

**REGIONAL CONSULTATION ON INVESTMENT IN LAND AND WATER  
3-5 October 2001, Bangkok, Thailand**

**Investing in Irrigation and Drainage  
in the context of Water Policy and Institutional Reform**

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**INTRODUCTION**

Participatory irrigation management and irrigation management transfer reforms often have the stated objectives of providing sustainable and adequate financing for operation and maintenance of irrigation and drainage services and of facilitating investment in the required rehabilitation or upgrading of irrigation systems.

Overall reform of water resources management often encompasses these reforms. It often includes demand management to encourage efficient water allocation and imposes new externalities on irrigation systems in terms of environmental performance.

In Asia, where the older public schemes reach the age of 30-40 years in most countries, the issue of rehabilitation, which is related to those of operation and maintenance and modernization, is becoming increasingly important. While for some countries the extension of irrigated land still represents an important part of irrigation programmes, in most countries rehabilitation programmes are taking on increasing importance. The content and orientation of rehabilitation in a context of PIM/IMT will therefore be critical.

This paper reviews the concepts of irrigation management transfer, modernization and service. The paper then examines IMT and PIM in the context of reforms towards integrated water resources management.

It is important to understand the actual characteristics and water management in the systems that are being transferred. Thus, the paper reviews the actual systems as they exist and impact and results of IMT and PIM programmes in the region and focuses more particularly on water management for rice, which is the most important crop in the region.

The paper then expands on the notion and consequences of service orientation in irrigation and drainage, and examines requirements in training and capacity building in the sector.

In the conclusion, some general findings and recommendations are made on investment in irrigation and drainage systems in the context of water policy and institutional reform.

In two separate annexes, the decline in public investment in the sector and the relation between irrigation and drainage development and poverty alleviation are discussed. Poverty alleviation is increasingly the overarching socio-economic development goal of countries and donors.

## A. SOME DEFINITIONS

### Irrigation Management Transfer and Modernization

Irrigation management transfer (IMT) can be defined as the turning over of authority and responsibility to manage irrigation systems from government agencies to water user associations. This involves two key roles: the authority to define what the irrigation services will be and the authority to arrange for the provision of those services. After IMT, the water users, typically organized into a water users association (WUA) decide what services should be provided, what their objectives and target should be, what service performance standards are acceptable. Arranging for the provision of those services includes choosing service providers and collecting whatever resources are required to implement the desired services.

Modernization of an irrigation system could be defined as the act of upgrading or improving the system capacity to enable it to respond appropriately to the water service demands of the current times, keeping in perspective future needs, or as a process of technical and managerial upgrading (as opposed to mere rehabilitation) of irrigation schemes with the objective to improve resource utilization (labor, water, economics, environmental) and water delivery service to farms. The process involves institutional, organizational and technological changes. It implies changes at all operational levels of irrigation schemes from water supply and conveyance to the farm level. The objective is to improve irrigation services to farmers although improvements in canal operation will generally be a critical first step in the process. It is they who have to take the final decisions on the modernization programmes and improvements should not stop at the canal level.

Modernization thus defined assumes that IMT has taken place and that farmers are in a position to decide on the level of service they want and are willing to pay for. The term “modernization” refers therefore not only to the rehabilitation, upgrading or transformation of physical infrastructure in irrigation systems but also to innovation or transformation in how irrigation systems are operated and managed.

IMT programs commonly include efforts to rehabilitate, upgrade or modify irrigation infrastructure. They also often include efforts to introduce new management systems or procedures that are consistent with the expectations and constraints which result from IMT, such as service agreements, management audits, asset management and information systems. In the context of IMT, modernization is related to the process of transformation from supply-driven to service-oriented water delivery and to changes in governance of the systems for goal setting, which includes the decision on the service to be provided by the system.

There is a general acceptance of the principle that water management institutions should be consistent with hydraulic management units, either at the basin, system levels or within the systems, and in practice the configuration of the irrigation systems has had a great influence on the design of PIM/IMT programs. Other important linkages are related to the setting of objectives for the irrigation systems. Relevant to IMT would be among others the determination of cropping patterns by a previously top-down institution and of the service to be delivered to farmers and on the other hand the necessity to manage water supply and drainage effluents in a river basin/integrated water resources management perspective rather than for the single purpose of irrigating crops.

## Service

The notions of water delivery service and of generalized service-orientation of institutions in the irrigation sector, whether river basin agencies, reformed irrigation agencies, irrigation service providers or water users associations has become central in new concepts and definitions of participatory irrigation management and irrigation management transfer. Literature on the evaluation of impacts of on-going participatory irrigation management and irrigation management transfer programmes in terms of water service delivery, agricultural productivity and agricultural performance indicates that improved service is a problem area. The sustainability of the water users associations is however now seen to depend on their capacity to provide an adequate water delivery service and control and to allocate water and to provide an improved service to enable gains in agricultural productivity. This is essential for the capacity of farmers to pay water and for the water users associations to be financially viable. As a result, it is now recommended that strategies of gradual improvement of irrigation systems be adopted to support the transfer of water management responsibilities and associated rights.

The concept of irrigation service was introduced in the 1980s together with methods to evaluate service quality. Service is not an abstract or generic notion: it can be qualified precisely in terms of equity, reliability and flexibility as well as adequacy. The degree of flexibility in frequency, rate, duration is what distinguishes and characterizes classes of service quality from rotation to on-demand. Thus, the decision on the flexibility at all levels and ultimately at the farm is the most important decision as regards service. Flexibility is most closely related to improvements in agricultural performance, crop diversification, etc. The service definition will also specify the responsibilities of all parties (farmers, Water User Associations (WUAs), operators of the tertiary canal, operators of the secondary canals, operators of the main canals, and project authorities) in operating and maintaining all elements of the system. A main canal provides water, with a certain level of service, to secondary canals. Each upstream layer in a hydraulic distribution system provides service to the layer immediately downstream of it. The actual levels of service at each layer must be examined to understand the constraints behind the level of service that is provided to the field.

There is a wide range of levels of irrigation service, and the nature of the service may vary significantly from a highly flexible service differentiated at the farm level to an inflexible service provided on an undifferentiated basis to a large number of farmers. It is therefore important to qualify the level of service. The levels of service may be different at each layer. It is also important not only to identify what the existing level of service is, but also what the expectations are at each layer of operation. In service-oriented water management, the decision on the level of service against the cost for providing this service, from ISP to WUAs and WUAs to users, is expressed through service agreements which are the foundation of an asset management strategy and managerial capacity upgrading programs which are translated into financial plans. Service agreements may be a modality to force a negotiation on service levels and initiate a process towards a transformation of top-down irrigation agencies by providing accountability and transparency.

## **B. PIM/IMT, MODERNIZATION AND INTEGRATED WATER RESOURCES MANAGEMENT**

### Irrigation sector reform and water sector reform

Participatory irrigation management lies squarely within an integrated water resources management perspective and the policy and institutional changes that this new perspective demands. The growing understanding of the centrality of water rights and water allocation issues reinforces this integration. Clearer water rights and farmer participation in basin water resources management to facilitate more equitable, more efficient processes to improve water use efficiency and reallocate water among users become an important issue. The question of the restructuring and reorientation of the existing irrigation agencies towards assuming responsibilities in implementing water resources management further strengthen these linkages.

#### **Possible new roles for irrigation agencies**

- River basin planning
- Water resources allocation & monitoring
- Development of new policies and regulations
- Environmental monitoring and enforcement
- Groundwater monitoring and control
- Project planning, design and construction
- Technology transfer to IA
- Advisory services to associations
- Monitoring of association performance
- Arbitrating disputes

### The need for a long-term vision

Integrated water resources management is a continuing process that needs to be integrated into economic development processes. In this context, it is necessary to have a long-term vision of integrated water resources management and of the transformations that will be required in each sector.

For this purpose, the validity of strategic planning approaches to identify actions that need to be taken by each actor in each sector by redefining missions, goals, objectives, strategies and priority plans for immediate action has been tested by FAO and ESCAP in four countries in the region: Malaysia, Philippines, Thailand and Vietnam in 2000. This exercise was coordinated with the global, regional and national visioning processes animated by the World Water Council and Global Water Partnership in preparation of and as a follow-up to the Second World Water Forum at the Hague, 2000. This international initiative was taken with the objective of averting the looming water crisis and foster immediate concerted action.

At the occasion of national round tables organized this year, these four countries have reconfirmed their national water visions.

<b>Malaysia</b>	In support of Vision 2020 (towards achieving developed nation status), Malaysia will conserve and manage its water resources to ensure adequate and safe water for all (including the environment).
<b>Philippines</b>	By the year 2025, water resources in the Philippines are being used efficiently, allocated equitably and managed sustainably with provisions for water-related disasters.
<b>Thailand</b>	By the year 2025, Thailand will have sufficient water of good quality for all users through an efficient management, organizational and legal system that would ensure equitable and sustainable utilization of its water resources with due consideration on the quality of life and the participation of all stakeholders.
<b>Viet Nam</b>	The Vietnamese Water Vision is the integrated and sustainable use of water resources, the effective prevention and mitigation of harms caused by water for a better future on water, life and the environment.

Considering the national vision and specific considerations of food security, agricultural and rural development, the countries have defined sectoral visions that encapsulated integrated water resources management goals and developed priority action plans. Significantly, irrigation management transfer and participatory irrigation management were high on the agenda in each country. By applying strategic planning approaches to the irrigation sector, Vietnam and the Philippines found that mere rehabilitation of irrigation infrastructure would not be sufficient to achieve the vision and that the pilot introduction of modern water control and management concepts was identified among the main priority actions. Modernization of irrigation systems is already an integral part of Malaysia's water resources management strategies and is one of the measures being studied at present in Thailand.

The study has shown that in practice several important issues need to be considered while one analyses organizational change for participatory irrigation management:

- Arrangements will need to take into account water rights and allocations in a river basin perspective;
- Modernization of irrigation systems can be understood as the combination of water management strategies and related institutional and technical solutions;
- An integrated water resources management perspective, even in the long term, requires changes now.

