and animal power at the low end, and 5 HP diesel and electric pumpsets at the high end. (3HP pumpsets are on the market but at prices so close to 5 HP

3 This brief summary cannot do justice to the paper, which is carefully argued in detail.

pumpsets that the latter are often preferable even where they involve installing overcapacity). For U P, Sanghal (1983) has estimated that a 5 H P pumpset irrigates on average a gross total of 5 hectares in kharif and rabi. However, in UP over 80 per cent of operational holdings are less than 2 hectares. For millions of these small and marginal farmers there is no scale of technology on the market which fits their land size.

If a technology could be found or devised which was cheap, robust, efficient, and appropriate for the scale of operation of small and marginal farmers; it would have positive livelihood effects by enabling more small and marginal farmers to become self-sufficient on their land, and by reducing their vulnerability to impoverishment through having to sell land.

This last effect has been significant in Bangladesh. Where handpumps for irrigation have provided a 'safety net' for the marginally landed (Howes, 1985). This has counteracted their vulnerability to having to sell land and become landless, and this in turn has benefitted those already landless by restraining competition for casual agricultural work. In most of India, a higher horsepower than human lift would seem best, perhaps in the range of $\frac{1}{2}$ to $2\frac{1}{2}$ horsepower. Such a scale of technology would fit very well in the IRDP.

(*vi*) *Organization for water sharing*

With larger scale lift technology, livelihood-intensity for resource-poor farmers can be achieved through organization for water sharing. One example is groups in Vaishali, Muzaffarpur and Deoria Districts (Pant, 1984, Pant and Pai, 1984). In Deoria District, Niranjan Pant reports success in involving small and marginal farmers and the weaker sections. Compared with Vaishali and Muzaffarpur, groups in Deoria are smaller (an average of 8 compared with 16), and pumpsets smaller, and command areas also smaller (11 acres compared with 16). Another example is the Gram Gaurav Pratisthan in Purandhar Tehsil of Pune District where the system of Pani Panchayats around single lift irrigation pumps allocates water equitably to members who, being those who have

not been able to afford pumps themselves, are almost by definition the resource-poor.

Organisation for water-sharing faces problems of scale. It can be very livelihood-intensive, but it also requires careful and sensitive nurturing. It is not clear how widely and rapidly replicable such approaches are.

(*vii*) *Water rights to people*

Groundwater and small surface water on common land are common property resources, access to which in practice usually depends on land ownership and the ability to appropriate the water, for example by sinking wells and lifting the water. Those who are better off thus appropriate what in principle belongs to all. But water rights can be variously allocated, retained, and consolidated so that they are enjoyed by the land-poor. Three well known examples will be cited briefly.

The Sukhomajri, Harijan Nadah, and Nadah villages near Chandigarh have adopted and implemented the principle of equal rights to water in small surface reservoirs on the part of all village households, including the landless. The principle, known as haqbandi (Malhotra, 1982), has evolved and survived for some five years, and enables the landless to gain either by sharing cropping in with their water, or selling it or otherwise trading or giving it for goodwill or other benefits.[4]

The Gram Gourav Pratisthan in Purandhar Tehsil, Pune District has assisted in the formation of Pani Panchayats in which rights to water are proportional to the number of members in the family for whom the basic subscription has been paid, at the rate of ½ acre irrigated per family member up to a theoretical ceiling of 2½ acres per family. The rights are normally subject to the family having land within the command to which the irrigation water

4 For published sources see Misra *et al*, 1980; Franda, 1981; Grewal *et al*, 1911; Seckler and Joshi, 1982; Malhotra 1982 : and SPWD, 1984. There is also a large ephemeral literature. A book should be written, preferably by the villagers.

can be applied, but there is also provision for the landless to share water, enabling them to become sharecroppers to those with land. In this water-scarce area, water is pumped up from percolation tanks, dam reservoirs, or wells in nallahs. Larger farmers had already installed pumps in some places for the cultivation of sugarcane but sugarcane is prohibited for Pani Panchayat members because it takes too much water.[5]

