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IRRIGATED NON-RICE CROPS: ASIA'S UNTAPPED RESOURCE

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Prelude

IIMI's New Director General: Looking Ahead

IIMI Review: IIMI will soon be four years old. What do you see as the major accomplishments in that time?

Lenton: IIMI has made substantial achievements in three fundamental areas: institutional development, program, and finance. Regarding the first, we have translated an idea into a reality. Four years ago, there were many ideas, some of them conflicting, as to what IIMI should be -- particularly since IIMI's product appeared to be far less clearcut than that of other international research centers. Those different ideas have now been translated into a coherent organization with a clear mission, a well-defined research product, and a strong multidisciplinary staff working on the ground in five countries. The demand for our services has increased, and we are about to place staff in four more countries during 1988.

Programmatically, even though most of our projects are long term in nature, we are already beginning to see initial results. In Indonesia, the Philippines, and Sri Lanka, we have completed the first phase of research to assist irrigation agencies to find better ways to manage irrigation systems for diversified cropping during the dry season, a particularly important problem in Southeast Asia as a result of recent rice production surpluses. In Pakistan, we have developed a methodology to permit managers to assess the impact of location on canal water delivery. In Sri Lanka, we have developed a performance monitoring methodology to assess the impact of water shortage on rice yields. Other irrigation management innovations will emerge from our research in the near future. We are also beginning to play a significant service role in some countries; in Nepal, for example, our staff are starting to have an impact on governmental assistance programs to the farmer-managed sector, and many donor agencies are increasingly turning to them for assistance in program development.

Financially, we have weathered the early financial difficulties which many new organizations face, and now have a substantially more stable and diverse funding base. Our total budget for 1987 was about US$ 4 million; for 1988, it is about US$ 7 million, most of which has already been received in the form of grants or projects.

"... We have translated an idea into a reality."

IIMI Review: What do you see as the major challenges ahead?

Lenton: We still face challenges in all three of these areas. Programmatically, we must continue to ensure that our work has a direct impact on national efforts to improve irrigation management. During the past 20 years, many developing countries have looked to irrigation as a means of increasing agricultural production, enhancing rural income and generating employment opportunities. However, much of the investment in irrigation development to date has yielded returns well below expectations. Because there are relatively few opportunities left for new irrigation development in many countries, we must find ways to increase the performance of existing systems. That can only come about through better management.

Institutionally, we have to implement a structure that will ensure a unified program within a decentralized framework. Because IIMI is one of the first institutes to work in a significantly decentralized way, there are virtually no organizational models to emulate. And financially we must continue to work towards developing a secure and long-term funding base that will enable us to implement our program strategy to the fullest.

IIMI Review: Have you set priorities for meeting those challenges?

Lenton: It is not so much a question of priorities as of sequencing. All three challenges are important. We need to define a strategy and program that will most effectively enable us to achieve our mission. We need to develop and implement an organizational structure to accompany that strategy. And we need to develop a financial framework that will help us to secure the financial resources that we require to implement our strategy.

IIMI Review: IIMI is now in the final stages of completing a long term strategy document. What are the major components of that strategy?

Lenton: First, and most important, the strategy document clarifies IIMI's overall mission, its comparative advantage in relation to other institutes, and its clients. For example, the document clearly states that IIMI's principal clients are agencies and policy making bodies concerned with irrigated agriculture in developing countries. It proposes that IIMI will both generate a research product (which we have termed "irrigation management innovations" to denote a wide range of approaches to improve irrigation performance), and provide services to irrigation agencies to enable them to effectively implement such approaches. It clearly identifies six major problem areas on which IIMI will concentrate its efforts. And it delineates three geographical regions in which IIMI will initially conduct its programs. All these combine to give IIMI a much more focused program, concentrating on what IIMI does best, and where it has the greatest potential for impact.

IIMI Review: How will that strategy affect IIMI's present program?

Lenton: The present program provides an excellent basis for implementing this strategy. IIMI has already undertaken field research in all six problem areas that comprise its proposed strategy. However, some changes will be needed in the orientation of the present program as well as in its organizational structure. For example, IIMI's future program will place a much greater emphasis on the application of basic management principles to the management of irrigation systems, and on the development of practical approaches to irrigation management that irrigation agencies can use.

IIMI Review: Does IIMI's decentralized mode of operation -- a small headquarters unit and many country units -- have any adverse effect on funding?

Lenton: There are advantages and disadvantages. A decentralized mode of operation offers the possibility of generating substantial amounts of total funding in comparison with centralized organizations because of the opportunities to access bilateral sources of funding. For example, IIMI has just received a US$ 2 million grant from the United States Agency for International Development to support its operations in Pakistan, and a US$ 600,000 Technical Assistance grant from the Asian Development Bank to support its work in Indonesia. IIMI's total 1988 budget of approximately US$ 7 million is substantially larger than that of most other international agricultural research centers not affiliated with the Consultative Group for International Agricultural Research.

However, a decentralized mode carries with it the danger that the relative amount of unrestricted funding in proportion to the total may be less than desirable. For instance, only about a third of our total 1988 income is unrestricted. For that reason, IIMI needs to find ways to increase the amount of unrestricted funding it receives to enable it to have the capacity to develop and support an integrated program that examines key problem areas that cut across several countries, rather than simply manage a set of unrelated project activities. □

JOHN COLMEY

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Many Asian countries are now promoting irrigated non-rice cropping to alleviate falling rice prices. But managing irrigation for non-rice crops is not easy.

Conclusions

IRRIGATED NON-RICE CROPS: ASIA'S UNTAPPED RESOURCE

Throughout Asia, rice is the single largest contributor to agricultural Gross Domestic Product (GDP). It is the primary wage good, and attracts more producers and is grown over a larger total agricultural area than any other crop. Ninety percent of all rice is produced and consumed within Asia. It drives economies and sustains cultures. But all that may be changing.

Despite recent setbacks, the world market price for rice has fallen and shows few signs of reversal. Between 1981 and 1985, the price of rice in the world market fell by almost 50 percent. The drop in prices clearly reflects the dramatic success of improved rice technologies developed by the International Rice Research Institute (IRRI) and the many national rice research institutes. Once a major imported crop, most Asian countries have now achieved near self sufficiency -- Indonesia, the Philippines, Sri Lanka, India, and Thailand, among others.

According to a recent World Bank Policy Paper, partial diversification out of rice is now imperative if agriculture is to continue to play a major role in economic growth, and if rural incomes are to be sustained. Recognizing this, many Asian governments have begun to encourage or support the diversification process by promoting the production of non-rice crops in those areas and in those seasons when such crops have a comparative advantage. The greatest potential lies on well-drained soils in irrigated areas during the dry season.

But there are numerous constraints to that process. A major constraint is that most irrigation systems in Asia have been designed to grow rice during the wet season. An entire generation of irrigation engineers and irrigation managers has been trained to work within those parameters. Agricultural development policies have evolved to support rice production and marketing. Donor agencies and national governments are now turning to research and training agencies to assist in promoting the transition.

In 1985, the Asian Development Bank (ADB) and the Government of the Philippines asked IIMI to begin research in the Philippines to assist irrigation agencies in identifying constraints to producing irrigated non-rice crops during the dry season, and in finding ways to alleviate those constraints. The request followed an ADB supported study of IRRI and the International Food and Policy Research Institute (IFPRI) on "Food Demand and Supply for Developing Member Countries." That study concluded that the Philippines had a comparative advantage in the production of irrigated rice and non-rice crops.

IIMI later initiated similar projects in Sri Lanka and Indonesia; the latter project was also supported by ADB. In all three countries, IIMI has evaluated constraints, and has begun testing irrigation management innovations based on results of action research with the assistance of collaborating agencies. A full report synthesizing the results from all three countries is expected in mid-1988.

Soil moisture tests can provide useful feedback to irrigation managers.

According to Senen Miranda, IIMI irrigation engineer and co-leader of the Sri Lanka study, the research in all three countries begins with three assumptions substantiated in the project's first two years: first, water control is more demanding in terms of supply or removal of water for non-rice crops due to far stricter requirements for water -- in contrast to rice, water must be delivered intermittently and for specific periods of time. Second, irrigation systems that were designed for irrigating rice operate most efficiently under conditions of continuous flow and full supply level. Miranda says the only way that condition can be met during the dry season is by rotational distribution of the limited water supply, further complicating irrigation management.

Those two assumptions lead to a third. "Irrigating non-rice crops during the dry season requires greater management effort," says Miranda. "This can only be achieved by installing physical structures or technologies -- hardware -- or by increasing labor and managerial input -- software. The latter can come by increasing farmer participation in management or by enhancing the management capacity of agency staff."

In Sri Lanka, IIMI's field sites are located in the dry zone of the North Central Province. IIMI has chosen two irrigation systems to study: the first is the 35 year-old, 1,214 hectare (ha) Dewahuwa System, which was designed for irrigating rice during the wet season, and is managed by the Irrigation Department; the second is the Kalankuttiya Block of the Mahaweli Authority's System H, a 2,042 ha segment of a 10-year old system which was designed for irrigating rice during the wet season and non-rice crops during the dry season. Both systems are supplied by storage reservoirs. All research was carried out with the collaboration of the two governing agencies and their staffs.

Although plans for irrigating non-rice crops have been in place for over ten years in both systems, neither system has been fully successful in meeting related objectives. Crop diversification was introduced into Dewahuwa in 1975 following a Japanese-supported rehabilitation project; however, the effort was effectively in abeyance until 1984. The area cultivated since has remained well below that originally anticipated by the Japanese engineers. Likewise, although the original designers of Mahaweli System H anticipated that 60 percent of the irrigated lands would be under non-rice crops during the dry season, the actual area cultivated has been far less.

IIMI's two years of research suggest that diversified cropping has been constrained by management problems below the secondary channel level and by the lack of credit and the high risk associated with growing non-rice crops. "A major factor constraining the farmers' ability to diversify their cropping pattern," says Chris Panabokke, IIMI Agronomist and project co-leader, "is the unreliability of supply at the farm level. By that I mean the ability to feel certain that water is coming at a certain time and in a certain amount regularly. There is the further problem of how to share the water below the turnout as the data shows great variability in the amount of water going to field channels. When water is not delivered to the turnout as scheduled, there tends to be a free-for-all when it arrives."

To a certain extent, reliability is beyond the control of the agencies. At the beginning of the dry season, agencies estimate how much water has been stored and tentatively plan rotation schedules. If rain falls early in the season, water rotations are postponed to avoid over-irrigating water sensitive non-rice crops. If rain falls in mid-season or no rain falls, rotations are postponed to conserve the diminishing supply. And dry zone rainfall is extremely uncertain. Problems also arise when water schedules are changed to accommodate farmers' requests for more water. "Neither scheme," says Miranda, " has an adequate communication system to transmit scheduling changes to farmers."

David Groenfeldt, an IIMI Economic Anthropologist who leads the research on organizational aspects, believes farmers could be better organized. "There is no formal farmer organization below the secondary level in either system. Although there are farmer leaders in each system, a leader does not make a group," he contends.

"In Kalankuttiya," he says, "there is a farmer representative who is elected every three years; however, many farmers don't know who he is, and those that do know rarely communicate with him. In Dewahuwa, a farmer representative is selected by farmers to coordinate the farmers within a turnout group.

Irrigated onions in Sri Lanka. Cash inputs for non-rice crops can be three times that required for rice.

However, a turnout group can have as many as 50 farmers who may or may not be located in the turnout,* may or may not be owners of the land they cultivate, and may or may not know each other on a personal level. Farmer representatives for each turnout meet periodically with irrigation officials, but it would be inaccurate to say that they represent a group consensus among turnout farmers. The role played by farmer representatives is useful but it does not fulfill the communication needs of farmers and officials. In terms of water distribution, farmer organizations and cooperation among them can facilitate rotations, and rotations seem to be where the problems lie."

Despite these problems, farmers who do grow non-rice crops appear to do well in the head ends. "Farmers," says Panabokke, "have been obtaining yields that are about 75 percent of those achieved in Sri Lanka's research stations, which indicates adequate water supply. However, those yields drop near the tail ends of the turnouts. But in general," he continues, "Sri Lankan farmers are inclined to grow rice when there is a liberal water supply in the dry season, even though non-rice crops return greater net profits than rice."

"Growing non-rice crops is a high risk venture," says Edward Martin, an IIMI Agricultural Economist. "Cash and labor inputs can be three or four times higher for non-rice crops than for rice crops. In contrast to rice, farmers must stay in the field during irrigation and they can't irrigate at night, which means a lot more time is required to manage water. An unreliable water supply increases labor input because the farmer has to wait for water delivery. All these are associated with increased opportunity costs, as there is less time for off-farm employment."

