IRRIGATION MANAGEMENT:

PRIORITIES FOR RESEARCH AND ACTION IN THE 1980s

Robert Chambers

Institute of Development Studies
University of Sussex
Brighton
BN1 9RE

29 October 1979

Contents

This paper[1] is concerned with the management of large, medium and community-level surface flow systems of irrigation, with the main attention directed to large and medium systems. The issues concern all those, of whatever discipline, who are engaged in trying to improve irrigation systems. They are as relevant to engineers and agricultural scientists as they are to social scientists, all of whom should feel that this is their subject. For part of the argument is that major opportunities in irrigation are not exploited simply because we limit ourselves to our traditional disciplinary domains; and management belongs to everyone.

---

1. For comments on the version delivered at the IRRI Irrigation Managment Workshop, 26-30 March 1979, I am grateful to participants at that workshop; and for comments on a later version, to Robert Wade. Responsibility for the views expressed, and errors and omissions, is of course mine alone.

Values and criteria

A first step is to be clear about objectives and values. The values which underlie this paper are conventional enough in being concerned with the reduction and elimination of rural poverty on a permanent basis. The relevance and potential benefits of irrigation hardly need spelling out - in increasing food production especially with the new technologies; in stabilising flows of food and income; in spreading food and income flows more evenly round the year, reducing seasonal shortages and stress; in slowing, arresting and reversing processes of impoverishment; and where there is population pressure, in supporting and retaining rural populations and reducing rural to urban migration. In seeking to enhance this relevance the approach in this paper is utilitarian. Research should be useful in achieving benefits for poorer people. It is true that pursuing exciting ideas, chasing serendipity, exploring intriguing comparisons, and testing and developing theory may produce useful insights. But my plea is for a search for analysis, understanding and ideas in areas which look likely to lead to practical applications; and this directs attention especially to those dark areas about which we know rather little and where the chances of breakthroughs may be greatest.

The objective of seeking breakthroughs which may contribute to the reduction and elimination of poverty affects the way one approaches irrigation and thinks about it. A major obstacle, difficult to reverse, is the intellectual conditioning imparted by professional training. Irrigation is *par excellence* a subject involving many disciplines. It is a difficult subject because of the nature and interactions of water, physical irrigation systems, seasons and climate, agriculture, bureaucracy, communities and cultivators. Moreover, many of the important elements in any comprehensive study of irrigation are difficult to measure. Professionals then take refuge in simplification by narrowing vision, by diligently plodding down a disciplinary rut, by measuring the measurable and neglecting the rest. One common symptom is to talk of a single objective. Thus, for example, we have

> "The main objective of management is to ensure a proper return on investment" (Swann 1975:1)

and

> "The purpose of irrigation is to create and maintain the optimum moisture regime for plant growth and in particular to maximise production of that part of the plant which is the harvestable product" (Willens 1975:1)

It is unfair to quote such sentences out of context, and it is most unlikely that either author would wish to claim exclusiveness for his criterion. But the fact remains that for whatever reasons - whether disciplinary specialisation, personal values, organisational obligations, or sheer preference for closure on a single manageable and measureable concept, single criteria are adopted in speech, writing and thought, and mislead if they obscure or eliminate other and wider criteria and the true complexity of judgement and choice.

In practice we are faced with multiple criteria for assessing what constitutes improvement in an irrigation system. To suggest what those criteria should be is hazardous but necessary. My own preference for criteria which can be used to interpret the main poverty-reducing objective in relation to irrigation in Asia are the following. They are disparate, but all can be applied to water use, to institutions, to other elements in an irrigation system, and to choices between alternative directions in research and action. The first two criteria are now a commonplace; the third is unlikely to be contentious; and the last two are more environment-specific and more debatable.

(i) productivity, meaning the ratio of production or of some measure of economic value of production, to scarce resources used or consumed. We may thus have the productivity of labour, of land, of other scarce resources, or of an irrigation system as a whole. For thinking about priorities in research on irrigation, the most useful gauge is often the productivity of water.

(ii) equity, referring to a fairer rather than a less fair distribution of resources and livelihoods. In its most common usage it refers to the equitable distribution of water to cultivators, but in a wider sense it includes opportunities for secondary and tertiary employment generated by irrigation.

(iii) stability, referring to the capacity for long-term sustained irrigation without environmental depletion, deterioration, or loss of productivity. It refers particularly to avoiding salinity, silting, waterlogging, weed and pest infestation, erosion, or groundwater depletion.

(iv) population-support. In many environments it is critical to support larger numbers of people at adequate levels of living all round the year. Where water is scarce, this leads to thinking about water in terms of the livelihood-intensity of its alternative uses. This may include the smoothing of seasonal troughs in food and income flows, and continuity of work, employment and production around the year. These seasonal aspects are especially significant from the point of view of reducing poverty (Chambers et al. 1979).

(v) Convenience of water supply. "Convenience" conflates several criteria that apply from irrigators' points of view about water supplies. Different authors use different words for different purposes in different contexts. Some examples are "reliability" including a reduction of uncertainties surrounding water supply (Harriss 1977:375), "predictability" and "appropriateness" (Wade 1975a:303), and "predictability", "certainty" and "controllability" (Reidinger 1974:81). It may be useful to think of convenience as combining predictability and appropriateness, where predictability of water delivery includes both reliability (low risk of failure) and certainty (knowledge of the planned delivery and of the low risk of failure); and where appropriateness of the water delivered includes quantity, place of delivery, timeliness and controllability.

