Managing Water for the Poor

Proceedings of the Regional Workshop on Pro-Poor Intervention Strategies in Irrigated Agriculture in Asia

Bangladesh, China, India, Indonesia, Pakistan and Vietnam
Colombo, 9–10 August 2001

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INTERNATIONAL WATER MANAGEMENT INSTITUTE

IWMI receives its principal funding from 58 governments, private foundations, and international and regional organizations known as the Consultative Group on International Agricultural Research (CGIAR). Support is also given by the Governments of Ghana, Pakistan, South Africa, Sri Lanka and Thailand.

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Hussain, I.; and E. Biltonen, eds. 2001. *Managing water for the poor: Proceedings of the Regional Workshop on Pro-Poor Intervention Strategies in Irrigated Agriculture in Asia, Bangladesh, China, India, Indonesia, Pakistan and Vietnam, Colombo, 9–10 August 2001.* Colombo, Sri Lanka: International Water Management Institute.

/ water management / irrigated farming / surface irrigation / large-scale systems / poverty / rural development / investment / conflict / participatory management / policy / rice / case studies / Asia / Bangladesh / China / India / Indonesia / Vietnam /

ISBN 92-9090-470-4

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About the Project

The project on "Pro-Poor Intervention Strategies in Irrigated Agriculture in Asia" is being undertaken by the International Water Management Institute (IWMI), with financial support from the Asian Development Bank (ADB) under its program on Agriculture and Natural Resources Research at CGIAR Centers. It is a multi-country project with case studies in six developing member countries (DMCs) of the ADB: Bangladesh, China, India, Indonesia, Pakistan and Vietnam. The main objective of this project is to determine realistic options for increasing returns to poor farmers through improving the overall performance of established medium- and large-scale surface irrigation systems (canals). Case studies under the project are being carried out in collaboration with national research and development organizations and agencies in the participating countries. The project duration is 30 months starting from January 2001.

In early 2000, IWMI submitted a draft grant proposal under ADB's Regional Technical Assistance (RETA) program to undertake a study on pro-poor intervention strategies in irrigated agriculture in Asia on the basis of expressions of interest from the Bank as well as from IWMI's collaborating research institutions and agencies. Initially, the idea was to focus on small/micro-scale irrigation covering assessments of mainly small-scale technical interventions in about ten countries. However, after discussions and deliberations, the ADB and IWMI jointly decided that the project should focus mainly on nontechnical interventions in medium- and large-scale irrigation systems covering the above six countries. On the basis of the agreed version of the proposal, the ADB prepared a Technical Assistance (TA) agreement between the ADB and IWMI, identified as "RETA 5945 – Fifth Agriculture and Natural Resources Research at CGIAR Centers: Study on Pro-Poor Intervention Strategies in Irrigated Agriculture in Asia" dated 8 February 2001. The TA agreement was authorized in mid-February 2001.

This 30-month project is budgeted at a total of US$1.96 million, out of which the ADB will provide US$ 1 million, while IWMI and the six participating countries will contribute the remaining sum in equal share, mostly through complementary activities and in the form of logistical support for field work. The national research activities to be carried out by the partner institutions and agencies, including the development of country study work plans, will be through specifically arranged research contracts.

IWMI initiated the inception activities soon after the TA agreement was authorized in February 2001. The project leader assigned by IWMI for this study visited participating countries to meet with representatives of national research institutions and implementing agencies to discuss study implementation arrangements—including forming study teams, identifying study sites and developing study work plans.

IWMI developed an overall work plan for the project and outlined the broad study approach to be followed for country case studies, which was discussed with the ADB in early April 2001. While there was general agreement on the overall project approach, the ADB provided valuable suggestions on the draft work plan. Meantime, IWMI requested country partners to develop country-specific work plans. The draft country work plans were completed in June 2001.

In addition, IWMI and the ADB jointly decided to hold national workshops in each of the participating countries with a view to obtaining input into the project from stakeholders at the inception stage. The main objectives of the country-level workshops were to: a) disseminate information about the project; b) involve stakeholders in the project right from the planning phase and obtain their input in the project; and c) identify and discuss country-specific issues related to irrigation management and poverty, discuss the overall project approach and identify suitable sites for case studies in each of the participating countries. The workshops were led by country study teams and IWMI representatives and were held between 12 March and 25 June 2001. Participants represented a range of disciplines and areas including academics, researchers, water policy makers and water managers. Representatives from the ADB resident missions in China, Indonesia and Bangladesh also participated in the workshop.

On the Regional Workshop

After the national workshops, the regional workshop was held in Colombo, Sri Lanka, during 9–10 August 2001. The purpose if the workshop was to discuss and agree upon the overall and country-specific work plans, implementation arrangements, specific research issues to be studied, methodological frameworks to be adopted, and study sites and irrigation systems to be included in the project. In addition to international scholars and IWMI staff, two of the study team members (a team leader and one other key team member) from each participating country were invited for the workshop. In addition to presentations and discussions on country work plans, participants from each country presented issue papers on topics related to irrigation sector reforms/irrigation against rural poverty.

This report is divided into three main parts. Part 1 provides a detailed report on the regional workshop discussions and outcomes. Part 2 gives a summary of the final project approach and framework. Part 3 presents some of the papers with overviews of the issues related to irrigation management and poverty for each of the participating countries. A list of the names of workshop participants is given in the appendix to this report.

Part 1

Pro-Poor Interventions Strategies in Irrigated Agriculture in Asia: Brainstorming on Research Design (Report on Regional Workshop Discussions)

Intizar Hussain, Eric Biltonen and Madhusudan Bhattarai

Introduction

The first regional workshop for the research project on "Pro-Poor Intervention Strategies in Irrigated Agriculture in Asia" was held in Colombo, Sri Lanka during 9–10 August 2001. The workshop was attended by IWMI researchers and study team members from Bangladesh, China, India, Indonesia, Pakistan and Vietnam. Keynote speeches were delivered by Robert Chambers and John Mellor. A special guest presentation was given by John Taylor. The purpose of the workshop was to present, discuss, revise and finalize the issues, general approach and methodological framework of the study. The workshop was organized into the following eight sessions:

- Session 1: Opening, project introduction and presentation of keynote and special guest addresses.
- Session 2: Presentation of country papers (general issues).
- Session 3: Presentation of overall work plan by IWMI researchers.
- Session 5: Discussion on overall work plan issues, approach and methodologies.
- Session 4: Presentation of country work plan by country study team members
- Session 6: Presentations on specific topics (Irrigation System Performance, Water Accounting, and Gender and Poverty) by IWMI researchers.
- Session 7: Finalizing discussions on research issues, study approach and methodologies.
- Session 8: Presentation on study implementation plan by IWMI.

In addition, an important session was held on the evening of 9 August on Participatory Rural Appraisal, which was led by Robert Chambers.

Session 1: Opening, Project Introduction, Keynote Addresses and Special Guest Presentations

The workshop opened with a welcome address by David Molden of IWMI. Molden discussed the linkages between irrigation, food security and poverty. He made the important point of how proper management of irrigation can help alleviate rural poverty. In light of the project, Molden talked on the issue of quantifying impacts that irrigation can have on the rural poor. He also mentioned about IWMI's recent initiatives on the Global Dialogue on Water, Food and Environment, and how the current project also fits into the Global Dialogue program.

The next presentation was given by the Project Leader, Intizar Hussain also of IWMI. Hussain gave a brief introduction of the project. The project background, goals and objectives and project scope were briefly outlined. He mentioned that in most developing countries of Asia, poor management has resulted in unsatisfactory performance of irrigation. The poor performance has resulted in physical impacts, such as tail-end water deprivations, and salinity and waterlogging. These issues have been studied quite thoroughly. However, poor performance has also resulted in socioeconomic impacts typified by persistent poverty in irrigated areas. Socioeconomic impacts of irrigation performance have not been studied in any greater depth. The project aims to examine the links between irrigation performance and poverty in order to better devise interventions that will contribute towards poverty alleviation. The ultimate outcome of the project will be to develop a set of pro-poor interventions for improved performance of irrigation systems in developing countries of Asia.

Keynote Speech 1—Robert Chambers

Following Hussain's presentation, the first keynote speech was given by Robert Chambers. He discussed developments that have occurred in the fields of poverty and irrigation over the last 10 years. He began by discussing some controversies in poverty measurement concepts, and the current status of defining poverty. The first point he made was that "poverty is pronounced deprivation of well-being." Well-being, in turn, is a multidimensional concept, so that poverty is also multidimensional. Therefore, the traditional concept of poverty as being solely income-related constrains the analyst from gaining a through understanding of poverty. He suggested that by broadening the concept of poverty, more effective and meaningful research can be conducted. The broader concept of poverty changes the development goal from one of increasing incomes to one of moving "from ill-being to well-being."

Chambers highlighted the different dimensions of poverty, and mentioned about the temporal aspects of poverty. He emphasized the importance of seasonality in agriculture, and implications of seasonal fluctuations for the poor—a vulnerability context.

Further, he mentioned that, too often a definition of poverty is imposed on the analysis. Chambers related that the poor have a great understanding of their condition from which can be drawn a wealth of knowledge. By allowing the poor to define the concept of a good or bad life, the various dimensions of poverty can be illuminated. Thus, the poor are more capable of a much more complex analysis of their situation than they are normally given credit for. He also suggested including visual analyses to collect poverty-related information.

In addition, Chambers suggested that an objective of the pro-poor project could be to: Identify, promote, and catalyze *feasible* irrigation interventions with *potential* to enhance the *net well-being* of *poor people* on a large scale (italicized emphases are his).

He stressed the fact that irrigation concerns more than just the farmers, for example, irrigation's impact on the employment of landless and rural livelihoods and seasonal intervillage migration of labor. He cautioned that we should also analyze irrigation impacts on the rural landless labor in this project, which are important components for securing the rural livelihoods. Chambers emphasized that the political economy of institutional change, as we are trying to address some of the issues here, is another important dimension of this project. He explained the key words of the above objective as:

"Feasible" concerned the identification of who the potential losers and gainers will be from any of the institutional changes. The feasibility of an intervention must be considered if there are powerful people who will lose because of the institutional change, such as the irrigation bureaucracy or the construction lobby. In particular, there should be a search for win-win situations where everyone gains from the institutional change.

"Potential" relates to the degree to which changes could impact poverty.

"Net well-being" is about the bargaining power of those impacted. He offered an example of hydrological interactions, and links between canal irrigation and groundwater recharge.

"Poor people" relates to the self-identified group to be targeted. The targeted poor must be enlarged beyond simply farmers to cover seasonal workers who migrate into the irrigated areas. If this group is ignored, then benefits of irrigation will be underestimated.

The group was encouraged to "think backwards" in regard to the project. Specifically, what outputs and outcomes will need to occur for the researchers in July 2003 to agree that the project was successful in obtaining its objectives?

Six principles of research highlighted by Chambers were:

Cost-effectiveness. This is a standard consideration.

Optimal ignorance. This concerns how much we need to know to reach meaningful conclusions. There is often a drive to obtain more precision in results than is necessary.

New knowledge. This research should aim to create new knowledge rather than repeating what has been done before.

Significant realities. This concerns such things as seasonality changes, what actually happens with water distribution, and how a WUA actually operates. The concern is to get at what the actual situation is instead of the situation that is presented. In other words, this principle aims to overcome information distortions. Chambers gave the example of what happens to water at night. This is an inconvenient time to do research, but it is often the time when important things are happening.

Flexibility. This relates to the spare capacity of the researchers. If the project time is so tightly scheduled and the methodology so rigidly defined, then researchers will be unable to respond to any unforeseen issues that may arise. The project (and the researcher) will be much more productive, if researchers are allowed a degree of flexibility and allowed to reserve some spare time for unknown information that may come up during the field activities.

Thinking backwards. This entails designing the project from the viewpoint of what will need to happen in July 2003 in order for the project to be successful. Chambers suggested that consideration be given as to how the information will influence people. Three suggestions given by Chambers were that policy makers like a) *quotations*, b) *sound bites*, and c) *stories*.

One of his major conclusions from the discussions on the research principles was that we should not restrict the project solely to the fixed questionnaire and rigid schedule.

Then he highlighted three types of situations especially to be analyzed for the project. These include

- situations where interventions have already occurred,
- situations where no interventions have occurred, and
- situations that are experiencing declining growth.

In situations where interventions have already occurred, an analysis can proceed along the lines of trend analysis. In situations where no interventions or declines in growth have occurred, then an analysis of constraints will be necessary. This will involve an identification of causal relationships.

Chambers complimented the use of brainstorming sessions held during the six national-level workshops under this project. He stated (based on material from national workshop proceedings) that he believed these had been productive. He then offered the possibility of using brainstorming sessions with the poor and stressed that these could be valuable for the success of the project.

Chambers closed his presentation with three questions for the participants. The questions were:

1. How flexible can we be? We should search for and learn from innovations.
2. Action learning/research? The concept of learning by doing.
3. How much research analysis can local/poor people do? Involving the poor and allowing them to define themselves and their situations.