Cash inputs -- fertilizers, pesticides, and hired labor for weeding and harvesting -- are also much higher for non-rice crops. "Institutional credit," he continues, "is scarce, and non-institutional credit carries interest rates as high as 20 percent per month. And in contrast to rice, which has an established market, the market price for non-rice crops is highly unstable." Despite the risks, farmers that take the plunge can still make a profit. But for now, it's a plunge that only the wealthier farmers can afford to take.

Following two seasons of observations, IIMI in collaboration with the operating agencies, moved to intervene in the two systems with the aim of improving the reliability and equity of water delivery below the secondary canal. "The basic management principle underlying the intervention was information feedback between farmers and agency officials," says Miranda.

"We employed two strategies," says

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*In Dewahuwa, farmers can take water from turnouts at every level of the system unlike Kalankuttiya where they can take water only from the field channel turnouts.

Panabokke, "a rotational plan and post-issue meetings." A rotational plan, developed in mid-season for the distributary channels and field channels, provided farmers and agency staff with a clear set of performance targets. The post-issue meetings, which included agency officials, IIMI field staff, and farmers or their representatives, provided the opportunity to discuss the previous issue and to plan the next issue. To assist in the process, IIMI field staff monitored canal flows and ground water tables, and surveyed farmers to provide the agency with regular information feedback on how the system was performing.

Canal flow measurements can provide managers with critical information on water distribution.

The intervention accomplished two objectives, though it was relatively more successful in Kalankuttiya than in Dewahuwa. "The equity among the field channels improved significantly," asserts Panabokke. "Ratios of 3 to 1 became 1.5 to 1. Second, there was increased interaction between the farmers and agencies concerning the rotation plans, and better communication as to when the rotational issues would take place. The rotational planning also allowed managers to accommodate crop needs by changing the frequency of issues (from 1 in 7 days during crop establishment, to 1 in 10 during the mid-growth stages, and to 1 in 7 near harvest time)."

"Understanding how the farmers and the agencies worked allowed us to bring them together. By presenting feedback to them in the form of water measurements, we created a focal point for the discussion," Panabokke says. "More importantly, increasing the reliability of rotation issues enhanced the capacity of the farmers to take over management functions below the turnout."

In the Philippines, management practices for irrigating non-rice crops are relatively undeveloped. Until very recently a major importer of rice, increased rice production has dominated agricultural policy for the past 15 years. "All irrigation planning, regardless of the season, is effectively directed toward rice," says Miranda.

There are many existing irrigation systems in the Philippines that irrigate diversified crops. The sources for moisture for dry season non-rice crops are derived from rainfall, diverted river flows for irrigation, and groundwater. Although information is available on crop water needs and agricultural practices, little information is available on effective irrigation management for non-rice crops during the dry season.

Against that background, IIMI, in collaboration with the National Irrigation Administration (NIA), the Ministry of Agriculture and Food, and the Philippines Council for Agriculture and Resources Research and Development (PCARRD), began research in 1985 to identify constraints and develop practical guidelines for irrigating non-rice crops. The research is carried out in parts of three systems (in Mindanao at the Allah Valley, South Cotabato; and in Luzon at Nueva Ecija, Tarlac, and Ilocos Norte).

"In the Philippines," says Alfredo Valera, IIMI's Resident Scientist, "the government does not yet have a working policy that promotes the irrigation of non-rice crops. Past policies have pushed rice production at all costs, in all seasons."

"At this time," he continues, "agencies don't plan for non-rice crop production. If farmers don't ask for water they won't get it. The specific water requirements of a certain crop do not come into play. The impact of government policies is that farmers will grow rice if there is sufficient water. Effectively, any irrigated non-rice crop production that takes place is the result of water shortage rather than deliberate planning.

Consequently, the Philippines research has been carried out at a very basic level which begins with demand assessment. "Currently we're working on a methodology for rapidly identifying those parts of irrigation systems suitable for diversified crops," says Valera. "To do this, we are developing a microcomputer-assisted grid cell encoding technique that produces a detailed map showing the spatial distribution of land types." The methodology is intended for operational planning where there is a minimum set of field data, as often exists in the Philippines.

As in Sri Lanka, farmers' decisions to grow non-rice crops is heavily influenced by economics -- the level of returns expected and the risk of production. The same factors come into play in Sri Lanka, the Philippines, and Indonesia: availability of labor, credit and financing, and marketing. Farmers' lack of experience with irrigated non-rice cropping, lack of irrigation management practices and unreliability of water supply, irrigation service fees, insufficient credit and marketing facilities (informal credit rates range from 13-18 percent per month), and dry season rainfall, all serve as a disincentive to farmers to grow irrigated non-rice crops during the dry season. Not surprisingly, early research results on profitability have been mixed, and only in a few locations has a significant difference in profitability been shown.

In Mindanao, the economic situation is complicated by a bimodal rainfall pattern. "Farmers in the lower portions of the system argue that rainfall is sufficient for non-rice crops," says Valera. "There is a general feeling that if they're going to pay for water, they might as well grow rice. The result is a very inefficient use of water for both rice and non-rice crops. In those systems, we have been trying to convince the farmers (using demonstration farms) that the returns on irrigated non-rice crops would more than pay for the water charges." According to research findings at that site, irrigated corn, in particular, will bring higher profits than irrigated rice. As to management practices, research is carried out at the farm and system level. Both canal flow and water tables are monitored at all sites. At the farm level, different irrigation methods -- furrow and basin flooding (the most common) -- are used for different crops with varying success of application efficiencies, ranging from 38-80 percent.

The study on irrigation management at the system level was confined to documenting the operations of each system using water measurements and data on irrigated area, status of farming activities, and water adequacy. Full results will not be out until 1989.

The Philippines research therefore is aimed at identifying the efficiency of existing ad hoc procedures of both farmers and agencies. Scientists thus monitor water flows in farmers' fields, which the agencies have not done. Based on those findings, scientists now hope to introduce systematic procedures and guidelines for delivering water to non-rice crops based on scientific principles and experience. Practices documented in Sri Lanka and Indonesia will guide this effort.

Indonesia, where IIMI began research in 1985, contains some of the most sophisticated irrigation systems in Southeast Asia. The construction costs of technical irrigation systems are much higher than in the Indian sub-continent. Cropping intensities in the research sites in Java, where the majority of IIMI's research is conducted, range between 220-350 percent. Unlike the Philippines where research is aimed at determining the guidelines for growing irrigated non-rice crops, research in Indonesia is aimed at maximizing yields from irrigated non-rice crops during the dry season through better management.

According to Sam Johnson, IIMI Team Leader in Indonesia, research focuses on supply and demand; that is, determining and improving how demand is assessed, and how supply is managed and delivered. Research is carried out collaboratively with the Directorate General of Water Resources Development and the Provincial Irrigation Services of East, West, and Central Java, where the bulk of the research is underway.

Early in the research, IIMI scientists found that the way rice was irrigated during the wet season affected irrigation of the non-rice crops during the dry season. "In rice-based systems, farmers build up the shallow water table by creating an artificial confining layer which keeps the water in the field," says Johnson. "Essentially farmers create a small lake with plants growing out of it, and irrigation practices during the wet season are planned to maintain the lake at a certain level –during rains you drain it, during dryer periods you irrigate. When you move into the first dry season, a farmer must decide whether he can maintain that lake for another season, and if he thinks he can, he will grow rice. In this case, in the absence of rains, irrigation water is used to recharge the lake.

"As you move into the second dry season," he continues," it becomes obvious to farmers that, except in a few low lying areas, there is insufficient water left in the soil profile to maintain that lake. Now the farmer has to drain the lake for non-rice crops requiring less water." This difficulty is reflected in the resultant low yields. Farmers might obtain soybean yields of 1 ton/ha, whereas a typical farmer in the US might average 3 tons/ha.

"We also noticed that farmers irrigated only once or at most four times during the dry season," Johnson adds. "It became clear that farmers were subirrigating, using water left in the lake from the previous wet season, and we later verified that by monitoring the groundwater table. With a high groundwater table, the roots run shallow along the sun-dried portion of the soil; when the lake falls, the crop is immediately stressed and the farmers irrigate. The practice was stress, response, stress, and response."

Thus irrigation managers in Indonesia are faced with two problems, managing the water in the soil profile and managing the water delivered by the irrigation system.

IIMI researchers are currently examining the relationship between the time the water table begins to fall and the timing of water delivery. "We hypothesized," says Johnson, "that if irrigation was held back to let the water table fall sooner, farmers could plant their non-rice crop sooner and have a better medium to grow their crops. This would also open the door to regular irrigations."

In general, determining water demand is far more important and far more difficult for non-rice crops. Non-rice crops vary in water requirements and length of growing season. Thus optimum irrigation management requires an adequate assessment of the mix of crops and the amount of area grown to each. "That," says Johnson, "really becomes complicated under the intense farming conditions found in most of Java."

In Indonesia, management begins at the village level. In each village a farmer is designated as a village water master, who collects information on the amount and mix of non-rice crops grown in the village's portion of the irrigation block. Every 10-15 days the village master reports this information to a water inspector, who collects similar information from every village master in the block. He then determines the amount of water that should be allocated to the block. Blocks average about 100 ha and about three plots per ha.

That information is transferred up the

Cropping intensities in Java can be as high as 350 percent.

system, where a system water master pools information from the different water inspectors, and totals the water requirement for the individual system. The demand is then compared with the available water supply. If the available water exceeds the demand, the total demand required is delivered for the next ten days. If the water supply is less than demand, the water master calculates a ratio between supply and demand. If the ratio falls below 0.7, a rotation is considered.

In Indonesia, this theory is far more difficult in practice. As management begins at the village level, so do the problems. Research results have shown that the village master's reports are very rough estimates, which, when transferred up the system, often lead to excess water being diverted into the blocks.

Johnson's team therefore began to look for a way to improve the accuracy of reporting. The team prepared a series of block maps which delineated the village blocks by color and the farmers' fields by number. The team gave these to the village water masters along with a form which they could then carry with them to the field to check off and total up the crop amounts. They gave a similar map and a calculator to the water inspector so he could randomly cross-check the accuracy of the village water masters' reports. As expected, the accuracy of reporting increased significantly.

Johnson admits, however, that there are reservations, primarily economic, about block maps. Considering the approximate 4.5 million ha in the public irrigation system, the mapping costs come to around US$ 23 million. And the maps grow obsolete over time due to changes in land holdings. Nevertheless, Johnson believes the maps would still pay for themselves. "The payback," he says, "comes in water savings because farmers tend to overirrigate at present and, to a lesser extent, in better yields."

Turning to the supply side, the team concentrated on monitoring and feedback. "Our whole approach to supply," says Johnson, "was to get the monitoring and feedback loop working." On the supply side, the manager gathers and analyzes information, and passes it upwards in the management system. At the highest level, management determines the amount of water to be released to a system and directs orders to a gate keeper to release it. The gate keeper sets the gate to release a fixed amount of water over a fixed period, according to the flow through the gate at the time of setting. It is assumed, at least in practice, that flow rate will be constant during the ensuing issue period. And that is where the system breaks down.

The source rivers in Indonesia are short and relatively fast. Rain falls in the mountains and moves quickly down the streams. The gate keeper is expected to read the gates during the delivery period, which in theory provides the manager with a monitoring and feedback system to determine when or if the flow fluctuates. "However," Johnson says, "when I looked at the data in the manager's office and saw that flow rates over a series of issue periods almost exactly equalled the planned rates, I told the manager that it was not possible."

"When we followed the feedback from the gate keeper upward, we found the data changed hands three or four times verbally or on slips of paper, and that, by the time it reached the chain of command, it exactly equalled the scheduled flow rates. The system was almost, at least on paper, 100 percent efficient," says Johnson.

IIMI staff and local provincial irrigation service collaborators developed an official record book for the gate keeper to replace the lined notebooks they generally bought in the local market. It gave the record keeper a feeling of greater responsibility, and provided a systematic way to keep records. IIMI staff have recommended that the figures recorded in the book be used as the official record. The idea has been successful to a certain extent.

"But," Johnson continues, "there is a vicious circle. Higher level officials usually do not use the field data as it is not considered accurate, and the field staff collecting the information don't concern themselves with accuracy because the information isn't used. One requirement for breaking that circle is for increased recognition among managers that operation is the main task."