These five criteria are more useful as a checklist than as a set of measures to be quantified. Their main potential may be as an aid to judgement in cost-effective thinking about priorities.

Research biases

The next stage in identifying priorities for research and action is to ask what in practice determines choices of research subject in irrigation, especially, but not only, in the social sciences. To do this we have to make ourselves vulnerable to introspection. There may be many reasons why people choose to work on irrigation. At a deep level, a psychologist might speculate connections with early childhood conditioning. At a less impenetrable level, some of the factors which determine choices are:

-geographical accessibility. But the poorer people are often remoter from urban centres and tarmac roads, and tailends on large irrigation systems are sometimes (as for example often in the Dry Zone in Sri Lanka) generally less accessible than the top ends.

- prominent project bias. Research concentrates on projects and programmes which are internationally visible. The Mwea Irrigation Settlement in Kenya and the Muda Project in Malaysia are two examples.

- design and construction bias. There is a marked tendency to study and concentrate on the earlier stages of irrigation development rather than the later. The design and construction states of medium and large projects exercise an almost hypnotic attraction to the neglect of subsequent operation and maintenance.

- quantification bias. The desire to measure, and hence the tendency to study, what can be measured and to neglect what cannot.

- researchability bias. The tendency to pick topics which can be researched with reasonable certainty that a tidy and respectable paper will be the outcome, preferably publishable in an international journal. This applies also to the choice of subjects for post-graduate theses, where responsible and experienced supervisors may guide students towards subjects which are sufficiently researchable, using conventional methods, for there to be a good chance of a safe degree without too much supervision.

- paradigm bias. The tendency to do further research on topics which have already been researched. The existence of a literature attracts attention and provides a springboard, some scope for comparison, some security, and an agenda of questions. A provocative book or article (for example Wittfogel's Oriental Despotism) may so stimulate or enrage that many researchers set out to test and refute it.

- diplomatic bias. Myrdal, in Asian Drama (1968 : 15-16; 939), decried that harmful effects of the diplomacy of research. Research in Third World countries, as elsewhere, sometimes concentrates on issues which are not sensitive, neglecting informal sanctions and rewards, and political activity. But these are often critical to understanding and prescription. The bias is self-reinforcing: when these aspects are omitted in writing, later researchers neglect them not only for diplomatic reasons, but out of ignorance. With irrigation, Bottrall (1978 : 45) has recently stressed how the sensitivity of some issues leads to their neglect. Some of the most significant papers, dealing with the real world of irrigation management, are stamped NOT FOR QUOTATION. Often what is not to quoted is the revelation that unofficial pressures, rewards and sanctions induce officials to supply irrigation water out of turn, or to ignore infringements, or to favour one group at the cost of another. When such behaviour is mentioned, it is usually in general terms. Thus de los Reyes (1978 : 196):

> "The ... water rotation scheme is further affected by pressure placed by influential persons on the irrigation

officials, or imposed by existing or newly developed social relations between farmers and irrigation officials, or between farmers and water tenders"

The observation is significant and applies to irrigation officials in many places in many countries.

- professional and disciplinary biases. Perhaps the most powerful biases derive from professions and disciplines. Each is programmed to focus on certain issues.

"Hydrologists concern themselves with, for example, the water cycle and the movement of water from one form or location to another. Engineers concentrate on the design and construction of works, using their mathematical skills to calculate stresses, capacities, flows and the like. Soil scientists may try to measure percolation rates in different soils with different water applications. Agronomists investigate crop water requirements. Sociologists study the micro-level village community, the allocation and appropriation of water, the origins and resolution of conflicts. Economists try to calculate the costs and benefits of alternative ways of obtaining or using water, and argue about pricing policies. Medical men estimate levels of pollution, contamination and infection. Each profession and each discipline is pointed towards certain aspects of irrigation such as these, and is programmed with relevant research skills. Moreover, professional prestige and advancement are achieved through work which is highly regarded by fellow professionals. Research tends to use conventional methods

> and, in Thomas Kuhn's terms (Kuhn : 1962) to be designed to refine existing paradigms. Is it sometimes, or even generally, true that research priorities are generated less by the situation of rural people than by the preoccupations of professionals?" (Chambers 1978 : 390).

Professional and disciplinary biases, combined with others, impel research in certain directions. Within any one discipline, research may become inbred. An existing literature focuses attention on certain issues. Subsequent mutual citation reinforces the tendency. Papers and journal articles take off into self-sustaining growth. In the social sciences concerned with irrigation, examples can be found both in economics, and in sociology and social anthropology.

The fascination of economists with water pricing has generated a substantial literature on the subject. There are only six sections in the Bibliography on Socio-Economic Aspects of Irrigation in Asia (IRRI and ADC, 1976), but one whole section is devoted to this single topic of water rates. Perhaps this is not surprising: water pricing is something economists can do familiar types of sums about: it lends itself to the exercise of the skills with which their professional training has endowed them. But this concentration of effort and attention has costs. The time and energy of economists has opportunity costs; and perhaps more seriously, a myth may be generated that individual cultivators actually pay, or could be induced to pay, for the quantity of canal water they use in irrigation, when this is not the case anywhere in Asia (Levine and Wickham, 1977 : 8). For "water" rates are usually related to the area of land irrigated or intended to be irrigated and not to the amount of water supplied and used.