### Environmental externalities

Historically, modifications to irrigation projects have not given thorough consideration to environmental consequences. But scarce water and concern for environmental impacts increase the need for improved on-farm irrigation management. Low irrigation efficiencies have been documented in various projects, and improved irrigation efficiencies are often listed as a major source of "new" water. However, it is now evident that return flows from an "inefficient" project are often the supply for downstream projects, in the form of surface flows or groundwater recharge. Therefore, typical project irrigation efficiencies in the 20-30% range by themselves give no indication of the amount of conservable water within a hydrological basin unless that project is at the tail end of the basin. Conservation (i.e., less spill, deep percolation, and seepage) within one project may deprive a downstream project of part of its accustomed water supply.

Most "new" water for existing basins and projects will only appear if there is improved irrigation water manageability by farmers. The potential sophistication of on-farm water management is highly dependent upon the level of water delivery service provided to individual fields, which in turn depends upon the conveyance manageability within the complete water distribution system.

#### The methods that yield "new" water

1. Improved Water Use Efficiency (WUE), where WUE is defined as

$$WUE = \frac{\text{Crop Yield}}{\text{Irrigation Water Consumed}}$$

Improved WUE can come from improved use of rainfall, improved timing of irrigations to match critical stages of crop growth, improved investment in fertilizers, pesticides, and cultural practices, reduced water logging.

2. Improvements in the quality of surface return flows.
3. Reduction of deep percolation from farmer fields, and the associated reduction of nitrate leaching.
4. Reduction of on-field deep percolation destined for a salt sink.

The critical importance of maintaining minimum flow rates and water qualities in natural drains and rivers is increasingly being understood. In the U.S.A. and Europe, for example, many of the recent irrigation system modernization efforts have stemmed from the need to reduce in-stream damage to endangered species of fish. In Malaysia, modernization strategies also incorporate similar environmental objectives for rivers. The quantities and timing of river diversions, and qualities and quantities of irrigation return flows, have a tremendous impact on the environment. Increasingly the issues will have to be explicitly dealt with by irrigation systems and farmers in the region. This is already the case in some of the most economically developed countries, and will be a future requirement in other countries, which must be anticipated now.

## C. IRRIGATION SYSTEMS IN ASIA

### The actual irrigation systems

The concepts used for the development of irrigation by colonial powers were adapted to the conditions and to the objectives of irrigation in the past. Irrigation was extensive and the water resources were not regulated by large storage reservoirs. The design standards adopted in many developed and developing countries after the mid 1900s to deliver water according to crop demand were conceptually more advanced. However most of them fail to meet that objective because of the deficiencies of the water control technology and complexity of the operational procedures. Managing an irrigation system equipped with manually-operated gates at each branching point is a very complex task. In many cases, the systems were designed to be operated at full capacity without consideration for operation at less than full supply. The use of technology with continually adjustable structures which has been the norm during the three decades of intensive development of irrigation in developing countries from 1960 to 1990 has badly affected the performance of irrigated agriculture in many countries. Even the best qualified managers and operators would not be able to manage these systems to the highest standards. They simply cannot work. They are now impeding the transfer of management to user associations. They are being successfully automated in western countries but not in developing countries.

The farmers served by these systems responded to the economic changes and poor performance or inadequate service by tapping additional water resources to overcome the limitations of the existing systems, which were under sized for intensive irrigation such as the typical structured design systems or provided erratic water supply, to be able to adopt modern cultivation practices and diversified cropping patterns: tampering of control structures, pumping from canals, drains, borrow pits, replacing animal-driven pumps by motor-pumps and more recently tapping groundwater resources with a dense system of shallow wells or deep tubewells which provide the flexibility and reliability needed for modern irrigation at farm level. These responses from the farmers are inevitable.

If the water distribution rules define a pattern of water distribution that does not match technically feasible and desired goals of the water users, the users will subvert these rules. This will lead to poor water delivery performance and increases in the cost of irrigation to users. Inconsistency in the water distribution rules creates difficulties in system operations that are likely to lead to inefficient and inequitable water distribution performance. Especially inconsistency of rules between various levels: reservoir, main canal, channels is detrimental. Rules in channels cannot be followed if there is unpredictability of delivery by main canal.

Making water delivery match goals is important. The need for change in response to changing environment, changing agriculture, diversification, etc. requires adapting water distribution rules to changing demands. The users, on the other hand, must accept the limitations on uses imposed by water availability and the features of the system. These considerations call for a greater attention to an analysis of operational rules at all levels in the system and particularly to a proper articulation of operational rules at the interface between the future irrigation service providers and water user associations, to the necessity of improving operations in the upper levels of management if water users associations are to be

in a position to develop applicable rules and procedures, and to the necessity of incorporating at all levels production objectives of the farmers.

Very few countries have adopted the full spectrum of modern irrigation concepts and standards. In a few cases, the design makes use of the most advanced technologies for water control but the water distribution strategy lacks the flexibility required for a service oriented delivery. In other cases, the technology is inadequate to satisfy the stated objective of modern irrigation. More frequently, neither the technology nor the strategy meets the definition of service orientation, including the projects with faulty designs, and operational procedures designed for the convenience of the operators, not of the users.

Initial system designs may represent a severe constraint to the adoption of new and more flexible operational procedures. Many problems related to inequity and unreliability of water service can be attributed to design and operational procedures, which, if left unchanged, will produce the same results whatever the governance setup. The question whether the technical/hydraulic dimension of irrigation can be brought under the control of agents focused on non-technical user-derived objectives is central as is this would characterize a service-oriented management. The case for reassessing the design standards, configuration and operational procedures at the moment of transfer as a result of a review or resetting of both internal objectives in terms of service with the water users and external objectives with water resources management institutions is therefore compelling.

An appraisal of initial conditions and performance of the systems to be transfer would allow both a better design and strategic planning of physical improvements together with a definition of the service to be provided both by the irrigation service provider to WUAs and by WUAs to their members, with indications on ways and means to achieve these service goals and improve them in the future, given the forces of change that effect the irrigated sector. To meet the conditions of the future, water delivery from irrigation projects should be more flexible and reliable. Operation rules should be transparent and understood by the users. As for requirements on system operations resulting from integrated water resources management, water rights and the necessity to satisfy different water uses with same primary infrastructure are not the only issue. Water obligations related to disposal and quality of effluents, other environmental requirements are or will be part of the externalities imposed on system managers in all countries.

### Groundwater and IMT

In many parts of the world, groundwater is a major emerging problem. In some areas, overexploitation is posing a major threat to the environment, health and food security. The explosion of groundwater irrigation in some countries is a farmer response to the lack of flexibility and, in the worst cases, the unreliability of the canal irrigation systems. Water recycling and the conjunctive use of groundwater mostly happen as a desperate response from farmers who are unable to obtain their share of irrigation water from the canal or from systems managers as a way to rectify problems of management capacity and shortcomings of the original design. The benefits that the changes have brought to farmers include increased quantity of water, increased reliability of water and freedom for the families to choose their own crop strategies. Service requirements of the farmers are thus met, where possible, from other sources than the delivery of the main surface systems.

It is therefore perplexing that, in spite of an affirmed service orientation, IMT or PIM programs often fail to take into account actual the service needs as expressed by farmers' actual practices and actual water management in the systems. New institutions appear to reflect the stated operations of the canal systems and not appear the need for combined management of water delivery, drainage, water recycling and conjunctive use. Whether this is a threat to the viability of the water users associations should perhaps be given more attention.

#### On-farm irrigation technology.

The slow adoption of new on-farm irrigation technology is a perplexing issue. A principal reason is perhaps that the focus of attention in developing countries has occurred at the farm level, and not at the level of operation of the main and conveyance systems. Farmers will not invest in water saving technologies if the service of water is not reliable and if the incentives for saving on water, energy and labor are not strong enough. Many important management objectives can only be satisfactorily realized if the main water distribution system is well operated, and only then high returns can be obtained from agricultural extension advice and the increased application of other complementary inputs.

#### Rehabilitation and upgrading

What are the practices through which physical works are planned in PIM/IMT programmes? Particularly in Asia, the most common planning tool is the walk-through. Lack of farmer participation in design and construction has been identified as a problem area and design processes are meant to be more demand-driven. The objective is to improve conveyance and reliability and reduce canal maintenance requirements (drop structures, etc.). PRA mapping, transects, of land tenure, farming systems, ecosystems are also tools used on the field, mostly to prepare canal layout designs and identify objectives of rehabilitation/improvement. In practice, a diagnosis of operation procedures is not performed and operational rules and procedures are not really discussed or linked to identified works. Physical works are not related to service or performance goals. As a rule, expectations are low. The initial focus on upgrading is generally on reliability and equity, which are admittedly the first issues to address but there is generally no vision of future requirements. There is no discussion of flexibility, i.e. there is no discussion of the main aspect of service quality.

There is still a significant knowledge gap on the impact of IMT and PIM in general. However results of recent impact evaluations and efforts to synthesize existing literature allow us to draw some general conclusions on the impact of PIM/IMT programmes on the quality of water delivery service. However, as most of these programmes have included some measure of rehabilitation or upgrading or infrastructure or on-farm infrastructure development, it is often difficult to separate farmers' involvement benefits from other changes such as rehabilitation.

Quality of operations and maintenance is often a stated goal of programmes, but most of the evidence is qualitative statements. General impression is that after turnover, services have substantially improved in regard to timeliness, reliability, and equity.. Increases in irrigated area and crop intensity are mentioned in many instances. Flexibility is not a service characteristic explicitly investigated but some results in terms of timeliness and adequacy are registered. Improvements in terms of water use efficiency are more uncertain.

In Asia, impacts are typically not noticeable in terms of agricultural performance: change in irrigated area, crop patterns, cropping intensity or yields, PIM has neither improved nor interfered with agricultural productivity. The future of farming is seen to depend on diversification of crops and a more commercial orientation. Diversification makes irrigation management more complex. Irrigation systems may not have enough capacity to deliver water for other crops or irrigation practices or may need to be operated differently. Greater reliability may be required, through improved main system operation or through more flexibility for farmers to locally distribute water according to their needs. The necessity of reengineering irrigation, i.e. taking a fresh look at key processes and how they can best be carried out and of considering both hardware and software elements is emphasized as irrigation becomes more commercial but is in apparent sharp contrast with design processes and their outcomes.