Johnson contends that across Asia, there is a widespread construction mentality. Construction is perceived as the professional job for engineers, with operation and maintenance left to more junior level employees. As the construction costs of new systems increase, emphasis is gradually shifting towards operation. "But," he adds" the push has to come from the top."

IIMI's research results allow for a number of generalizations to be made on the constraints to non-rice cropping in irrigation systems. Clearly, unreliable water supply serves as a disincentive to farmers by increasing the cost of labor because the time spent waiting for water reduces the farmers' opportunities for off farm employment. The answer to that appears to be better communication between agencies and farmers.

There are greater economic risks associated with non-rice cropping than with rice. Cash and labor inputs can be three times that of rice, and can be even higher in the absence of institutional credit. Heavy investments are at risk because of the uncertainty of market prices and dry season water supplies. Despite costs and higher risks, irrigated non-rice crops are more profitable on well-drained soils during the dry season.

Assessment of water demand for crops other than rice also needs to be improved. As a system becomes more sophisticated, demand assessment becomes the constraining factor. More information needs to be collected in the field regarding the type and extent of non-rice cropping. Then water tables and canal flows can be monitored to provide feedback to managers and farmers on the efficiency and equity of irrigation.

Most important, in diversifying from rice to non-rice crops in rice-based irrigation systems during the dry season, there appears to be almost a geometrical increase in the managerial input required. That suggests that there has to be either an increase in technology or an increase in management staff. There is a third alternative, that being the transfer of management responsibility to farmers. All involve costs, though the last option is least costly to agencies while increasing the cost of labor input by farmers.

"Many experts" says Johnson, "argue that as you move from rice to non-rice crops you have to increase the hardware. I would argue that, given an existing system in Indonesia, you can increase efficiency significantly by taking the slack out of management before you reach a point where you have to put more cement in the ground. After you've improved the management level, you can then identify where the cement has to go. But management has to take the lead." □

JOHN COLMEY

Opinions

IRRIGATION UNDER THREAT: A WARNING BRIEF FOR IRRIGATION ENTHUSIASTS

*Ian Carruthers**

I believe we, the irrigation community, are at an important juncture so far as irrigation policy and investment are concerned. Although it may appear self-evident that irrigation must play a pivotal role in the era of agricultural intensification that we are now being forced to enter, it is by no means certain that this role will be offered.

I have therefore cast this paper as a cautionary tale. Unless the growing unease regarding the merits of irrigation is quickly dispelled, then national governments and the donor community alike may turn their back on the sector. If this comes about, then the present relative complacency about Asian food security may prove to be misplaced. Furthermore, the comparatively small but nevertheless important contribution irrigation can make to Africa's agricultural recovery and future growth will also be threatened.

There are clear indications that irrigation is becoming less popular. In a global review, H.M. Horning, recently retired head of the Land and Water Division of FAO, presents a depressing account of expansion of irrigation area. He estimates that although irrigation occupies 210 million ha in developing countries, 14 percent of the cultivated land, and the rate of growth in area was 5 percent per annum between 1965-75, it fell to only 1.5 percent from 1975-85. Clearly the availability of suitable land and accessible water in close proximity is reaching its limit. We can identify several additional factors contributing to this.

Macroeconomic difficulties of governments and shortfalls on aid budgets are now, more than ever, constraining government efforts. New irrigation development is too expensive -- the obvious and cheap projects are already developed. Heightened environmental consciousness and recognition of the problems of salinization of soils, catchment protection, flood protection, and water-related disease control, all require large capital investment and the introduction of apparently intractable management-intensive operating systems. There are increased marketing problems of major irrigated crop products and a growing prejudice against cash crops, especially in relation to Sub-Saharan Africa. And last, there has been a political failure to support irrigation development in crucial spheres such as service charges, amidst suspicion that the regressive income distribution impact is often deliberate.

"If new irrigation... should become unfashionable, no matter how unjust, both capital and recurrent expenditures will become increasingly scarce."

Within the irrigation sub-sector many new projects are less attractive than alternatives. Two potential alternatives include, first, the current shift, especially in Southeast Asia, to intensification of existing irrigation through multiple cropping and on-farm investment such as tubewells: and second, rehabilitation, completion, and modernization which are often urgent and, given huge sunk costs, promise high return investments.

However, if new irrigation, its intensification or rehabilitation, should become unfashionable, no matter how unjust that might be, both capital and recurrent expenditures will become increasingly scarce. Irrigation supporters should not be complacent about the virtues of their sub-sector. The most important threats to be faced at this time are problems of "markets," "finance," "management," and "environment."

Irrigation advocates will puzzle over doubts on the merits of irrigation. They will point to the production successes of the Indian sub-continent and stress the role of irrigation in achieving this agricultural growth. India, with a population increase of well over one million persons per month, is now virtually self-sufficient in foodgrains. Most of us can probably remember the impact of bad monsoons in the mid-1960s that gave rise to books with titles such as *Famine 1975* and *The Hungry Planet,* and provided political support for the massive USA PL480 food aid transfers. Irrigation, particularly

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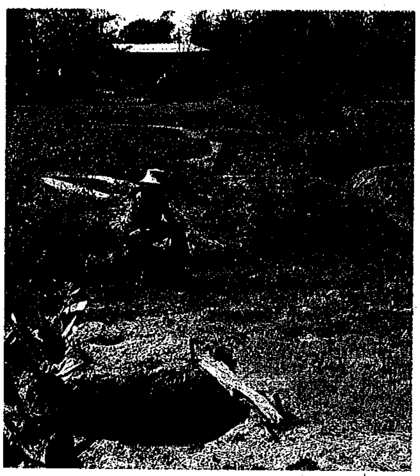
groundwater irrigation, is widely believed to have drought-proofed India -- a claim that is undoubtedly true for the present. However, fertilizers and new crop varieties, with and without irrigation, have probably provided the bulk of the incremental production. This is all the more so in Pakistan where fertilizer consumption has doubled in the last 10 years, providing the main source of the 3-4 percent annual growth in agricultural production.

Nevertheless, as irrigation advocates will no doubt argue, it is irrigation that provides the necessary conditions for complementary agricultural technology to reach its potential. It is worth remarking, as an aside, how often partisan evaluation from suppliers of one of the joint inputs to production claim all the incremental benefits to a favored single input -- hence the benefits from an irrigation project may be separately claimed by agricultural researchers, engineers, credit agencies, the extension service, educationists, health workers, transport enthusiasts, and others.

Every scientific advance in technology complementary to irrigation, increases the physical return to water investments. For example, new seeds, better fertilizer advice, and crop protection all shift the water response function upwards. The production successes in Asian rural developments are, to varying extents, supported by irrigation. Irrigation improvements explain the increased rice production in Philippines, Indonesia, Thailand, Pakistan, Sri Lanka, and elsewhere. Thailand's agriculture, has been so successful that there is now restraint on its exports to the EC. Indonesia, once a large rice importer, has reached the peculiar situation where it cannot afford to buy and store all the domestic rice surplus at present prices, it cannot find a profitable export outlet, and it cannot leave the rice on the market for fear of domestic political repercussions should rice prices collapse. Diversification from rice is a key goal, but it presents all large rice producers with intractable technical marketing problems.

Most of the obvious alternatives to rice face a highly price inelastic demand schedule. Hence even partial success in diversification may provide little additional financial benefit. Indeed it is conceivable that the total income from rice substitutes could fall with any increased production. The supply related problems of success make up part of the worry of those financing irrigation.

The market problems of irrigation will be exacerbated by external and internal pressures that create macroeconomic management problems. Governments that are concerned with food security are likely to find the surplus disposal programs of Europe and USA and the efficient rainfed agriculture of countries such as Canada, Argentina, Australia, and New Zealand the most secure source of food. Despite much rhetoric in the EC and USA, there is little prospect of effective reform of agricultural policy that will cut the food and feed grain, beef and sugar surplus that depresses world prices. Indeed, there is an enormous reserve of political will to continue farm support despite the fact that in the EC and USA support of agriculture is now estimated to be costing every family $900 and $700 per annum respectively.



"Irrigation, particularly groundwater irrigation, is widely believed to have drought-proofed India..."

Within developing countries, urban-based and urban-biased treasury ministers, intent on keeping urban voters well-fed, and sometimes with eyes on counterpart funds they gain from selling food aid, will all too often prefer real food security, which for them is imports, rather than the risks of trying to squeeze food from a disparate, impoverished peasantry. Such short-term perspectives are common among developing country politicians, and deprive domestic agriculture in general and irrigation in particular, of resources.

It may appear paradoxical that in rich countries with only 2-10 percent of the population in agriculture, there is strong political support for huge agricultural subsidies, whereas in poor countries, where farming is the basis of livelihood for 30-80 percent of the population, we find a sector starved of resources and subject to direct and indirect taxes. There is no paradox. When farmers are few the majority can subsidize them, when they are the majority they must perforce pay their way and support other State activities. Irrigation farmers in developing countries suffer like other agriculturists from adverse domestic terms of trade, but given the financial subsidies they almost always receive in the form of free or virtually free water, they are generally less exploited than those agriculturists who depend on rainfall.

Moves are currently underway in many countries to give farmers higher prices; for example, to exempt them from export duties or the harmful impact of overvalued exchange rates. This might be expected to give a boost to the irrigation sector. Unfortunately such moves also require the elimination of subsidies for inputs, and typically irrigation capital and recurrent costs are highly subsidized -- often to the tune of 100 percent. In World Bank experience, the legal covenants agreed with sovereign governments for cost recovery on irrigation projects are frequently broken. In most countries, government commitment to initiate a water charging policy, and having done so to enforce water rates, is seriously lacking. An absence of political will in this area is a key ingredient in a chain such as that of Figure 1.

Figure 1. A probable chain of irrigation problems resulting in the absence of strong political leadership.

poor enforcement of revenue policy
▼
inadequate irrigation budget
▼
substandard operation and maintenance (O&M)
▼
unreliable irrigation
▼
unprofitable agriculture
▼
poor adherence to the revenue policy

The Bank review showed that at audit, soon after completion of the projects, O&M was already satisfactory in about one-half of the 48 projects. Clearly many were already well on their way to becoming fashionable rehabilitation projects.

In the past, irrigation has been hopelessly oversold. The forecast rates of returns to irrigation have been excessively optimistic. Typically, schemes have cost overruns, delays in completion, and are slow to achieve forecasted agricultural benefits. Costs as specified are also underestimated deliberately or in error. What should be integral components, such as land levelling, field channels, land drainage and adequate communications, are all too often excluded from design. In the operating phase, government departments or other managing agencies do not have adequate recurrent financial resources for various reasons, hence operational defects abound. Management of the schemes in line with design often seems impossible.

Despite problems, the rice economies have seen yields double or even triple in the last 25 years, and double and even triple cropping is technically possible. In the arid zones, the potential productivity is enormous. Nevertheless, there are early warning signs that the central government planning authorities, who have for a long period favored irrigation in allocating public sector resources and promoting private investment, as well as the various bilateral and multi-lateral aid agencies, are beginning to critically focus on the gap between this potential and the realized benefits. The specter of an investment backlog for drainage, deferred maintenance, replacement of old structures, modernization and so forth, is beginning to make the open-minded observer, the non-irrigation enthusiast, cautious, even suspicious, of expenditure in this sector.

"In the past, irrigation has been hopelessly oversold..."

If finance is to be found to bring O&M standards up to design, there is a growing consensus that it must come from the farmer beneficiaries. Devising mechanisms for obtaining small amounts of money from large numbers of admittedly poor, though not usually ultra-poor, small farmers, is one of the greatest challenges facing the irrigation advocates.