For their part, sociologists and social anthropologists have concentrated their attention on irrigation communities. Their studies are sometimes of great interest. A community is studiable and irrigation provides a sharp focus for exploring and comparing social organisation and its determinants. Some, like Wade's surveys of village organisation on canal systems in India, are directly relevant to policy. But others are pointed towards the disciplinary concerns of sociology and social anthropology rather than towards the objectives of irrigation development. They contribute to knowledge; the question is whether they also contribute to practice.

The clustering of research around certain subjects like these may have benefits. Sometimes there is a critical mass, a certain number of studies that have to be carried out, to enable comparative analysis to carry us to new insights. But more usually this clustering seems to narrow vision, leaving gaps: questions which are not asked; aspects and activities which are not examined; methods of research which are not adopted; and consequently opportunities missed and benefits foregone. The challenge is to see what lies in the gaps left dark by disciplinary searchlights. As with other _terra incognita_, the benefits of exploration may be high. In terms of the five criteria - productivity, equity, stability, population support, and convenience to irrigators - and through them the main objective of reducing poverty, these gaps may represent terrain where the deployment of research resources will have high pay-offs.

Neglected Potential in Irrigation Management

The greatest gap is probably system management, and especially the behaviour, motivation and management of those who manage and distribute the water. Except for the work of Bottrall (1978, 1978a, and Newsletter of the ODI Irrigation Organisation and Management Network, 1975 to present), Wade (see references), Ali (1978) and other contributors to the Commonwealth Workshop on Irrigation Management (Commonwealth Secretariat, 1978), and Moore (forthcoming) there has been little research, analysis and writing concerning the management of the bureaucracies which manage medium and large irrigation systems.[1] Though astonishing at first, this neglect can be understood in terms of the interlocking operation of the research biases listed above. At the same time, there are indications that this is an area of potential for achieving the objectives of irrigation.

Again and again, analysis of other aspects of irrigation leads towards the importance of efficient and predictable operation of the larger irrigation system. The report on a 1976 research seminar on irrigation systems in Southeast Asia cites evidence from the Philippines and the Pekalen Sampean Irrigation Project in East Java (Lazaro et al., 1977 : 6). Valera and Wickham reporting on action research in the Philippines, have written (1976 : 7):

> "In traditionally managed systems, there is little benefit to be realized from intensive on-farm development as long as the supply of water in the distribution canal is unstable and unpredictable. For example, farmers with

---

1. Many of the points made in this section have already been made by the authors cited, but responsibility for them here is mine alone.

> easy access to water have little incentive to build on-farm ditches because they already receive more than enough water. Farmers at the lower end of the system likewise cannot be expected to build ditches if the supply of water in the canal is not sufficient to supply these ditches reliably."

The same authors two years later, reporting on six years' research in the Philippines on irrigation systems ranging from 3,600 to 75,000 ha., reinforced the point:

> "...Most farmers will cooperate provided they get a dependable supply of water.... To the extent that farmers can depend on good management within the system, they can be expected to take more initiative at the farm level. The program to encourage farmers to form irrigation associations would also be enhanced by more predictable main-system management. It is very difficult, however, to convince a farmer to build a potentially useful farm ditch if he feels that there will be no water in the canal to supply the ditch when it is completed."
> (Wickham and Valera, 1978 : 74)

In similar vein, Duncan (1978) reported preliminary findings from a study of efforts to achieve greater farmer participation in the operations and maintenance of a 1,840 ha. pilot area in Thailand. He concluded that the condition that seemed most essential for full farmer participation was the adequate and timely delivery of water in the main irrigation system. He found only a modest response in farmers participating in new irrigators' groups and in following recommended irrigation schedules and practices. He wrote: "Perhaps the principal factor is undependable water delivery in main irrigation systems". Without added attention to main-system operation and maintenance, he considered it unrealistic to expect greater participation of farmers in off-farm operation and maintenance (ibid. : 191). Much earlier, in Sri Lanka, the sociologist with the UNDP appraisal mission for the Mahaweli Ganga irrigation project found at least three of his survey findings pointing at system water management as a concern, and he concluded that "It seems that the functions of the Irrigation Department need to be looked into in the colonies" (Barnabas, 1967 : 56; Chambers, 1975 : 5). But he did not look into them himself; nor did anyone else. Apart from the work of Bottrall, Wade and Moore, the furthest one is usually taken into the bureaucracy is the lowest level - the ditchtender or his equivalent, as in the studies and analyses of Coward (see references). The operation of the larger system is, in Wade's phrase, a "black box".

Let us consider the potential from improving main system management.

First, the area under command of canal irrigation is large and increasing. One estimate[1] puts the net area under bureaucratically managed canal irrigation in South Southeast Asia at 50 million ha. In its 1978-83 Five Year Plan India alone has planned to extend that by no less than eight million ha. (Government of India, 1978 : 20). On a smaller scale, but one significant nationally, Sri Lanka has embarked on accelerated implementation of the Mahaweli Project, far larger than

1. Personal communication, Alan Early. This is a very approximate and provisional estimate.

any previous irrigation undertaking in the country. With the priority attached to extending irrigated acreage by these and other national governments and by the major donors, especially the World Bank, a sustained and substantial increase can be foreseen in the areas under command of canal irrigation in South and Southeast Asia.

Second, there is gradually mounting evidence that improved management can achieve both production and equity objectives on existing systems.

At one level, this can be seen in terms of expected potentials which are not realised. It is very common for the areas actually irrigated to fall far short of those planned. An example is the Uda Walawe project in Sri Lanka. It was estimated that 81,000 acres could be developed (ADB, 1969 : 80), but in 1977/8 only 18,000 acres, less than one-quarter of the estimate, was receiving water. This was largely the result of permissive water issues at the top end; indeed, the issues had been so permissive that the top end was the only end. Even allowing for gross errors in earlier appraisals, one cannot doubt the potential at Uda Walawe both for higher production and for benefits to a much larger population of irrigators.

