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In Search of a Water Revolution: Questions for Managing Canal Irrigation in the 1980s

by

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This paper is concerned with the main system operation of large and medium-size canal irrigation in South and Southeast Asia. The argument and the conclusions are designed to complement and support the many initiatives -- including improved design and construction, physical improvements to delivery systems, field layout and leveling, agronomic and hydrological research, and community-level organization -- that are being undertaken or contemplated to improve large and medium-size irrigation systems.

VALUES AND CRITERIA

A first step is to be clear about objectives and values. The values that underlie this paper are concerned with permanently reducing and eliminating rural poverty. The relevance and potential benefits of irrigation hardly need spelling out: increasing food production especially with the new technologies; stabilizing flows of food and income from year to year; spreading food and income flows more evenly round the year, and reducing seasonal shortages and stress; slowing, arresting, and reversing processes of impoverishment; and where there is population pressure, supporting and retaining rural populations and reducing rural to urban migration. This paper calls for a search for analysis, understanding, and ideas with practical applications; and this directs attention to those areas about which less is known and where the chances of breakthroughs may be greatest.

In practice, there are multiple criteria for assessing what constitutes improvement in an irrigation system. The following criteria can all be applied to institutions, to water

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distribution and allocations, to other elements in an irrigation system, and to choices between alternative directions in research and action.

Productivity

This refers to the ratio of production, or of some measure of economic value of production, to scarce resources used or consumed. There is thus productivity of labor, land, other scarce resources, or an irrigation system as a whole. In considering priorities in irrigation, the most useful gauge is often, though by no means always, the productivity of water, because water is often the most limiting factor. But it must be recognized that each situation must be assessed separately, and that water may be limiting only at some time of the year.

Equity

This refers to a fair distribution of resources and livelihoods. In its most common usage, it describes the equitable distribution of water to cultivators, but in a wider sense it includes opportunities for secondary and tertiary employment generated by irrigation. Population support is one aspect. In many environments it is critical to provide adequate livelihoods for a larger number of people the year round. Where water is scarce, water should be thought of in terms of the livelihood-intensity of its alternative uses. This may include the smoothing of seasonal troughs in food and income flows, and providing continuity of work, employment, and production around the year. These seasonal aspects are especially significant for reducing poverty and preventing impoverishment (Chambers et al 1979).

Stability

This refers to the capacity for long-term sustained irrigation without environmental depletion, deterioration, or loss of productivity. This refers particularly to avoiding salinity, silting, flooding and waterlogging, weed and pest infestation, erosion, and groundwater depletion.

Utility to irrigators

This refers to the utility to irrigators of the quantity, timing, and predictability of the water they receive or obtain. Different analysts have used different words to describe water supplies: *reliability,* including a reduction of uncertainties surrounding water supply (Harriss 1977), and *predictability, certainty,* and *controllability* (Reidinger 1974). Utility to irrigators can be divided into appropriateness and predictability of water delivery. Appropriateness here includes quantity, place of delivery, timeliness, and controllability; and predictability includes both reliability (low risk of failure) and certainty (knowledge of the planned delivery and of the low risk of failure).

In any irrigation system there will be tradeoffs between these four criteria, and quantification of those tradeoffs may often be difficult. The criteria can be used as a checklist for determining priorities when appraising an irrigation system.

THE POTENTIAL IN IRRIGATION SYSTEM MANAGEMENT

Surprisingly little research and writing in the social sciences is directly relevant to the management of the bureaucracies which manage medium and large irrigation systems.[1] There are, however, indications that this is an area with considerable potential. Again and again, analysis of other aspects of irrigation leads toward 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 relevant evidence from the Philippines and the Pekalen Sampean Irrigation Project in East Java (Lazaro et al 1977). Valera and Wickham (1976), reporting on action research in the Philippines, wrote:

> "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 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."

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[1]Exceptions include the work of Ali (1978, 1979), Bottrall (1978a, b; see also Newsletter of the ODI Irrigation Organization and Management Network, 1978 to present), Moore (1979), and Wade (1975a, b; 1976; 1978; 1979a, b). Many of the points made in this section have already been made by these authors.

Other research suggests that farmers are likely to cooperate in off-farm water management activities provided adequate and timely delivery of water in the main irrigation system can be assured (Duncan 1978, Valera and Wickham 1976). Much earlier, in Sri Lanka, the sociologist with the UNDP appraisal mission for the Mahaweli Gange irrigation project found at least three of his survey findings pointing at system water management as a concern, causing him to conclude that research on the operation of the irrigation bureaucracy was needed (Barnabas 1967, Chambers 1975). But the furthest one usually taken into the bureaucracy is at the lowest level -- the ditchtender or his equivalent, as in the studies and analyses of Coward (1973; 1976a, b). The operation of the larger system remains, in Wade's phrase, a *black box*.