PIM has generally led to modest efforts by farmers to improve management efficiencies and responsiveness. Significant future expenditures loom in the future unless observed under-investment in O&M is halted. It is therefore recommended to replace periodic rehabilitation with on-going infrastructure improvements jointly financed by government and the farmers, with the objective to improve performance and ensure financial viability and physical sustainability of irrigation. An issue for the sustained success of participatory irrigation management is therefore the availability of financial instruments that allow farmers to invest in the upgrading of their irrigation systems. Decentralized irrigation improvement funds are increasing proposed in IMT programmes. Required support services could be: assessment of system facilities, credit, and design and construction assistance. The assessment can be done jointly by agency and WUA or contracted out: annual maintenance planning, selective improvement, planning whole-system rehabilitation.

Low productivity is also often associated with small farm size, a subsistence orientation, production of low value crops such as grains, inappropriate agricultural policies, a poor natural resource base, and inadequate agricultural services. It is necessary to address these issues or provide assistance through other agencies for production increase, or to subsidize the association. For farmers, the second-generation IMT problem is to increase farm productivity to pay higher irrigation fees and to take advantage of possible improvement in irrigation service quality.

#### Type of investment projects

Lending for irrigation has progressively changed over time from a project-specific nature of investments to take the form of sector loans or national/regional in scope projects supporting the objectives of participation and capacity building. These projects often combine a mix of low cost rehabilitation projects and management reforms with attention to improved operation and maintenance and user participation. Low cost rehabilitation of irrigation infrastructure, in some cases an investment to catch up years of differed maintenance, cannot correct the deficiencies of the original design, if the causes of deficiencies are not identified through an in-depth diagnosis of the current system. In Asia, where the older public schemes reach the age of 30-40 years in most countries, the issue of rehabilitation is becoming increasingly important. In theory, rehabilitation provide an opportunity to take into account the management patterns of operators and irrigators. In practice, however, rehabilitation simply re-establishes the physical configuration of the original system. The content and orientation of rehabilitation in a context of PIM/IMT will therefore be critical.

### Towards gradual improvement strategies

PIM has generally led to modest efforts by farmers to improve management efficiency and responsiveness. Under-investment in O&M is also observed. It is therefore recommended to replace periodic rehabilitation with gradual on-going infrastructure improvements, with the objective to improve performance and ensure financial viability and physical sustainability of irrigation. Financial instruments that allow farmers to invest in the upgrading of their irrigation systems become critical. Decentralized irrigation improvement funds to provide matching funds from Government are increasing proposed in IMT programmes.

### Other regions have often adopted a radically different approach

In contrast with this model, IMT in other regions has often taken a very different shape, with a deliberate effort to change the control logic of the systems from the top down and the transfer of large units of the systems to large water users associations. IMT has been more engineering driven, and this is the main difference with Mexican, Turkish, US experience. The issue is whether basic flaws or constraints can be addressed with a light rehabilitation program and whether not doing so hampers IMT/PIM or jeopardizes the success of reform in terms of sustainability of institutions and financial sustainability.

### Toward new forms of IMT

WUAs as business enterprises are increasingly seen as a potential solution in the region, perhaps as a reflection of Latin American experience, and the question whether they might deliver other services to farmers is important in the debate on PIM reform. The formation of pilot farmer companies in two systems in Sri Lanka represents a paradigm shift, from PIM as joint management to the formation of the farmer company: agri-business development and irrigation management turnover, in open-market economy, with irrigation more than a sub-sector of agriculture, but seen in tandem with trade, commerce and industry. Water is seen as a commodity and no more tied to land and is transferable.

The farmer company is the institutional mechanism for commercialization of farm operations. Distributary canal organizations will continue to function for water management and O&M. Resources allocated by government for O&M will be advanced to the company which will have four divisions: irrigation, primary production, commercial, finance and administration. The irrigation division will be responsible after transfer of management of the system and provide water rights based on land entitlement.

PIM in Sri Lanka has failed to have results in terms of O&M, water management or productivity, so to implement participation systematically, organizations need a critical mass of mutually reinforcing practices, a participative system with an eye on the product and market. It is therefore necessary to shift the focus of PIM to agriculture as an enterprise resulting in a phased turnover of the irrigation system in totality. New suggested management strategies are significant (conjunctive use, etc.). It is suggested that this pilot experience may be a laboratory for larger Asian countries.

## Second-generation problems: required services to water users associations and farmers

Among the major second-generation problems for associations, the most significant are:

- Insecure water rights
- Financial shortfalls
- Rehabilitation
- Lack of financial and administrative management expertise

For farmers, the second-generation problem is to increase farm productivity to pay higher irrigation fees and to take advantage of possible improvement in irrigation service quality:

- Production credit
- Extension service
- New technologies
- Markets and market information
- Access to inputs
- Post-harvest services

All irrigation systems require periodic rehabilitation and modernization. If WUAs defer rehabilitation, they will also not upgrade the systems. It is suggested by many authors that, for rehabilitation, a sharing of costs is appropriate. Required support services to water users associations would be:

- Assessment of system facilities
- Credit
- Design and construction assistance

The assessment can be done jointly by agency and WUA or contracted out:

- Annual maintenance planning
- Selective improvement
- Planning whole-system rehabilitation

Assistance in selection and supervision of consultants and contractors can be made at the level of the federation of WUAs to each WUA.

## **D. RICE**

### Rice in Asia

In most of Asia, rice is not only the staple food, but also constitutes the major economic activity and a key source of employment and income for the rural population. Water is the single most important component of sustainable rice production, especially in the traditional rice-growing areas of the region. Reduced investments in irrigation infrastructure, increased competition for water and large water withdrawals from underground water lower the sustainability of rice production. However, despite the constraints of water scarcity, rice production must rise dramatically over the next generation to meet the food needs of Asia's poor. By year 2025, rice production in Asia must increase by 67 percent from the 1995 production level in order to meet the increased demand for this cereal which is the staple for more than one-half of world's population. Producing more rice with less water is therefore a formidable challenge for the food, economic, social and water security of the region.

About 80-90 percent of all freshwater resources used are for agricultural purposes and more than 80 percent of this water is used in irrigating rice. In other words, the efficiency of water use in irrigated rice production systems must be significantly increased. The existing strong interdependence between water use in the crop production subsystem and the operation of the irrigation facilities for water service elicits the need for pursuing a comprehensive agenda for improving the performance of rice irrigation systems.

### Diversification

Since no major net addition to currently irrigated rice areas is expected in the coming decades and major breakthroughs in raising yields of rainfed rice systems are unlikely to be available during this period, most of this additional rice will have to be produced in irrigated areas. In rice irrigation systems, rice monoculture is overwhelmingly the dominant practice. Diversification of the crop production system in these areas is desirable for several reasons. First, diversification will open opportunities for increasing farmers' income from their limited land resources. This is particularly important at the present time when profits from rice culture are very low and declining. Second, it is increasingly evident that, as productivity of the land under rice monoculture under wetland conditions is declining over time, a diversified agriculture will be more sustainable in the long run. Third, with increasing scarcity of water, irrigated agriculture will have to aim at maximizing return to water rather than return to land. Present rice culture systems require more water than most other food crops, both in terms of quantity of food and calorie produced. Therefore, a major scope exists for increasing returns from water by growing diversified crops, especially in areas of water shortage. To enable farmers to diversify their cropping pattern, they must be provided with facilities to exercise crop choice options, which is presently lacking in most rice irrigation systems.

### Upgrading rice schemes

The task of upgrading or modernizing an irrigation system for rice cropping in the wet season and for diversified cropping in the dry season is complex. It requires that any permanent structural or physical upgrading to be done for rice must also conform to the requirements of the diversified crops to be grown in the dry season. It is therefore logical to assume that the

upgrading of common denominator factors, i.e. factors that are relevant for both seasons, could be upgraded permanently and these should be handled by the main irrigation system. Examples of these would include upgrading of water control, drainage, reliable schedule of water delivery, etc. at the main system. The on-farm, crop-specific factors could be handled seasonally by the farmers themselves as individuals or as groups. Examples of this type of upgrade would include the same items, as above, but at the farm level. Provision of flexibility will become an additional requirement.

Reliable water supply is critically important for diversified cropping, as farmers have to invest much more for these crops compared to rice. Areas that are far from the irrigation source generally suffer more water shortage in the dry season compared to near-by areas. Means of augmenting water supply in these areas, if they are suitable for diversified cropping, have to be found. Shallow groundwater development through the private sector is often the most reliable and affordable water source for this purpose. Groundwater has the advantage of being available on demand at the farm and able to avoid major water distribution problems.

Suitable methods of water application to the crop (e.g., basin, furrow or basin-cum-furrow), methods of controlling seepage from canals or neighboring rice areas (e.g., dikes, interceptor channel, dike-cum-interceptor channel), or means of drainage enhancement (e.g., collector gravity drain, pumping, collector-cum-pumping) will be required. Diversified cropping requirements must be thoroughly considered in pursuing the modernization process, with the objective of raising farmers' incomes through provision of flexibility and option to choose crops in the dry season.

#### Water management for rice

As far as rice water management itself is concerned, whether one aims at raising water productivity or water use efficiency, it is now widely accepted that a river basin perspective should be adopted with much more attention being paid to defining the boundaries of intervention (farm, system, basin). Substantial progress has been made in defining concepts and methodologies (water accounting, modeling, etc.) but available data, which are already woefully inadequate to assess the merit of interventions at the farm or system level, water abstraction and even cultivated and irrigated areas, are even more lacking for the adoption of integrated river basin approaches. More attention must also be paid to water quality issues and particularly the release of pollutants (fertilizers and other agro-chemicals) and salt concentration.