Elsewhere, examples have been identified of improved management which has led to benefits in production and equity. Two of these were responses to crises of water shortage which led to temporary tightening of water issues and higher production by more irrigators than would otherwise have occurred: the first was on a command of 185,000 acres in Andhra Pradesh in 1976 (Wade, 1979); the second was on the command of 13,000 acres of the Rajangana Scheme in Sri Lanka, again in 1976 (Shanmugarajah and Atukorale, 1976).

In a third example water scarcity was induced administratively. This was on the Tungabhadra High Level Canal in Andhra Pradesh (Wade, 1978). This canal had a potential cultivable irrigated area of 112,000 acres but by 1976 was irrigating only 84,000 acres or 75 per cent of that potential. Resolute administrative tightening of controls and enforcement of existing regulations in 1976 improved water supplies to the tail end and induced a large-scale switch from paddy to other crops which made more productive use of the water.

The fourth and fifth examples, both from the Philippines, are monitored experiments from which figures can be derived. The results reported are startling. In 1975, researchers from IRRI working jointly with the National Irrigation Administration introduced improvements in water distribution on Lateral C of the Peñaranda River Irrigation System, an area of about 5,700 ha. Production in the dry season of 1975 was up 97 per cent on the base year (Valera and Wickham, 1976).

In a later experiment, another team from IRRI working with the National Irrigation Administration on the Lower Talavera River Irrigation System reported increased production of about 60 per cent,[1] comparing one wet and dry season with the next wet and dry season (Early, 1979 and personal communication), in spite of serious pest attacks in the second dry season.

---

1. The significance and replicability of this figure remain to be clarified.

The scale of the potential suggested by these figures can be indicated by an order of magnitude calculation. If we make paddy a proxy for all crops grown on bureaucratically managed canal irrigation in South and Southeast Asia, then we would have a total current production of 156 million tons of paddy (50 million ha. net x cropping intensity of 1.3 x 2.4 tons/ha. per crop) or rather more than 100 million tons of rice from canal irrigation.[1] With rounding downwards, this means that for every one per cent increase in production, about one-and-a-half million tons of paddy or one million tons of rice would result; a 20 or 30 per cent overall increase - by no means impossible on the evidence so far - would mean 20 or 30 million tons of additional rice. These figures may anyway be underestimates in terms of foodgrains, since on some large Indian systems in semi-arid areas the effect of tightening water control would be a shift into crops which are more water sparing than paddy, and more productive per unit of water. One can reasonably estimate that for each per cent increase in the productivity of water, at least one million tons of (husked) foodgrain would be produced. Further, the reforms involved would have benefits in terms of equity since more water would go to the tail and the relatively deprived tailenders would do better.

In the light of these potential benefits, the neglect of the management of irrigation systems as a subject for research and for developing and testing new approaches is at first difficult to

---

1. I am grateful to Alan Early for this order oi magnitude calculation. Pending more accurate figures, it should be treated with caution, and if cited, always done so with the qualification that it is subject to substantial revision when further information is available.

comprehend. With a water revolution of such magnitude waiting in the wings, it is a puzzle why national governments, and international agencies like the World Bank which lend heavily for investment in irrigation, have not given this the highest priority. There are numerous interlocking reasons. Many of these are to be found in the research biases noted above. The professional skills of economists and engineers are consummated in the high status activities of appraisal, design and construction much more than in the less prestigious activities of operation and management. Diplomatic bias is at least as powerful an explanation. The distribution of irrigation water is the very stuff of politics. Water is money. It is then scarcely surprising that what actually happens in the distribution of irrigation water is a sensitive area. Some researchers hold off. Aid agencies prefer to ignore what really happens. A social scientist working for a consultancy firm on an appraisal for a large irrigation project has that part of his report which tackles the realities of water distribution discreetly edited out. Civil servants and politicians may not wish to recognise that there is a nettle to be grasped. In Sri Lanka, although the priority for management reform has been pointed out since 1974, there is to the best of my knowledge still (1979) no substantive research on the management of irrigation systems, although this is critical for the largest development project in the country. Yet another reason for neglect is the ease with which blame for low irrigation efficiencies can be and is projected onto farmers. Thus on irrigation in Pakistan, the authoritative World Development Report 1978 states: "Wasteful water management and poor maintenance can be blamed in large part on the hierarchy of social relationships among farmers" (para.40). A final reason for neglect is that the management of an irrigation bureaucracy falls in the natural domain of no present discipline concerned with irrigation and rural development. It is a no man's land, dead ground, perhaps a minefield. Prudent professionals cultivate their gardens more intensively and do not look over the fence. The behaviour of the staff who manage irrigation systems belongs to no one.

Research and Action Priorities

Against this background, research can be recommended on the management and potential of irrigation systems, and especially on the management and behaviour of those in irrigation bureaucracies who control and allocate water. Five related clusters of subjects appear especially important.

(i) The search for the non-zero sum

In all five cases of water reform mentioned above, less water was issued to topenders than they would have received without the reform. Topenders usually resist such changes, believing they will lose by them. Indeed, the central difficulty in all redistributive reform is the people who lose or believe they will lose, leading to the well know political difficulties and pressures which have stalled and subverted so many land reforms. The challenge here is to see to what extent the zero sum in which one man's gain is another man's loss can be avoided; or to put it more specifically, whether the supply of water to the tailend can be improved without topenders becoming worse off. To the extent that this can be achieved, reform will be very much easier to implement.