Keynote Speech 2—John Mellor

John Mellor gave the second keynote speech. This speech began with the declaration that irrigation is going to play a key role in poverty reduction in Asia. Worldwide, poverty and hunger are predominantly in the rural sector as compared to urban. He mentioned that urban poverty is a direct function of rural poverty. That is, landless rural people migrate to nearby urban areas mainly because of the large differences in the real wages between the urban and rural sectors. Furthermore, the difference in real wages is continuing to increase. Hence, irrigation plays a critical role in poverty alleviation by raising the rural wage rates.

Citing recent studies by Timmer and Ravallion, and other related studies from World Bank research teams, Mellor stated that urban growth has a minimal impact on poverty reduction, while rural growth has a more significant impact on poverty alleviation. Therefore, it is the structure of growth (agriculture v. industrial, or capital-intensive v. labor-intensive) that is important for poverty reduction. This is caused by the powerful multiplier effects (or indirect impacts) from agricultural growth. He suggested that poverty analysis should focus on income changes from both direct and indirect effects.

Irrigation has both direct and indirect impacts in alleviating poverty. The rural poor, generally, produce goods and services that are not internationally traded. The poor, those with little or no land, are thus dependent upon the rural nonfarm sector for their income. This means that there must be local demand, which can come from increased local incomes. In that context, agriculture plays a very distinct role in expanding the demand for locally produced goods and services. He discussed the dynamic potential of irrigated agriculture and provided other examples of why irrigation is a critical component for an effective poverty reduction strategy.

In justifying irrigation for poverty reduction, Mellor referred to the elasticity of poverty reduction to increases in GDP. For every 1 percent increase in GDP, there is a corresponding decrease of 2 percent in poverty. However, a World Bank study showed that only 35 percent of poverty reduction could be explained by this increase in aggregate growth. This leaves 65 percent of the reduction of poverty unexplained by GDP growth. Thus, poverty reduction depends upon the structure of GDP growth. The unexplained growth is largely attributable to indirect impacts generated in the country, where agricultural growth plays a critical role.

Therefore, to alleviate poverty the demand for goods and services produced must be improved. The domestic demand can be expanded by increased local incomes, primarily by on-farm income. Irrigation can be the catalyst to increase the farm incomes through yield improvements and technical changes in the agriculture sector. The increased incomes will then be used to purchase the locally produced nonfarm goods and services, which will further expand the rural employment. This will ultimately lead to rural industrialization and increased off-farm employment activities. However, urban growth has no such strong relationship on reducing the poverty level as indicated by the recent development process seen in some of the East Asian economies.

Small farms and women must be included in the growth process in the agriculture sectors. Mellor emphasized the fact that it is not aggregate growth but the structure of growth that matters most for the reduction of poverty in the developing countries. Technical change in the agriculture sector, facilitated by irrigation, will increase the marginal productivity of employment and the employment prospect in the rural sector; hence, the nature of employment-related impacts of the agricultural growth process are critical for poverty alleviation.

Agricultural growth tends to lower food prices, so that exports become a more realistic possibility due to less upward pressure on the industrial real wage rate and on the real foreign exchange rate, which otherwise would increase as per the food prices. This also reduces pressure on the real exchange rate and helps stabilize the macroeconomy, since the less-developed countries cannot import the needed food grains to meet the growing food demands in the domestic market even if it is available in the international markets.

Citing examples from the recent Ravallion and Timmer analysis with large datasets, Mellor said that there is usually a 3- to 4-year lag in realizing the impact of agricultural growth on poverty. This means that the indirect impacts generated by agricultural growth (multipliers) are more relevant than the direct impacts. Their analyses also showed that where there is unequal distribution of land, agricultural productivity increases do not have a significant impact on poverty, for example in Pakistan, some parts of East Asia (Philippines) and Latin America, in the recent past. In this situation, labor is cheap and the generated rural income is siphoned out to the urban sector. Furthermore, the consumption patterns of the elite are usually not

met with goods and services produced in the local rural sectors, rather they are met from industrial-and service-related urban production.

In areas that lack potential for irrigation development or agricultural growth, migration becomes an important poverty alleviation strategy. Mellor suggested that the project may look at the demand for products produced by the poor people. Additionally, the use of potentially utilizable water resources must be examined. A final reminder was given to the group to not lose track of the fact that incomes must be raised.

In conclusion, Mellor mentioned that the recent trend is an accelerated growth rate in agriculture where there is growth in the irrigated area and thus irrigation is vital for the rural transformation process. The large-scale increases in agricultural production will allow large-scale participation of the rural poor in the production sector. He stressed the need to improve management and other institutional aspects of irrigation, especially in light of several cases of misallocation of irrigation investments in the past. However, there remains significant scope for expansion of agricultural production through reforms in the irrigation sector, particularly improving the irrigation water allocation in the tail-end reaches of canals.

Special Guest Presentation—John Taylor

A special guest presentation was made by John Taylor of Southbank University, UK. Taylor presented his experience in China of how institutional reforms can impact poverty reduction. He mentioned that water has been the most problematic factor in China throughout its development process. He stated that it would probably be easy to show how irrigation can increase incomes. However, figuring out how to develop interventions that both improve efficiency and alleviate poverty would be difficult. Farmer participation in managing water resources is a key means to improving irrigation management.

Taylor began with an outline of the background of irrigation in China where poor irrigation performance is characterized by several conditions. These include:

- Poor management of irrigation systems due to small and fragmented landholdings.
- Water charges that are too low to cover the operation and maintenance (O&M) costs and collected water charges that are not used for O&M, which discourage investment.
- Water charges based on land area rather than on volume, discouraging efficient water use.
- Low farmer participation and ownership contribute to low management efficiency, conflicts, and low collection of water charges.
- Reduction of irrigated area due to urbanization (fertile eastern areas are being replaced with less-fertile land in the arid western regions).
- China lacks a quantifiable and clear water rights system, which discourages investment in efficient technologies and management.

- Irrigation management is fragmented among different levels of government, rather than being unified according to hydraulic boundaries.
- Lack of effective water licensing and control over water results in overdraft of groundwater in water-short areas.
- Poor maintenance and declining infrastructure conditions.

Taylor related a brief history concerning water user associations (WUAs) in China. WUAs in China were first piloted in World Bank projects in the Hubei Province. Of particular focus is the use of Self-Financing Irrigation and Drainage Districts (SIDDs), which replaced formerly diverse management agencies. SIDDs comprise Water Supply Corporations (WSCs) and WUAs. The WSCs sell water to the WUAs based on volume of water used. The volume-based charges encourage the WUAs to use water more efficiently. The WUAs collect charges from their members to purchase water from the WSC. The WUA has the responsibility to design, construct, maintain and manage water delivery to the farm level. There are now 250 WUAs and 17 WSCs in 8 provinces across China. Additionally, China is in the process of drafting a new water law. This will extend the use of the SIDD system to other provinces.

In the areas where SIDDs have been introduced there have been several improvements including:

- reduced wastage
- improved canal maintenance
- improved designs from farmers for physical rehabilitation
- fewer crop failures due to more efficient water use
- economies of scale generated through group action
- reduced flooding
- improvements in soil conservation

There is also some evidence that water prices have been reduced but only a limited analysis has been done on this issue. The more relevant question, however, is whether irrigation management transfer/participatory irrigation management (IMT/PIM) has reduced poverty and brought benefits from a pro-poor perspective.

Taylor then addressed the issue of how WUAs can contribute to poverty reduction directly. *The general conclusion is that pro-poor impacts are a result of the ability of WUAs to facilitate the establishment of an enabling framework and enabling environment for poverty reduction.* Specifically, WUAs and SIDDs have increased the security of farmers by guaranteeing a regular supply of water to the farmers. There has also been a marked reduction in conflicts among water users. The WUAs have also increased participation of users in the decision-making process and there have been productivity improvements. In general, the well-being of the people has improved. Indebtedness has been dramatically reduced.

Taylor stated his ideas of more direct contributions that WUAs could make to poverty alleviation. He observed that one aspect of WUAs, which could contribute to poverty reduction, included flexible deferral of water payments by poor households. Additionally, irrigation can free a farmer's labor availability allowing that labor to be put to more productive uses. Women, in particular, experienced reduced time commitments since water delivery was now guaranteed. Formerly drought-induced indebtedness had disappeared as well as reductions in the incidence of drought.

While the above results do not lend themselves to generalizations, it was pointed out that *WUAs had facilitated an enabling framework for poverty reduction.* Additionally, the WUAs seemed to have mitigated some of the adverse effects of poverty.

Taylor called on more research to be done. Problem areas included the perceived inability of farmers to meet long-term capital costs of the irrigation system. Another problem was the lack of capacity needed among local governments to foster a strong commitment to the WUAs. The observations that Taylor made justified the need for further research into the poverty alleviation impacts of improved irrigation management.

The first session concluded with Taylor's presentation.

Session 2: Presentation of Country Papers

Session 2 of the workshop was dedicated to the presentation of papers by each of the participating countries on issues related to poverty and irrigation in their respective countries. The purpose of the presentation of country papers was to give a brief description of the existing situation and issues concerning poverty and irrigation in each country. Presentations were organized in alphabetical order by country name. Only a summary of some of the issues raised for each country is presented below. Full details are available in country papers in the next sections.

Bangladesh

Nityananda Chakravorty presented the paper for Bangladesh. He discussed several issues related to the situation in Bangladesh. He stated that reforms in the institutions have been slow. The marginal productivity of water in Bangladesh is currently unknown and expenditures for O&M are far below the requirements. Within Bangladesh, there are land distribution inequalities with 60 percent of the land being owned by only 20 percent of the people. Additionally, there are head-tail inequalities in water distribution. In light of this, irrigation has limited scope for poverty reduction. He emphasized the fact that understanding the institutional aspects of irrigation is critical for improving the overall efficiency and equity of irrigation.

At the farm level, farmers have a limited ability to pay for the O&M charges. One solution is for the farmers to practice crop diversification and adopt participatory water management. Chakravorty stated that this would help poverty reduction and increase water use efficiency. Likewise, he suggested that research covering the broad-based agronomic, economic, social and ecological issues is necessary to optimize production through low-cost technology and participatory water management.

China

China's presentation was given by Jikun Huang. Huang began by relating that China had one-fifth of the world's population, but only one-fifteenth of the world's arable land and one-nineteenth of the world's water resources. He then related the importance of water institutions and policies for sustainable water use. Though water-saving technologies are lacking they have been promoted, but they have not been widely adopted. Additionally, irrigation is faced with financial constraints where it is difficult to raise adequate funding. Finally, China experiences low water charges. Water fees have been introduced, but they are hard to implement and monitor.

Considering all these factors, Huang stated there is a need to search for innovative approaches. The conventional wisdom has widely ignored responses from various stakeholders and rising water scarcity. Important areas that should be examined are determining how income growth impacts poverty reduction, the investment and institutional policies, and legal system as related to water. These issues are difficult to implement and often involve high transactions costs. However, there is great room to improve water institutions and policies.

Huang highlighted the increasing emphasis of the Government of China on reforming water rights and associated institutions. He concluded that the past trend cannot be extrapolated linearly into the future. The government, farmers and the industrial sectors need a new approach to tackle the growing water-scarcity problem in China. Based on experience, he reemphasized the point that improvement in water institutions is a critical factor in dealing with water-sector problems and water scarcity.

India

Barbara van Koppen, IWMI researcher, presented her recent research paper on the topic "Poverty Dimensions of Irrigation Management Transfer in Large-Scale Canal Irrigation Systems in Andhra Pradesh and Gujarat in India." This research involved a comparison of a large-scale statewide IMT reform process recently carried out in Andhra Pradesh with irrigation management in Gujarat. Specifically, she examined two different modes of IMT and poverty dimensions involved in the IMT process. She tested two broad hypotheses on the mode of IMT process: a) whether the canal water is "farm-size neutral," and b) whether the impact of IMT on poverty in Andhra Pradesh and Gujarat is similar.

The IMT processes carried out in Andhra Pradesh and Gujarat are of two different types. In Gujarat, IMT was implemented sequentially, first from pilot cases and then expanding to larger areas starting in 1995. In Andhra Pradesh IMT involved major institutional changes occurring statewide in a single phase in 1997.

Her major findings from the extensive field study involving a survey of more than 700 households in the two states are that canal irrigation is not farm-size neutral. Specifically, small farmers in Andhra Pradesh are more dependent on canal irrigation than the farmers in Gujarat. In general, irrigation is an affair for the poor, more in the case of Andhra Pradesh than in the case of Gujarat. This could be because a larger percentage of surveyed households were dependent on agriculture in Andhra Pradesh than in Gujarat.

Further, in Andhra Pradesh, poor farmers are concentrated in the tail-end reaches of the canal systems, whereas such systematic differences are absent in Gujarat. She stated that getting more access and an adequate supply of irrigation water to the tail-end reaches of an irrigation system could be a pro-poor intervention.

Results of her research, however, disclosed no significant changes in income because of IMT, which succeeded in expanding the irrigated area. However, participation in IMT remains low, especially among small farmers in both states.

Indonesia

Mochammad Maksum presented the paper for Indonesia and began by discussing the development policy bias existing in Indonesia, and shifting focus from rice-based to welfare-based irrigation policy. Indonesia is undergoing experience with redefining the duties and responsibilities of irrigation institutions, capacity building of WUAs, IMT, promotion of self-financing activities and system sustainability activities.