Nevertheless, practices which minimize irrigation inflow are of a direct interest to farmers who see their water supply rationed and have to pay an increasing share of its cost, for managers and developers who also face rationing because of degradation of water resources, dam siltation, transfer to other sectors, etc. and have an interest in minimizing pumping costs, and operation and maintenance as well as development costs, and indeed for water resources managers who need to plan future irrigation developments with minimum environmental impact from withdrawals or reservoirs. In addition, many major rice-growing areas are located in coastal plains. Furthermore, water saving practices, which require greater water control, typically are associated with or part of packages to improve agronomic practices and the efficiency of use of other inputs, and therefore play an important role in total factor productivity. They therefore contribute to increasing not only water use or irrigation efficiency but also to improving or sustaining water productivity. Indeed, water management

methods, which improve water use efficiency, have been developed with a view to maintain crop yields and actually, when implemented properly, lead to yield increases (in the range of 15-20% in China for intermittent flooding and other methods). It follows that, although it is correct and necessary to use rigorous concepts for efficiency and performance at system and basin levels, and to determine under various conditions the optimum combination of improved technologies and water management practices that can meet water demand with least water consumed and managing return flows to ensure system and basin level efficiency, in practice it is difficult to find water management techniques proposed for adoption at the farm level which do not simultaneously raise irrigation efficiency and water productivity.

The range of possible strategies and their effect on various components of irrigation inflow requirements can be summarized in the following table:

Practices	T	E	S&P	SRO	RCL
Developing improved varieties	X				
Improving agronomic management	X				
Changing schedules to reduce evaporation		X			
Reducing water for land preparation		X	X	X	
Changing rice planting practices		X	X	X	
Reducing crop growth water		X	X	X	
Making more effective use of rainfall			X	X	
Water distribution strategies		X	X	X	
Water recycling and conjunctive use					X

The acceptance by farmers of the above strategies and practices will of course depend on economic factors. Furthermore, they depend on improved water control and management of water at the system level, as well as adequate irrigation (in particular a reticulated irrigation distribution system) and drainage facilities. Their availability in China has allowed farmers to adopt the water savings techniques described above. However, typically, at that level, conveyance, field canal and distribution efficiencies are particularly sensitive to the quality of management, communication and technical control. When water supply within the system is unreliable, farmers try to store more water than is needed. In many large irrigation systems, few control structures at any level and poor drainage structures and poor drainage networks contribute to a waste of water.

Being confronted with this rather large number of problems, it is not surprising that farmers are reluctant to shift to more demanding water management techniques than flooding. However, considering the growing water scarcity and pressure on the irrigated sub-sector within the water sector and on agriculture by other sectors of society and overall economic development policies described in previous sections, there is not much choice and farmers must be provided both with a conducive environment and a proper production tool, i.e. better performing irrigation services.

Improvements in the operation and maintenance of rice irrigation schemes through rehabilitation of the deteriorated systems, improvement of irrigation infrastructure for surface irrigation, irrigation management transfer, modernization, combining to various degrees institutional, organizational and technical changes, have been attempted in the region with mitigated degrees of success. Studies undertaken by the World Bank in recent years have evaluated the impact of irrigation projects. A study of 1995 evaluated the design of rice project in the humid tropics and concluded, from the strong degree of resistance of farmers to new design standards and the level of anarchy and chaos observed on the schemes, that the more reticulated systems, capable of supporting on-demand water delivery, were not appropriate under these climates. A more recent study (1997) assessed the agro-economic impacts of investments in gravity-fed irrigation schemes in the paddy lands of Southeast Asia, to determine whether and how the quality of O&M services influences the sustainability of those impacts.

At four of the six sites, the areas supplied by the irrigation systems were significantly less than planned. Cropping intensities were also substantially lower than expected at three sites and falling at a fourth. Only one scheme had attained both its area and intensity targets. Paddy yields varied widely —between schemes and in comparison with expectations— but a weighted average for the wet and dry seasons at all the schemes was about 3.3 tons, or 85 percent of appraisal projections. However, farmers had not diversified out of paddy. Indeed, the concentration on paddy had increased. Output was between 32 and 73 percent of appraisal estimates for five schemes. The returns had also been driven down by the decline of the international price of rice.

Overall, agency and irrigator performance appeared to be substantially better than expected. Farmers cooperated to achieve at least basic O&M objectives regardless of the level of maturity of the formal organization. There were no substantial negative constraints on irrigated production attributable to poor performance in O&M. Those O&M operations that are essential to keep sufficient supplies of water flowing to the great majority of the fields were adequately carried out. The study also noted the dismantling of complex technological control systems installed in the 1980s in favor of fixed structures that have no adjustments and structures that adjust automatically to changes in water levels; the rejection by farmers of both rotations and gates. Rotations do occur, but they tend to break down under conditions of shortage, which is when they are most needed.

The main finding was that given that they offered poor economics and low incomes, these paddy irrigation schemes faced an uncertain future. Small-holder irrigated paddy could no longer provide the basis for a growing, or even stable, household economy, driving younger family members off the farms while older members who stayed behind concentrated on basic subsistence crops, social capital would erode and O&M standards were likely to suffer. As economies expanded, irrigated paddy would not be able to compete with the incomes to be had from other employment opportunities. Improved O&M performance would not rescue them.

The study made these recommendations:

- Sharpen the response to O&M failures by disaggregating O&M; identifying the poorly performing components; and dealing with disincentives specific to each, such as the tertiary gates that farmers below consider unfriendly.

- Simplify the infrastructure and operations technology by converting to fixed and automatic controls that need less human intervention and by supporting authorities that plan with the farmers to abandon equitable rotations by rationing water during emergencies.
- Promote the transfer of management to farmers and their WUGs judiciously by recognizing that organizing user groups pays off, but also accepting that immature WUGs cannot handle some management responsibilities.
- Improve household earnings by diversifying cropping systems and supporting research, extension, and marketing services keyed to specialty crops and integrated, high-value farming.

The findings and conclusions of these two studies, combined with the results of the evaluation of modernization projects conducted by IPTRID in 1998, seem to be rather pessimistic and contradictory. However, put together, they tend to indicate that present project designs or operations are not capable of supporting both economically and technically the intensified, diversified and more water efficient and productive rice production systems which will be required in the future. They also seem to indicate that purely software solutions or mere improvement of operation and maintenance do not deliver the expected results in terms of improvements in performance and yields. They also reveal that many modernization or improvement efforts have been inappropriate, poorly adapted to local circumstances and the specific character of rice-based production systems, and incomplete or fragmentary. Conjunctive is practiced within “modern” irrigation schemes: it may provide a solution but is not available in all places.

## **E. TOWARD SERVICE ORIENTATION**

### Design processes.

Performance of irrigation projects is determined by a combination of physical, institutional and policy factors. The gap between potential and actual outcome is strongly related to over-optimistic assumptions of the hydraulic performance at planning stage, and in a number of cases to faulty and unrealistic designs as well as construction. The performance of operation of irrigation systems is influenced by the capacity of the management agency to apply the operational rules defined by the designer. Many designs are difficult to manage under real field conditions. The professional context explains why design irrigation engineers know little about actual distribution processes. Some of the reasons lie in administrative and behavioral reasons, mostly associated with the lack of experience, effective accountability and feed-back from operation of design engineers, whether in irrigation agencies or in local and foreign consulting firms, in lending policies of financial institutions, in lack of accountability of operators and managers to the users. In countries with large development of irrigation, the state officials have often entrenched engineering practices. The planning, design and construction process must produce a system and conditions capable of accommodating effective management practices. IMT provides an opportunity to correct the administrative and behavioral reasons at the stages of design, construction and operation.

Modern design is the result of a process that selects the configuration and the physical components in light of a well- defined and realistic operational plan, which is based on the service concept. It is not defined by specific hardware components and control logic, but use of advanced concepts of hydraulic engineering, agronomy and social science should be made to arrive at the most simple and workable solution. The most important issue is the system ability to achieve a specific level of operational performance at all levels within the system. A proper operational plan is the instrument that combines the various perspectives and helps reconcile conflicting expectations between the users, the project manager, the field operators and the country policy objectives. The second step in the planning of an irrigation project is the decision about water deliveries i.e. the frequency, rate and duration of water deliveries at all levels of an irrigation system.

A water delivery schedule does not necessarily imply a specific design. A rigid schedule of water deliveries to the farm turnouts may use modern irrigation hardware and computerized decision support systems to make the water deliveries reliable and equitable, but a project designed for rigid rotation through simple non-adjustable structures or for proportional distribution cannot be operated for flexible water distribution. To a large extent, the layout, original design criteria and standards used for an irrigation project limit the options for its rehabilitation and modernization. In extensive irrigation projects with the objective of thinly spreading water, the design capacity decreases from upstream to downstream. Traditional delivery systems have no or little flexibility built into them and do not attempt to match water deliveries to crop needs. In responsive irrigation projects, the design capacity increases when moving downstream to accommodate the need for flexibility.