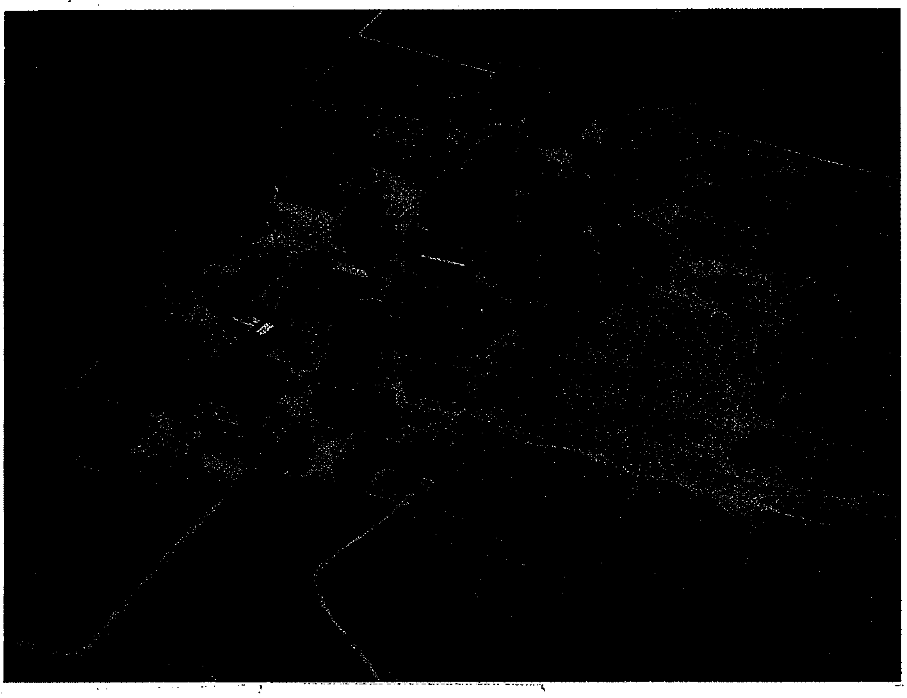
Management and environment are two terms with such multifarious meanings that although they inevitably appear in any list of irrigation problems, they fail to convey any precision in diagnosis. Of course management defects abound--that is why there is now an International Irrigation Management Institute (IIMI). The exact nature of the problems is hard to discern which is why of course IIMI is engaged in research.

My hypothesis would be that irrigation managers are like peasant farmers before high-yielding varieties and chemical fertilizers -- efficient but poor. It is unlikely that much improvement can be made with their existing resources or within existing irrigation institutions (supply agencies and user groups). This is not a call for a massive injection of cash resources or new parastatal bodies to look after irrigation. Some of the ingredients that do appear to me to be necessary in many countries before resources are injected are first, a rehabilitation of the budgeting process, often now virtually a game played without enthusiasm but with great cynicism; second, a higher degree of autonomy and accountability in managerial matters though not necessarily privatization, which is becoming so popular in UK and elsewhere; third, a post-experience education of managers to upgrade professional skills (with basic tools: economics, statistics, accounts, personnel etc.; awareness level training in analytical techniques: OR techniques, CPA linear programming, survey design and analysis, systems analysis, model building and simulation; training in modern office technology including communication equipment and micro-computing with standard software packages; and finally but most important, training in interpersonal skills of teamwork, leadership, verbal presentation, and media work). More thought also needs to be given to appropriate farmer management training as there is little doubt that most governments have exceeded their capacity to effectively supply services to farmers, and farmer-managed services must become a more important source of support.

Within the discipline of economics, there is a lively debate as to its current relevance to developing countries with protagonists who either believe economic principles are universal, transcending culture and politics, or who believe economics, whether neo-classical or Marxist in origin, has little relevance in the Third World. Similarly there is a debate in management science with those at one end of the spectrum who subscribe to a generally applicable theory or set of theories of modern management, to those at the other end who claim such theories devised for industry in rich countries have little relevance to those who work in the rural sector of poor countries. This latter group also argue that the Japanese, who appear to transgress key principles of modern management, are demonstrably successful. It might be worth adding that apparently Japanese farmers are also successful managers receiving over US$ 10 billion in subsidies in 1985 and convincing consumers to pay food prices 60 percent above what they would be if world prices were charged.

I would argue that, despite important reservations, there is a set of relevant principles/formal management theory that can help managers to understand their problems and to formulate key questions, and there is a set of relevant analytical techniques that can guide them in acquiring and analyzing the data, provided they have a minimum of subject matter expertise in agriculture, engineering, and a range of other subjects including insights from social sciences. Given such broad intellectual demands, we must aim to encourage the highest calibre entrants into the irrigation service. The cadre needs convincing of its professionalism, and I wish IIMI well in its research and extension task in this regard. Irrigation development is now primarily a management task and not a design and construction task, and we must adapt our institutions and skills in line with these new opportunities.

We should not underestimate the extent and nature of the management problems. They are not simply a set of engineering problems. Repetto (1986) summarizes several studies and identifies the following list:



- Responsibilities are fragmented among construction, operating, agricultural, and financial agencies, which do not coordinate to provide good services to farmers.
- Most government irrigation agencies are not accountable to the farmers they serve, either for employment or funds.
- There are usually no effective means for monitoring and evaluating the performance and effectiveness of the system.
- Irrigation agencies in many countries are staffed with poorly trained, supervised, motivated, and rewarded operatives.
- Many agencies are plagued by pervasive corruption and indiscipline.
- Water users within sections of public irrigation projects, who are physically interdependent by virtue of a common water supply system, usually don't organize, cooperate, or participate effectively in operating and maintaining the system.

He then goes on to characterize irrigation projects not as hydraulic systems to be run according to engineering principles, but as socio-economic systems, where all participants – farmers, managers, and politicians -- presently maximize their private interest at the cost of the social good. Thus management problems are symptomatic of the underlying conflicts in the political economy of irrigation. Our management science has to penetrate these symptoms if the real causes of the problem are to be addressed. Repetto rightly stresses that all the complicated incentive systems must be invoked as part of any management solution to the problems listed above. Management skills can be improved, but the problem has to be respecified as one of applying a multidisciplinary art and not simply one of using traditional engineering science.

Despite lacking a clear definition of their remit, the environmentalists are perhaps the greatest threat to the irrigation sector. Environmental impact assessment of irrigation is likely to produce high-ranking criteria and provide an increasingly operational perspective for selection of new and rehabilitation projects. Environmental impact has economic, biological, and social dimensions that have to be integrated to give an overall synthesis if a practical criterion is to be derived.

Planners have passed the stage of simply describing the repercussions of irrigation projects on bio-physical processes in the area. Attempts are normally made at describing and evaluating the effects on bio-physical systems but social impact -- the repercussions of development on individuals, groups, and cultural norms -- is not always recognized as important. But things are changing. Cornucopians who believe technical solutions will arise whatever the problem are less evident in planning groups, and are being replaced by environmental managers, or even by advocates of rules based on "ecological" morality. Irrigation cannot be divorced from changes in ideas regarding the environment, fed as they are by well-publicized philosophical tracts on environmental issues; increases in scientific knowledge; the obvious problems of large-scale projects which have created a widespread mood of caution; and numerous well-documented, practical, managerial, legal, health, political, and participation problems. The impact on irrigation development in developing countries of this environmental mood is less than in developed countries, but this could rapidly change.

The recommendations of a report, widely read and cited, show the extreme antagonism water resource projects are generating among some influential environmentalists.

"In the light of today's knowledge, it is clear that the building of large-scale water development schemes can only be justified to an electorate and to the world at large by systematically covering up -- as governments and their advisers have shown themselves adept at doing -- their true implications.

Unpalatable as it must undoubtedly be to the dam-building industry, there is clear evidence that building large dams is not an appropriate means of feeding the world's hungry, of providing energy, or of reducing flood damage.

For it to be so, we would have to accept as largely expendable the human and non-human population of the whole area affected by the dam, simply in order to further the political and financial interests of a very small minority.

To persuade Third World governments to abandon plans to build water-development schemes, to which they are often totally committed, is a lost cause. The only way to prevent their construction is to appeal directly to donor governments, to development banks, and to international agencies without whose financial help such schemes could not be built. It is not that the latter are more responsible, only that they operate in the industrialized world where public opinion can be mobilized more readily against the pursuance of their present policies.

We thereby call upon those organizations, herewith, to cut off funds from all large-scale water-development schemes

(Continued on Page 24)

Irrigation Systems Performance Monitoring and Evaluation: Reliability, Resiliency, and Vulnerability Criteria for Assessing the Impact of Water Shortage on Rice Yield

Poh-Kok Ng[1]

A simple and low-cost methodology for measuring the field-level water adequacy and equity of distribution in lowland rice irrigation systems has been successfully developed at the International Irrigation Management Institute. The method consists of measuring the inflow and outflow of water from the irrigation command area, and installing perforated PVC tubes to monitor the fluctuations of the perched water level in paddy fields. Indices for measuring the frequency, duration, and intensity of water shortage have been developed. These three indices, termed reliability, resiliency, and vulnerability, respectively, correlate very well with crop yield from sample irrigation systems in Indonesia, Sri Lanka, and the Philippines. The methodology appears applicable across countries, seasons, and sites. This paper briefly presents the methodology and the summary of results from the three countries.

Detailed discussions of the methodology and its application as a management tool for continuous monitoring and evaluation of the performance of irrigation systems are included in an IIMI Research Report.

Conceptual Approach

Irrigation development may generate efficiency and equity benefits, as well as improve the environment and human conditions. The efficiency benefits may derive from increase in yield per hectare in area already planted and/or in the expansion of new area for cropping. Yield increase may come from the direct effect of improved water conditions to crop, or from the use of additional inputs such as fertilizers that are complementary to water. In addition to increased production, irrigation development is likely to also reduce the variability of yields over time and space, thus contributing towards a more stable and equitable food supply.

To measure the direct effect of improved water conditions on yield, we need a variable that reflects water conditions and is functionally related to yield. The conventional approach is to use water itself as the variable in a production function (Hexem and Heady 1978). This approach, however, is more suitable for analyzing experimental data rather than field data.

An alternative approach, which we adopt, is to relate yield to some index of water shortage derived empirically from the field (Small 1985). Ideally, such an index (or indices) would incorporate information on the frequency, duration, and intensity of water stress throughout the crop's various growth stages.

The extent to which yield is depressed due to moisture stress conditions, or conversely, the benefits gained from improved water conditions, can then be estimated from the functional relationships between yield and these indices. This, in turn, allows estimation of the aggregate gain in production from, or the loss thereof from the lack of, new or further irrigation investment.

Empirical Method

The technique consists of measuring the inflow and outflow of water from the irrigation system, and installing vertical perforated PVC tubes in representative parts of its command area to monitor the daily fluctuations of the perched water table in paddy fields. These perforated tubes, which act as observation wells for the water level in paddy fields, measure 5-10 cm in diameter and 100 cm in length. They are installed to a depth of 50 cm below the soil surface in sample paddy plots. Readings of the water level in these tubes are taken daily from the date of transplanting to harvest. Yield from the sample paddy field is estimated by crop cuts. Additional data such as fertilizer applications can be collected, if so desired, from a farm survey to estimate the complementary effects of other inputs to water on crop yield.

Data on depth to standing water in paddy fields from the date of transplanting to 20 days before harvest are used to compute three indices called Reliability, Resiliency, and Vulnerability. These three indices are descriptors which reflect, respectively, the frequency, duration, and intensity of water shortage experienced at each sample paddy plot (perforated tube).

Reliability describes how likely a system is to fail or violate a performance threshold, in this case, how frequent water level in the paddy field falls below a performance standard that defines stress condition for the crop; Resiliency, how quickly it recovers from such failure, i.e., the expected time duration of moisture stress once it occurs—the shorter the time, the more resilient it is; and Vulnerability, how severe the consequences of failure may be, i.e., the expected maximum severity of moisture stress once it occurs (see also Hashimoto et al. 1982). These three performance indicators refer to the operation of the water delivery system causing the moisture stress and not simply to the stress condition itself.

It is conventional in irrigation design to derive the crop water requirements figure based on soil, climatic, and evapotranspiration (ET) demands—which is about 600-800 mm per crop for paddy rice. In practice, however, the amount of water actually used to grow a paddy crop in many irrigation systems in Asia is much more—typically 1,500 mm or more, eliciting suggestions of "wasteful" or "inefficient" use of water.