Topenders who receive less water may lose in many ways, including the following. They may be using flooding to inhibit weed growth; without enough water to keep their fields flooded they may lose yield through weeds, or be forced to substitute labour or weedicides for water. They may believe (perhaps correctly) that they get higher paddy yields with flowing water which is cooler than with standing water which is warmer. Where land is uneven, as Duncan (1978 : 190) has pointed out, farmers who flood their fields increase yields from the high parts which otherwise would not receive adequate water. Farmers with localised small areas of high seepage may also sensibly want plenty of water to prevent those areas going dry early. Farmers may have crops at different stages of growth, reaching the stages at which they are most sensitive to water stress at different times, so that they rationally desire a continuous supply of abundant water. Farmers fear the risks of not having their fields full of water: flooding is an insurance. If a field is full and being constantly replenished, then at least a number of days' supply of water is assured and risk and anxiety reduced. Abundant water also reduces interpersonal and intergroup friction compared with times of scarcity and competition. And finally, running through all these points, is the loss of yield if water is not enough.

Thinking of this list of reasons, listening to the protests of topenders about their need for water, and observing the liberal issues of water to topenders on many systems, diverts attention from the question whether there might be conditions in which farmers would prefer less water. Unless they suffer from severe flooding, topend farmers are unlikely to raise this issue. They are accustomed to liberal issues and have adapted to them. Topends are the first parts of new irrigation systems to receive water and start with regimes in which water is abundant. Tailend demand and potential scarcity only arise later as the irrigation network is extended; but by then the practices and expectations of topenders have set and they know no alternative to abundant water.

In three of the five cases cited above, howeve, topenders either may not have lost, or actually gained, from the reform. Of these three, the Tungabhadra example is complex and equivocal, while the two Philippine examples show a clearer pattern.

On the Tungabhadra, Wade reported that:

> "Discussions with farmers in several villages revealed that ... many had come to the conclusion that two ID (irrigated dry) crops would be very much preferable to a single crop of paddy, and consequently intended to switch to ID the following year regardless of how lenient or otherwise the Irrigation Department was on unauthorised paddy - so long as the Irrigation Department undertook to extend the water supply from the present closure date ... as it had promised to do" (1978 : A-11).

Interpreting this change of attitude is difficult. The farmers who favoured changing to two ID crops tended to be those who had difficulty securing adequate water for a paddy crop. These included farmers who were tailenders on distributaries which took off near the head of the main canal (Personal communication, Wade). They were thus topenders in one sense, but tailenders in another. There is also a question whether more or less water would be required for two ID crops than for one paddy crop. Even if these farmers expected to gain, there were other topenders who had been receiving water illegally, who lost because they no longer received it. Topender benefits were, thus, mixed, with some losing, and some, it seems, expecting to gain. The significance of this example is not that it permits a clear conclusion about the zero sum, but that it shows room for manoeuvre, and some farmers apparently prepared to trade off quantity of water or the growing of an accustomed crop, for other benefits.

Topender benefits in the other two cases, from the Philippines are clearer. On the PENRIS system, Valera and Wickham (1976) reported substantial increases in production in all sections of the scheme, although the increase rose sharply towards the tailend. For the four main sections, top to tail, the percentage increases (area cultivated x yield) comparing the dry season of 1975 with the dry season of 1973, were 23, 69, 154, and 1,494 per cent respectively. Topenders' main gain in the first year was from a higher area planted, and in the second year from an increase in yield. Tailenders gained from both. On the LTRIS system (Early, 1979), the changes reported at the top end were more dramatic. For the laterals which were monitored at the top, middle, and tail, a comparison of yield (tons/ha.) for the wet season of 1976 before intervention and the wet season of 1977 after intervention, gave percentage increases of 94 and 62 for two topend laterals, 16 and 10 for two middle laterals, and an average of 104 for three tailend laterals (ibid., Table 3). Yields were levelled up, having previously been highest in the middle.

In both PENRIS and LTRIS there was at first excessive water at the top; and this excess was transferred through to the tail. The situation was far from zero sum, although topenders were at first cautious towards the changes. Valera and Wickham reported for PENRIS that

> "Farmer involvement in the pilot project was carried out through the meetings and ditchtender contact informing them of the rationale behind the project, and obtaining their goodwill and cooperation. Farmers in the upper reaches of the lateral gradually came to support the new scheme once they were assured of an adequate share of water even in times of water shortage." (ibid. : 4)

The question, then, case by case, is whether topenders can indeed benefit, according to their own criteria, from management reform. One of the most significant trade-offs may be in timeliness and predictability of water supply on the one hand, and quantity on the other. In a state of near-anarchy, farmers are likely to prefer a continuous flow. In a controlled situation, they may benefit from a smaller flow in the following ways:

(i) timeliness of operations

(ii) retention of fertilizer and fertility in the soil[1]

(iii) avoiding waterlogging

(iv) greater ease of water control at the field level

(v) predictable and perhaps lower labour inputs for water control and release of time in between waterings for other activities

(vi) an additional crop if adequate water is saved and delivered

(vii) a switch to more profitable crops which use less water and which cannot be grown with flooding.

1. This point is made without adequate reference to the technical literature and may require careful modification. Levine and Wickham, for example, have written of Philippine irrigation that "There is no evidence that fertilizer nutrients move with the water from one field to the next provided the rate of flow is slow enough that soils are not carried with the water" (1977:6).