### Key elements of sustainable service oriented I&D management

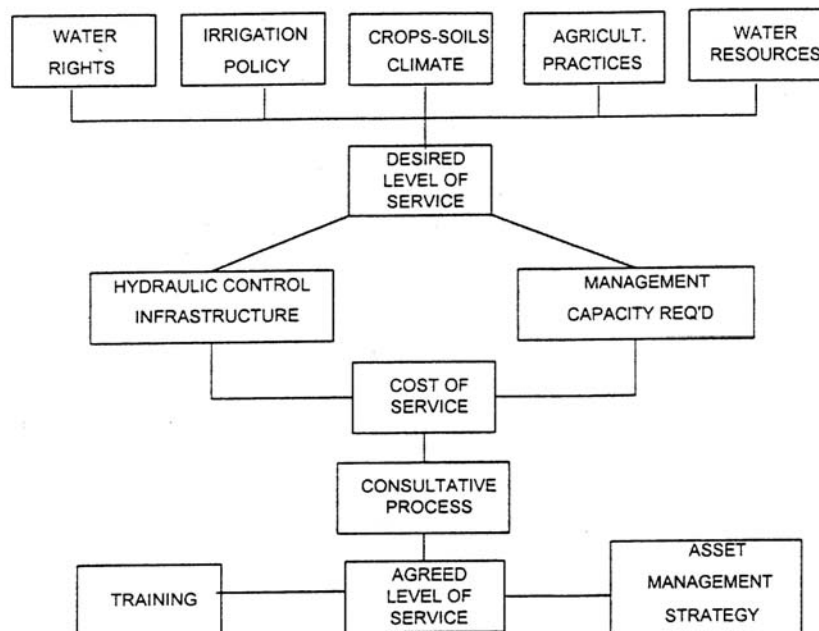
Sustainable service oriented irrigation and drainage management can be characterized by the following:

- It is output-oriented: the cost of the service provision is based on well developed operation and asset management programs
- It involves users to determine levels of service and the associated cost of service
- The irrigation and drainage organization should be able to recover the cost of service provision either from direct consumers or from subsidies
- It relies on an appropriate legal framework that provides protection for users, the organization providing service and the general interest of society

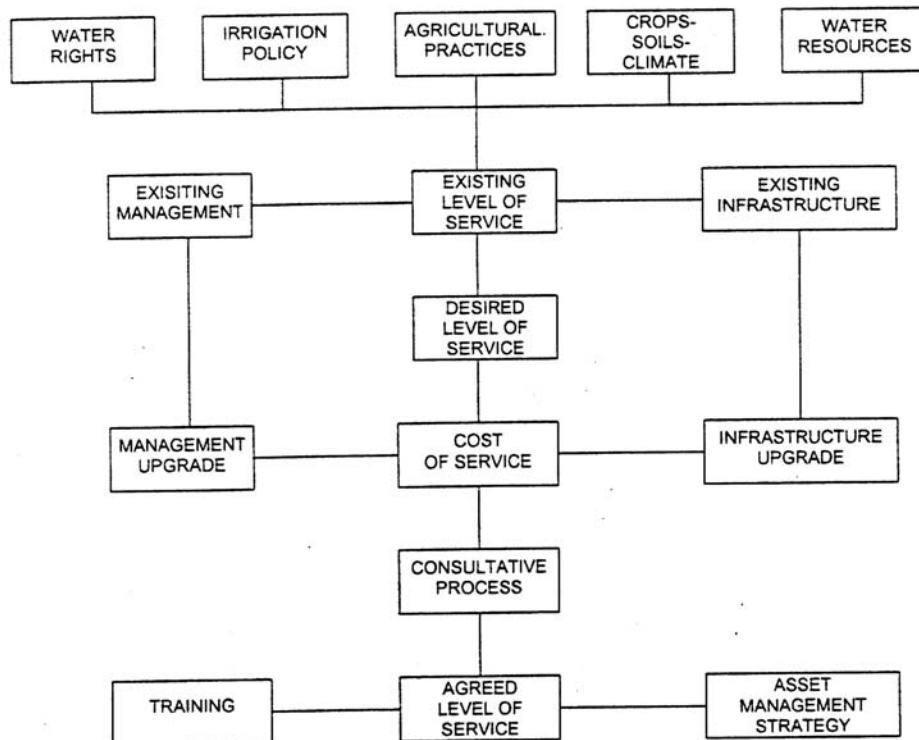
### The decision on level of service

The level of service consists in a set of operational standards set by the irrigation and drainage organization in consultation with irrigators and the government and other affected parties to manage an irrigation and drainage system. It must emerge from an extensive consultation process. It should become a series of norms (targets) against which operational performance is measured. It must be revised on an on-going basis to respond to changes in irrigated agriculture and requires careful consideration of the cost associated with specific levels of service. A strategic planning and management approach is recommended. The formulation of level of service specifications is the central decision for strategic planning and future operation and management.

For new or rehabilitated irrigation and drainage scheme the following process could be applied:



For existing irrigation and drainage schemes:



### Service agreement

It is necessary for all service relationships to define services (transactions) and the conditions attached to them, and payment required for obtaining these services. These must be stated in quantifiable and measurable terms that are easily monitored and controlled. These can be formulated in service agreements in the form of contracts that contain details on the level of service to be provided by the organization, the obligations of customers and the organization and the process for resolution of conflict should these arise.

A service agreement consists of two main elements:

- Transactions
- Accountability

The service agreement should therefore contain details on:

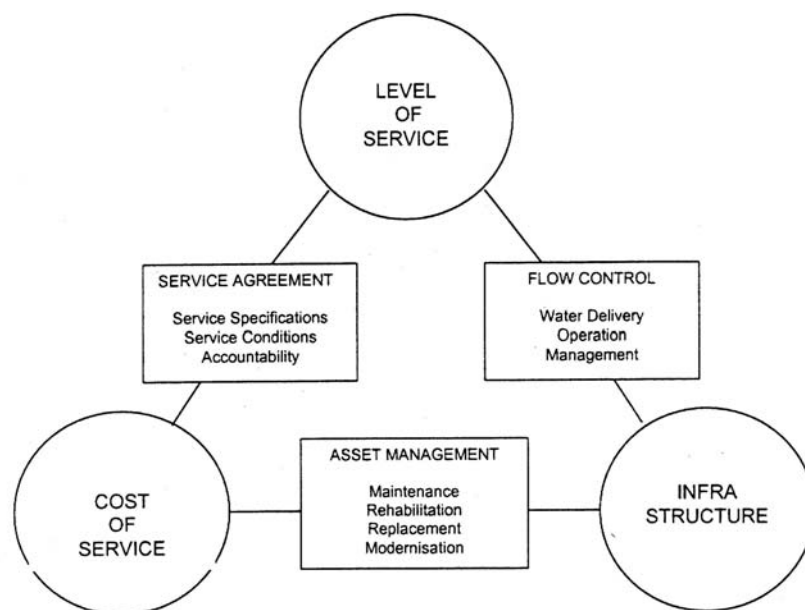
- Specification of service to be provided
- Amount and form of payment of service by users
- Monitoring procedures to verify whether services are provided as agreed
- Liability to both parties for not fulfilling the agreement
- Relevant authority to settle conflicts
- Procedure for reviewing and updating the service agreement

Accountability mechanisms defined through the service agreement provide:

- Operational accountability: monitoring, evaluating, controlling and enforcing
- Strategic accountability: mechanisms that users have to control the formulation of the service agreement
- Constitutional accountability: mechanisms by which users can influence the strategic decision making process of the organization

### Level of service, cost of service and infrastructure

The following figure illustrates the main relationships between the level of service, its cost and the infrastructure necessary to supply it. In particular, the same infrastructure can provide very different levels of service according to how it is operated.



### Management of irrigation systems

Each level of service, to be achieved, depends on operational parameters. Requirements in terms of flow control systems and human resources must be clearly understood and planned for. It is also necessary to understand the internal mechanisms of irrigation systems, and to provide selective enhancement of those internal mechanisms, if irrigation project performance is to be improved. These "details" are so important that it has been argued that investments must be based around specific actions to improve them, rather than deciding on the framework for detail improvement only after the investment is approved.

Management of irrigation systems in a business and service oriented mode is also a complex operation. It requires advanced managerial skills and the ability to process and interpret large amounts of data. A feature of modern design and operation is often the minimization of the collection of large amounts of data for statistics while information needed for operation increases. For example water requests and water deliveries have to be recorded and matched with conveyance capacity, seasonal water allocation and total water availability. Water

deliveries have to be converted into financial transactions. Payrolls and financial assets have to be managed as well as stocks, spare parts, vehicles and construction equipment. Maintenance programs have to be implemented and closely followed.

Modern information and management systems are imperative to assist managers in performing efficiently their tasks. These tools can be used irrespective of changes in management structure, but the needs will also be felt by WUAs. The availability of management support tools can be seen as a means to facilitate their taking over their new managerial responsibilities.

### Monitoring and evaluation

The effects of any program that modifies the organizational arrangements for providing the service must be evaluated in terms of the quality of that service. In a typical IMT monitoring and evaluation system, key issues about outcomes and impact include as potential immediate outcomes the quality of the water delivery service. Possible eventual impacts are related to socio-economics and productivity. Potential areas of interest for water users are estimated to be the quality of O&M, the cost of O&M, the use of funds collected, agricultural and economic productivity. Impacts, which are the indirect or ultimate effects of an intervention, include cropping intensity, number of crops grown, if design and operational rules are performance-oriented. M&E is meant to provide information but also to strengthen local management capacity, enhance skills and support problem solving by WUAs. Standard tools are: walk-through and inspection of irrigation systems, planning maintenance or rehabilitation priorities, preparing O&M plan, supervising field staff, conducting technical audits.

In the service concept, the outcome and impact indicators listed above are actually the specific objectives of service-oriented management. Indicators can be classified as indicators for comparing the performance of irrigated agricultural systems, or external performance indicators, and internal process indicators. External indicators examine values such as economic output, efficiency, and relative water supply (i.e., ratios of outputs and/or inputs). Targets are set relative to objectives of system management, and performance measures tell how well the system is performing relative to these targets. These performance indicators are primarily applicable to compare actual results with what was planned – say, to compare outputs from a project before and after. The objective of internal indicators is to assist managers to improve water delivery service to users. Internal indicators include indicators to concretely measure service at all levels and could be very useful in M&E systems as service is generally assessed simply by sampling or polling.

### Irrigation management audits, asset assessment and management, benchmarking

Benchmarking, which uses primarily external performance indicators, could be introduced as a way for continuously assessing management performance before, during and after IMT and maintaining a dynamic of improvement. Irrigation management audits can be used to assess performance according to key indicators listed in a service agreement.

Where infrastructure is still owned by the government after IMT, they can be a joint exercise between the irrigation agency, WUA and local government to assess governance and service

provision, including technical, financial and organizational aspects. A prerequisite for management audits is a detailed initial assessment of assets to be transferred with their condition and functionality, and systematic monitoring of assets through detailed survey and monitoring.