In Bangladesh, considerable experience has now been gained with the organization of landless groups with pumps who sell water and sometimes their labour as well to farmers. The pumps are either low lift to take water from canals and standing water, or for shallow tubewells. Begun by PROSHIKA, the approach has been replicated by two other voluntary agencies, the Bangladesh Rural Advancement Committee and the Grameen Bank—and by a Government agency, the Bangladesh Rural Development Board, which has implemented a pilot programme. By mid 1985 the PROSHIKA groups alone numbered 170. Considering the many difficulties faced, the programme has been remarkably successful.[6]

In all three of these cases, a higher proportion of the value added by the water is commanded by the land-poor than if they lacked water rights. In Sukhomajri, those who sharecrop with their water get a better deal than if they were normal sharecroppers without water. In the Pani Panchayats, the members are irrigating for themselves instead of working for others. In the landless irrigation programme, participants often gain doubly—from sale of the water, and from the linked sale of their labour. In all three cases, thus, the use of water is livelihood-intensive compared with alternatives. If sukhomajri villages allowed only those with land to take water, the land-poor would have lost out instead of gaining command over the resource and consequent income and production If the Pani Panchayats had not been set up, the very scarce remaining water would have continued to the appropriated by larger farmers growing sugarcane, generating less employment and

---

5 For published sources see Morehouse, 1981 and GGP, 1983.

6 See Wood, 1912, 1984, and 1985.

incomes per unit water for the land-poor. Without the landless irrigation programme in Bangladesh, its members would have remained desperately poor and dependent, and would have impoverished others of the very poor by competing for other work and income opportunities.

The principle of water rights to people has thus been put into operation. The big question is whether voluntary agencies or government organizations are able effectively to spread the principle in practice wide and fast enough to have a nationally significant impact. To the extent that they can, and the organizations and rights endure, the water appropriated will have a much higher livelihood-intensity than if 'normal' development had taken place. The opportunity is, however, once-for-all, and must be seized at the right time or it will be too late.

Implications

The livelihood approach to irrigation has many implications for analysis, for research, and for policy. Some of the more obvious and important can be listed.

(*i*) *For analysis*

Adequate and secure livelihoods are a criterion for use in social and economic analysis. The definition of poverty and poverty lines in terms of average income is statistically convenient but captures only part of what poor people want and need. Reliability of income is important. Assets also matter : a person with a lower income but the security of reserves of assets may be better off than a person with a higher income but nothing to fall back on to deal with contingencies. Again, a year-round spread of income-earning opportunities matters to poor people, but is not directly captured by an annually averaged poverty line : the value to poor people of irrigation-intensity which fills a dead season can be out of proportion to the income earned, preventing as it may do indebtedness and impoverishment.

The implication is that anlysis of benefits from irrigation (as from other projects) should give prominence to livelihoods. The fact that

quantification is difficult makes the concept of livelihoods inconvenient for professionals but this should not deter thinking in livelihood terms. Analytical methods are needed for notional estimates of livelihood effects as an input into irrigation planning. Pending such methods, an agenda of questions generated by livelihood thinking can be applied to project appraisal design and operation in canal irrigation, and to policy and practice with small-scale irrigation.

These questions include:

—size and stability of incomes of the land-poor and resource-poor farmers

—spread of income throughout the year

—safety nets against impoverishment

—migration

—different effects on women and men

(*ii*) *For research*

Research on the impact of irrigation has been biased to certain rather obvious forms of counting. A short list of relatively neglected topics is the effects of irrigation on :

- wages
- male-female wage differentials
- the social relations of employment
- vulnerability to impoverishment
- out-migration—seasonal, semi-permanent, and permanent
- in-migration—seasonal, semi-permanent, and permanent
- livelihoods in areas to which out-migrants no longer go, and from which in-migrants come
- distribution between classes of the value added by irrigation under different conditions

- the quality of life of women, including dowry effects

With canal irrigation, there are many subjects of importance, including methods, experience and net livelihood effects of

- higher intensities on smaller areas compared with lower intensities on larger areas
- water distribution reform
- water rights reform, especially a study of West Banas Project in Rajasthan
- land rights reform, especially social anthropological-style studies of whether, how, and how much poorer people gain from the lower ceilings on irrigated land.