A research and action priority is, then, to assess to what extent, in what circumstances, and how, reform can be non-zero sum and thus beneficial and acceptable to topenders. This may more often be the case in areas of higher rainfall, like the Philippines, than in areas of lower rainfall, like central India. Many of the questions here will require the combined expertise of agronomists and agricultural economists to identify ways in which topender farmers might benefit, this analysis to precede any change in water issues. Wherever the zero sum can be avoided, reform should be less difficult. But it is likely that such analysis will reveal many systems in which topenders have to lose, where reform will therefore be much more difficult, and where it will require a deliberate political component if it is to succeed.

(ii) Political Engineering

If water is the stuff of politics, then the solutions to water problems must often themselves be political. Where topenders have to lose, there will be an especially strong case for "political engineering". The reform of the Tungabhadra High Level Canal cited by Wade is suggestive. Redistribution of water from topenders to tailenders was sought by an administrator and an engineer. Some topenders were to lose, notably those who had been growing paddy when their land had not been zoned for it. One enabling factor in the success of the reform appears to have been that the Minister for Local Government represented a constituency in the tailend, which could not reliably receive water if much of the upper reach was growing paddy (Wade, 1978 : A-10). This raises the question whether special political representation of tailenders' interests can offset the natural advantages which topenders enjoy through their physical position. Such representation is probably rare. This means that there may be widespread scope for political engineering through creating irrigation constituencies for a management committee to make decisions about water allocations between groups. Any such committee might include an over-representation of tail enders to offset their natural disadvantages. Crucially, a management committee might, through its decisions and representativeness, legitimate the unpopular work of staff who have to deny water to those who want it.

The research and action priority here is to identify existing cases where there are irrigation constituencies and management committees, to analyse the comparative experience, and to devise and disseminate approaches for adaptation, introduction, testing and development elsewhere.

(iii) Management: staff and procedures

The challenge here is to identify what different behaviour is needed on the part of irrigation staff and then to make it sensible for them to adopt that behaviour.

As a preliminary, a realistic understanding is required of the real world of irrigation staff. They are often behaving rationally in very difficult personal and political circumstances. These have to be understood as part of the system which is to be made to operate differently. Research is needed to enable us to know about "how irrigation officials at various levels actually make decisions, about the sort of pressures that are brought to bear on them and their response to those pressures. (And one must know, too, about what decisions they do not make and the pressures which are not brought to bear on them.)". (Wade, 1975 : 1,743)

Bottrall and Wade have shown that the real world of irrigation staff is researchable. As in bureaucracies generally, they find an informal system which does not correspond with the formal. They find variously examples of political influence, of civil servants being threatened with transfer, of unofficial augmentation of official salaries, of systematic falsification of water flow records, of care being taken not to know about infringements, of tacit connivance at a host of illicit practices. They also find (for example Wade, 1978) instances of imagination and courage on the part of civil servants who resist pressures and manage to improve production and the equity of water distribution.

In most reforms, two changes in behaviour are likely to be needed: first, resisting pressure from irrigators for more water; and second, disciplined control (in terms of timing, quantity and location) of water movements. For both of these there must be incentives which override counter-incentives. Decisions about water allocations made or endorsed by management committees representing all cultivators may legitimate action which is unpopular with some groups. In addition, a more disciplined and tightly controlled organization may often be a necessary complement. Detailed attention to procedures, as for example by Valera and Wickham (1976), Honadle (1978), and most recently Benor (Government of Andhra Pradesh, 1979), is also likely to be a significant element in any effective reform;

and experiences such as that with the pasten system of water distribution in Indonesia are likely to be relevant (Pasamdaran and Taylor, 1976). But whatever the mix, more comparative research, analysis and testing is needed to identify and develop combinations of approaches which will make it rational, on their own terms, for irrigation staff to behave in the desired manner, and especially at times to deny water to irrigators who want it. Without this, water reform can be expected to fail. Unfortunately, this is a point which many concerned with irrigation policy and practice find difficult to grasp.

(iv) Approaches to appraisal

The appraisal of existing irrigation systems is liable to follow patterns determined by disciplinary competences especially in engineering, agriculture and economics. The questions confronted may be complex and may pose serious problems of integration and solution. Even where recommendations concerning water distribution are made, they are unlikely to be effectively implemented unless the questions raised in this paper are confronted. The central problems in change are usually not technical but rather concern human behaviour. A new, more realistic approach is needed.

The analysis above provides possible points of entry for such an approach, simple at least in its initial questions, even if seeking the answers may by stages lead into more complex investigations. The search for the non-zero sum, the priority of political engineering, and the focus on staff management and operating procedures, together suggest an agenda and sequence for appraisal different from those derived from normal disciplinary approaches.

This approach would entail this sequence of questions:

(i) What water is available?

(ii) How is it in practice distributed?

(iii) How should it be distributed?

(iv) Could the change in distribution be non-zero sum for all irrigators?

(v) What combinations of water distribution, political engineering, staff management conditions, and procedures, would make it rational for staff to change the distribution as considered desirable?

If these questions were the core of an appraisal, the prescription which flowed from them might be more practical and more far-reaching than those generated by conventional approaches. At the very least, this approach, or something like it, should be tested and its potential assessed.