#### Design and operation for IMT.

Management of a relatively large system is generally divided between various units. The locations of the interfaces between these levels have an important influence on the way the system is operated and its hydraulic performance. If management of the main system has to be divided between units, the interface should be located at hydraulic “breakdowns” such as reservoirs. The trend is to transfer the management of large sections of irrigation systems to large user associations, such as Turkey and Mexico. The contractual approach to bulk supply provision or irrigation service provision may require changes in hardware and operational rules at the interface between the management levels. Precise, but user-friendly, control of flows and measurements of volumes is needed. Reforms often include the establishment of water rights and trade of these rights, and the pricing of water on a volumetric basis. The design of irrigation projects should take these reforms into consideration. A rigid system with fixed distribution structures is not compatible with water trading. Measurement and control are required where trading is expected to occur. The layout of the canal network should also be designed so as to be integrated with not only the roads and drainage system, but also with the multi-level of management, whether from the agency or user associations.

#### Economic evaluation.

Conventional economics use a high discount rate for future costs and benefits and fail to show the importance of maintenance in sustaining the life of a system and the livelihood of farmers. The result is that a project with a low initial cost, which deteriorates quickly and is dependent for continued survival on timely and properly funded maintenance, or with high operation costs (pumping schemes) is preferred to one that is constructed to need less maintenance or lower operation costs because it appears cheaper. Such a project may not be sustainable without government subsidies, and will have to be abandoned unless governments keep a policy of subsidizing irrigated agriculture. Subsidies do leak to non-poor farmers. But lack of subsidies (or too low) may mean farmers – especially poor farmers – become unable to pay the full cost of water fees (especially if for example, prices fall as they have done for staples) and so unable to support private sector involvement. On the other hand, too much subsidization may mean investments are made in poor-quality projects, with low rates of return.

## **F. THE NEED FOR SUPPORT SERVICES AND CAPACITY BUILDING**

Political commitment and a legislative framework are important to provide the basis for institutional reforms, but efforts devoted to institutional development and capacity building can determine to a considerable degree the success or failure of the devolution process. Defining which support services are essential to be provided is an essential step in the IMT process. Such services may include capacity building in managerial, financial and regulatory needs of water users associations as well as technical support for irrigation system operations, maintenance, rehabilitation and upgrading. Training of service providers should be an important part of the IMT process. However, support services is a critical component that is sometimes overlooked in the design of IMT programs which have limited funding for capacity building. This section examines the type of support services needed for water users associations and farmers within irrigation systems and irrigated agriculture.

### Support Services after IMT

Capacity building is a long-term process and should not stop with the formal transfer of management responsibilities. Unfortunately, funding and support programs are often limited to the IMT process and WUAs are left at a critical stage without much further support, endangering the sustainability of the WUAs.. The different support services which may be needed after IMT are indicated below.

### ***Support services offered by the WUA***

Sustainability of water users organization will depend to a large extent on their capacity to provide an adequate water delivery service, to control and allocate water, to maintain the hydraulic infrastructure and to promote gains in agricultural services.

Support services that were previously provided by government agencies may also become part of the WUA responsibilities. These may include agricultural extension, technical assistance, legal matters and training programs. Federations of WUAs can be fairly successful in providing a wide range of services in addition to the O&M and administrative services they have taken over.

### ***Role of the irrigation agency in supporting irrigation management and modernization***

The irrigation agency has been the main player in many IMT programs during and after the IMT process. It is the main provider of support services, which typically include technical advise on O&M activities, and training and support in administrative and financial matters. It is important that irrigation agencies support the IMT process and have a clear understanding of their tasks and roles towards WUAs. In Andra Pradesh, continuing support to WUAs by the irrigation agency is ongoing and a program of maintenance and rehabilitation is underway, in which the irrigation agency will provide further training in O&M, budgeting and bookkeeping. A system of joint technical, financial and social audits of WUAs is being developed. Governments should specify clear policies whereby support services for rehabilitation and upgrading of irrigation systems will be provided after IMT. These should be designed so as to promote local self reliance rather than inefficient and unsustainable dependence on the government.

### ***Strengthening agro-economic development***

There appears to be a strong correlation between the productivity of irrigated agriculture and the sustainability of water users organizations. Hence, there is rationale for governments to promote development of agricultural production potential, intensification of farming systems, and development of agri-business and marketing opportunities. Support services in IMT should therefore not be limited to water delivery and O&M tasks only, but should comprise support in all aspects that will improve performance and sustainability of irrigated agriculture. More support services are required in schemes with low agricultural productivity, to motivate and enable farmers to take over water supply services both technically and financially.

### ***Role of agricultural extension***

Agricultural extension played an important role during the years of the green revolution in promoting improved agricultural practices and contributing to substantial leaps in agricultural productivity. Trained to work closely together with farmers, agricultural extension could also play an important role in providing direct support to WUAs in intensifying irrigated crop production and promoting agri-business.

With governments committed to the privatisation of services, many extension agencies, however, are suffering from a lack of funding and decreased capabilities. Moreover, inter-agency competition is constraining or preventing an effective synergy of activities between agricultural and irrigation agencies and is reducing the inputs and support of the agricultural agency in many IMT programs. Two questions arise: Is there indeed a need to re-design and re-vitalise government extension systems, particularly in countries with weak agri-business sectors? Or is there need and potential for private sector or non-governmental organisations to take over agricultural extension services?

### ***Role of the private sector in provision of agricultural supplies and credit***

The private sector can play an increasingly important role in supporting irrigation management organizations. Suppliers of agricultural inputs, farm machinery and on-farm irrigation equipment may offer technical advice and assistance in further improvements of the irrigation and agricultural production system. Several countries report on the difficulties experienced by WUAs in owning and maintaining equipment for transport, desiltation, land leveling and construction works. It is apparent that many operation and maintenance tasks could be entrusted to specialized private sector contractors. Further, marketing and agri-business organizations and suppliers of agricultural inputs may play an important role in the promotion of more profitable agriculture and supply of equipment and credit and provision of technical advice. However, this will likely involve contract farming and other business linkages with suppliers of agricultural support services. Agricultural credit plays an important role in intensifying irrigated agriculture.

### ***Irrigation advisory services and on-farm water management***

More effective use of water at farm level can contribute importantly to increasing and intensifying agricultural production. Studies have shown that an effective on-farm water management program that improves the field irrigation and drainage system, promotes land leveling and introduces sprinkler or micro irrigation systems can increase harvested irrigated

area and yields significantly. In most countries irrigation agencies have little experience and interest in on-farm water management, while in most cases agricultural extension workers have no expertise in water management. Specialised advisory services or on-farm water management programs to introduce appropriate field irrigation technology and methods may need to be considered.

#### *Role of river basin management organizations*

Growing competition for water between different sectors has led to the formation of basin-wide organizations to regulate water management and to the basin-wide allocation of water to different interest groups within river basins and watershed catchment units. Agreement on procedures for water allocation and watershed management among different water users are important in this and require a forum for negotiation and consultation, entrusted to river basin organizations. Although institutional arrangements are, in many countries, still in formative stages, the role of river basin management organization in providing support services to irrigation management organizations may become increasingly important and may include legal advice and development and adjudication of water rights within basins.

#### *Legal support*

Even though initial legislation for the formation of management organization may be provided for at the start of IMT, continued support may need to be given to water users organizations to assist them to improve and modernize the regulatory framework in the water sector. Normally, further support and guidance will be required for matters of water rights, water allocation rules and regulations, protection of assets, resolution of disputes and imposition of sanctions.

#### Training and Capacity Building

Training and extension is an important tool for developing the knowledge and skills of farmers and WUA officials to undertake management responsibilities and develop more profitable irrigated agriculture. Generally, training of WUAs included training in financial and administrative management as well in technical aspects of operation and maintenance. However, the quality of training varies greatly and it is often reported to be not adequate or ineffective. Countries with a more focussed effort and commitment to IMT developed extensive training programs for both WUA and staff of the irrigation agencies. Training has been directed to developing skills in financial and administrative management and technical operation of the system, but has been used in particular also as a tool to sensitize and motivate farmers, local leaders and staff of the irrigation agencies. Fewer IMT programs included training for the irrigation agencies. This is surprising given the fact that the irrigation agency is normally required to play a central role in the transfer process.

Training often proved to be ineffective and more effective training approaches need to be developed. Agency staff at almost all levels need to be involved with trainers-of-trainers programs. Also, in several cases reported in the profiles, WUAs may provide training support services to their members, in particular in agricultural production methods and in development of markets and agri-business.

### Cost of Institutional development and capacity building

In many IMT programs, only small budgets are provided for institutional development, training and capacity building. As the IMT process is often driven by the government's lack of funds, many countries fail to allocate the minimal funding required to establish an effective support program to ensure the formation of sustainable irrigation management organizations. This may constitute a serious threat to the sustainability of WUAs after IMT. The impacts of well-designed training and capacity building programs have not been studied in a systematic way and may be one of the reasons for the limited funding allocated to institutional development.

### The case for a massive re-training of engineers and managers in irrigation agencies, consulting firms and Irrigation Service Providers

Intensified and on-going training programmes for both professionals in the reformed irrigation agencies, consulting firms who will provide advisory services to water users associations and to the managers of water users associations and the technical staff that they may employ for operation and maintenance of their irrigation schemes are understood as one of the conditions for sustained success of the transfer programmes.

It is therefore essential that these programmes introduce and provide knowledge on ways and means to design and operate irrigation systems cheaply for good performance and adequate service to farmers as they evolve toward more commercial forms of agriculture. An appraisal of initial conditions and performance of the systems to be transfer would allow both a better design and strategic planning of physical improvements together with a definition of the service to be provided both by the irrigation service provider to WUAs and by WUAs to their members, with indications on ways and means to achieve these service goals and improve them in the future.

It is suggested that the Rapid Appraisal Process developed and used in the evaluation of modernization programmes of IPTRID could be used for this purpose at programme appraisal stage and for individual irrigation systems. The use of internal process indicators would be useful in monitoring and evaluation systems.