Let us consider the potential from improving main system management.

- The area under command of canal irrigation is large and increasing. The net area under bureaucratically managed canal irrigation in South and Southeast Asia is about 50 million ha. In its 1978-83 five-year plan India alone has planned to extend that by no less than 8 million ha (India Planning Commission 1978). On a smaller but nationally significant scale, Sri Lanka has embarked on accelerated implementation of the Mahaweli Project. With the priority attached to extending irrigated area 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 area under command of canal irrigation in South and Southeast Asia.

- There is accumulating 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 realized. It is 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 32,794 ha could be developed (ADB 1969), but in 1977-78 only 7,287 ha were receiving water. Water was issued freely at the top end when the planned hectarage implied stringent controls on water issues. As always, there were multiple explanations at different levels, including porous soils and inappropriate cropping patterns. But even allowing for errors in earlier appraisals, less permissive management of water allocations could have enabled a much larger population of irrigators to benefit and much more to be produced.

Elsewhere, five examples of improved management that have led to benefits in production and equity have been identified.

- Two were responses to water shortage crises 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 74,899 ha in Andhra Pradesh in 1976 (Wade 1979a); the second was on a command of 5,263 ha of the Rajangana Scheme in Sri Lanka, also in 1976 (Shanmugarajah and Atukurale 1976).

- In a third example, water scarcity was induced administratively. This was on the Tungabhadra High Level Canal in Andhra Pradesh (Wade 1978). The canal served a potential cultivable irrigated area of 45,344 ha but by 1976 was irrigating only 34,008 ha or 75% 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 crops that made more productive use of the water.

- The fourth and fifth examples are monitored experiments in the Philippines. The results reported are striking. In 1975, IRRI researchers working jointly with the National Irrigation Administration (NIA) introduced improvements in water distribution on Lateral C of the Penaranda River Irrigation System (PENRIS), an area of about 5,700 ha. Production in the 1975 dry season increased by 97% on the base year (Valera and Wickham 1976). In a later experiment, another IRRI team working with the NIA on the Lower Talavera River Irrigation System (LTRIS) reported increased production of about 60% (Early 1979 and personal communication), despite serious pest attacks in the succeeding dry season.

If a 10-20% improvement in system productivity could be achieved in South and Southeast Asian canal irrigation, additional production could amount to tens of millions of tons of foodgrains; and much of this would be produced by tailenders who are at present relatively deprived of access to water.

To realize this potential well-focused and unbiased studies are needed. But there are professional problems.

- The professional skills of economists and engineers are more fit for appraisal, design, and construction than for operation and management.

- Irrigation management problems can be sensitive issues to the irrigation bureaucracies; they may not be researched because of that (Bottrall 1978a). De Los Reyes (1978) indicates how water rotation schemes are affected by pressures placed by influential persons on the irrigation officials, or that result from social relations between farmers and irrigation management staff.

- There is also the temptation of blaming the irrigators for water waste rather than examining how water is distributed and supplied.

- The problems and behavior of the staff who manage irrigation systems have been historically a neglected research area for various reasons, which include the sensitivity issue and the lack of interest of any given group of professionals. But changes in water distribution require changes in the behavior of the concerned staff. Unless their rationality is understood as part of the system, attempts to improve water distribution may not succeed.

ISSUES IN ACTION RESEARCH

In seeking any change in the allocation of resources, a basic question is *who will gain and who will lose*. If all will gain, change is easier. If some must lose, it is necessary to anticipate their resistance and to find ways by which it can be overcome, or by which the group can be compensated for or reconciled to their loss. Land reform has often foundered because the powerful and well-off must lose. Water reform is, however, not so clear-cut. It affects three groups of people: top-enders, tailenders, and the irrigation staff.

In seeking to achieve water reform, three questions can be addressed:

1. *Can all irrigators gain*? In the five examples cited earlier, less water was issued to top-enders than they would have received without the reform. Top-enders usually resist such changes, believing they will lose by them. The challenge here is to see whether the supply of water to the tailend can be improved without the top-enders losing.

Top-enders who receive less water may, however, lose in many ways.

- Top-enders may be using flooding to inhibit weed growth; without enough water they may lose yield to weeds, or be forced to substitute labor or herbicides 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) has pointed out, farmers who flood their fields increase yields from the high parts, which otherwise would not receive adequate water. Farmers with localized small areas of high seepage may also want plenty of water to prevent those areas from going dry early.