For lowland rice systems water is used, however, not only to fulfill ET

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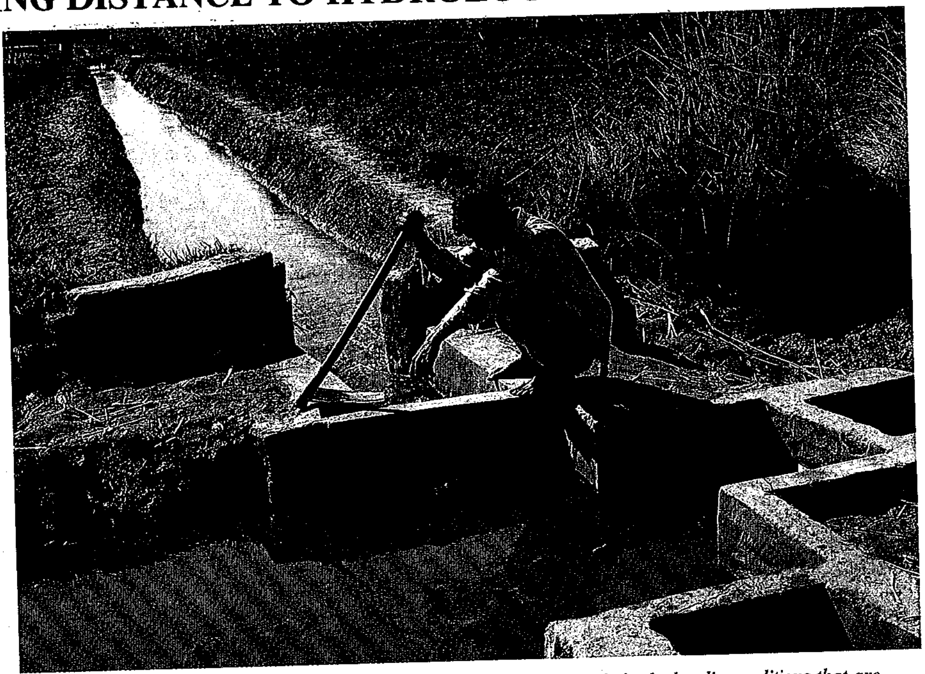
EQUIVALENT DISTANCE: RELATING DISTANCE TO HYDROLOGY



If distance effects in irrigation systems are non-linear, it is logical to look for hydraulic conditions that are also non-linear.

Irrigation professionals routinely subdivide irrigation systems into head, middle, and tail ends, particularly in relation to equity. However, IIMI staff in Pakistan believe that may be misleading, and have shown that rehabilitation strategies based on such geographical distinctions can, in some cases, lead to greater inequity rather than less.

Hammond Murray-Rust, then irrigation engineer at IIMI Pakistan, says that for the past ten years he has been trying to describe location in irrigation systems. He now thinks he has a partial answer, at least for Pakistan, in a methodology called "equivalent distance." The methodology attempts to define location in terms of the distance and the hydraulic conditions in channels upstream of any point in the system.

"I have been concerned for a long time by the relationship between linear distance down an irrigation system and performance," says Murray-Rust. "The overall head, middle, and tail classification fails to reflect what I see as a non-linear decline in performance down most systems. You can almost always identify a tail, but you can't really distinguish between a head and a middle. You see a lot of random variability as you move down the first two-thirds of the system, and only after that does it decline sharply.

"If distance effects in irrigation systems are non-linear," he continues," it is logical to look for hydraulic conditions that are also non-linear. The approach I've taken is to view each section of the canal system in terms of total overall supply and demand for that section. If the ratio between supply and demand is high, then that location will be less vulnerable to improper water management than one where demand is close to supply.

"Consider, for example, a farmer near the top of the system who wants 1 cusec of water going into his structure, when there are 50 cusecs going past his structure. That particular farmer is far less vulnerable to variation in discharge, than a farmer downstream who demands 1 cusec from a discharge of 5 cusecs going past his structure. The first farmer only has to capture 2 percent of the flow, whereas the second farmer must capture 20 percent. If there is a 1 cusec change in flow, from 50 to 49, the first farmer will still require close to 2 percent of the flow, whereas the second farmer will now need to capture 25 percent. Thus as you go downstream the sensitivity to change increases exponentially."

That is the basis of equivalent distance. Vulnerability to variable or inadequate water supply depends not on distance alone, but on distance modified by a supply and demand ratio.

To test the utility of the Equivalent Distance model, Murray-Rust and his colleagues collected data from the Lagar Distributary, in the command of the Upper Gugera Branch of the Lower Chenab Canal in the Pakistan Punjab. This particular distributary offered him an opportunity to assess distance effects without variation due to different types of control structures, because 22 of the 23 outlets along the 20 km main canal were replaced by proportional dividers during the 1930s. The staff measured the amount of discharge received through each of the 23 structures. The first step was to relate the amount of discharge to the actual distance down the channel.

"Initial analysis of those data," says Murray-Rust, "showed the expected result: a curvilinear relationship that was flat at the top, with a slight turn at the middle and a sharp decline at the tail."

He then multiplied the actual distance between successive structures by the ratio of the discharge in the main channel to the discharge into the structure, which in effect shrinks the distance by the percentage of discharge demanded by the structure. Thus in the reach above where the farmer demands 1 cusec from a 50 cusec main canal flow, or 2 percent, you shrink the actual distance to that structure by 98 percent.

When he accumulated these modified distances down the system, he found a much closer relationship to the collected data. "If you're taking one percent of a big discharge it doesn't matter if you're one foot or 100 feet down the channel, the structure is insensitive to that distance. So when you multiply the distance by that ratio, it shrinks all the distances at the head end, but doesn't shrink them so much at the tail end. And in the last section the equivalent distance is the same as the actual distance. The result is almost a straight line relating the equivalent distance to the ratio between actual and designed discharge. And you get a much better fit to the data."

Murray-Rust believes there is great potential for using equivalent distance as a management tool. "The most important advantage to managers is that it will allow them to identify management opportunities that are geared to reducing a single parameter," he says. "In our study, we used the percentage of designed discharge actually passing through the structure as our performance criterion, as opposed to the actual distance itself. So if you have a channel that is designed to pass one cusec through a structure and it is passing 1.5 cusecs, you have a discharge that is 150 percent of the designed discharge. Of the 23 structures, we found a range which varied from 175 percent of design down to 16 percent of design, a ratio between head and tail of about 11 times. That is pretty inequitable."

"If you plot designed discharge on a graph, it will be a nice straight horizontal line. And that is the design objective in Pakistan, to give everyone the designed discharge. When you look at our data of actual percentage received, the line is a straight line with a downward slope. The angle of that slope is a measure of inequity. So the steeper the line the greater the inequity. All your management activities should then be directed toward moving that line as close to horizontal as possible," he explains.

With a single measure of inequity, managers could effectively test management alternatives through the simulation or prediction of the proposed activity. "We found one interesting case where lining of watercourses along the distributary actually increased the inequity along the distributary," says Murray-Rust. Lining of watercourses can alter hydraulic conditions in the structure and increase discharge by eliminating the backwater effect of the watercourse. This would mean that there is less water available further downstream along the distributary. In the case we studied, four watercourses had been lined, all in the upper half of the distributary. If you assume that the discharge through the structures in the upper half of the canal increased roughly a half cusec each, it means that there are two cusecs less at the tail. So if you plot the percentage of designed discharge actually received, that line is steeper than it would be in the absence of the intervention. That suggests that it would be better to line the watercourses near the tail, while desilting the upper portion to try to get a water level as close as possible to the designed level."

Murray-Rust admits that the utility of the methodology will only be determined through further application in real irrigation systems. In particular, it requires testing in irrigation systems outside Pakistan where there is greater management potential through the presence of operable control structures.

A full report is forthcoming and should soon be available at IIMI Headquarters. □

JOHN COLMEY

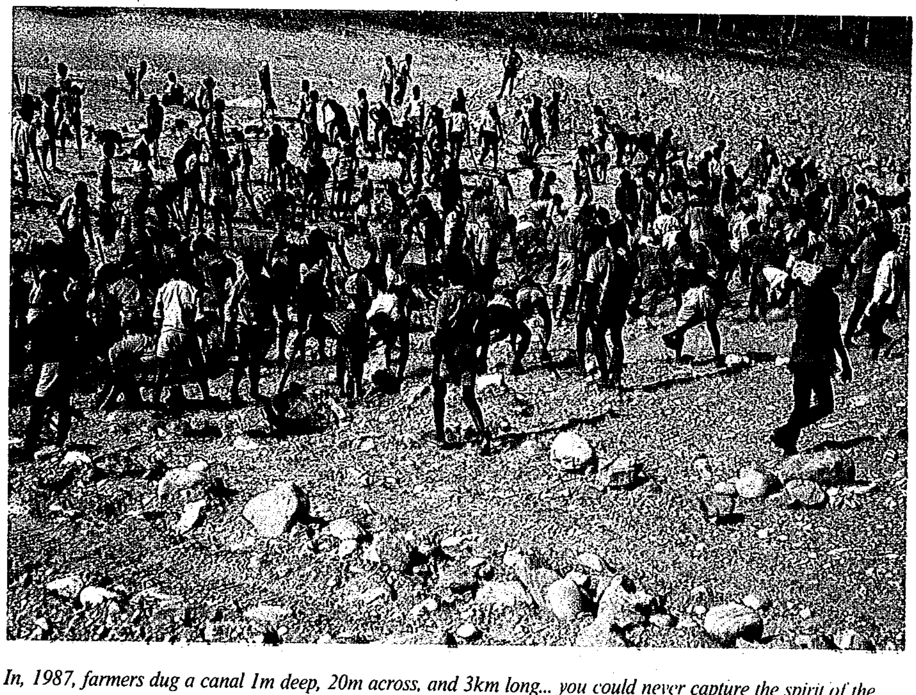
VIDEO DOCUMENTS FARMER-MANAGED IRRIGATION

There is no substitute for a field trip when it comes to explaining to irrigation officials the problems of an irrigation system. But in countries where travel is difficult and limited to certain periods of the year, few high level officials have the time to make such trips. The answer, says Prachanda Pradhan, IIMI social scientist in Nepal, is to bring the field to the official through a video.

IIMI's first video, which was directed by Pradhan, documents the seventy year history and the associated development of farmer institutions in a large farmer-managed system that diverts water from the Karnali river, in the Tarai (plains) of Southwest Nepal. IIMI contracted Worldview International Foundation, a non-profit communication foundation with offices in Sri Lanka and Nepal, to film and produce the video.

"We learned about the system from WECS staff and reports. They had sketchy information about labor mobilization and the problems farmers faced in managing the system. So we decided to visit the system and see for ourselves."

IIMI staff from Headquarters and Nepal visited the system in 1986. They found that there were three systems of 5,000 ha (each diverting water from the Karnali River into the Kailali district) that had federated their organizations in the past year. This federation of



In, 1987, farmers dug a canal 1m deep, 20m across, and 3km long... you could never capture the spirit of the event in a report.

systems is among the largest farmer-managed systems in Nepal. It is also one of the most difficult to manage -- the Karnali has huge fluctuations ranging from 300 m3/sec in the dry season, to 28,000 m3/sec during monsoon. Farmers, working through village and command level committees have to mobilize over 100,000 person days per year to operate and maintain the system.

Pradhan says that field visits to the system, which is about two days' drive from Kathmandu, are easiest during March or April. "The impression one comes away with at that time, when the river is at its lowest level," says Pradhan, "is of an inoperative system in complete disrepair. There is no irrigation at that time, and the monsoon floods destroy many of the wooden structures and temporary diversions." As a consequence, past requests from farmers for government assistance have, for the most part, gone unnoticed.

In 1985, farmers' problems were accelerated when silt left by a major flood raised Karnali's river bed, obstructing dry season water flow down the 3 km stretch to the system intake. Pre-monsoon water flow, which increases with snow melt in the mountains, is critical for land preparation activities. In response, farmers organized a central committee, made up of farmer representatives from the 104 village and three command committees, to mobilize the labor to desilt that stretch of the river.

"You have to see it to believe it," says Robert Yoder, IIMI Agricultural Engineer, also in Nepal. "Over 1,000 laborers come from as far away as 30 km to participate in the operation. The organizational requirement is tremendous. In 1987, farmers dug a canal 1 m deep, 20 m across and 3 km long -- they moved the equivalent of 10,000 truckloads of rock and debris by hand. You could never capture the spirit of the event in a report."

In addition to documenting the desilting operation, the video explains the organizational structures that farmers have evolved to manage the system, as well as the problems that led to the farmers' request for assistance. These problems include the dependence on wood for structures in the face of accelerating deforestation, the increasing labor requirements, and the increasing population pressure. "Government assistance to this strong federation of organizations in replacing forest products with Gabion wire is one way to improve the reliability of the system, and reduce the operation and maintenance cost," says Yoder.

Pradhan says the video will be shown in Nepal to illustrate farmers' capacity to operate and maintain large irrigation systems even in the face of extremely difficult technical problems, and to begin identification of areas where governmental assistance would be beneficial. "Our interest is to propose assistance strategies that enhance and capitalize on organizations and water distribution principles evolved by farmers. The video will help us present the case."