A pilot training programme on modernization concepts and application of the Rapid Appraisal Procedure, which builds on the knowledge synthesis acquired in recent years on modern design principles and participatory irrigation management shows promising results. Its application to a system in Thailand by staff of the Royal Irrigation Department gave very promising results. Similar training courses will be held in Iran, Vietnam, Indonesia and Nepal in the coming months. A concept for a more ambitious re-training programme based on the same concepts and tools has been developed by FAO and could be supported in the context of efforts to improve the performance of programs to transfer the management of irrigation systems to the users.

## G. CONCLUSION

The notion of water delivery service and of generalized service-orientation of institutions in the irrigation sector, whether river basin agencies, reformed irrigation agencies, irrigation service providers, water users associations has become central in new concepts and definitions of participatory irrigation management and irrigation management transfer. The evaluation of impacts of on-going participatory irrigation management and irrigation management transfer programmes is one of the reasons of this evolution.

Literature on the evaluation of impacts of on-going participatory irrigation management and irrigation management transfer programmes in terms of water service delivery, agricultural productivity and agricultural performance indicates that improved service is a problem area.

The service orientation of irrigation water delivery does not appear to be sufficiently taken into account in processes and tools for design and preparation of operation and maintenance plans infrastructure rehabilitation works, monitoring and evaluation systems. For the large systems, partial or gradual transfer may not provide explicit steps for a real decision on service and the gradual building upstream of governance structures by federation a constraint to address the central strategic questions of service at the beginning of the transfer process. For small or traditional schemes, the question of future needs of irrigated agriculture is often not asked. IMT has rarely affected the design processes. The sustainability of the water users associations is however now seen to depend on their capacity to provide an adequate water delivery service and control and to allocate water and to provide an improved service to enable gains in agricultural productivity.

In the context of Asia, diversification of rice crops is a major issue for increased income by farmers and improved agricultural and water productivity. This in turn is essential for the capacity of farmers to pay water and the water users associations to be financially viable. A more forward-looking strategy anticipating these future needs is therefore required.

As a result, it is now recommended that strategies of gradual improvement of irrigation systems be adopted to support the transfer of water management responsibilities and associated rights. Concepts of irrigation management transfer/participatory irrigation management transfer and modernization are therefore converging. However, there are still some substantial differences: modernization stresses that the infrastructure/physical improvements which must be supported must be designed with a view to improve equity and reliability of water delivery service and evolve towards increasing levels of flexibility. Operational and technical details become very significant. Environmental considerations need to be better taken into account in a perspective of integrated water resources management.

A more forward-looking strategy anticipating these future needs is required. Recent visioning processes in the water sector provide a good condition for strategically planning organizational and technical changes in participatory and irrigation management. This in turn is essential for the capacity of farmers to pay water and for the water users associations to be financially viable. An appraisal of initial conditions and performance of the systems to be transfer would allow both a better design and strategic planning of physical improvements together with a definition of the service to be provided both by the irrigation service provider

to WUAs and by WUAs to their members, with indications on ways and means to achieve these service goals and improve them in the future.

Although the relationship between design and operation is not univocal, initial system designs may represent a severe constraint to the adoption of new and more flexible operational procedures. Many problems related to inequity and unreliability of water service can be attributed to design and operational procedures, which, if left unchanged, will produce the same results whatever the governance setup. Many of the transferred systems cannot effectively provide needed or a reasonable level of service, now and in the future, with a limited program of repairs or with rehabilitation. This threatens the capacity of the water users associations to carry the costs of operation and maintenance of the systems unless service is improved significantly and unless they are in a position to improve agricultural performance.

Knowledge in the field on how to design and implement service-oriented water control and management is lacking but capacity building components for agency decision makers and field staff, ISP/project operators and managers, consulting firms, water users associations do not address sufficiently the practicalities of design, operation etc. on top of governance aspects and advisory services. Even if conjunctive use and recirculation are practiced in many cases, PIM/IMT often only concerns surface water systems and their management. This may be a problem for the viability of the newly created institutions.

Delivering an improved service, securing a water right, charging a water fee may require improved water control and measurement of discharges at all levels of the irrigation system. One can therefore argue that there is a case for reassessing the design, configuration and operational procedures at the moment of transfer as a result of a review or resetting of both internal objectives in terms of service with the water users and external objectives with water resources management institutions.

Another serious issue is to ensure that rehabilitation, modernization do not increase farmer dependence on the government, In particular, it is now thought that irrigation system improvement works should be planned and implemented after transfer. Subsidies may still be required but they should be smart. The new ideas about decentralized irrigation improvement funds are an example of these “smart” subsidy systems that encourage investment of the users in the maintenance and upgrading of their schemes.

The required transformation of irrigated agriculture will not take place just as a result of transfer and demand for improved services. Technical advisory services, financing arrangements, and other agricultural support services will be required.

Therefore, concerning the financing of irrigation and drainage systems in the context of water sector and institutional reform, the following conclusions can be made:

1. The IMT and PIM reforms do present good opportunities to redress the present under-investment in operation and maintenance or upgrading of the irrigation and drainage systems;
2. The service-orientation of irrigation and drainage service providers represents a new model for financing of irrigation and drainage services;

3. A condition for the success of these reforms is that farmers be provided with a good service: this may entail a significant departure from the mere cosmetic or light rehabilitation or upgrading which is typically financed in the context of IMT/PIM programmes in the region;
4. A second condition for the sustained success of participatory irrigation management is the availability of financial instruments that allow farmers to invest in the upgrading of their irrigation systems;
5. A third condition is a substantial increase in the training and capacity building components of these programmes;
6. A fourth condition seems to be that irrigation sector reforms should be part and parcel of a more general reform of water resources management, in which issues of water allocation, water rights, ownership of transferred assets and the future of the irrigation agencies are addressed;
7. Another condition for the sustainability of the reforms is the development of a suitable service environment to assist farmers in increasing the productivity of agriculture.

## DECLINE IN IRRIGATED INVESTMENT ?

### Public investment in irrigation has declined

Data on irrigated areas, globally and across regions, show that the rate of growth in irrigated area has declined, and has been accompanied by a decline in lending for irrigation by international donors. There has been a large decline in real lending since the late 1970s and early 1980s, when it peaked. By 1986-87 World Bank lending was only around 40% of peak lending, and lending by other donors shows similar trends.

Many Asian countries show a decline in real irrigation expenditure in the late 1980s. Annual expenditure in China and Sri Lanka was cut by nearly 50% between late 70s and 80s. In the Philippines the level in the late 1980s was only 1/3 of that in early 80s. Expenditures peaked later in Bangladesh, Indonesia and Thailand, but these countries also show a decline in investment in irrigation. In India, public sector investment in irrigation has been stagnant or declining since the mid-1980s.

### Private sector investment

What of private sector irrigation? Much groundwater is privately owned e.g. India, Bangladesh, etc. so monitoring both use and development of groundwater sources is difficult. But data from FAO's AQUASTAT programme suggest that investment in groundwater development has offset the decline in public investment (mostly surface schemes). Indeed, the most significant innovation over the recent decades is estimated by many to be the diffusion of low-cost low-lift pumps and tubewell technology.

Successful strategies for the dissemination of improved on-farm irrigation such as treadle pumps, low-cost drop and sprinkler systems and more generally small-holder land and water management systems are now understood to rely on private sector initiative (manufacturing, dealer networks, installation) and mass-marketing. The idea is that these investments are highly profitable. The issue is therefore to make systems that are accessible also to the poor or to facilitate their access to rural credit, and not to rely on subsidies that are typically shown to ration or limit the dissemination process.

In the Asia region, private investment in surface irrigation systems is still in its infancy or contemplated in the reform policy documents, mostly under the pressure from external donors. However, it is not totally absent and there are interesting examples to be found in China, Vietnam or Cambodia. In Australia or New Zealand, IMT is often understood as privatization, as previously public assets are transferred. Although recent problems with privatization of other industries as well as domestic water supply has led to more caution in the promotion of privatization of irrigation services, this path to IMT should not be neglected.

In Latin America, private sector investment has historically been important and only gave

ground to public sector investment during the 1970s. In Mexico, a substantial number of irrigation units covering a large proportion (around 40%) of irrigated area were privately owned, even before reforms of publicly-funded irrigation districts shifted control to water user associations. Increases in private sector investment in irrigation infrastructure have been dramatic, and have helped compensate for the 41% decline in federal government investment between 1991 and 1995. In Chile, with one of the most privatised irrigation sector in Latin America, farmers have to, by law, contribute as much as 75% to new pumping and channel irrigation projects, with the result that only the most profitable schemes are built. But the extent of private sector involvement in the approval, funding and operation, management and maintenance of irrigation projects has increased water efficiency with booms in agricultural exports despite a small decline in irrigated area per capita.

In Mexico, the increase in private sector investment has led to improvements in performance of some irrigation systems. Removal of sediment from canals and drains, irrigation budgets and user contributions have all increased dramatically after irrigation management transfer from the public to the private sector. Increased water efficiency in Chile is largely attributed to the increase in private sector involvement. However private sector investment, especially by the poor, relies upon access to credit facilities and technical assistance, yet subsidies for infrastructure investments can create incentives to invest in non-viable projects or in projects with relatively low rates of return.

#### What are the reasons for the decline in public investment?

The decline in investment in irrigation is largely ascribed to falling economic rates of return to irrigation projects, both new and existing, making other sorts of investment better options for scarce resources. This may be because higher-returns works are usually built first [e.g. best sites for dams have already been chosen] leaving less good ones for later, because of rising costs of construction, or falling recovery of costs from users, declining agricultural prices, declining water-use efficiency or increasing negative impacts [e.g. health and environment].

Returns to irrigation are however comparable to alternative investments in agriculture and non-agricultural projects. In an evaluation of 192 World Bank funded irrigation projects implemented between 1950 and 1993, 67% received an overall satisfactory rating with an average internal rate of return of 15% at evaluation. There was no downtrend in ERR. The relatively constant ERR is despite falling world agricultural prices and should carry through to, and parallel results for, trends in returns to irrigation.