Pakistan

Mohammad Ashfaq presented the paper for Pakistan. He mentioned that rural poverty in Pakistan has been increasing during the 1990s. He discussed several problems concerning irrigated agriculture in Pakistan. These included waterlogging, salinity, inequitable distribution of water, poor O&M and other institutional issues. Then he discussed the evolution of irrigation interventions in Pakistan beginning in the 1960s with the SCARP (Salinity Control and Reclamation Projects) program. In the 1990s, the SCARP program experienced a transition to farmer management. In the recent past, there have been other institutional changes including the formation of Provincial Irrigation and Drainage Authorities (PIDAs), Area Water Boards (AWBs), Farmer Organizations (FOs) and Water User Associations (WUAs), within a broader devolution of power. However, the pace of these reforms is very slow.

Vietnam

Doan Doan Tuan presented the paper for Vietnam. Tuan discussed the reasons for poverty in Vietnam including low access to land and other resources by the poor. Additionally, the poor suffer from low capacity to adopt new farming practices.

Session 3: Presentation of Overall Work Plan

The overall work plan was presented by Intizar Hussain and Eric Biltonen. Hussain began by discussing the fundamental aspects of the project. He first summarized the issues raised in country papers as well as during the national workshops held in each of the participating countries. These issues were organized under the following broad categories: 1) general issues,

2) irrigation performance, 3) institutions and management, 4) finance, 5) environment, 6) water rights, and 7) concepts and definitions of poverty. Specifically, issues identified in each country under these categories were:

General Issues

Landlessness and small landholdings
Low returns from crop production
Need for crop diversification and emphasis on non-crop agriculture
Need for empowerment of farmers with production technology
Need for improving credit and marketing facilities

Irrigation Performance

Low water use efficiency
Poor quality of irrigation service (adequacy, timeliness, reliability)
Problems with water allocation and distribution, head-tail inequities
Poor irrigation infrastructure, O&M issues
Waterlogging and salinity
Lack of water measurements

Institutions and Management

Inappropriate policies and institutions
Lack of transparency, consistency, democracy and partnership in irrigation management
Importance and the need for users' participation/IMT
Lack of capacity of farmers for handling IMT
Need for capacity building for WUAs and managers
Suggested interventions may be good, but implementation is a major problem
Institutional reform/IMT may improve system performance but may not have any impact on poverty
Slow pace of institutional reforms
Lack of coordination among irrigation agencies
Irrigation agencies opposing reforms
Solutions may become problems—influence of the elites

Finance

Inadequacy of financial resources for system management
Low O&M cost recovery
Low water charge collection rates

Environment

Salinity and waterlogging
Difficult natural conditions
Quality of land and water resources

Water Rights

Unclear water rights
Implementation and enforcement problems

Concepts and Definitions of Poverty

Poverty—level of water deprivation
Community-defined concept/definition of poverty
Relative poverty and not absolute poverty (China)

The above list does not exhaust all the issues raised at the regional and national workshops, but it does highlight the most important issues raised. As it would be impossible to address all of these issues under the current project, a more specific list of issues needed to be developed. This was one purpose of the regional workshop.

For the project, poverty will be assessed using both income and non-income measures. The study will be undertaken in two to four irrigation systems in each of the participating countries.

Hussain mentioned that there are three key dimensions of this project:

- Assessing the poverty *impacts* of irrigation performance
- Developing an understanding of the *existing problems*—constraints and opportunities, and
- Learning from institutional *innovations*.

Hussain made a detailed presentation on study objectives, research issues, questions and hypotheses, conceptual framework, study approach and research methodologies.

He gave a brief review of developments of the concepts and definitions of poverty. While there is a wide range and depth of concepts, it was proposed to primarily use income as the poverty measure. The justifications for this were based on both practical reasons and the assumption that many of the other components of poverty are related to income.

The proposed project framework considers a poor household's access to various resources and how these resources are shared and managed among the macro, meso, system, and household levels. The analytical complexities arise from complicated interactions between

various types of resources and institutional structures, processes and functions. Actions and strategies adopted at all levels result in outcomes, which could be positive or negative. These outcomes or impacts have direct and indirect impacts at all levels, including the household level, and determine the level of affluence or poverty in a given socioeconomic environment. Details of the conceptual framework are given in part 2 of this report.

The general approach was presented in terms of both research components and study "outcomes." Because of the complex nature of the topic, some of the research components serve as inputs to other research components. Therefore, how the research components progress to reach the research objectives was demonstrated.

To better design this project, it was deemed important to determine what outcomes would be needed to judge the project as a success when the project concludes in 2003. Desired project achievements for July 2003 were listed as:

- quantification of estimates of impacts of irrigation on poverty
- assessment of performance of irrigation systems
- identification of opportunities and constraints for improved system performance and poverty reduction
- learning of lessons based on experiences from various innovations in irrigation sector
- identification and evaluation of guidelines/options for future interventions in irrigation
- identification of key areas for further research

Hussain closed his presentation with several suggestions for further discussion. He encouraged the participants to further discuss and provide feedback in the following areas:

- components of the project-coverage
- overall design
- research hypotheses
- number of irrigation systems to be studied
- data collection procedures
- concepts
  - poverty (income, water deprivation, other)
  - irrigation system
  - performance (good, poor)

Session 4: Discussion on Overall Work Plan Issues, Approach and Methodologies

Following the presentation of the overall work plan a general discussion was held to gather participants' feedback regarding the project design and methodology. Robert Chambers began the discussion by expressing his concern over the use of Participatory Rural Appraisal (PRA) methods. His experience has shown that PRA is a powerful tool, but it is too often used incorrectly or abused. He offered to hold a separate discussion session that evening. The PRA presentation was held from 8.00 to 11.00 p.m. following dinner.

Hammond Murray-Rust spoke next and raised several concerns. His main concern was that the project was attempting to do too much and may run into problems because of the broad scope. His second concern was based on the *a priori* assumption that distributional patterns of poverty along the head, middle and tail reaches of an irrigation scheme was unfounded. He stated that there are too many factors affecting poverty and these factors could not be narrowed down to only location. Finally, he expressed concerns that the work plan was not clear on the performance indicators. Murray-Rust stated that performance must be tied to a subjective agreement between people and management. He stated that the performance level is indicated by the "extent to which you did something you intended."

Samad expressed a similar concern regarding the breadth of the study. In particular, he mentioned about the research questions, which he felt were very broad. He suggested that the project would benefit by keeping the focus narrow and that the presented formulation of the project would entail enormous data requirements.

Bhattarai suggested that it may be better to separate the focus of the study on two distinct levels, and clearly listing the kind of information and data to be collected from the surveys of the irrigation-system level and the household level. Hence, the number of irrigation performance indicators at the system level should be restricted. Similarly, the institutional analysis should be primarily conducted for system-level issues and not at the household level. The study needs to separate these issues clearly at this stage.

Hussain responded by generally agreeing with the comments. He mentioned that the list of indicators might need further refinement. He stated that studying the locational aspects of irrigation and poverty is an important part of this project and is, perhaps, an important way to understand the links between irrigation management/performance and poverty.

Hussain also indicated that this project is not purely an academic exercise. The driving interest of the project is to determine the extent to which irrigation and system performance relate to poverty. While some of the initial activities of the project are of broad coverage, these will help identify areas of more in-depth analyses. The project will focus on key issues for in-depth study.

Hammond Murray-Rust stated that interventions are those things that can be managed. He suggested that a focus be kept on looking only at those things that can be managed.

Sakthivadivel asked whether the level of analysis would primarily be the household. He suggested that the potential interventions should be checked to see if they are in agreement with the target poor. That is, that the poor are of the same thinking. He also offered an example of irrigation happening outside of the system area and to check whether there is really a net gain from better management. Hence, it is important to know, first, how much of the water is being used by irrigated agriculture now, and how much system efficiency we can actually improve by better management of the system.

After a short break, the discussion on the work plan was continued. John Mellor offered extensive comments at this point. The objectives of the project were built around the facts that irrigation is important to poverty alleviation and that irrigation performance is crucial in this respect. He reiterated the point that the project must make separate lists of those interventions that affect the users and those interventions that affect everyone else. This point was made to stress the importance of indirect impacts of irrigation on poverty. He stated that the indirect impacts would be twice as great as the direct impacts of irrigation.

Mellor then discussed several related issues such as determining who is participating in irrigation management, who gets water and who is deprived, and when and where along an irrigation system this happens. He mentioned that efficiency of irrigation systems could be improved through better policies and institutions. Furthermore, policies affecting irrigation systems as a whole and policies affecting household-level decisions should be separated.

He suggested looking at relationships between income and poverty. From a well-designed questionnaire, information could be generated on the employment structure within irrigation system command areas and this could help analyze direct and indirect impacts of irrigation on poverty. He suggested looking at factors such as occupational differences by location within the systems (head, middle and tail reaches). This will help separate policy impacts on full-time farmers, part-time farmers, and the rural landless.

Mellor mentioned that rural household behavior suggests that when incomes rise, women and children are the first to be pulled out from farm labor. Increased incomes allow labor substitutions from intra-farm and inter-farm sources. This increases the ability of farm households to allocate household labor to other activities, such as school or off-farm employment. This has important implications for the social welfare in a village. Hence, the income effect of better access to irrigation is a critical dimension of development and poverty, which should not be neglected in this study.

Raju expressed concern that it is not clear who is being identified as the poor, whether the poor are water-deprived, income-poor, poor by design of irrigation project, and whether deprived of canal water or deprived of water from other sources. He also asked whether the study area concerned the actual irrigated area or the designed area. He asked whether the water deprivation concerned the canal only or the whole system. Finally, he suggested that financial self-sufficiency needed to be precisely defined. He also suggested that more coverage in the project is needed on issues like financial self-reliance of irrigation systems and the degree of self-reliance of an irrigation system.

Hussain responded by stating that water deprivation may not necessarily mean that the household is generally poor, that there may be people who have access to other sources of water, that the poor may not necessarily be associated with water deprivation if they have other sources of income, and that attempting to define poverty in terms of irrigation water, deprivation may pose conceptual problems. He suggested, though, that if the tail-end reaches are prosperous then either they have access to groundwater (alternate source of water) or they are near a market town (alternate source of employment). He then stressed that full financial self-sufficiency is rarely found and that, however, the importance lies with the degree of financial self-sufficiency.

Hunzai offered the comment that less concern should be placed on defining who is poor and more on which aspects of irrigation are more productive and with greater distribution of benefits. In addition, he stressed the need for a system-level focus of the study and for documentation of the institutional innovation practices in different irrigation systems across the countries.

Bhattarai commented that in consideration of the scope and objectives of the study, two levels of analyses may facilitate successful achievement of the stated objectives. He suggested making a clear distinction between the analysis of the irrigation-system level and the analysis of the household level. The irrigation-system study involves PRA, system performance and institutional analysis, whereas the household/farm-level analysis involves household-level data collection and farm income and crop yield differences across households, and analysis across irrigation-system reaches and household groups.

Chakravorty commented that poverty has many dimensions and the factors behind poverty vary largely between systems and countries. The factor responsible for poverty in Bangladesh is not the lack of access to sufficient water but the lack of adequate facilities for drainage. Other aspects of concern are pollution and health-related issues of irrigation systems. He suggested that the project is confined to a complex regime. He suggested that the existing physical system cannot be changed easily because of the level of sunk capital involved but new projects can incorporate pro-poor aspects. He suggested that all stakeholders must be in all tiers of irrigation management but even this will not guarantee that the poor have a voice. Chakravorty reiterated the point that poverty must be looked at through multiple dimensions. He then stated that there are some problems with PRA and that, therefore, we should design the project such that both PRA and household-survey tools will complement each other.

John Taylor stressed that there are certain aspects of poverty that cannot be addressed by irrigation, so not all aspects of poverty can be addressed by this project. It will be better to narrow down the scope of project activities and coverage of the project.

Barbara van Koppen briefly mentioned that other sources of water such as groundwater should also be covered in this study.

Chakravorty suggested that the poverty mapping and poverty analysis constitute a very complex component of the project. Therefore, it is better if we either limit the focus of the analysis or reach a consensus on the operational definition of poverty that will cover this project.

Hussain responded that defining the poor is not easy and that we need some broad criteria and consensus. He asked the participants whether they could propose any quantifiable measures in addition to the ones already proposed for the project (income/expenditure, household assets/resources, etc.) and develop a consensus view.

Samad stated that income is a good index for poverty as income has a strong correlation with other aspects of poverty. Additionally, income is a very practical criterion to measure poverty.

Chambers mentioned that poverty is a very complex term and extremely difficult to measure in reality. He asked the question, "Income is a simplification, but is it?" Chambers suggested that income is being offered as a proxy of poverty but that income is not a good indicator. Rather, a process should be facilitated so that the definition of the poor is self-identified by the community. He felt that self-identification actually simplifies the process and makes it participatory. Hence, PRA type of exercises and better participation of poor people in the survey for defining poverty, resources mapping exercises of PRA, visual analysis, etc., may be a better method to tackle this critical issue.

Huang agreed that income poverty can be a hard concept to use in the field. He related his experience in China where they used three to four indicators for poverty. His research

team then used an expenditure-based measure of poverty and an assets-based measure of poverty like housing quality, and presence or absence of other selected household assets like a color or black TV or a refrigerator, to identify poor households in a village.