With small-scale irrigation, topics for research might include

- micro-studies of the livelihood effects of power supplies and pumping efficiencies
- studies of the implementation, effects and scope for 'saturation' approaches
- further investigation in different environments of the operation of water markets, factors affecting them, and effects of tariff and spacing policies
- assessments of the market for small-scale lift technology
- studies and comparative analysis of water-sharing, methods of implementation, and the physical and social scope for replication
- monitoring, evaluation and studies of the spread of approaches which allocate water to people not land.

(iii) For policy and practice

The many implications for policy and practice of a livelihood approach to irrigation include:

- reform of water distribution on canal irrigation
- implementation of land ceiling regulations to increase benefits to the poor

- on new canal irrigation, allocating water from the start on a sliding scale or with a land ceiling above which there would be no additional water entitlement, to benefit smaller farmers.
- improving power supplies, especially in areas with concentrated poverty and at times of the year when labourers lack work
- advisory services for increasing pumping efficiencies
- camps (for credit, technical advice, and installations) for a selective policy of 'saturation'
- review of tariff and spacing policies to increase, improve and lower the cost of water sales
- R and D to develop cheap, robust and efficient lift technology in the ½—2½ HP range[7]
- promotion by voluntary and government agencies of organisation for water sharing
- extension and further development by voluntary and Government agencies of small-scale irrigation which allocates water rights to people, including the Sukhomajri, Pani Panchayat, and landless irrigation groups approaches

One major question raised by the livelihood approach concerns regional policies. The net livelihood effect of a quantum of higher production in, say Punjab or Haryana may be much less than in eastern UP or Bihar.[8] The case for concentrating irrigation development where poor people are and where irrigation potential is easy to tap is strong, and points especially to groundwater in the lower Gangetic basin.

Long check lists tend towards overinclusive speculation. This list could, however, be ranked for implementability and estimated net

7 Two possibilities are battery-powered electric pumpsets, where the batteries would be charged mainly at night (which is when much electricity reaches rural areas anyway) and producer gas generating electricity for decentralized supply to small pumpsets (Joshi *et al*, 1983).

8 Obviously many factors are involved and the issues are not simple.

APPENDIX

Expected Effects of Interventions in Small-Scale Irrigation

Effects	Better power supply	More efficient pumping	"Saturation"	Power Tariff policy	Action Small-scale pumpsets for small producers	Small producers share a water source	Water rights to people not land
Increasing gross irrigated area	×××	××	×	×	×	×	×
And intensity	××	×	×	×	×	×	×
More water sold more reliably	×	×	××	××	—	—	×
More water at lower costs to water purchasers	×	×	××	×××	—	—	—
More work for casual labour	××	××	×	×	—	×	—
Small landowners less vulnerable to having to sell land	×	×	×	×	×××	××	×
Land-Poor gain better access to water	×	×	××	×××	×××	×××	×××

×××=major impact
××=medium impact
×=low but still significant impact
—=nil or slight impact

Comparisons are vertical, in relative significance, not horizontal in terms of total potential impact

livelihood effects. Those policies and practices which then headed the list would deserve the most serious consideration.

Conclusion

This paper has argued for a shift from production thinking to livelihood thinking with irrigation, and has applied this to analysis research and policy. Livelihood thinking implies a mental paradigm shift which some, especially statisticians and economists, may find difficult. Irrigation engineers are already moving fast from thinking about construction, maintenance and water conveyance, to thinking about production. For them it may be easier to keep moving and see livelihoods as the outcome of their work. By unbiased field visits and open-ended interviews they can appreciate the enormous difference made to landless labourers by a secure second or third irrigation season, or the indirect effects of good irrigation like enabling more girls to go to school.