He admits however that the video, which took a year to produce including four weeks in the field, was a lot of work. "I don't think I'll take on another one any time soon." □

ROCKEFELLER FOUNDATION FUNDS IIMI/IRRI COLLABORATION

The Rockefeller Foundation has provided US$ 1.2 million to IIMI to initiate a collaborative research program with the International Rice Research Institute (IRRI), headquartered in the Philippines. The project, which is currently being implemented in the Philippines, Bangladesh, and Indonesia, offers IIMI an important opportunity to collaborate with one of the 13 International Agricultural Research Centers supported by the Consultative Group on International Agricultural Research (CGIAR).

The work plan will address three options within the context of reduced economic returns from irrigated rice lands. These include increasing the economic yields of rice, increasing the area served by scarce water resources through more effective and efficient irrigation system management, and introducing crops of higher value than rice into the irrigated rice farming system. The first is a major element of IRRI's Core Program, and the second, an integral part of IIMI's mandate to improve irrigation system management. Both institutes are concerned with obtaining higher economic and more equitable social returns from water and associated land resources. Taking these factors into account, a major emphasis will be placed on the agronomic, water, and irrigation system management issues related to non-rice crops in irrigated farming systems.

In the Philippines, research will build on the work of both institutes in the context of irrigation management for both rice and non-rice crops. It is anticipated that the experience, broad discipline, and scientific strengths of IRRI will provide an excellent base for addressing the major questions associated with more economic and equitable use of scarce irrigation water.

In Bangladesh, the program will build on IRRI's research carried out in collaboration with the Bangladesh Water Management Department and the Bangladesh Rice Research Institute. That research sought to demonstrate the value of improved agricultural practices for rice production combined with relatively modest changes in irrigation management. The IIMI/IRRI program will address two of three options: increasing the economic and the social efficiency of rice production and water use.

In Indonesia, the program will again build on the ongoing projects of both institutes. IIMI is currently working with the Directorate General of Water Resources Development to improve irrigation management practices related to irrigating non-rice crops during the dry season. IRRI has been working for a number of years with the Sukamandi research station to develop its research capacity in the area of soil-water/tillage interactions in rice/soybean systems. The Indonesia program complements that in Bangladesh by addressing the third option -- the productivity of non-rice crops in rice-based farming systems -- and by exploring, in the Indonesian context, the factors affecting the increase in equity and efficiency of water use.

The three projects are expected to continue over a three year period. Work will begin with a series of conferences in each country with participating institutes and agencies. Those conferences will further refine the research objectives and strategies by including the input of host country partners. □

JOHN COLMEY

IIMI TO INITIATE RESEARCH IN BANGLADESH

IIMI hopes to initiate activities in Bangladesh with support from the Ford Foundation sometime in early 1988. A Memorandum of Understanding with the Government of Bangladesh is expected to be signed shortly.

According to Gil Levine, IIMI Senior Associate and chief architect of the Bangladesh initiative, an IIMI program in Bangladesh can make a significant impact on irrigation management. "If you consider investment in irrigation and irrigation potential, the four major Asian countries, with the exception of China, are India, Bangladesh, Pakistan, and Indonesia. And, if you look at the sense of need that those governments have and their willingness to commit resources to that need, those four countries represent far and away the major investing group. Consequently, increased understanding and application of new ideas will have an important impact."

If you consider investment in irrigation and irrigation potential, the four major Asian countries, with the exception of China, are India, Bangladesh, Pakistan, and Indonesia.

"Bangladesh is unique among those countries because it has a short history of irrigation, dating back to its independence; at the same time, it has the needs for irrigation efficiency, equity, and productivity, characteristic of a late stage in irrigation development. This is because of the population pressure, and the highly energy-dependent nature of current irrigation practices.

"Under these circumstances, it is difficult to transfer technologies or innovations directly from other countries. Therefore the need to study the circumstances and the possibilities within Bangladesh itself becomes critical," says Levine.

"The next five year plan anticipates that 60 percent of the agricultural area will be brought under irrigation. That," he says, "represents more than double the current irrigated area with a wider dispersion of irrigation types, including a heavy emphasis on surface water systems on tributary streams, where Bangladesh has relatively little experience."

IIMI has identified three agencies in irrigation with which it could collaborate: the agricultural research establishment embraced by the Bangladesh Agricultural Research Center (BARC), the Bangladesh Agricultural Development Corporation (BADC), and the Bangladesh Water Development Board (BWDB).

BARC and its associated institutions --Bangladesh Agricultural Research Institute and Bangladesh Agricultural University -- is primarily concerned with ground water. BADC is an implementing agency that works in the area of deep tubewells; more recently it has begun to turn over these systems to farmers for their management. The BWDB is primarily concerned with large tubewells and large lift systems from the rivers, though recently it has shifted emphasis to providing more services to farmers.

Because of the emphasis on management issues, IIMI expects to recruit a specialist in organizational management to head its collaborative program in Bangladesh. That recruitment is now underway. In addition to working with one or more of those three agencies, a strong administrative and research relationship is envisioned between IIMI and the International Rice Research Institute (IRRI) which is currently carrying out collaborative research with the Bangladesh Rice Research Institute and BWDB. Linking with IRRI will allow IIMI to take advantage of IRRI's strong working relationship with Bangladesh's agricultural research community. IIMI will also benefit from the administrative and logistical arrangements, thus reducing the cost and time necessary to initiate its program.

Perhaps most importantly, "the addition of social science to Bangladesh's agricultural and engineering capacity will create a strong triumvirate to undertake work in irrigation," says Levine. □

JOHN COLMEY

IIMI HOSTS SECOND SPECIAL AWARDEE

"We used to get into the channel when we saw the irrigation official's motorcycle. He went his way and we went ours. But Sunil Gunadasa used to walk along the bunds at night trying to spot channel breaches by torchlight. His dedication gave us a new awareness of ourselves as a group with common interests." (Dassenayake, a farmer leader from Kimbulwana.)

"Now we know that one inch of standing water is sufficient. Flooding the field at critical stages can decrease the yield due to loss of fertilizer." (Seeladasa, elected farmer representative from Kimbulwana.)

The settlers under the Kimbulwana reservoir in western Sri Lanka are subsistence rice cultivators. Every year, until 1979, cultivation commenced when the storage tank began to spill. When it did, it was a case of who was the quickest and smartest at turning the most water into his field, regardless of how.

In 1979, A.M.S.Sunil Gunadasa, IIMI's second special awardee, came to Kimbulwana as a Technical Assistant from the Irrigation Department. Through ten years of field experience elsewhere in Sri Lanka, Gunadasa had learned the physical and man-made constraints to good irrigation management.

After reviewing the deterioration of the irrigation system that had taken place since its restoration in 1956, he allotted one cultivation season to repair the channel structures and employed the farmers as day laborers. "Rehabilitation of a system must consider and remedy the original reasons for decline," comments Gunadasa.

Born in a remote village and educated at St. Mary's College, Chilaw on Sri Lanka's north western coast, Gunadasa joined the Irrigation Department, one of many government line agencies involved with agricultural production. The Irrigation Department gave him two years of training in subjects related to civil and irrigation engineering, and sent him to the field to operate as a liaison between the administration and farmers.

"Farmers need proper technical guidance to participate in system improving activities for their own benefit," says Gunadasa. When he first declared his intention to limit and rotate water releases, the farmers sent a petition to the government agent of the district. Through field demonstrations, he convinced farmers that a well-managed 12 hour rotational issue was more efficient and equitable than the previous system of continuous issues for three or four days. A water issue timetable was prominently displayed and communicated among the farmers. After the 1980 dry season when stage 2 of rehabilitation was complete, Gunadasa expanded the rotational issue and provided a timetable for water issues to field channels throughout the command.

Gunadasa also demonstrated how to conserve rainwater by advancing cultivation time and reducing the land preparation period. If successful, farmers could then use the water for cultivation during the subsequent dry season. Since 1980, Kimbulwana farmers have completed two successful cultivations during the dry season in spite of low rainfall. "This was due to proper seasonal planning and strict compliance with the rules of water use," observes Gunadasa. A third inter-seasonal crop of pulses and vegetables has been possible every third year on 350 acres using what remained of the dry season water supply.

The farmers under the Kimbulwana reservoir now operate and maintain the entire water distribution channel network. The Ministry of Lands has recognized their enterprise by exempting the farmers from the statutory irrigation maintenance fee of Rs. 100 (US$ 3.30). "The 70 farmers in my unit clean the field channel twice for a cultivation season and if they don't participate, I send them a letter levying a Rs.50 (US$ 1.66) fine," explained one of the twelve elected farmer leaders. Farmer leaders meet every Tuesday to decide on water issues, with the guidance of Government agency officials. "Government officers can obtain results by trustworthiness, professionalism, impartiality, and a tactful approach," says Gunadasa.

Gunadasa advocates farmer participation in all activities: planning, implementation, construction, and operation and maintenance.

IIMI selected Gunadasa as its 1987 Special Awardee for his efforts in bringing improved water management practices to the farmers of Kimbulwana. IIMI presents the award to irrigation managers who have successfully carried out management innovations; awardees are invited to IIMI to document their experience with professional assistance from IIMI staff members. "It is the only way I would have been able to document my experiences," says Gunadasa. The Special Award Scheme is one element of IIMI's Professional Development Program.

The Kimbulwana Oya Case Study will be published in early 1988. □

SIROHMI BOTEJUE

Farmers dragging buffaloes across the channel have to pay a fine. Farmer organization has given the farmers of Kimbulwana an awareness of themselves as a group with common interests.

IIMI CO-SPONSORS HYDERABAD WORKSHOP & ASIAN STUDY TOUR

"The question was not the 'why' but the 'how' of farmers' participation."

"Participatory management must include the concepts of empowerment of people, and accountability of the bureaucracy to people." So began a recent policy workshop on "People's Participation in Irrigation Management" held at the Administrative Staff College of India in Hyderabad. The workshop, attended by senior Indian policy makers, was co-sponsored by the Ministry of Water Resources, Government of India, IIMI, and the Ford Foundation. The conference also included a study tour to Indonesia and the Philippines.

"As this is the first IIMI effort in India, it was considered useful to reach the senior administrators in charge of irrigation policy making in India through a high level workshop on policy issues in irrigation management," said P.S. Rao, an IIMI Senior Scientist. "IIMI felt that such senior people would also benefit by exposure to experiences in other Asian countries which have tried to implement policies similar to those dealt with in the workshop. However, it was important to ensure that the policy responses be appropriate to Indian conditions," said Rao.

IIMI felt that such senior people would also benefit by exposure to experiences in other Asian countries which have tried to implement policies similar to those dealt with in the workshop.

"By and large, the workshop achieved these objectives." But Rao cautioned, "Irrigation in India is a state subject and the conditions and complexities vary from one state to another. One must be careful in generalizing about problems of irrigation in India."

The Workshop, which ran from 28 June to 21 July, included 18 senior irrigation policymakers from nine Indian states and the central government of India. K.K.Singh, Chairman, Agriculture and Rural Development, Administrative Staff College, coordinated the workshop. Singh also made several key presentations, including a paper on the Public Tubewell - 175 LG in Uttar Pradesh, part of a World Bank scheme, and a case study of the Tribal Lift Irrigation Cooperative Societies in Gujarat, which documented experiments conducted on different forms of system management with varying degrees of farmer participation.

The workshop stressed the need for bureaucratic reform and for greater efforts to promote responsible farmer participation. According to Douglas Merrey, IIMI Social Scientist and workshop participant, "These efforts could be successful only if there is a high level of political support, and a willingness to empower people -- endow their groups with legal rights -- and make the irrigation bureaucracy accountable to the water users." Participants presented examples of people's participation in irrigation management, including turning over authority to recognized groups, in Gujarat, Kerala and Andhra Pradesh.

Most of the case studies were based on experiences in India. However, many participants shared their own experiences with people's participation. These presentations led to lively and useful discussions, and demonstrated a wide range of efforts already underway in India.

In addition, several presentations related experiences from other Asian countries. Benjamin Bagadion, an IIMI Board Member, presented a paper on the Philippine experience in using "Community Organizers" (COs). Merrey presented a similar report on the Sri Lankan experience with "Institutional Organizers" in the Gal Oya irrigation system (D. Hammond Murray Rust, IIMI Agricultural Engineer, co-authored the paper). And Senior IIMI Associate Gilbert Levine provided a paper on Taiwan's irrigation associations, and linked the experience to wider policy issues.

Study tour participants, led by Singh, Rao, and Senen Miranda, head of IIMI's Professional Development Program, visited irrigation schemes in the Philippines (5-12 July) and Indonesia (12-17 July).