Conclusion: Towards a Water Revolution

Research and action in these four areas might provide the experience and the repertoire of interventions needed for management reform. But for implementation of reform, something more is required. The various ways in which many people - politicians, engineers, administrators, agronomists, sociologists, economists, and others - see and think about irrigation systems and irrigation management have to change. This means abandoning the secure territory of particular disciplines as bases for prestige and as sources of warming reassurance from peer and reference groups. It entails thinking in a non-disciplinary way, swimming, as it were, in open water. There is much empty rhetoric about multi-disciplinary work.

The reflex of adding disciplines to disciplines in teams of researchers, consultants and managers is not necessarily efficient. There are problems of communication, cf management, and of time involved in discussions. There is an even greater danger of assuming that someone else will handle the awkward questions (which very likely they will not). Scientists and engineers should not be allowed to get away with saying that something is a "people problem" and therefore not their business. Nor should economists or sociologists be allowed to get away with dismissing a defect in water distribution as a "technical problem". Scientists and engineers must come to think like social scientists, especially in terms of political economy, of who gains and who loses; and social scientists must come to think like engineers and natural scientists in terms of what is technically desirable and feasible. As Carl Widstrand (1978a: 19) has pointed out, it takes a very special kind of person, a social scientist for whom training is not yet provided, to take part in interdisciplinary work on water programmes. The same goes for technical disciplines. A priority for the 1980s is to learn how to train such professionals, and then actually to train them so that people of different disciplinary backgrounds think more like one another, and so that more interdisciplinary collaboration takes place in the same brain.

The challenge, then, is not just for research and action on irrigation systems. It is also cognitive. We are concerned with loosening, broadening and refocusing the ways in which engineers, agricultural scientists, sociologists, economists, administrators and other see irrigation and irrigation systems. For this process of loosening, broadening and refocusing to be cost-effective, we may also need new methods. No doubt something can be achieved with traditional learning approaches such as workshops, seminars and conferences. But these easily become repetitive rituals to celebrate unawareness. Perhaps it is time to make the process of learning enjoyable in new ways. Breakthroughs might be sought through individual insights gained in game situations and in role-playing, and through techniques adapted from group psychotherapy. In an irrigation game, actors might be engineers, water distribution staff, and farmers. Through playing a tailend farmer, an engineer might find scales falling from his eyes; through acting out responsibilities for water distribution, a sociologist might begin to understand the problems of an engineer. Armed with such understanding, engineers, agricultural scientists, sociologists, economists, administrators, politicians and donor agency staff might all come to appreciate better both the changes in behaviour needed and how to achieve those changes, if the multiple objectives of development are to be realised.

If the arguments of this paper are correct, it should not be beyond human insight, ingenuity and will to achieve water reforms in the 1980s. How widespread and effective those reforms would be depends initially on the speed, vigour and imagination of the research and action undertaken to explore the potential. The opportunity is to achieve both the production and poverty-reducing objectives of governments and donor agencies. The Green Revolution led to major increases in food production but the equity effects were mixed. In contrast, if the 1980s were the decade of a water revolution in South and Southeast Asia, not only would there be a quantum jump in food and crop production, but the beneficiaries would include millions of poor people who are currently deprived by their disadvantaged access to water.

References

Ali, S. Hashim. 1978. Problems in the Management of Large Irrigation Schemes. Pages 175-200 in Commonwealth Secretariat, op. cit.

ADB. 1969. Appraisal of Walawe Development Project in Ceylon. Asian Development Bank. 8 December.

ADC. 1972. Research and Training Network: A Seminar Report. No. 2. New York, August.

Andhra Pradesh, Government of. 1979. Project Report and Guidelines for Introduction of Warabandhi System in Sri Rama Sagar Project, Andhra Pradesh. Command Area Development Dept., Hyderabad. January.

Barnabas, A.P. 1967. Sociological Aspects of Mahaweli Ganga Project. FAO/Irrigation Dept. of Ceylon, Colombo.

Bottrall, Anthony. 1978. The Management and Operation of Irrigation Schemes in Less Developed Countries. In Carl Widstrand, ed., op. cit.

Bottrall, Anthony. 1978a. Technology and Management in Irrigated Agriculture. ODI Review, 2. London. pp.22-48.

Bromley, Daniel W., Donald C. Taylor and Donald E. Parker. 1977. The Economics of Water Reform: Institutional Design for Improved Water Management in the LDCs. Center for Resource Policy Studies Working Paper No. 8. School of Natural Resources, University of Wisconsin, Madison, October.

Chambers, Robert. 1975. Water Management and Paddy Production in the Dry Zone of Sri Lanka. Occasional Pub. Series No. 8. Agrarian Research and Training Institute, Colombo. January.

Chambers, Robert. 1977. On Substituting Political and Administrative Will for Foreign Exchange: the Potential for Water Management in the Dry Zone of Sri Lanka. In S.W.R. de Samarasinghe, ed., op. cit.

Chambers, Robert. 1978. Identifying Research Priorities in Water Development. Pages 389-398 in Widstrand, ed., op. cit.

Chambers, Robert, Richard Longhurst, David Bradley and Richard Feachem. 1979. Seasonal Dimensions to Rural Poverty: Analysis and Policy Implications. IDS Discussion Paper 142. Institute of Development Studies, University of Sussex. February.

Commonwealth Secretariat. 1978. Proceedings of the Commonwealth Workshop on Irrigation Management. Hyderabad, India, 17-27 October 1978. Food Production and Rural Development Division, Commonwealth Secretariat, London.

Coward, E.W. 1973. Institutional and Social Organizational Factors Affecting Irrigation: their Application to a Specific Case. In International Rice Research Institute, op. cit.