Chambers responded that physical indicators (such as land size or housing quality) are poor indicators of poverty. He stressed that we need to use PRA for effectively measuring the poverty level in a community. He mentioned a recent video documentary in Sri Lanka that explained clearly why PRA is a more effective tool for measuring poverty than other techniques. Likewise, PRA techniques have effectively been used in mapping poverty in other parts of South Asia, as in Sindhupalchowk district of Nepal and in several parts of India. Again, he suggested a self-identified process to measure poverty in the project methodology.

Bhattarai raised the issue that PRA could be a good technique for the information related to community-level and village-level characteristics like average yield or the number of households below a certain income level in a village. However, he raised doubt whether PRA is equally relevant to the collection of detailed information on household characteristics and individual wealth, such as level of income, level of household inputs used, and individual consumption expenditures.

Samad raised questions concerning the unit of analysis and whether PRA techniques are good for this.

Chambers stated that PRA visuals are very good for a household-level analysis.

Tuan suggested that considering the nature and scope of the project, irrigation-related poverty should be the only focus of the study. He suggested that we should seek those interventions with a direct link of irrigation systems to poverty, and not to other general factors. He also suggested listing the possible irrigation and poverty-related problems by countries and selecting the relevant issues from this list. He then stated that the feasibility of the proposed interventions must also be judged against the willingness of the government to accept them.

Huang mentioned about water institutions and actual versus theoretical implementation of institutional change. He said that in-depth analyses of performance may not be useful. Additionally, it would be costly in terms of time and money to collect detailed information and data. He suggested that a minimal emphasis be placed on system performance and more emphasis be focused on the household level study.

Murray-Rust stressed the importance of understanding what irrigation performance really is. Some of the indicators suggested may not be indicators of irrigation performance. He stated that we needed to get the objective of the irrigation system to understand performance and its impact on poverty.

Murray-Rust said that if the objective is to improve performance then helping the poor is a "wish." Otherwise, the objective needs to be to help the poor. The idea of participation is so that peoples' objectives are included in management. Finally, the benefit of participation is that better information reduces uncertainty and improves reliability. Performance is a measure of the level of service.

Taylor countered by stating that irrigation performance improvement could provide an enabling environment for the poor to benefit from irrigation, and that performance improvement interventions could contribute towards poverty alleviation.

Session 5: Presentation of Country Work Plans

The country partners presented their detailed country work plans.

Session 6: Presentations of Topics by IWMI Researchers

Session 6 was opened with a presentation by Hammond Murray-Rust on Irrigation Performance Assessment. He began by stating that to assess performance a list of criteria was needed. The first criterion was adequacy, which deals with supply and demand. The second concerned reliability, which aims to minimize variability. The third was equity, which he defined as differences in adequacy and reliability. He then gave a short example comparing two irrigation systems, each with different levels of each criterion. His point was that comparisons are useless because there was no context or objective. Then he offered three rules for the assessment of irrigation performance.

Rule 1 was that "management needs targets." That is, management sets targets and tries to meet them. Operational performance is then concerned with how well the targets are met.

Rule 2 was that the targets need tolerances or standards against which they can be measured. Targets need a defined level of service expressed in a set of measurable and verifiable terms. There should be a specified target and an acceptable level of deviation. If the criteria are met, then performance is judged adequate.

Rule 3 defined two objectives for management with related questions. The objectives were stated as follows:

Management objective 1
Did I do what I was supposed to do?
Do people trust my management skills?

Management objective 2
Are the right things being done? That is, if targets are met, are the objectives fulfilled?

Murray-Rust made the point that it is crucial to link the targets to the objectives. The difficult part of performance assessment is to understand the linkage between the objectives and the operational targets. Objectives can include the establishment of right as well as setting output goals. Finally, it is imperative that the aspirations of all stakeholders are included.

He concluded by highlighting the differences between management performance and the impact (of management) indicators. Management performance is the process of setting objectives. They measure outcomes that reflect the interaction of management and external indicators, but are not managed. He indicated that system comparisons and diagnoses through output/impact indicators may not be useful.

David Molden emphasized that some sort of problem diagnostic analysis using output and impact indicators may be essential and useful for this project.

In reference to the overall project, Murray-Rust made four points. The first point addresses the method in which we get the beneficiaries involved in all three steps of the management process. The second point was determining the irrigation system objective. The

third point was to identify targets for level of service. The final point concerned how to get operations to meet the objectives.

Barbara van Koppen presented a paper on gender indicators for assessing irrigation performance, particularly evaluation of gender impacts of irrigation systems. These indicators were developed based on case studies in Nepal (Gandak irrigation), India (Gujarat irrigation), and Burkina Faso in the southern Africa region.

She highlighted that we can effectively include gender-related factors while evaluating the impacts of irrigation similar to other performance factors related to economics, engineering and institutional dimensions.

Sakthivadivel made the final presentation on water-accounting methodologies. He discussed methods for increasing the productivity per unit of utilizable water resources. The three methods included the development of further resources by increasing storage and diversion facilities, the use of more of the developed water for beneficial uses and the production of more output per unit of water depleted.

Water accounting uses a water balance approach, which classifies outflow components into different categories. The means for saving water and increasing productivity of water follow from four categories: beneficial depletion, non-beneficial depletion, uncommitted outflow and committed water.

Sakthivadivel discussed several methods to reduce non-beneficial depletion. Options included the reduction of evaporation of water applied to fields and from fallow land. There is also the reduction of water flow to sinks. Additionally, there is a minimization of the salinity of return flows. Finally, there is the option of reusing return flows.

In regard to increasing the productivity of water per unit of water consumed, there are several options. These include changing crop varieties, crop substitution, deficit, supplemental or precision irrigation, improved water management and improving non-water inputs.

To realize benefits from tapping uncommitted outflows, the management of existing facilities can be improved. Additionally, return flows can be reused or the number of storage facilities can be increased.

Session 7: Finalizing Discussions on Issues, Approach and Methodologies

The finalizing discussion served as a wrap-up for all the discussions in presentations and to gain a consensus for the work plan. Hussain presented the following proposals for revising the work plan based on the workshop discussions and presentations. The following research topics/components were proposed to be taken up in the study:

- Review and assessment of existing policies related to irrigation water and institutional arrangements
- Assessment of poverty in selected irrigation systems
    - Characterization of the systems (physical, socioeconomic...)
    - Identification and locating of the poor (mapping poverty)
- Diagnostic analysis

- Is poverty due to irrigation-related factors or other factors?
- Performance assessment

- Special topics—analysis of institutional interventions/innovations
  - Irrigation financing, cost recovery/water charges/water pricing
  - IMT/PIM
  - Water allocation/distribution procedures, water rights
- Identification of constraints and opportunities for improving irrigation system performance through pro-poor interventions

The following research hypotheses, which were slightly modified with input from the workshop, were proposed to be tested in this project.

1. Canal reaches receiving less irrigation water have a lower productivity and a higher incidence of poverty.
2. Under existing conditions, small, marginal and poor farmers receive fewer benefits from irrigation than large and nonpoor farmers.
3. The greater the degree of O&M cost recovery the better the performance of irrigation management.
4. PIM/IMT leads to improved irrigation system performance that, in turn, reduces poverty.
5. An absence of clearly defined water allocation and distribution procedures and absence of effective and clear water rights (formal and informal) adversely affect the poor more than the nonpoor.
6. There is scope for improving performance of irrigation systems under existing conditions, with effective and improved institutional arrangements.

Following the presentation of the research hypotheses, a general discussion was held to gain participant feedback and reaction.

In particular, while some had suggested using well-being or food security as measures of poverty, it was agreed that income would be used as the main poverty measure for this project. For specific topics, the range of irrigation systems studied would be broadened to include systems where innovations had occurred. Finally, it was suggested that the analysis focus on the household and system levels. Household questionnaires could then be supplemented with PRA.

Raju stated the need to examine the legal framework and how it serves to provide an enabling framework.

Chakravorty expressed concern over the planned poverty mapping, stating that it would be operationally difficult. The difficulty is caused because poverty would be distributed

sparsely. This would require significant amounts of data. Also, he mentioned that if cost recovery did not refer to private interests, then there would not be any meaning.

Chambers highlighted the difficulty in choosing the key informants. However, PRA can be used on an irrigation system. He suggested that NGOs are a good source of qualified people.

Chambers remarked on the aspect of cost recovery dealing with management's effort to recover the money it paid for the post.

Hunzai mentioned about looking at institutional reform instead of only IMT. The focus should be on cost-effectiveness/efficiency rather than on cost recovery.

Maksum stated that he generally agreed with the research issues, but suggested that each country be allowed to come up with its own methodologies.

Chambers reiterated his belief that more learning could be gained with greater diversity in approaches. He stressed methodological pluralism.

Raju posed a question concerning the minimum sample size, especially considering the size and whether this would include those with and without land.

Chambers concluded the sessions by giving the participants some suggestions including:

- *Ask them*—complexity, a way to get a handle on the complexities involved is to simply ask the target group.
- *Be flexible*—spare capacity, pluralism. This deals with leaving spare time in the process to respond to unforeseen developments or methods.
- *Perceptive*—hidden factors. This involves careful analysis to get at the true story.
- *Reflective*—diaries of methodologies. He recommended that all researchers keep diaries so that the researchers could look back and remember what they were thinking at different periods to offer more understanding.
- *Give the full picture*—realism, making sure that the project gets the actuality of the situation rather than reporting what is presented to us.

Session 8: Study Implementation Plan

Hussain made a detailed presentation covering the following administrative matters and aspects of the project:

- Memorandum of understanding between IWMI and partners
- IWMI's research principles
- National Consultative Committees (CCs)
- Partner study teams, and team members
- Project financial matters

- Study contracts, payments and disbursement plan
- IWMI's and partners roles and responsibilities
- Project methodological guidelines
- Project activities and sequencing
- Project outputs, standards and requirements
- Upcoming events including CC meetings and workshops

The workshop closed at 6.30 p.m. on 10 August with some discussion related to administrative matters. Hussain thanked all participants of the workshop for their very valuable contributions to the project.

Part 2

Pro-Poor Irrigation Intervention Strategies in Irrigated Agriculture in Asia: Developing the Project Framework

Intizar Hussain and Eric Biltonen

Background

Despite the remarkable expansion of irrigated agriculture in Asia that brought dramatic increases in food production in the past three decades, there remain vast areas in the established irrigation systems where productivity and incomes of farmers remain extremely poor. This is attributed to inequitable distribution of water caused by poor management and to a range of other physical, sociocultural and economic constraints. The efforts of governments of the developing countries to address poverty reduction in these specific areas have been limited and ineffective due to lack of proactive policies and actions, and knowledge of how alternative economic, institutional, governance, and technical interventions can address poverty-related constraints. However, an increasing number of developing countries in Asia are recognizing the looming water-scarcity situation and the ever-increasing food demand across the region, and are moving toward major policy and institutional reforms to optimize the management of their water resources. Enhancing the productivity of poor farmers in these areas should be prioritized, as they are most vulnerable to water scarcity. The International Water Management Institute (IWMI) has proposed the study to assist the developing countries in determining realistic options for improving the returns to poor farmers in the water-scarce areas. A rigorous analysis of poverty-related constraints and the impacts of a range of potential pro-poor interventions on those specific constraints will be conducted, focusing on selected low-productivity irrigated areas and their peripheries in the participating countries, Bangladesh, People's Republic of China, India, Indonesia, Pakistan and Vietnam.

Goal, Objectives and Scope

The overall goal of the proposed study is to promote and catalyze equitable economic growth in rural areas through pro-poor irrigation interventions in the participating developing countries.

The immediate objective is to determine realistic options to improve the returns to poor farmers in the low-productivity irrigated areas within the context of improving the overall performance and sustainability of the established irrigation systems.

The study will focus on selected representative low-productivity irrigated areas and their peripheries with a large number of people under persistent poverty in the participating countries. The emphasis is on identifying and assessing a set of appropriate economic, financial, institutional, governance and technical interventions at field and system levels, and changes in the overall policy and institutional framework as far as they affect access to water resources for the poor. The scope is as follows:

1. Analysis and field research on the impacts of the current policy and institutional framework, and the impacts of underlying physical, economic and sociocultural conditions on the selected areas in particular and on the overall irrigation systems at large, including the assessment of opportunities for, and constraints on, improving productivity in these less-productive areas through improved access to irrigation water.

2. Identification and in-depth evaluation of a range of potential pro-poor economic, financial, institutional, governance and technical interventions at field and system levels against a set of criteria including cost of implementation and potential to reduce poverty, and assessment of necessary changes in the overall policy and institutional framework under which such interventions could most effectively address poverty reduction in the study areas.

3. Formulation of a set of appropriate interventions and the policy and institutional frameworks, including adequate support systems, required to ensure large-scale uptake, replicability and higher impacts within and between Asian countries to culminate into a) the guidelines for identifying and evaluating appropriate pro-poor interventions and enabling policy and institutional framework for irrigated agriculture in Asia, and (b) country-specific action agendas for the selected low-productivity areas of the participating countries.