In the Philippines, a National Irrigation Administration (NIA) consultant arranged visits to small and large irrigation systems (PORAC-GUMAIN, AMRIS and UPRIIS), lift and gravity type, with farmers' organizations involved in their management to different degrees. In addition to talking with farmer representatives, participants met with officials from NIA in the field and at NIA headquarters.

In Indonesia, initial discussions with senior officers of the Directorate General of Water Resources Development were followed by visits to the Madiun project in East Java and to 'subaks' (village level farmer - managed systems) in Bali.

After the tour, a participant commented that "The sense of ownership and belonging brings out the inherent cooperative nature of human beings, apart from the fact that local knowledge contributes to better planning, design, and low cost construction." He added that levying irrigation service fees in "kind" rather than in "cash" was one way to offset inflation. Another observed that appropriate incentives and farmer involvement could improve fee collection.

Community Organizers in the Philippines and Institutional Organizers in Sri Lanka were seen as useful catalysts to motivate and organize farmers, due at least in part to their independence from the bureaucracy. It was also noted that the success of the farmer organizations in the Philippines appeared to be due to greater economic and social equity at the village level than found in India. Strong government support through agency backstopping was also considered necessary. One participant suggested that the government should subsidize farmer organizations at least initially. Another participant felt that the NIA's learning process approach and self-sustaining status contributed towards achieving the participatory management target. The transition period in turnover was also considered useful as it resulted in farmers becoming assured of water supply while demonstrating their ability to manage the system. Similar pilot projects were suggested for India.

In Indonesia, IIMI social scientist Douglas Vermillion's knowledge of the language and the systems helped the participants to understand the subak community system with its emphasis on traditional religious values and nonviolation of procedures. The subaks, it was felt, have adopted an area development approach with the farmers' association, keeping water management and agriculture in focus. Participants however did not view the subak system as replicable in India due to Bali's unique religion context and plentiful water; but the emphasis on making maximum use of water was commended. Some similarities with Indian systems were however noted, specifically between subaks and traditional south Indian tank systems.

The Indian visitors appreciated Indonesian efforts to ensure equity among the farmers. A few participants felt however that farmer participation in both the Philippines and Indonesia, in the context of large government subsidies, was still too new for assessment.

The participants returned to Hyderabad on 20 and 21 July to discuss their experiences and, based on those discussions, to make recommendations to the state and central governments in India.

The Hyderabad Workshop recommended that people's participation was essential to strengthen the autonomous human organization, fostering amicable relations among farmers and confidence in the irrigation system. It would optimize water use for agriculture, preventing waste. It encouraged community responsibility for management of assets and improved fee collection, leading to financial autonomy and defraying of maintenance costs. This would reduce the overall cost of irrigation while contributing to social equality. The participants also felt that farmers' participation would result in better maintenance of the system, in better water management at the tertiary level and equity in water allocation with the allocator being accountable to the farmers. It could lead to better and more equitable water management especially during dry seasons, and more effective communication between farmers and government departments.

The workshop recommended a minimum service area of 400 to 500 ha respecting hydraulic and social boundaries as a viable unit for self-managed farmer organizations. The Indian policy makers also advocated a two to three tier hierarchical organization from a unit for basic operation (40-100 ha), up through a unit for management (400-500 ha), to a coordination unit and, in very large systems, an apex organizational unit.

The participants also made strong recommendations for an active and accountable extension service at the grass root level, and for water charges collected from farmers to remain in the systems with farmers being given incentives to assist in collection. Finally, drawing from the Philippine and Sri Lankan cases, the participants urged special efforts for promoting farmers' organizations (FOs), to be made either through existing extension services (provided with appropriate training and incentives) or through special organizers.

FOs should be legally recognized, with provision for takeover in case of malfunction. They will gradually provide other inputs and services including marketing.

Workshop participants agreed that to act on these recommendations would require a national consensus, as stated by the Indian Irrigation Ministers' Conference. □

SIROHMI BOTEJUE

It was important to ensure that the policy responses be appropriate to Indian conditions.

(Continued from Page 11)
that they may plan to finance, or are involved in financing, regardless of how advanced those schemes might be."

Such an extreme recommendation is not the outcome of a skimpy pamphlet but a well-documented if strident three volume study. Their position is supported by journalists highlighting prominent failures such as The Economist's February 1985 report on the infamous Bura Scheme in Kenya:

Originally, 35,000 settlers were supposed to grow cotton and a few staple crops on 14,000 hectares of land at Bura, which would have a total population, including traders and others, of 65,000. Today, seven years after work began, only 2,800 hectares have been planted. Much more than that has been cleared, but the dust blowing up from it makes it unlikely that there will be enough topsoil left to grow crops. Some 2,000 families -- maybe 20,000 people -- have moved to Bura. Ten villages, out of a planned 25, are finished; the sites for other villages, marked by neat little rows of stand-pipes, look a bit like graveyards.

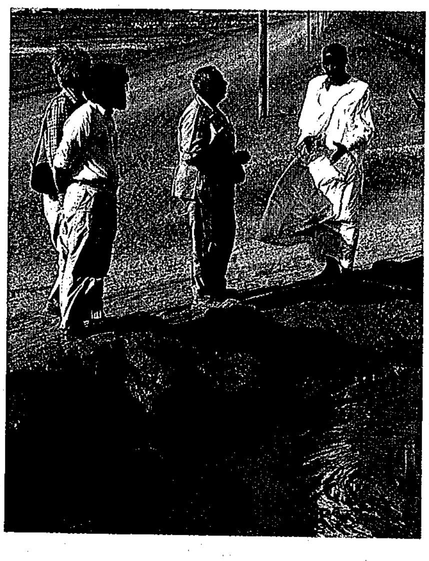
The scheme's failures have become part of development folklore: an official of the World Bank, the project's biggest donor, has compiled a 40-page bibliography on the project. Costs proved much higher, and crop yields lower, than the planners had budgeted for.

Although the size of the project was drastically reduced, spending went ahead unchecked: capital costs have risen from the $98.4m planned in 1977 to nearly $110m so far. The pumped irrigation system, which was supposed to be a stop-gap until a gravity system could be developed, is still Bura's only source of water. This has serious consequences: the pumps often break down, depriving the crops of water. The conclusion of a World Bank appraisal last year was that the project's management was over-centralized and incompetent."

Irrigation enthusiasts cannot ignore such reports nor dismiss them as unique. These problem schemes must be countered by reports of success. And the problems themselves must be accurately addressed and resolved.

Robert Repetto (op.cit) in another recent iconoclastic attack on irrigation, serves a grave more general warning that links problems of markets, finance, management, and environment.

The political economy of public irrigation systems leads to poor use of water and invested capital. Pervasive (economic) rent-seeking, which stems from the divorce of benefits from financial responsibility, distorts investment decisions, the design and operation of irrigation systems, and patterns of water use. The consequences are inefficient, inequitable, fiscally disastrous, wasteful of increasingly scarce water, and environmentally harmful. While the rent-seeking phenomenon is legendary in public irrigation systems in the United States, it is being underemphasized in the rest of the world. Those concerned with irrigation development are trying to "work around it" to improve the performance of public irrigation systems by physical rehabilitation and efforts to strengthen management. These efforts, while also critical, are unlikely to succeed unless the incentive issues are squarely faced. Much can be done to correct incentives by placing financial responsibility on beneficiaries. Successful models exist, and now is an opportune time for change."



If he is right, irrigation professionals had best study and replicate the successful models. The enthusiasts may for their own reasons keep the irrigation bandwagon moving, but the US$100 billion he claims is likely to be spent on irrigation in the rest of this century will only be forthcoming if a much-improved operating performance is demonstrated.

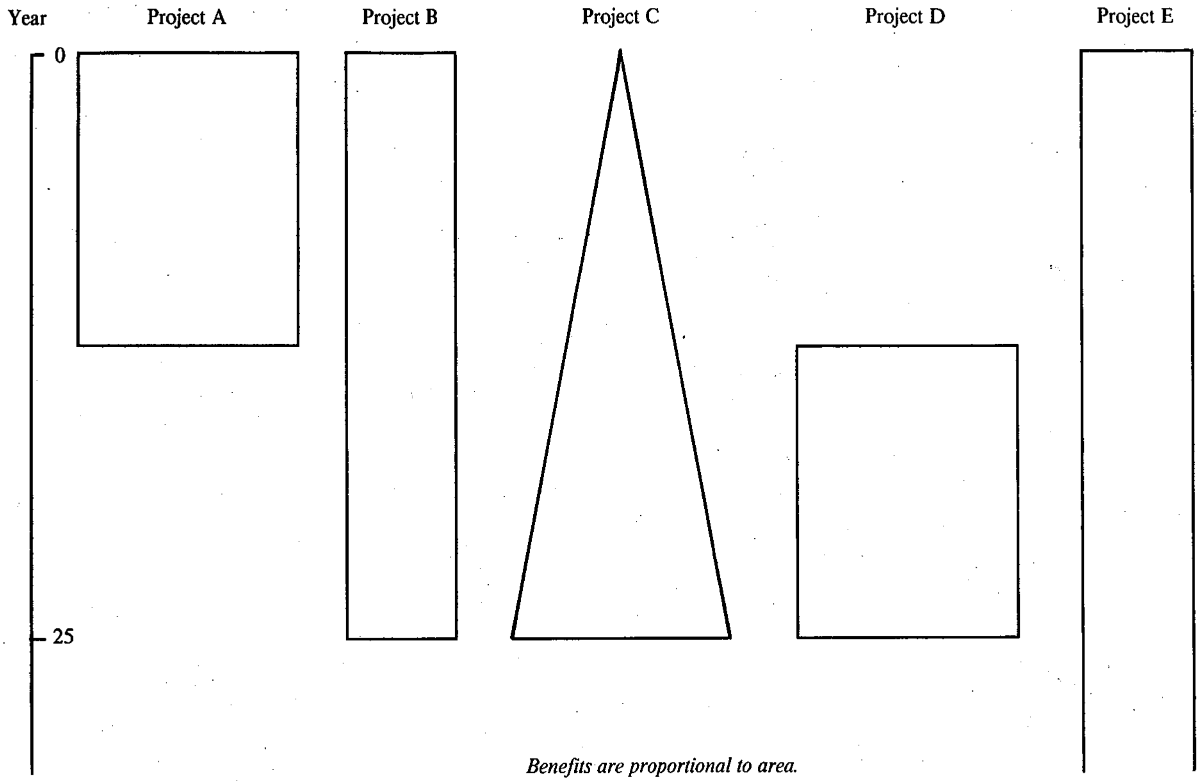
Finally, I feel bound to complain that we seem to be slow learners. In 1976, I was one of several authors who prepared a workshop report entitled "A suggested action programme on irrigation management" that was part of the British Government submission to the World Water Conference in Argentina in 1977. The report concluded that management was inadequate, new projects were a pitfall and priority should be given to improving existing irrigation. Seven specific recommendations were made to achieve this: more evaluation and feedback to include technical, political, organizational, managerial, and farmer incentive issues; more prestige and resources for O&M; more political support for necessary and unpopular measures (e.g., farmer discipline); improved extension and training; encouragement and experiment with small irrigation groups; more modernization and intensification; and a political priority for irrigation.

Movement in these areas has been slow. Indeed an agenda for reform today, more than ten years later, would include all of the elements in that seven point program.

The irrigation lobby should not always see the environmental lobby as an enemy. There is one particular area where current economic practice adds grave problems to irrigation development and where environmentalists could bring helpful pressures. All participants to irrigation planning and ex-post evaluations are aware that irrigation is a longterm investment. Although expensive, it is not particularly risky. The main risk stems from the fact that the speed with which potential benefits can be realized is slower than most plans predict. Irrigation is a tortoise wishing it was a hare. Mindful of my fables, I recall that it is often better to be a tortoise. However, the investment appraisal rules do not favor the slow but sure investment.

The main economic criterion for selecting investment is some form of net present value (IROR, CBA, or NPV). The effect of this is to give emphasis to early benefit. To bring out the point I wish to make, I need to show some arithmetic gymnastics. The key points are well illustrated in Figure 2. The first four of the five projects produce equal amounts of total benefit over a 25 year life. Economic assessment using any discount rate would rank the projects A,B,C,D. Project A could involve pumped sprinkler irrigation but after 10 years the soil is eroded and the project ceases. Project B is an O&M project.

Figure 2. Diagram showing various distributions of benefits for a given level of investment.



Benefits are proportional to area.