- Farmers may have crops at different growth stages so they want a continuous water supply. If farmers fear the risks of not having their fields full of water, deep flooding is an insurance.

Despite these possible losses from insufficient water, the question of whether there might be a situation in which farmers would prefer less water should be considered. In three of the five cases cited here, top-enders either may not have lost, or may actually have gained, from the reform. The Tungabhadra example is complex and equivocal and demonstrates room for maneuver, with some farmers apparently prepared to sacrifice quantity of water or the growing of an accustomed crop for other benefits; however, no clear conclusion about gainers and losers can be drawn.

Top-ender benefits in the cases from the Philippines were 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 tail end. For the four main sections, top to tail, the percentages of increase (area cultivated x yield) from the 1973 dry season to the 1975 dry season were 23, 69, 154, and 1,494% respectively. Top-enders' main gain in the first year (1974) was from a higher area planted, and in the second year (1975) from an increase in yield. Tail-enders gained from both. On the LTRIS system (Early 1980), laterals were monitored at the top, middle, and tail. A comparison of the 1976 wet season yield before intervention and the 1977 wet season yield after intervention showed yield increases of 94 and 62 for two top-end laterals, 16 and 10 for two middle laterals, and an average of 104 for three tail-end laterals (*Ibid*, Table 3). Yields leveled up at the top end and tail end, having previously been highest in the middle.

There had previously been excessive water at the top in both PENRIS and LTRIS; this excess was transferred through to the tail. The situation was far from zero sum for top-enders, although they were initially cautious about the changes. They gradually came to support the new scheme once they were assured of an adequate share of water even in times of water shortage (Valera and Wickham 1976). The question, then, is whether in a given situation top-enders can indeed benefit, according to their own criteria, from water redistribution. One of the most significant trade-offs may be between timeliness and predictability of water supply on the one hand, and quantity of water on the other. In a state of near-anarchy, farmers are likely to prefer a continuous flow. In a controlled situation, they may perceive a higher utility in less water predictably supplied. Their benefits may derive from:

- more timely operations;
- more retention of fertilizer and fertility in the soil;
- less waterlogging;
- greater ease of water control at the field level;
- more predictable and perhaps lower labor inputs for water control and release of time between waterings for other activities;
- an additional crop if adequate water is saved and delivered;
- a switch to more profitable crops that use less water and that cannot be grown with flooding.

An action research priority should,therefore, assess to what extent, in what circumstances, and how reform can benefit top-enders, or at least not penalize them. This may be more common in areas of higher rainfall and top-end flooding, like the Philippines, than in areas of lower rainfall, like central India. This question requires the combined expertise of engineers, agronomists, and agricultural economists and of other disciplines. Wherever top-enders can gain, or not lose, as in the Philippine examples, reform should be less difficult. There may be many such opportunities. But it is likely that analysis will also reveal many systems in which top-enders do have to lose, where reform will therefore be more difficult, and where it may require a deliberate institutional component if it is to succeed.

2. *Institutional engineering: can decisions be enforced*? Because water is a valuable resource for which there is competition, solutions to water problems must often have an institutional or political component. Where top-enders have to lose, there will be an especially strong case for "institutional engineering." Action research priority here is to explore possible alternative solutions to the problem that will suit the physical and socio-economic environment of the farmers concerned. Identification of existing cases where there are irrigation constituencies and management committees, analysis of comparative experience, and innovation of approaches for adaptation, introduction, testing, and development elsewhere should be considered priority research problems.

The reform adopted in the Tungabhadra High Level Canal, as cited by Wade (1978), is an interesting and relevant example. Redistribution of water from top-enders to tailenders was sought by an administrator and an engineer. Some top-enders were to lose, notably those who had been growing paddy when their land had not been zoned for it. An enabling factor in the success of the reform appears to have been that the Minister for Local Government represented a constituency in the tail end, which could not reliably receive water if much of the upper reach was growing paddy (Wade 1978). This raises the question whether special representation of the tailenders' interest can offset the advantages that top-enders enjoy through their physical position. Perhaps a management committee, which can make decisions about water allocations between groups, can be created with an overrepresentation of tailenders to offset their physical disadvantages. Such a management committee might legitimize the unpopular work of staff who have to deny water to those who unduly want it.

3. *Management: how will the irrigation staff be affected*? The problem here is to identify the different behavior required of the irrigation staff and to make it sensible for them to adopt that behavior.