Irrigation and Rural Poverty

Positives

The overall goal of irrigation development in developing countries has been the socioeconomic uplift of the rural masses. Within this goal, the governments of the developing countries have promoted irrigation for several broader objectives such as economic growth, rural and agricultural development, national food security, protection against famines and intensification of land use. Huge investments have been made in large networks of canal irrigation to achieve these objectives. Subsidized irrigation supplies, along with many other input subsidy programs have been established for the socioeconomic transformation of

national and regional economies and rural communities. However, as the socioecological externalities of irrigation became apparent, and as scope for further irrigation development became limited and donor support subsided, the focus shifted from development to management of irrigation. The new paradigm focuses on growth with equity and sustainability.

Irrigation has a strategic importance in agricultural production. There is little dispute of the fact that agricultural output per hectare is substantially higher on irrigated fields than on nonirrigated fields. Irrigated agriculture has been adopted by many poor farmers as a source of food security, income and employment. It has also been adopted by the rich and well-off as a business activity, as an investment alternative and, often, as a means to exert social influence and political control.

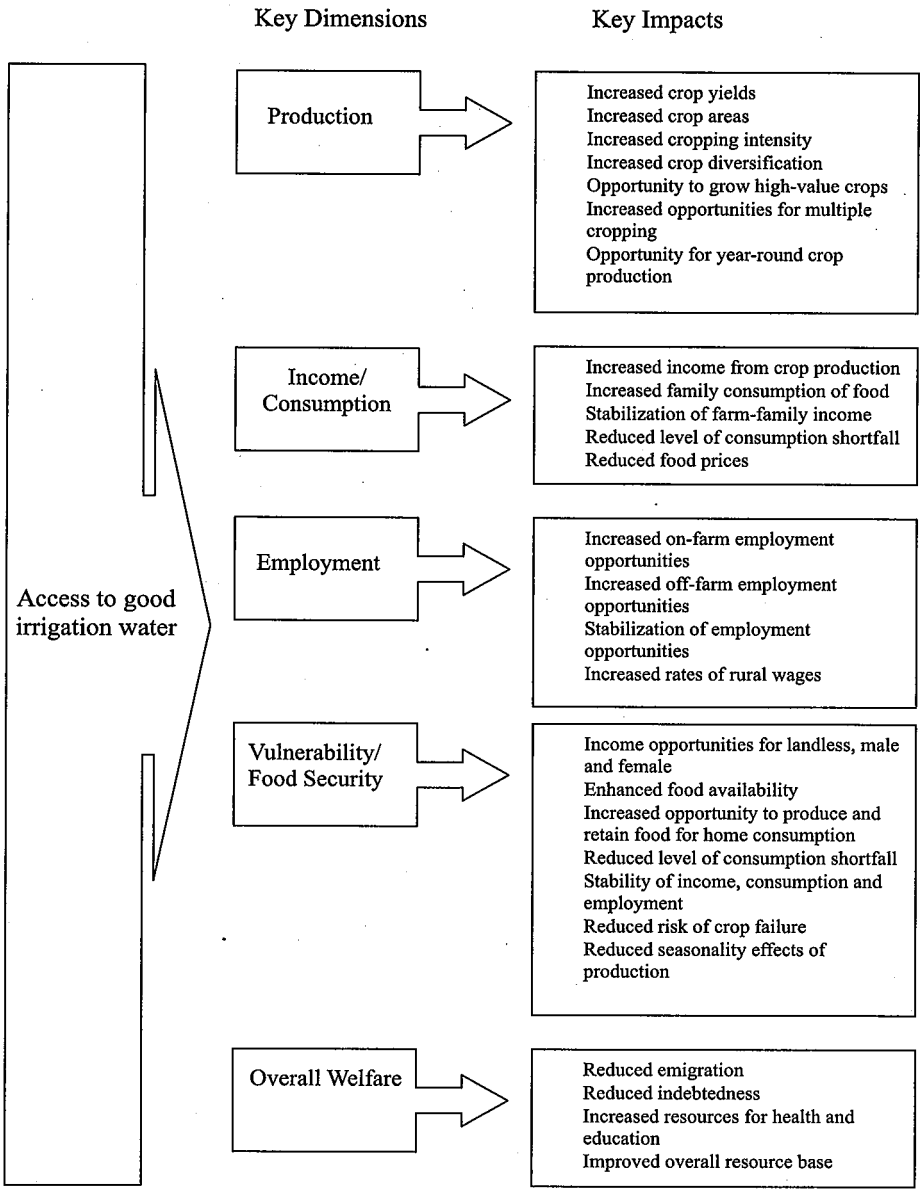
Irrigation has been regarded as a powerful factor for providing food security, protection against adverse drought conditions, increased opportunities for more employment and stable income, and for offering opportunities for multiple cropping and crop diversification. Access to reliable irrigation enables farmers to adopt new technologies and intensify cultivation, which lead to increased productivity, overall higher production and greater returns from farming. This, in turn, opens up new employment opportunities both on-farm and off-farm, and improves income, livelihood and the quality of life in rural areas. Overall, irrigation water, like land, has an important wealth-generating function, specifically in agriculture and generally in rural settings.

There are five key dimensions of how access to good irrigation contributes to socioeconomic uplift of rural communities—production, income/consumption, employment, vulnerability/food security and overall welfare (figure 1). In general, access to good irrigation allows poor people to increase their production and incomes, to enhances their opportunities to diversify their income base and to reduce their vulnerability caused by seasonality of agricultural production and external shocks. Thus, access to good irrigation has the potential to contribute to poverty reduction and to move from ill-being to well-being.

Negatives

Access to good canal irrigation depends upon the performance of irrigation systems, including its hydrological, infrastructural, agricultural, socioeconomic and institutional dimensions. There is significant evidence that performance of large- and medium-scale canal irrigation systems in most developing countries has been poor. Historically, the large- and medium-scale canal irrigation systems have been owned, managed and operated by government agencies. These publicly managed systems are generally characterized by poor management, unreliable water supplies, poor maintenance, deteriorating infrastructure, unsustainability, inefficiency and inequity in water use and distribution, and financial dependence. These problems result in smaller irrigated areas than what could potentially be irrigated with available supplies, lower cropping intensities and crop yields, tail-end deprivation, increased problems of waterlogging and salinity, and lower returns from farming—resulting in overall reduced benefits to society from the available resources and little or no antipoverty impacts from irrigation. The vicious circle found in the irrigation sector of many developing countries is described in box 1 and figure 2 (modified from the World Bank 1999).

Figure 1. Key dimensions and linkages between irrigation and socioeconomic uplift of the rural communities.



With increasing realization of these problems, coupled with budgetary pressures and the need to reduce public expenditures for irrigation, there has been a significant emphasis on the strategies for performance improvement through reforms in the irrigation sectors of the developing countries of Asia. Steps toward development of policies and laws on irrigation water, basin level approaches to planning, irrigation management transfer to user organizations, changes in irrigation financing policies including irrigation charging policies, are all part of the reform initiatives.

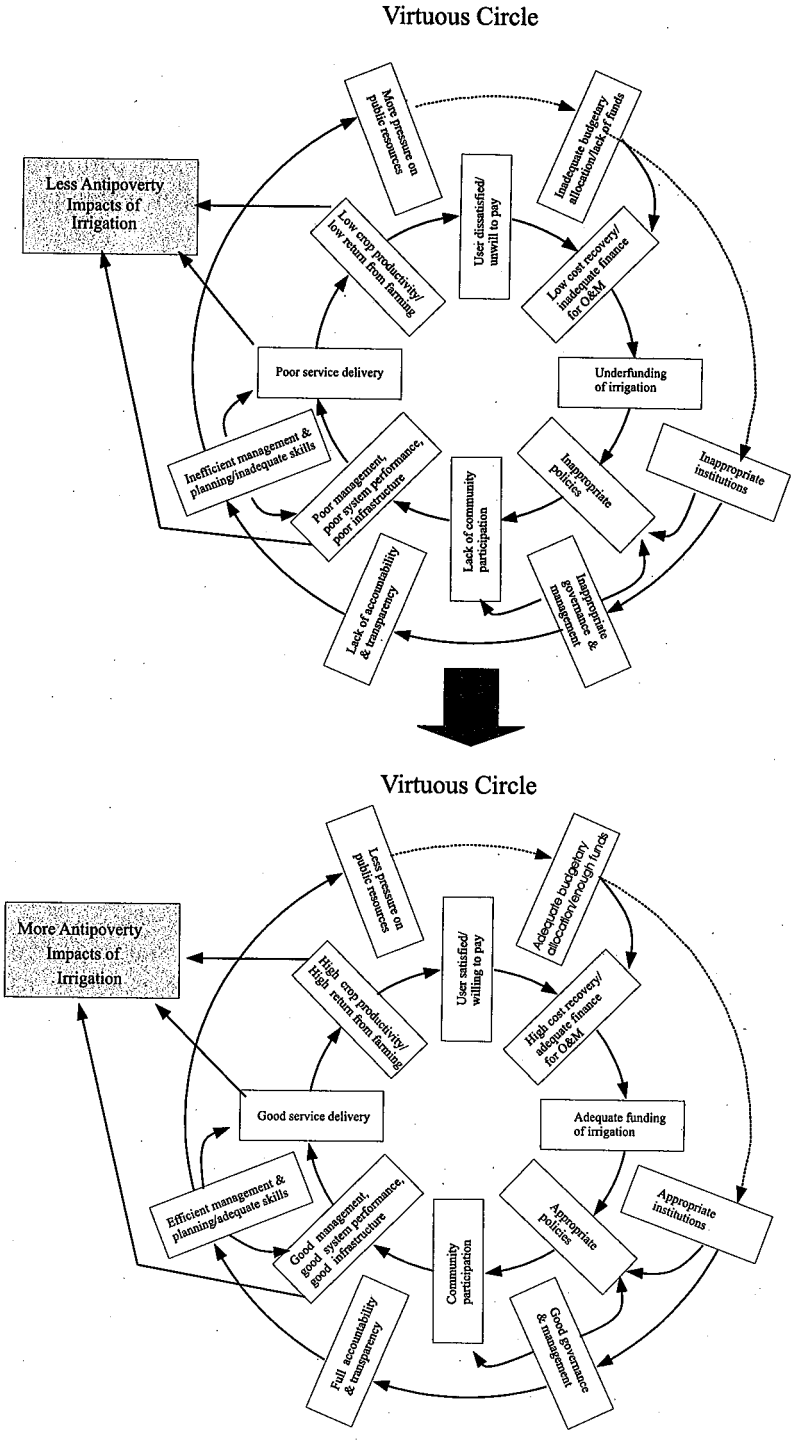
The overall goal of initiatives on the improvement of irrigation performance is to better utilize the available water resources and to increase overall agricultural productivity. It is implicitly assumed that equity concerns in the overall strategy for performance improvement would benefit communities, including the poor. The underlying assumption is that performance improvement would increase the "size of the pie" and that the poor would also benefit from the bigger pie. This is similar to the "trickle down" approach in general agricultural-development strategies pursued during the 1960s through the 1980s. Most agricultural-development experts would agree that the trickle-down approach was not very effective in reducing poverty. In the irrigation sector, general performance-improvement initiatives may prove another form of the trickle-down approach, specifically to the irrigation sector. It is timely to ask questions like: to what extent can the overall irrigation-performance improvement benefit the poor?; how and to what extent can poverty concerns be incorporated into reform initiatives?; which approaches and models have greater positive impacts on poverty? and what specific pro-poor interventions need to be incorporated into general performance-improvement strategies?

Box 1. From vicious circle to virtuous pro-poor circle.

The current situation in the management of the irrigation sector may be characterized by a vicious circle as shown in figure 2. The starting point in the vicious circle is most likely poor delivery of services resulting from poor management, poor infrastructure and poor system performance, and from inappropriate sector policies and lack of community participation. These factors lead to low crop productivity and overall low returns from farming, which, in turn, lead to water users' dissatisfaction with quality of irrigation services and their unwillingness to pay irrigation charges resulting in low cost recovery. This, combined with inadequate budgetary allocations for the sector, results in underfunding of the sector. All the factors given in the inner loop are the effects of the underlying causes, which are inappropriate governance and management, and inappropriate institutions resulting in overall inefficient management and planning, reducing antipoverty impacts of irrigation.

The key to convert this vicious circle into a virtuous one is to correctly diagnose and address these underlying causes. The research work in this project will focus on developing an understanding of these underlying causes in the vicious circle and identify strategic interventions that, in additon to improving overall management of the sector, also enhance antipoverty impacts of irrigation.

Figure 2. From vicious circle to virtuous circle.



Ambiguities and Unknowns

While it is clear that appropriate institutions, policies and management practices are needed in moving from the vicious circle to a virtuous one, the fundamental question is: what are those appropriate institutions, policies and management practices? There is a vast amount of literature suggesting various types of performance-improvement interventions. These include decentralization of control, users' involvement in irrigation management, regulatory instruments and market-based approaches. However, there is no consensus on how, and to what extent, these interventions contribute to improving system performance. More importantly, it is not clear how these interventions help enhance the role of irrigation in its contribution toward poverty alleviation or, in other words, how performance improvement interventions can be designed so as to provide an enabling environment for the poor to secure greater benefits from irrigation.