Project C is a slow rehabilitation project, but Project D a slowly-built labor intensive scheme. Project E produces twice as much benefit but the investment lasts 50 years. At 10 per cent discount rate, the project with twice as much net benefit would add less than 10 percent to total NPV and at 15 percent discount, double the production gives less than 3 percent extra to NPV.

Environmentalists worry greatly about Project A especially if the net present value results in irreversible deterioration in the soil. They would rightly point out that any net benefits from repeating B, C, and D, and any technical improvements that might take place, are not taken into account in the original calculation.

Some environmentalists would consider any weighing of benefits by the time in which they occur to be immoral. Others would argue it is the poverty of the beneficiaries that is important in deciding weighting, not when benefits arise. Who is confident that, say, a typical Bangladeshi in the year 2000, with 157 million countrymen, will be any less poor than today? Why should we, as irrigation investors using 15 percent discount rates, argue from a monopoly position regarding resource development, that a dollar to a Bangladeshi in 2000 will be worth the equivalent 16 cents of today's benefit, i.e., one-sixth of a dollar? It can be argued that discounting is only valid if the next generation is expected to be wealthier such that diminishing marginal utility arguments can be deployed.

Most irrigation enthusiasts are uneasy about the "tyranny of compound interest" or its reciprocal, the discount rate. It is responsible sometimes for the haste to get benefits, the dropping of components to lower early costs, the ignoring of large late-arising benefits and costs (e.g., salinization of soil) and worst of all, the fraudulent manipulation of forecasts to ensure that the project arithmetic produces the minimum cut-off rate of return. I have argued elsewhere that investment criteria have to be multiple, that they are not inherently equal, and that the economic criteria although important, need not be the dominant test. Environmentalists with a different perception of time issues can do much to aid and not hinder irrigation development.

It is vital that the reputation of irrigation as a productive sector for public and private investment is rehabilitated. Population growth is continuing and a further 1.4 billion are expected in low and middle income countries by the year 2000. With extremely limited scope for increases in area cropped, the specter of Malthus is never far away from us. Sir Kenneth Blaxter (1986) concluded very dismally.

"One can argue that the pessimism of Malthus was largely dispelled in the nineteenth and early twentieth century by increasing the land resource consequent upon the opening up of new lands in the Americas, Australia and Southern Africa. In the last half century, the pessimism has been further attenuated by the success achieved in increasing yield per unit area through the use of energy derived from past eras of photosynthesis to augment that currently produced. There is at present no sign of some new additional delaying tactic that could be employed to postpone Malthus' vista."

If we are to thwart the Malthusian predictions of population growth controlled by "misery and vice" to give time for a new delaying tactic to emerge, then the full panoply of modern agricultural technology together with effective and reliable irrigation will be essential. We can no longer feed the world simply from rainfed agriculture on compost-enriched soil. Irrigation is going to be a central component of sustaining food supplies and livelihoods. □

Publications

IIMI publications are available free by writing to the Communication and Publication Office, IIMI, Digana Village via Kandy, Sri Lanka. Because some publications are in short supply, please request no more than three titles. Shipments will be by surface mail; allow one to three months for delivery.

International Irrigation Management Institute. 1987. Fellowship and Special Awards Program. Digana Village, Sri Lanka. April. IIMI pub 86-09.

This brochure describes IIMI's Professional Development Program, with special attention to fellowships and special awards for irrigation professionals. Application procedures are included.

Asian Development Bank and the International Irrigation Management Institute. 1986. Irrigation service fees: Proceedings of the Regional Seminar on Irrigation Service Fees, Manila, 21-25 July. Manila, Philippines: ADB pub.

The proceedings contain a compilation of the country papers and conclusions of the seminar, part of which reviewed the results of a study conducted by IIMI to examine the procedures used in five Asian countries to levy irrigation service fees on farmer beneficiaries.

International Irrigation Management Institute and Water and Energy Commission Secretariat (WECS) of the Ministry of Water Resources, Government of Nepal. 1987. Public intervention in farmer-managed irrigation systems. Digana Village, Sri Lanka: IIMI pub. IIMI pub 86-21.

In many countries, farmer-managed irrigation systems account for a significant portion of the irrigated area and food produced. A growing recognition of their importance has led irrigation agencies to assist these systems by increasing water supplies and improving reliability. Results have been mixed. To identify and define research issues and appropriate methodologies related to public intervention in farmer-managed irrigation systems, IIMI and WECS held an international conference in Kathmandu, Nepal. These 18 conference papers present recent and ongoing research, as well as agencies' experiences, on farmer-managed systems.

International Irrigation Management Institute. 1987. Irrigation management for diversified cropping. Digana Village, Sri Lanka: IIMI. IIMI pub 86-33.

Improvements in rice growing technologies during the last two decades have resulted in a number of countries, especially in the humid tropical regions of Asia, nearing self sufficiency in rice production. Consequently, policies are shifting in these countries toward minimizing the under-utilizaton of land by increasing the cropping intensity of irrigated areas, particularly by growing non-rice crops during the dry season. These workshop papers discuss the advantages of, and constraints to, crop diversification in different country situations throughout Asia.

Cowell, Robert L. 1987. Communication audit: A field method for assessing communication in irrigation organizations. Digana Village, Sri Lanka: International Irrigation Management Institute Management Brief No. 3. June. IIMI pub 86-34.

Discusses the concepts involved in using a communication audit as a management tool for helping to improve irrigation system performance through improved communication within the agency responsible for system operations. It reviews some of the methods an irrigation manager might use to evaluate the effectiveness of communication within his own unit, and explains what a manager will encounter if a communication audit is conducted on his unit by outside auditors.

International Irrigation Management Institute. 1987. Annual Report for 1986. Digana Village, Sri Lanka. August. IIMI pub 87-04.

International Irrigation Management Institute Management. IIMI Review,. vol. 1, No. 1 (May). IIMI pub 87-05.

The IIMI Review is published three times per year to inform irrigation management professionals, researchers, and others who may be interested in IIMI and its efforts to improve and sustain irrigation performance in developing countries. This first issue contains articles on financing irrigation systems, irrigation studies in the Philippines, IIMI's new strategy in Africa, and a paper by Hammond Muuray-Rust called "The impact of lining on water distribution in Ghordour and Lagar (Pakistan) distributaries."

Merrey, Douglas J. amd Senarath Bulankulame. 1987. Responsibility in irrigation system management: Some policy suggestions for Sri Lanka. Digana Village, Sri Lanka: International Irrigation Management Institute Management Brief No. 5. September. IIMI pub 87-17.

This Brief suggests a classification scheme for irrigation systems in Sri Lanka, a set of broad policy objectives for each type of system, and possible strategies to achieve the policy objectives.

Hydraulics Research, International Irrigation Management Institute, and the Irrigation Department - Sri Lanka. 1987. Irrigation design for management: Asian Regional Symposium. Kandy, Sri Lanka, 16-18 February. Wallingford, England: Overseas Development Unit of Hydraulics Research Ltd.

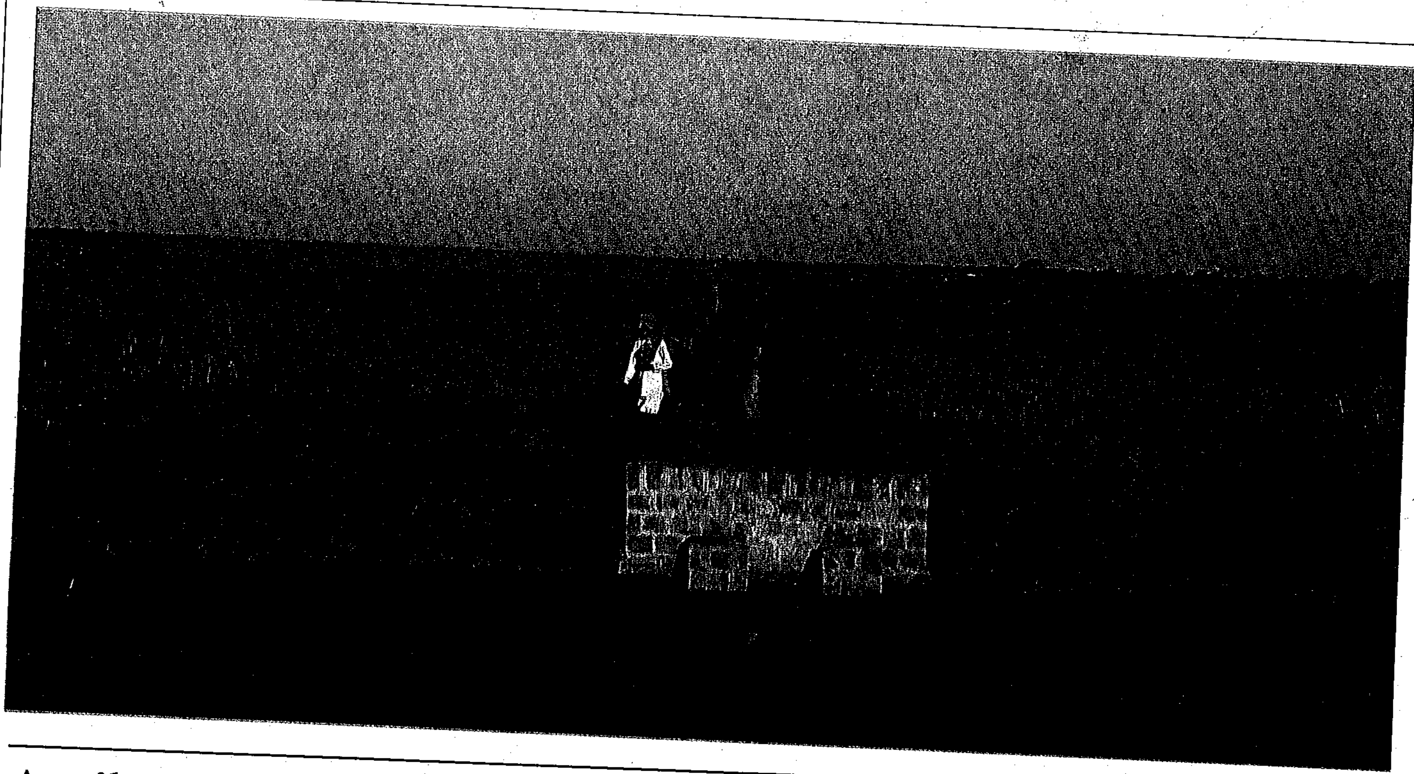
The proceedings contain a compilation of papers presented and/or submitted to the symposium. Topics covered included: multi-disciplinary approaches to irrigation design, improved design for management - new projects, improved design for management - rehabilitation, organization of farmer participation,institutional framework for irrigation management, impact of design on management, and methodology and case studies.

Due to the high costs of postage and printing, only *The IIMI Review* and the *IIMI Annual Report* will be automatically sent to the entire mailing list. A periodically updated publication list will also be sent to mailing list members.

If you wish to be added to IIMI's mailing list, please write to: Mrs Shanthi Dissanayake, Dissemination Officer, IIMI, Digana Village via Kandy, Sri Lanka.

Thank you for your understanding and cooperation.

Calendar



April

18 - 19 - Workshop with IIMI clients to ascertain their views on IIMI Strategy Paper, Digana.
30 - Meeting of Sri Lanka-IIMI Consultative Committee.

May

23 - IIMI's Director General to give 1988 Gerald Lacey Memorial Lecture, International Commission on Irrigation and Drainage, British Section, London.

June

13 - 14 - Meeting of IIMI Program Committee, Digana.
15 - Meeting of Executive & Finance Committee, Digana.
16 - 18 - Meeting of IIMI Board of Governors, Digana.

The 14th International Congress on Irrigation and Drainage, organized by the International Commission on Irrigation and Drainage (ICID), is to be held in Rio de Janeiro, Brazil, from 29 April - 4 May 1990. It is being hosted by the Brazilian National Committee of the ICID. The Congress topics, chosen to reflect central concerns of the world irrigation community, are "The Influence of Irrigation and Drainage on the Environment with Particular Emphasis on Impact on the Quality of Surface and Ground Waters" (Question 42) and "The Role of Irrigation in Mitigating the Effects of Drought" (Question 43). A special session will be held on "Socio-economic and Technological Impacts of Mechanized Irrigation Systems." The 1990 symposium will be on "Real-time Scheduling of Water Deliveries."

Requests for information in regard to submission of papers should be addressed to: The Secretary, International Commission on Irrigation and Drainage (ICID), 48 Nyaya Marg, Chanakyapuri, New Delhi, 110 021 (India).