With improvements to existing canal irrigation, and improvements and expansion of small-scale irrigation, the livelihood potential of irrigation is vast. The impact of irrigation in any one place can be dramatically greater than that of, say, the IRDP. On part of the Bhima Project, for example, total income from the sale of agricultural produce was three times higher three years after irrigation had been introduced (IFAD, 1984). Few approaches to rural development can match such dramatic transformations. As a weapon against poverty, irrigation has been undersold. In those areas where it is feasible and economic, well-implemented irrigation development is probably the single most promising direct means of reducing rural deprivation.

REFERENCES

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, B 1981. Water resource development and rural women. Mimeo, Ford Foundation, 55 Lodi Estate, New Delhi-110 003.

Bottrall, A F 1981. Comparative study of the management and organization of irrigation projects. World Bank Staff Working Paper No 458, World Bank, 1818 H Street N W, Washington D C 20433.

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

Chambers Robert 1985, Putting 'last' thinking first : a professional revolution. *Third World Affairs 1985*, Third World Foundation of Social and Economic Studies, London, pp 78-94.

Chambers, Robert 1986. Canal irrigation at Night. *Irrigation and Drainage Systems*, Vol 1, No 1.

Chambers, Robert and Harriss John 1977. Comparing Twelve South Indian Villages, in *Green Revolution? Technology and Change in Rice-Growing Areas of Tamil Nadu and Sri Lanka*, ed B H Farmer. (London : Macmillan), pp 301-322.

Chambers, Robert and Deep Joshi 1983. Notes, Reflections, and Proposals on Groundwater Development Following a Visit to Gonda District. Eastern U P Ford Foundation, 55 Lodi Estate, New Delhi-110 003, March 9.

Charan, A S, n d, Investment in irrigation projects and its impact on pattern of income distribution—A case study of the West Banas project in Rajasthan Mimeo.

Dozina, G Jr Kikuchi K and Hayami, Y 1978. Mobilizing resources for irrigation development: a communal system in Central Luzon, Philippines; in *Irrigation Policy and Management in Southeast Asia*, International Rice Research Institute, Los Banos, Laguna, Philippines, pp 135-142.

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

Franda, Marcus 1981. *Conservation, Water and Human Development at Sukhomajri*, American Universities Field Staff Reports 1981, No 13, Asia P O Box 150, Hanover NH 03755.

G G P 1983. *Pani Panchayat (Dividing Line between Poperty and Prosperity)*, Gram Gourav Pratisthan, Purandhar Tehsil, Pune District, Maharashtra, November.

Ghosh, M G 1984. Impact of irrigation on income and empioyment—A case study in a Bengal village; in *Indian Journal of Agricultural Economics*, Vol 39, No 3, July-August, p 549.

Ghosh, M G 1985. Impact of new technology on income and employment —A study in a Bengal village. Agro-Economic Research Centre, Visva-Bharati, Santiniketan.

Grewal, S S, Misra, P R and Kehar Singh 1981. Integrated development of a small farm in Siwalik Foot Hills—A success story; in *Indian Farming* June, pp 21-25.

Groenfeldt, D 1984. Change, persistence, and the impact of irrigation : A controlled comparison of two northwest Indian villages, Ph D thesis, University of Arizona.

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, Rome, April.

IFPRI, 1985. *IFPRI Report 1984*, International Food Policy Research Institute, 1776 Massachusetts Avenuc NW. Washington D C 20036.

IWRS, 1984. *National Seminar on Ground Water Development—A Perspective for Year 2000 A D*, Proc Indian Water Resources Soc and Water Resources Dev Trng Center, Vol I, University of Roorkee, Roorkee 247-667.

Joshi, Deep, Seckler David and Jain, B C 1983. Social forestry wood gasifiers and irrigation : A synergistic relationship; in *Ford Foundation Delhi Discussion Paper Series No 3*, Ford Foundation, 55 Lodi Estate, New Delhi 110 003.