Key Research Issues

The central research issues in the above context are: whether, and to what extent, irrigation development and past management practices have contributed toward achieving the broader goal of socioeconomic uplift of rural communities and, if not, what are the causes of underachievements, and how have these affected the lives of the poor in rural agricultural communities. Alternatively, why do poverty and affluence coexist in irrigated agriculture, and in light of regional experience, what are the realistic options to make irrigation effectively pro-poor?

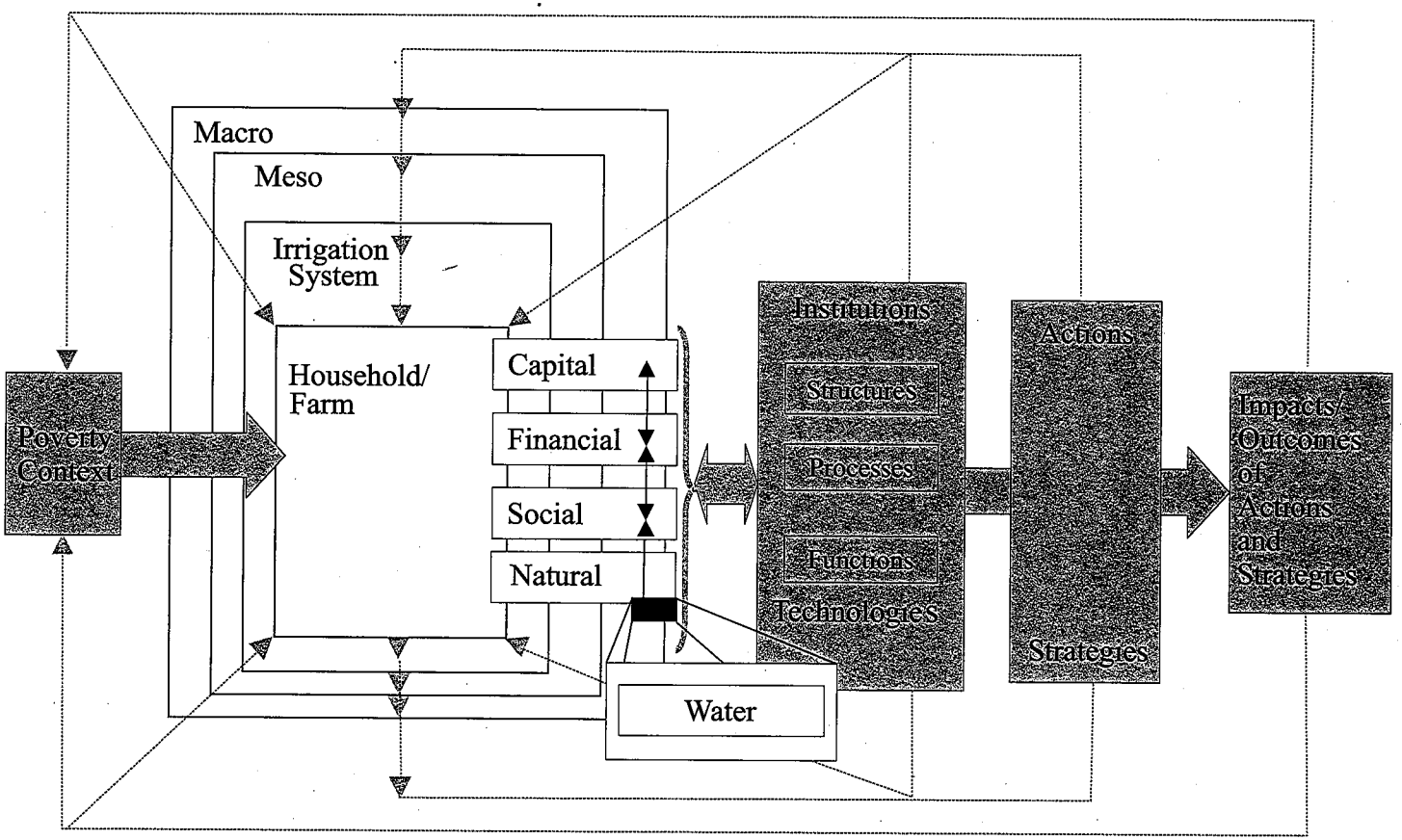
Conceptual Framework

The broad framework adopted for this study is graphically depicted in figure 3. This framework establishes the conceptual approach for developing specific methodologies for the project. The framework takes a holistic perspective in understanding socioeconomic and physical environments and highlights some of the complexities in studying poverty in irrigated agriculture [Some of the concepts used here are borrowed from the Sustainable Livelihoods Approach (SLA) for analyzing poverty (see Nicol 2000) for details on SLA].

The starting point in this framework is to develop a sound understanding of the poverty situation at the household level, the basic unit. A household is a part of an agricultural/ irrigation system that, in turn, is a part of the region/province/basin—which is a part of the macro or national socioeconomic system. A household is linked to these higher levels through a multitude of complexities, which come from several sources.

There is a stock of resources or endowments, which change over time. The resources are classified as capital resources (infrastructure...), financial resources (income, cash, credit...) social resources (education, skills, culture, social networks...) and natural resources (land, water...). These resources are shared across the various levels from macro down to farm/household level. Each household or irrigation system has a share of the total

Figure 3. Framework for studying poverty in irrigated agriculture.



available resources and these resources are interdependent. That is, a change in one resource will depend upon changes in the other resources.

In addition, there is a set of institutions and technologies. Institutions may be considered as combinations of policies and objectives, laws and regulations, organizations and their core values, operational plans and procedures, incentive mechanisms, accountability mechanisms, norms, traditions, practices and customs (Bandaragoda 2000). For analytical purposes, institutions may be perceived as comprising a) Institutional Structures; b) Institutional Processes; and c) Institutional Functions. Institutional structures refer to organizations, both formal and informal. Institutional processes refer to policies, laws, rules and regulations and practices. Institutional functions refer to implementation of institutional processes. Both processes and functions may be perceived as software parts of institutions. Structures are important because they develop the institutional processes, implement them and make them functional. All three components are deeply interlinked.

Institutions operate at all levels from the household to the macro/national level. Institutions and resources are also linked to each other. That is, institutions determine changes in stocks of available resources, and the available resources determine the type of institutions in place. Most importantly, institutions play a key role in determining how the available stock of resources is shared across households or systems, thus influencing access to these resources. Available resources, technologies and the institutions in place determine the type of actions taken and strategies adopted at each level (i.e., household to macro level), which result in certain outcomes. These outcomes could be positive or negative or a combination of both. Outcomes and impacts feedback affecting each of the four levels directly or indirectly—influencing the resource base, access to resources, and poverty situation at all levels. A good resource base with appropriate institutional arrangements and technologies combined with effective actions and strategies results in positive outcomes, which positively influences the entire system. However, inappropriate institutions and ineffective actions and strategies, even with a good resource base, may result in neutral or negative outcomes, adversely affecting the health of the entire system.

For positive poverty outcomes, two broad approaches may be adopted: a) redistributing the available resources in favor of the poor, and b) creating an enabling environment for the poor to benefit from available resources at various levels through appropriate institutions (technologies). However, there is no unique set of appropriate institutions that can be applied universally. A set of institutions may be appropriate under certain conditions, and may not be appropriate under others. Understanding these conditions and devising effective institutions are essential for any effort toward poverty alleviation

It is clear from the above discussion that irrigation water is only one of several natural resources in a complex set of stocks of various resources. Poverty is an outcome of complex interactions of the resources, technologies and institutions, actions and strategies, and their ultimate outcomes. It is naive to believe that all rural poverty problems could be solved through irrigation interventions alone. However, since irrigation is an important rural resource, improved access to irrigation could be an important contributing factor toward poverty alleviation through its direct and indirect linkages with other resources. Identifying appropriate institutions and the associated conditions under which they are effective are crucial in devising actions and strategies that lead to pro-poor outcomes.

As complex as it is to study poverty, it is even more complicated to isolate the impact of one factor, irrigation, on poverty. Considering the complexities involved and the need to maintain a sharp research focus, the study will focus on the following specific research issues and questions:

Specific Research Issue 1

Irrigation has been regarded as a powerful factor for increasing productivity, enhancing food security, providing increased opportunities for increased and more stable income and employment, and for increasing opportunities for multiple cropping and greater scope for crop diversification with increased overall returns from farming. Irrigation water is considered to have an important wealth-generating function in the agriculture and rural sectors. While there is little dispute to the fact that irrigation has benefited the poor, the overall benefits from irrigation are generally perceived to have been skewed in favor of the non-poor. Since poverty and affluence coexist within irrigated agriculture, the central research issue here is whether, and to what extent, poverty in irrigated agriculture is related to irrigation and non-irrigation factors.

Research Objective

To improve our understanding of how, and to what extent, irrigation contributes to poverty reduction, what the key dimensions are, and whether there are any spatial patterns in distribution of the poor and access to irrigation water along various reaches of irrigation systems. Linkage analysis involves analyzing impacts of irrigation on poverty.

Research Questions

1. What are the poverty situations in the study area?
2. Where, along irrigation systems, do the poor people live and are there any geographic patterns of the poor within an irrigation system?
3. What are the poverty prevalence and depths, trends, main causes, relation to income/asset distribution pattern, and key issues and strategies to reduce poverty (including those not related to irrigation)?
4. What are the benefits of surface irrigation for the poor and to what extent, including indirect benefits, to small farmers and landless? The issues include a) level of income/production/employment impacts, b) distribution of increased income/ production among the poor and the nonpoor, and c) impacts on other dimensions including food security, vulnerability and empowerment.

Specific Research Issue 2

There is significant evidence that the performance of large- and medium-scale canal irrigation systems in most developing countries has been generally unsatisfactory. Most large- and medium-scale canal irrigation systems are generally characterized by poor management, unreliable water supplies, poor maintenance, deteriorating infrastructure, unsustainability, inefficiency and inequity in water use and distribution, and financial dependence on government budgets. The vicious circle of the poor irrigation performance is generally perceived to reduce overall benefits to the communities from the available water resources. Since poor irrigation performance reduces the overall benefits of irrigation, the central research issue here is whether, and to what extent, poor irrigation performance affects the poor in the irrigated agriculture, and what the constraints and opportunities to increase benefits of irrigation are, through improved system performance, to the poor sections in rural agricultural communities.

Objective

To improve our understanding of irrigation performance and to establish and document a thorough knowledge of irrigation performance and management issues and their implications for the poor, specific to the country study areas.

Research Questions

1. What is the level of system performance in the study area?
2. What are the major irrigation water-related constraints to productivity?
3. What are the causes of unsatisfactory performance?
4. To what extent is poor system performance related to technical (farm water use, distribution patter among canals or higher levels), institutional, economic/ financial and regulatory aspects of system management?
5. To what extent will poor system performance (system efficiency and financial sustainability) dis-benefit the poor?
6. To what extent will improved system performance benefit the poor and what are the opportunities to reduce poverty by improving performance of irrigation systems?
7. What are the impacts of irrigation-related institutions, laws and policies on overall system performance, including impacts on productivity and on equity in access to irrigation water?

Specific Research Issue 3

Inappropriate institutions and management practices are generally regarded as fundamental causes of poor irrigation performance (as shown in the vicious circle above). Consequently, various institutional-related performance-improvement interventions have been proposed and initiated including user involvement in management, regulatory and economic instruments. However, there is no consensus on whether, and to what extent, these and other similar interventions and innovations contribute to improved system performance. Less clear is the evidence on how these interventions contribute to poverty alleviation or, in other words, how these help create an enabling environment for the poor to benefit from irrigation in the context of improving system performance.

Objective

The objective is to improve our understanding of the current interventions/innovations for improving performance of irrigation systems, specifically identification and assessments of current interventions and innovations with a focus on:

- IMT/PIM
- Irrigation financing—water charging/cost recovery
- Water rights and water allocation procedures

Research Questions

1. What various interventions and innovations have been adopted for improving system performance and what are their effectiveness?
2. What are their implications for the poor?

Research Outcomes

The above research work will lead to the following main activities:

1. Identification of opportunities and constraints for improving performance of irrigation systems.
2. Identification and evaluation of potential pro-poor interventions.

Research Questions

1. What are the measures necessary to improve system performance while ensuring optimal benefits to the poor? [The measures may include institutional (e.g., management transfer), regulatory (enforcing rules), economic (water pricing), and physical (water saving facilities) options.]

2. Are there any measures to provide discretionary benefits to the poor while improving system performance? [Specific options may include, for example, financing arrangements (discretionary levying to the nonpoor on capital and O&M costs) and others (employing the poor for water distribution operations to enforce distribution rules)].

3. What are the potential pro-poor financial, economic, technical, institutional and managerial interventions, and to what extent can they alleviate water-related poverty?

Key Research Hypotheses

1. Command areas of specific canal reaches receiving less irrigation water per hectare have lower productivity and a higher incidence of poverty.

2. Under existing conditions, small, marginal and poor farmers receive fewer benefits from irrigation than large and nonpoor farmers.