There is also an argument that investment in irrigation is falling because of rising costs of construction. This may well be the case in some areas. In India and Indonesia the real costs of new irrigation have more than doubled since the late 1960s and early 1970s; in the Philippines real costs increased by more than 50%; in Thailand by 40%, and in Sri Lanka, costs tripled. The result is lower returns to investment.

Poor and/or declining cost recovery could be another factor that explains declining trends. Public irrigation projects “have been an enormous drain on government budgets” mainly because cost recovery falls short of covering the actual costs. For example, in Pakistan in 1984 approx. Rs 1 billion were collected in payment for public irrigation services. Operation and Maintenance costs were about Rs 2 billion and annualised charges for past irrigation

investments were approx. Rs 5.9 billion. For five South and South-east Asian countries (Indonesia, Korea, Nepal, Philippines, and Thailand), actual government receipts covered less than 10% of the full irrigation costs. Increased fiscal pressure to recover costs or to reduce subsidies may also make irrigation projects less attractive other things being equal, but presumably cost recovery problems will affect all public investments. Given the growing demand for domestic and industrial water, and other sources of water squeeze tightening, this argument becomes less defensible.

The biggest surge in investment in irrigation occurred in the 1970s, leading some to argue that this was due to the rise in agricultural prices, due in turn to the two oil crises raising prices of inputs and transport and unfavourable weather conditions, and to argue further that declines in agricultural prices make future investment in irrigation unwarranted. If these events were perceived to be significant and likely to extend into the long-run, then this argument may have some merit. It is possible however that falling agricultural prices now are a consequence of rising irrigated area and hence higher global yields, and even more if extra irrigation creates incentives to green revolutions in seed-fertiliser use, and if these eventually raise yields (more accurately, net value added) more slowly than they depress farm prices (more accurately, farm output prices relative to farm input prices - fertiliser prices may be bid up, as well as crop prices down. However even if agricultural prices continue their downward trend, there is sufficient evidence that ERR can be maintained at acceptable levels.

A fourth reason behind declining investments in irrigation is declines in other aspects of irrigation performance in for example water use efficiency or conveyancing efficiency. Misincentives, such as poorly targeted subsidies, or inappropriate water pricing systems can induce overuse or wastage of water and eventual water table depletion. Inefficient irrigation damages the performance of projects.

## IRRIGATION DEVELOPMENT AND POVERTY ALLEVIATION

On-going research by FAO suggests that irrigation development has played a large role in poverty alleviation in Asia. There are huge regional differences in the proportion of cropland that is irrigated and these coincide with successes or failures in poverty reduction. In Africa only around 3% of cropland is irrigated and the region has experienced very little reduction in poverty in the 1990s [SSA had a poverty headcount of 47.7% in 1990 and 46.3% in 1998]. In contrast, 35-40% of cropland in Asia is irrigated and poverty reduction in the 1970s was substantial. The research argues that this is no mere coincidence, rather that differences across regions, countries and states within countries in irrigation is an important factor in determining rates of poverty reduction. The significant poverty reduction in many parts of India for example is attributed to the availability of irrigation, which not only boosted agricultural production but also made possible the adoption of modern farming technology – seeds, fertilisers and pesticides – that further reduced poverty.

### Irrigation and poverty alleviation

Irrigation may take many different forms from large dams and canals to small systems of shallow tube well, small sprinkler systems and porous pots. Irrigation may impact differently on the poor, depending on the irrigation technology itself, their position along the distribution system, the institutional rules governing access to water and maintenance of water systems and their ability to complement irrigation with other agricultural inputs. Furthermore the poor are not a homogenous group of people defined uniformly by a set of characteristics. Instead they are much more heterogeneous, comprising different ages, gender, ethnicity, education, different economic activity and location. Irrigation may affect different types of poor people in different ways: perhaps impacting on small farmers first through boosting yields and income levels, then impacting on landless labourers through increased demand for agricultural labourers, and then on the urban poor via lower food prices and possibly reduced migration of the rural poor to urban areas.

Irrigation facilities also require labour and other domestic inputs for its construction and maintenance. A project in Nepal that used labour-intensive construction to provide irrigation increased production potential by over 300% and income by over 600%, contributing immensely to food security. The impact of irrigation on poverty via employment will depend on the type of irrigation system used. For example, centre-pivot sprinkler systems - often hundreds of yards long - are a classic big-farm-biased, capital-intensive means to water control; but the same effect can be attained more labour-intensively through gravity-flow. The aim in both cases is to achieve better crop per drop, to save water: in one case with capital, in the other with labour. Price is one means to influence this choice, research and extension, another; land reform, a third.

### Impacts of irrigation on poverty via output, employment and prices

The first direct impact of irrigation on poverty is on output levels. Irrigation boosts total farm output and hence, with unchanged prices, higher farm incomes. Increased output levels may arise for any of at least three reasons. Firstly irrigation improves yields with a fixed amount of rainfall through reduced crop loss due to erratic, unreliable or insufficient water supply.

Secondly, irrigation allows for the possibility of double-cropping, and so an increase in annual output. Thirdly, irrigation allows a greater area of land to be used for crops. Hence irrigation is likely to boost output and income levels.

The second direct effect on poverty is via employment. Irrigation projects require labour for construction and on-going maintenance of canals, wells and pumps etc. This is likely to be an important sector of employment for the poor, especially the landless rural poor or rural households with excess labour or seasonal excess labour. In addition, increased farm output as a result of irrigation will stimulate demand for farm labour both within the main cropping season and across new cropping seasons, increasing both numbers of workers required and length of employment period. Rural poverty levels may therefore be reduced by increased employment opportunities. In addition there may be effects that extend to other areas if irrigation projects reduce migration to urban areas, and so reduce the pool of job-seekers and reduce pressure on the downward pressure on urban wages and the upward pressure on prices of housing and other urban infrastructure.

The third direct effect on poverty is via food prices. If irrigation leads to increases in staples or non-staple food output then this may result in lower prices for staples and food, in imperfectly open economies or if there are significant transport costs internationally, or from food surplus areas to towns or food deficit areas. Net purchasers of food will therefore gain from cheaper food, as will urban consumers.

Hence, examining the direct first-round effects, irrigation is likely to reduce poverty, via increased food output, higher demand for employment and higher farm real incomes among a) net food purchasers in irrigated areas, b) net food purchasers in non-remote unirrigated areas and c) the urban poor. Positive effects may be experienced by net food producers and waged labourers if effects of, respectively increases in output and employment outweigh effects of price falls. [This is increasingly likely with liberalisation of food trade; with falls in growth rate of irrigated area; and with better transport and falling transport-cost/production-cost ratios]. Negative effects might be experienced by surplus producers in remote, unirrigated areas but net food buyers there – who are usually among the poorest – gain from price falls.

### Longer-run impacts

In the longer run, irrigated land may encourage farmers to adopt or increase their use of fertilisers, pesticides, improved seeds and other agricultural inputs, and provide the stimulus for further research into improved plants and technology that lead to increased output, and so employment and incomes, with possible further price reductions. This green-revolution style virtuous circle is likely to lead to further poverty reduction.

Furthermore, irrigation probably switches farm use away from staples to higher-value products. As long as the rural poor can access appropriate new technologies, possibly also requiring access to credit markets, then poverty among small producers and landless labourers is likely to fall. The switch of crops in irrigated areas may also create or expand demand for the crops of unirrigated areas, so leading to poverty reduction in those areas. Examples of this can be seen in the context of modern seed varieties.

A second longer-run effect on poverty is via non-farm rural output and employment. As farm output and incomes rise and food prices fall, enriched farmers and workers will increase their expenditure on non-food products, leading to increased demand for non-food goods and services and so increased employment opportunities in non-farm incomes generating activities. These may include transportation, construction, food preparation and trading.

Perhaps the biggest long-run effect on rural poverty however is via stabilisation and risk reduction. Crop output levels will not only be on average higher but also experience less variance over seasons – because of double cropping for example– and over years as reliance on rainfall is reduced. Hence the poor are less likely to need to borrow to smooth subsistence consumption levels and so avoid the high capital market access costs that they usually face. In addition, less risky production of staples or other crops allows them to take more risks with other activities, encouraging diversification into higher risk but potentially higher income activities, such as cash crops for export or new non-farm activities.

To the extent that poor farmers do have access to irrigated land and other agricultural inputs, then the effects of irrigation via output, employment and prices, stabilisation and risk reduction are likely to be positive in both irrigated areas and unirrigated but non-remote areas. Remote unirrigated areas are likely to experience negative effects if transport or other market transaction costs are significant. The greater availability of food output, lower prices and reduced pressure on urban resources is likely to be positive.

Irrigation can help or harm the poor depending on how they are involved in the delivery, management and maintenance of irrigation systems. Water User Associations vary from system to system, in size and composition, and the extent of control they have over operations and maintenance of systems. If the poor actively participate and are fairly represented in WUAs then equitable or even pro-poor allocations of water at affordable cost may ensue. On the other hand, if the poor are marginalised, or not properly represented in WUAs then inequitable allocations may occur.

### In summary

There are a mixture of short-run and long run economic, socio-economic, environmental and political effects of irrigation that may have adverse or positive effects, and may affect different types of poor people [landless labourers, small farmers and the urban poor] in different ways. It is likely that cheaper, more abundant and stable food supplies, more farm employment, stabilisation and risk reduction, and spill-over effects to non-farm activities will be poverty reducing for large categories of the poor, although some groups, such as small food surplus farmers in very remote rural poor, may be negatively affected. However, the negative externalities of irrigation – on health and the environment – may be locally very damaging. Irrigation affects poverty via a variety of different transmission effects and different types of irrigation system affect different types of poor people. The chief effects are via increased employment and lower food prices: most of the poor (even the rural poor) gain an increasing share of their income from employment and are net food purchasers. As well as raising mean levels of employment, output and incomes, irrigation can also help reduce the variance of each, although there may be increased covariance. However, distribution of ownership of and benefit from water and water-yielding assets - small/big farm bias, and labour or capital intensity in use of new irrigation – is critical.