Coward, E.W. 1976. Indigenous Organization, Bureaucracy and Development: the Case of Irrigation. J. Development Studies, 13(1), pp.92-105.

Coward, E.W. 1976a. Irrigation Management Alternatives: Themes from Indigenous Irrigation Systems. Paper presented for Workshop on Choices in Irrigation Management, Overseas Development Institute, at Canterbury, September 1976. ODI, London.

De los Reyes, R.P. 1978. Stereotypes and Facts in Irrigation Management: Preliminary Findings from a Case Study of a Philippine Communal Gravity System. In International Rice Research Institute, op. cit.

De Samarasinghe, S.W.R. (ed.). 1977. Agriculture in the Peasant Sector of Sri Lanka. Ceylon Studies Seminar. Peradeniya.

Duncan, S. 1978. Local Irrigators' Groups: Assessment of their Operations and Maintenance Functions. Pages 185-198 in International Rice Research Institute, op. cit.

Farmer, B.H. (ed.). 1977. Green Revolution? Technology and Change in Rice-Growing Areas of Tamil Nadu and Sri Lanka. Macmillan. London.

Harriss, John. 1977. Problems of Water Management in Hambantota District. Pages 364-376 in B.H. Farmer, ed., op. cit.

Honadle, George. 1978. Farmer Organization for Irrigation Water Management: Organization Design and Implementation in Bula and Libmanan. Final report. Development Alternatives, Inc., Washington, D.C. August.

India, Government of. 1978. Draft Five Year Plan, 1978-1983. Planning Commission, New Delhi.

International Rice Research Institute. 1973. Water Management in Philippines Irrigation Systems: Research and Operations. Los Baños, Philippines.

International Rice Research Institute. 1976. Bibliography on Socio-Economic Aspects of Irrigation in Asia. Los Baños, New York.

International Rice Research Institute. 1978. Irrigation Policy and Management in Southeast Asia. Los Baños.

Kuhn, Thomas. 1962. The Structure of Scientific Revolutions. University of Chicago Press, Chicago, London.

Lazaro, Rogelio C., Donald C. Taylor and Thomas H. Wickham. 1977. Irrigation Systems in Southeast Asia: Policy and Management Issues. Teaching and Research Forum No. 6, Agricultural Development Council, New York, Singapore. May.

Levine, Gilbert, Harold Capener and Peter Gore. 1972. The Management of Irrigation Systems for the Farm. In Agricultural Development Council, op. cit.

Levine, Gilbert and T. Wickham. 1977. Some Critical Issues in Irrigation Planning for Southeast Asia. Paper presented at the seminar on Water Resources Problems in Developing Countries, University of Minnesota, July, and published by the Irrigation and Water Management Department, IRRI, Los Baños, Philippines.

Moore, M.P. forthcoming. The Management of Irrigation Systems in Sri Lanka: a Study in Practical Sociology.

Myrdal, Gunnar. 1968. Asian Drama. Penguin Books, Harmondsworth.

Psandaran, Effendi and Donald C. Taylor. 1976. The Management of Irrigation Systems in the Pekalen Sampean Irrigation Project, East Java, Indonesia. Research Note No. 01/76/RN, Agro-Economic Survey, Jakarta. March.

Reidinger, Richard B. 1974. Institutional Rationing of Canal Water in Northern India: Conflict between Traditional Patterns and Modern Needs. Econ. Development and Cultural Change 23(1). October.

Swan, C.H. 1975. The Management of Irrigation Schemes. Paper presented to the meeting on the Planning and Management of Irrigation Schemes in Different Social Environments, Overseas Development Institute, London. February. Mimeo.

Valera, Alfredo and Tom Wickham. 1976. Management of Traditional and Improved Irrigation Systems: Some Findings from the Philippines. Paper presented to the Workshop on Choice in Irrigation Management, Overseas Development Institute, Canterbury, September 1976. ODI, London.

Wade, Robert. 1975. Water to the Fields: India's Changing Strategy. South Asian Review, 8,4 July/October. pp.301-321.

Wade, Robert. 1975a. Administration and the Distribution of Irrigation Benefits. Economic and Political Weekly. 1 November.

Wade, Robert. 1976. Performance of Irrigation Projects. Economic and Political Weekly. 17 January.

Wade, Robert. 1978. Water Supply as an Instrument of Agricultural Policy. Economic and Political Weekly. 25 March.

Wade, Robert. 1979 (forthcoming). On Substituting Management for Water in Canal Irrigation. Institute of Development Studies, Sussex.

Wickham, T.H. and A. Valera. 1978. Practices and Accountability for Better Water Management. Pages 61-75 in International Rice Research Institute, op. cit.

Widstrand, Carl (ed.). 1978. The Social and Ecological Effects of Water Development in Developing Countries. Water Development, Supply and Management, vol. 7: Water and Society, Conflicts in Development, Part 1, Pergamon Press. Oxford.

Widstrand, Carl. 1978a. Is the "hydrologist" a water problem? Paper to Nordic Meeting on Hydrology in Developing Countries Nord-Torpa, Norway, 21-23 November. Norwegian Committee of Hydrology - International Hydrological Programme.

Willens, Alan F. 1975. Classification and Evaluation of Irrigation Systems - Notes on an Agronomist's Point of View. Paper presented to the meeting on the Planning and Management of Irrigation Schemes in Different Social Environments, Overseas Development Institute, London. February.

Wittfogel, Karl A. 1957. Oriental Despotism: A Comparative Study of Total Power. Yale University Press, New Haven.