3. The greater the degree of O&M cost recovery the better the performance of irrigation management.

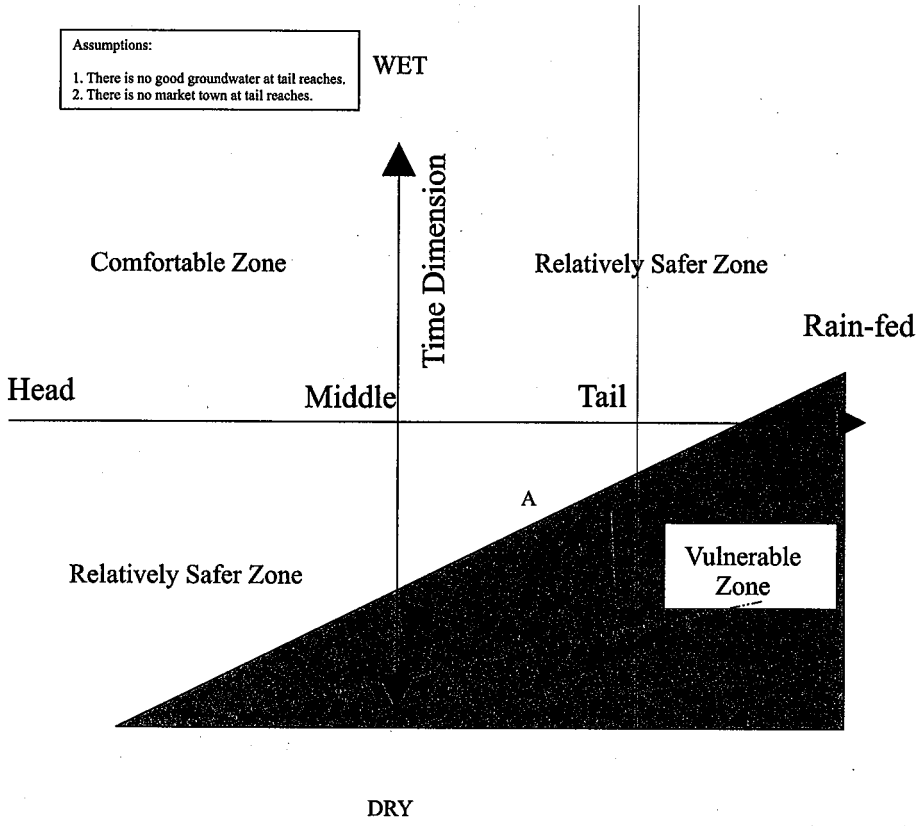
4. Effective implementation of PIM/IMT leads to improved irrigation system performance that, in turn, reduces poverty.

5. The absence of both clearly defined water allocation and distribution procedures and effective and clear water rights (formal and informal) adversely affects the poor more than the nonpoor.

6. There is scope for improving the performance of irrigation systems under existing conditions, with effective and improved institutional arrangements.

Figure 4 shows the hypothesized spatial and temporal impacts of irrigation on poverty. Access to irrigation water is hypothesized to decrease as one moves from the head to the tail end of the irrigation system. Households located at the head and middle reaches of the system, with locational advantage, are expected to be in a better position in both the wet and dry seasons (quadrant I-comfortable zone, and quadrant II-relatively safer zone). However, those located at tail ends and rain-fed areas may be in a relatively safer zone (quadrant IV)

Figure 4. Spatial and temporal dimensions of irrigation and poverty—hypothesized relationships.



during the wet season, but the same households move to the vulnerable zone (quadrant III) during the dry period (months). The graph indicates that households located at the head and middle reaches face potentially less risk of vulnerability to water scarcity as compared to those located at the tail reaches. The risk may increase as one moves from the head to the tail reaches. The important issue is whether the potential risk (probability) or the vulnerability zone (area) can be reduced through improved system performance with improved and effective institutional arrangements (from point A downwards).

These spatial and temporal representations may not, however, hold in situations where there is good groundwater at the tail ends, and where there are market towns closer to tail ends and rain-fed areas, as groundwater provides an alternative and reliable source of water, and the market towns provide a nonfarm source of employment. These are expected to reduce risk of vulnerability due to canal water scarcity and seasonality of agricultural production. Furthermore, the presented graph shows only one possible mapping of an irrigation system. The vulnerability zone and risk can be mapped to fit the conditions existing in any irrigation

scheme. While the above representation may hold true at a broad level (and may appear an oversimplification of reality), it does have important policy implications for poverty alleviation in irrigated agriculture.

Approach and Methodology

The study will adopt both explorative and rigorous analytical approaches for analyzing poverty, assessing irrigation performance, constraints and opportunities for improving system performance and institutional interventions. While the research focus will be at the household and irrigation system levels, the study will also assess macro-level irrigation and poverty-related institutions such as formal organizations, irrigation laws and policies.

As discussed in the previous sections, the research in this project has three key aspects:

1. Evaluation of impacts of irrigation on poverty—*analyzing irrigation-poverty linkages.*
2. Assessment of irrigation system performance—*diagnosing causes of existing irrigation performance-related problems.*
3. Assessment of current interventions in irrigation—*learning from innovations.*

Careful research design is essential for covering all three aspects in one study. The general approach of this study consists of selecting two to four medium- and large-scale irrigation systems in each participating country based on a number of criteria, including a) systems with and without interventions such as IMT and other innovations/experiments; b) systems with different management practices, different levels of performance, productivity and poverty, and c) systems representing water-surplus/adequate water/water-short situations.

The number of irrigation systems to be studied needed careful consideration of the trade-off between depth of analysis and coverage of systems. In consideration of available resources, the time frame for the study and manageability of the research, two to four representative irrigation systems will allow a meaningful in-depth analysis of poverty and system performance to be carried out. Because some of the selected systems may not have experience with innovative management and institutional practices, less in-depth analyses will be extended to other irrigation systems where innovative management and institutions are in practice (with a focus on specific topics: PIM/IMT, water charging/cost recovery, water allocation and distribution procedures and water rights).

During the national workshops conducted by IWMI and partners in each of the participating countries, the issue related to the selection of irrigation systems was discussed at some length. After deliberations, 18 irrigation systems were selected for in-depth analyses using a number of criteria as mentioned above.

Each of the selected irrigation systems will be divided into head, middle and tail reaches. The study will compare the situation across reaches and with nearby rain-fed areas. This approach will help in identifying and analyzing linkages between access to irrigation and poverty, mapping poverty along the irrigation systems, assessing distribution of direct

and indirect benefits of irrigation among the poor, including marginal, landless and non-poor farmers.

Research Focus

The project research will be implemented in selected irrigation systems. The focus would be on major surface water irrigation systems and large and medium-scale canal irrigation. The study may also include other sources of water, particularly groundwater, as far as they are related with surface water (hydrological interactions), although they will not be a direct focus in this study. Similarly, the study will cover only the agricultural uses of water. Other uses of water, including nonagricultural uses and micro-level multiple uses of water, will not be explored in the study.

Level of Analyses

The main research work will focus on two levels:

1. Household level
2. Irrigation system level

Analyses of impacts of irrigation and assessments of irrigation-poverty linkages will be undertaken mainly at the household level. While assessments of irrigation performance, evaluation of interventions and analyses of constraints and opportunities will be done at the system level most of the information collected at the household level will also feed into system-level analyses.

Since household and system levels are linked to meso/basin and macro levels, the study would also explore these linkages. However, at meso and macro levels, the study will only assess/review-related policies and institutions, such as antipoverty policies, irrigation management policies including water allocation policies and procedures, regulatory frameworks and irrigation financing. The study will also review irrigation-sector reforms currently underway in the participating countries. The purpose of these reviews will be to develop the context for in-depth analyses at the system and household levels.

Time Dimension

Household and sysstem level information will be gathered for one complete year, covering both wet and dry seasons during the year. Since the study fieldwork, including administering participatory rapid appraisals and household level surveys, is expected to commence during the last quarter of 2001, the information will be collected for the wet and dry seasons during the previous year, i.e., 2000–2001.

Types of Analyses

The study will use both qualitative and quantitative techniques and methods of analyses, based on a combination of both primary and secondary data/information. However, the emphasis will be on in-depth and rigorous quantitative analyses for each of the main research activities of this study.

Types and Methods of Data Collection

As mentioned above, the study will use both primary and secondary data and information. While most of the macro- and meso-level assessments will be based on secondary-level information, household- and system-level analyses will use mainly primary information and data collected through fieldwork. Data and information will be obtained from five main sources:

- participatory rural appraisals (PRAs)
- key stakeholder interviews/consultations
- household level surveys
- data obtained through primary measurements (for water accounting and water productivity)
- data obtained from secondary sources, such as past research studies, project reports and documents

Details on the types of data to be used for each of the research components and activities are given in the following sections. More details on specific methods, tools or techniques are provided in the project work-plan document.

Study Components and Sequencing of Research Activities

For manageability and sequencing of research activities, research work is divided into four components that comprise the main part of the study work. These are:

- assessment of poverty in irrigated areas and analyses of linkages between poverty and irrigation
- assessment of irrigation system performance and associated impacts on poverty
- assessment of institutional interventions and innovations
- identification and evaluation of identified potential pro-poor interventions

These components can be broadly described alternatively, based on the progressive nature of the research as shown in figure 5. The first division in figure 5, "Main Research Activities," refers to the research activities that provide outputs that form the base of knowledge required to achieve the study objective, but are indirectly related. The second division of figure 5 "Outcomes of Activities," refers to research activities that result in concrete outputs directly related to achieving the study objective. Finally, the third division, "Study Objective," states the ultimate objective of the research project. The figure illustrates the flow of activities in achieving the objective.

Specific Methods

Details on specific methods and tools are given in a detailed study work plan document. Summary of the some of the methods is provided below.

Measuring Poverty

In this study it is proposed to measure poverty in terms of the following two main dimensions:

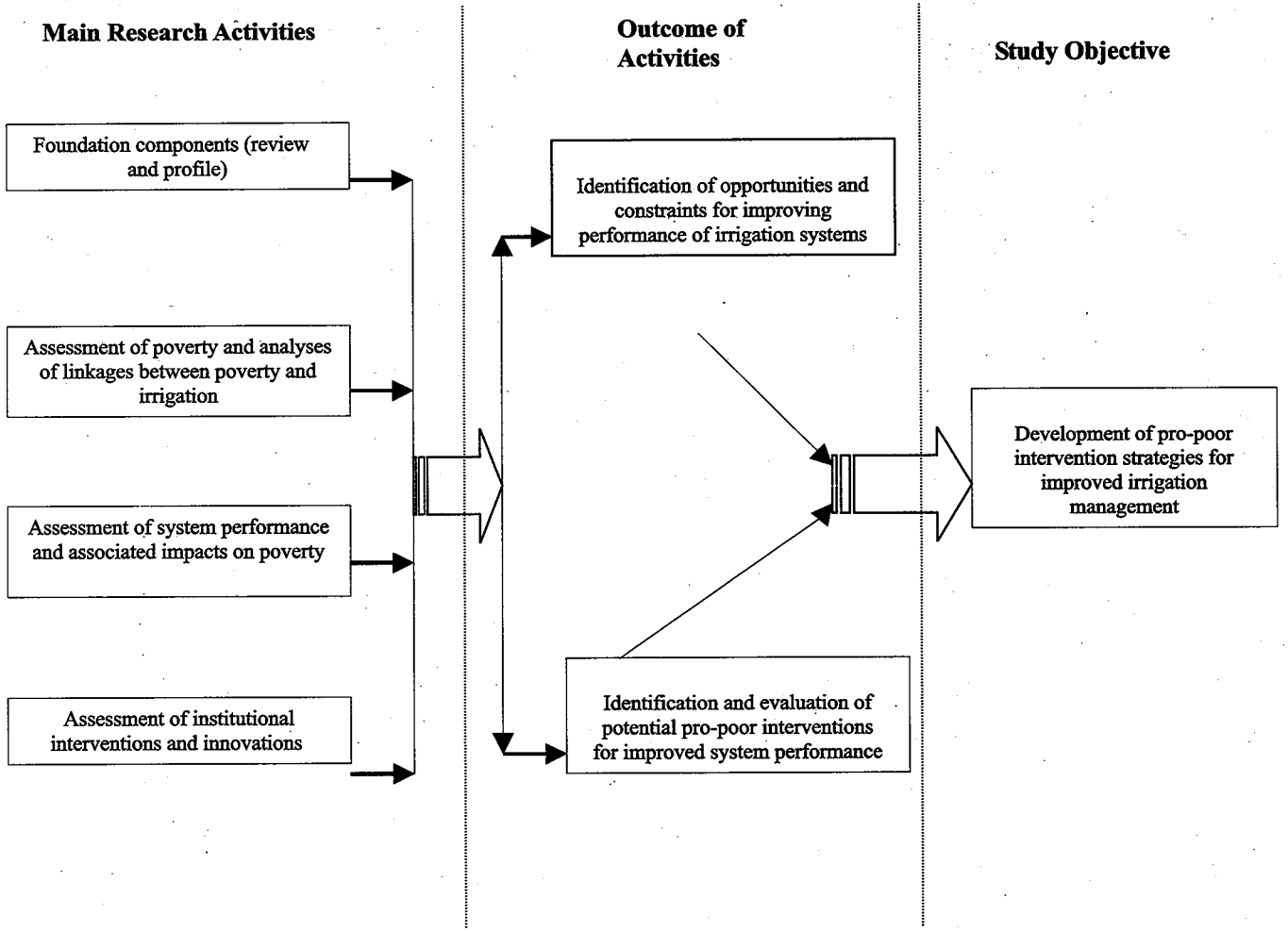
1. Income poverty, where the poverty line is defined as minimum income needed for basic needs to survive. This is a widely accepted approach and can be used to analyze income gained from various sources including irrigation-related enterprises.