A realistic understanding of the real world of the irrigation staff is necessary. One must understand "how irrigation officials at various levels actually make decisions, the sorts of pressures that are brought to bear on them and their response to those pressures. (One must know, too, the decisions they do *not* make and the pressures that are *not* brought to bear on them)" (Wade 1975a).

Bottrall and Wade have shown that the real world of irrigation staff is researchable. As in bureaucracies generally there are informal as well as formal systems. There are cases of political influence, of civil servants being threatened with transfer, of unofficial augmentation of official salaries, of falsification of water flow records, of turning blind eyes to infringements. There are also instances (see, for example, Wade 1978) 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 many reforms, two changes in behavior are likely to be needed: first, resisting pressure from some irrigators for more water; and second, disciplined control of water movements in terms of timing, quantity, and location. Both changes require staff incentives that override counter-incentives. Decisions about water allocations made or endorsed by management committees representing all cultivators may legitimize action that 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 (Andhra Pradesh Command Area Development Department 1979), is also likely to be part of any effective reform; and experiences such as that with the pasten system of water distribution in Indonesia are likely to be relevant (Pasandaran and Taylor 1976).

But whatever the mix, more action research is needed to identify and develop combinations of approaches that will make it rational for irrigation staff to behave in the desired manner, and especially at times to deny water to irrigators who want it. Irrigation staff must gain from reform; or, if they must lose, it must be made rational for them to accept their loss. Unless this issue is tackled realistically, water reform cannot be expected to succeed.

AN APPROACH TO APPRAISAL: QUESTIONS TO ASK

It is understandable that approaches to appraising existing irrigation systems should ask and seek to answer questions raised by the concerns of the professions and disciplines involved. The questions normally asked in hydrology, engineering, agronomy, economics, and community-level sociology are important. Their importance varies among systems and among zones within a system. But on their own they do not cover the management and operation questions raised in this paper. In particular, they bypass questions of distribution and allocation of water in the operation of the main system and questions of who may gain and who may lose in any changes in distribution and allocation.

The following questions can be addressed to an existing irrigation system:

- What water (quantity, timing, probability) is available?
- How (quantity, timing, place) is it in practice distributed?
- Using the criteria of productivity, equity, stability, and utility to irrigators, how can it be redistributed so that all concerned -- top-enders, tailenders, and water management staff -- will gain?
- What steps can be taken to achieve the changes needed?
- What changes in institutions and procedures will make it rational for those who will lose to accept their loss?

These questions are suggested as a framework or core for appraising an irrigation system, for identifying key technical questions, and for determining interventions.

THINKING TOWARD A WATER REVOLUTION

The potential of action research on these lines can best be established by trying it out. A precondition for success is a multidisciplinary tolerance and openmindedness among those who take part. This entails introspection about the ways in which irrigation systems are viewed.

For the future, perhaps scientists and engineers should not allow themselves to regard such questions as *a people's problem* and therefore beyond their competence. Nor should social scientists allow themselves to dismiss a defect in water distribution as *a technical problem.* My suggestion is for biological scientists and engineers to come to think like social scientists, for social scientists to come to think like engineers and biological scientists, and for all to think in terms of the management of people and of political economy, of who gains and who loses. 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, so that more interdisciplinary collaboration takes place in the same brain, and so that collaboration between individuals on teams can be more effective.

The challenge, then, is not just for action research; it is also cognitive. It concerns loosening, broadening, and balancing the ways in which professionals see irrigation and irrigation systems. For this, new syllabi and new methods are needed. As Carl Widstrand has pointed out (1978), 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 programs. No doubt something can be achieved with traditional learning approaches such as workshops, seminars, and conferences, although these can become repetitive rituals for celebrating unawareness. Other approaches include the use of games and role-playing, with irrigation engineers playing tail-end farmers, sociologists playing engineers, agriculturalists playing farmers' representatives, and so forth.

Whether water reforms could amount to anything that could be called a water revolution remains to be answered. Much depends on the speed, vigor, and imagination of any action research undertaken to find ways of changing main system management and the behavior of irrigation staff. The difficulty of such work may deter it, as may its lack of a disciplinary base. But not to attempt it can be a tragic loss of opportunity. For what is at issue both builds on and goes further than the green revolution. With a water revolution, perhaps millions of tailenders currently deprived by their disadvantaged access to water could, through a better water supply, benefit more not just from the water but also the new seed-water-fertilizer technologies. Whereas the green revolution achieved large increases in food production but brought about mixed equity effects, a water revolution would achieve both production and equity objectives at the same time. The search for such a revolution may be difficult but the stakes are high enough to seem worth a try.

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