Khepar, D D, Kaushal, M P, Thaman S K and Gurcharan Singh 1984. Efficiency studies on electric pumping sets in Punjab; in Proc IWRS *National Seminar on Ground Water Development*, pp 411-418.

Lele, S N 1984. Question to H V Dhamdhere and V S Pahdye in Water and Land Management Institute, Aurangabad, Maharashtra *Discussion on popers presented at National Workshop on Irrigation Scheduling*, Nov 12-13, 1983, p 10.

Malhotra, S P 1982. *The Warabandi system and its infrastructure*, Central Board of Irrigation and Power, Publication No 157, April.

Mehra, S 1976. Some aspects of labour use in Indian agriculture; in *Indian Jou of Agril Economics*,

Mishra, P R, Grewal, S S, Mittal, S P and Agnihotri, Y 1980. Operational research project on watershed development for sediment drought and flood control : Sukhomajri. Central Soil and Water Conservation Research and Training Institute, Research Centre, Chandigarh.

Moore, M P, Abeyratne, F, Amarakoon, R and Farrington, J, 1983. Space and the generation of socio-economic inequality on Sri Lanka's irrigation schemes; in *Marga*, Vol 7, No 1, pp 1-32.

Morehouse, Ward, 1981. Defying gravity: technology and social in *Development Forum*, UN, Geneva, September.

Pant, Niranjan 1984b. Community tubewell : An organisational alternative to small farmers' irrigation; in *Economic and Political Weekly, Review of Agriculture*, June, pp A-59-A-66.

Pant, Niranjan and Rai, R P 1984. *Group Tubewell : an organisational alternative to very small farmers irrigation in East Gangetic Plains, (A Report)*, Giri Institute of Development Studies, B-42, Nirala Nagar, Lucknow-226 007, June.

Patel, A S and Patel Haribhai, F 1984. Economic impact and efficiency of water use—A study of Dantiwada Canal Irrigation Project in Gujarat; in *Indian Jou of Agril Economics*, Vol 39, No 3, p 538.

Sanghal, S P 1983. Economics of irrigation by ground water sources in alluvial formations with special reference to Uttar Pradesh; in IWRS *National Seminar on Ground Water Development* pp 419-427.

Saxena, V N, Chowdhary, M K and Verma, O P 1983. Pump efficiency of existing installations in Newada, Mooratganj of Sirathu-Block, District Allahabad—A case study; in IWRS *National Seminar on Ground Water Development*, pp 403-409.

Seckler, D and Joshi, Deep 1982. Sukhomajri ; water management in India. *The Bulletin of the Atomic Scientists*, 38, 3, March, pp 26-30.

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.

Shah, Tushaar 1985 Transforming ground water markets in to powerful instruments of small farmer development : Lessons from the Punjab, Uttar Pradesh, and Gujarat, ODI, *Irrigation Management Network Paper*, 11d, Overseas Development Institute, 10 Percy Street, London WIP OJB, May.

Silliman, Jael and Lenton, Roberto 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.

Sinha, Basawan 1983. Water resources management in India : Problems and perspectives, typescript, Environment and Policy Institute, East-West Center, Honolulu, Hawaii, September 27.

Small, Leslie E 1983. *Irrigation and human welfare : A workshop report*, International Agricultural and Food Program, Cook College, Rutgers University, New Brunswick, New Jersey.

SPWD, 1984. *Hill resource development and community management : Lessons learnt on micro-watershed management from the cases of Sukhomajri and Dasholi Gram Swarajya Mandal*, Society for the Promotion of Wastelands Development, 11-A Vishnu Digamber Marg, New Delhi-110002.

Wood Geoffrey, D 1982. *The socialization of minor irrigation in Bangladesh*, PROSHIKA, Dhaka, November, 64 pages.

Wood Geoffrey, D 1984. Provision of irrigation services by the landless—An approach to Agrarian Reform in Bangladesh; in *Agricultural Administration* 17, pp 55-80.

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.

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, NY May.