2. Non-income poverty, including asset or resource poverty, vulnerability and food security, and social poverty, such as a lack of participation or involvement in social activities.

Income Poverty—Concepts of Chronic and Transient Poverty

There are two basic concepts of income poverty, static and dynamic. Static concepts relate to measurement of poverty at a point in time. Dynamic poverty relates to changes in poverty over time. The concept of dynamic poverty may be further analyzed as chronic poverty and transient poverty. Chronic poverty is defined as a state where a household's income (consumption) is constantly below the poverty line. Transient poverty, on the other hand, is a state where a household's average income (consumption) is above the poverty line, but the household is confronted with the possibility of temporarily falling below the poverty line—vulnerability situation. Transient poverty is also called stochastic poverty. There are distinct policy implications underlying the two dynamic concepts of poverty. Recent literature from the Asian region suggests that transient poverty is more prevalent, with 50–70 percent of the population identified as under transient poverty.

Figure 5. Study components and sequencing of research activities.



Measuring Income Poverty

The measurement of income poverty involves a) specification of an indicator of well-being such as income or expenditure, b) specification of a poverty line in terms of an income level or threshold below which a person or household is considered poor, and c) construction of poverty measures. The Foster-Greer-Thorbecke (FGT) is the most commonly used measures of poverty, which capture three aspects of poverty: incidence, depth/intensity and severity of poverty. These measures are: Headcount Index, the Poverty Gap Index and the Squared Poverty Gap Index.

Non-income dimensions of poverty will be measured using some of the key variables and indicators as given in figure 1.

Assessing Performance of Irrigation Systems

Performance of irrigation systems will be assessed in two stages. The first stage will involve diagnostic or exploratory assessment based on a few key indicators of performance. This will help in developing an understanding of the nature of the problem and the areas where research should be focused. Therefore, more in-depth assessments and analyses will be undertaken in stage two of performance assessment.

Criteria for Assessing Performance

In the diagnostic phase, attention will be given to the following criteria by which performance will be judged.

- productivity, equity and water supply
- sustainability (economic, environmental and infrastructure)
- institutional/organizational/management effectiveness

Each of these criteria/sub-criteria will be assessed using a set of indicators as specified in the project work-plan document.

Assessing Institutional Interventions and Innovations

This section provides a discussion and broad methodological framework for analyzing irrigation-related institutions at the irrigation system/subsystem and higher levels. The term "institutions" is vague and means different things to different people. In sociology, the concept of institutions is defined as "an organized, established procedures" (Jepperson 1991 as quoted in Bandaragoda 2001). In institutional economics, the term "institutions" is defined as "the rules of the game in a society or more formally the humanly devised constraints that shape human actions " (North 1990). In that sense, institutions are frameworks within which human interactions take place. The institutions set the ground rules for resource use and establish the incentives, information and compulsions that guide economic outcomes. The main purpose

for the creation of institutions is to reduce uncertainty in society by establishing stable structures for human interactions. Generally, institutions may be considered as combinations of policies and objectives, laws and regulations, organizations and their core values, operational plans and procedures, incentive mechanisms, accountability mechanisms, norms, traditions, practices and customs (Bandaragoda 2000).

Following some of the major concepts and contributions by North (1990), Ostrom (1993), Tang (1992), and Saleth and Dinar (1999) on institutional analysis, the operational meaning and a consistent analytical framework for the analysis of irrigation institutions in this study are subdivided into the following three main components (and subcomponents) accordingly.

1. Formal institutions (in the irrigation sector)

- legal framework/statutory law
- policy issues
  - rules and regulations
- administrative arrangements
  - irrigation agency
  - WUAs

2. Informal institutions (in the irrigation sector)

- social norms and customs, traditions
- common law/customary law
- societal code of conduct, conventions
- other adopted cultural norms in water uses, and water allocations

3. Enforcement mechanisms (in the irrigation sector)

- both formal and informal enforcement mechanisms for water allocation rules
- sanction and punishment mechanisms for violation of water rules
- provision of third-party enforcement and monitoring effectiveness
- conflict resolution, mechanisms and provision of independent judicial systems
- interaction between organization and water rules and institutions
- interaction between technology and institutions

- incentive structures facing the different actors (farmers, agency officials, etc.)
- transaction costs
- accountability and compliance on water rules and regulations

Considering the complexities involved and the need to narrow down the scope of institutional analysis, the study will involve a) a broad assessment of institutions, and b) an in-depth analysis of key aspects and areas.

Broad Assessment of Institutions

The purpose of the broad assessment is to develop an understanding of the existing key irrigation-related structures, processes and functions (this is basically one of the foundation components of this study). The assessment will focus on four levels: national or macro level, state/provincial/basin or meso level, irrigation system level and household level. Assessments at these levels will be mainly qualitative in nature, and will include identification of both formal and informal institutions, their operations and linkages, their strengths and weaknesses, and their implementation effectiveness and overall performance. In addition, it will be important to assess the implications of the existing institutions for poverty reduction, i.e., to what extent poverty concerns are built into them and to understand the constraints and opportunities, and identify the type of interventions that will make them pro-poor. The assessments will also cover the institutions that are being reformed.

The assessments will be based on the review of existing literature and documents on institutions, interviews with key stakeholders and PRAs. The institutional assessments under the above framework will set a stage for more in-depth analyses under other study components.

In-Depth Analyses

More in-depth analyses will focus on the following key institutional aspects of irrigation at the system level.

- IMT/PIM—user participation in irrigation management
- irrigation financing—water charges and cost recovery
- water rights, allocation and distribution procedures

While there is no specific single method or model that can be provided for undertaking analyses of these key institutional aspects of irrigation, in light of the above discussion and through a series of questions, a general framework is provided as a guide for purposes of analysis. The set of questions also highlights the type of information needed for in-depth analyses.

Users' Participation in Irrigation Management

- What are the current policies on user participation in irrigation management and the delivery services including O&M of the system, and what are their effectiveness in terms of practical implementation?
- At what level (primary, secondary or tertiary) are users involved in irrigation management? How many WUAs exist in the system? How does WUA contribute to water management decisions? How are WUAs formed and how are people selected? What socioeconomic groups do the members belong to? Are these controlled by local influential people/elites? Are they functional/effective (number of meetings, key decisions), and what are their overall performance? What is the nature of relations between irrigation agency staff and WUAs?
- What are the necessary incentive structures or regulatory instruments in place for users to participate in O&M of irrigation systems (why do head enders who control most water contribute to O&M of the system if these increases in the availability/ supply of water are mainly for tail enders)?
- Is there evidence to show that user participation improves systems performance (in terms of improved equity in water distribution and increased crop productivity) and contributes to poverty reduction?
- What are the necessary pro-poor interventions needed to increase user participation to improve system performance?

Irrigation Financing

- What are the policies and procedures for financing of O&M costs of irrigation?
- What are the objectives and mechanisms of O&M cost recovery?
- What are the actual and desired O&M expenditures in the selected systems?
- What are the bases for charging for irrigation water (i.e., O&M cost, benefits of irrigation...)?
- What are the methods for charging for irrigation water (i.e., area-based, volumetric...)? What is the structure and the level of irrigation water charges?
- What are the institutional arrangements in place for enforcement, charge assessments, collection and billing of irrigation water charges?
- What are the collection and assessment efficiencies, and collection costs?

- What are the equity and efficiency implications of present water-charging systems and practices?
- What is the capacity of farmers belonging to various socioeconomic groups to pay for irrigation water charges (analysis based on farm budgets will suffice)?
- What are the necessary pro-poor interventions needed in irrigation financing to ensure full cost recovery and financial self-sufficiency of the irrigation systems?

Water Allocation and Distribution Procedures, and Water Rights

- What are the existing (and newly developed) policies, procedures/methods, rules and practices for allocation and distribution of canal irrigation water at primary, secondary and tertiary levels? Who are the decision makers at these levels?
- What are their implications in terms of equity and water use efficiency?
- Are certain water allocation methods/rules better than others in terms of equity and overall benefits of water?
- What are the implications of present irrigation water allocation and distribution rules and procedures for the poor, small and marginal farmers?
- What are the necessary pro-poor interventions needed to improve water allocation and distribution that ensure improved overall system performance?
- What are the existing (and newly reformed) key irrigation water-related laws, rules and regulations and other legal instruments for managing irrigation water in the selected systems?
- Are they responsive to situations of increasing water scarcity?
- What is their effectiveness in terms of practical enforcement/implementation? What is the incidence of disputes related to irrigation water?
- What are the formally and/or informally established irrigation water rights? How are these rights practiced, and what are their bases in the selected irrigation systems? What are their implications for the poor, small and marginal farmers?
- What are the necessary pro-poor legal and regulatory interventions for improving performance of irrigation systems?

More details on relationships between formal and informal institutions and enforcement mechanisms, framework for analyzing incentive structures of agents and choice of appropriate institutions, and institutional-performance linkages are available in the project work-plan document.

Other Methods

Details of other specific methods for assessing poverty impacts of irrigation performance, and methods for analyzing constraints and opportunities for improving system performance through pro-poor interventions are given in the detailed project work-plan document.

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Irrigation, Agriculture and Poverty Reduction: General Relationships and Specific Needs

John W. Mellor[1]

Introduction

Irrigation offers potential for large increases in agricultural production and farm incomes. These increases are generally not initially concentrated on the poorest elements of rural society. Indeed, the very poorest tend not to have much land if any, and to survive almost entirely by labor. Thus, the connection is to be drawn between rising farm incomes, driven by irrigated agriculture, and employment of those with plenty of labor and very little land and capital.

We now know that the connection is powerful. The rural poor, who dominate poverty in low-income countries, are basically the producers of rural nonfarm goods and services that are non-tradable. The demand cannot come from exports, because of high transaction costs and low quality and, therefore, growing domestic demand is required if employment is to increase. Study after study shows that the rapidly rising farm incomes provide that demand. That is why studies consistently show that agricultural growth is the primary source of poverty decline.

Especially in Asia, irrigation is the most potent source of higher farm incomes and hence it is the driving force for poverty reduction. While a number of measures can increase the efficiency of irrigation investment in reducing poverty, it must be recognized that it is the indirect effects—working through increased demand for rural nonfarm goods and services—that have the impact. Thus, measures to emphasize improvement of inefficient irrigation systems, developing the remaining low-cost irrigation sources, which may lie substantially in already disadvantaged areas, increasing the equity of water allocations are all valuable. It is counterproductive to give up irrigation productivity for emphasis on direct reduction of poverty.

The General Relationship between Economic Growth and Poverty Reduction

The traditional interpretation of basic data on economic growth led to the conclusion that in the early stages of economic growth, inequality tended to increase and decreased only during later growth stages. This pattern is often called a J curve, for its distinctive shape, or the Kuznets curve, for the data generated by Simon Kuznets that were thought to document this relationship (Kuznets 1955).

Most of the analysis that led to this conclusion was based on historical data for the currently high-income countries. But, a range of literature from 1971 to 1995, covering developing countries, seemed to support the Kuznets hypothesis about worsening of income

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distribution in early growth stages. More recent literature, based on more sophisticated data analysis, finds contrary results.

Bruno et al. (1998) reviewed 63 surveys for 44 countries spanning 1981–92 and found no support for the worsening of income distribution. They further reviewed data from 45 countries for which time series were available and found that the bulk of variation in income distribution was accounted for by differences among countries and only 7 percent was accounted for by variation over time within countries. These data show that the distribution of income is quite stable over time within countries.

A large number of other studies confirm that growth does not worsen income distribution, and therefore does decrease absolute poverty (Fields 1989; Squire 1993; Lipton and Ravallion 1995; Ravallion 1995) or the proportion of the population in poverty.

Even before the current plethora of data on poverty reduction, time series for Taiwan showed that its pattern of growth provided decreased inequality from the very beginning (Lee 1971). For example, from 1970 to 1985, the Gini coefficient fell from 0.321 to 0.277 (Thorbecke and Wan 1999). Now that the relation of agricultural growth to poverty reduction is better understood and documented, the Taiwan case is particularly important for lessons about the processes that rapidly reduce poverty.

India has the best, and perhaps the only, long-term set of comparable data on income distribution in a large developing country encompassing considerable geographic variation in the various poverty-related variables. These data give "no sign that higher growth rates in India put upward pressure on overall inequality" (Bruno et al. 1998).

Based on sophisticated analysis of the Deininger and Squire data 1996, Timmer (1997) shows that "each one percent increase in per capita income for the overall population is matched by a one percent increase in income of the bottom forty percent in the income distribution." That is, growth is neutral to the distribution of income; all income classes participate equally.

All the preceding studies calculate relations between growth and more complex definitions of poverty, in addition to the headcount measure. In every case, the impacts are roughly the same or somewhat more favorable for the very poorest.

If the distribution of income does not change with growth, then a simple calculation shows to what extent population is lifted above any given absolute income line. It is on this basis that the World Bank estimates the effect of growth on poverty reduction. As we will see later, such simple estimates ignore the substantial variance in this average relation and shift attention away from the critical policy requirements for poverty reduction. In particular, it distracts attention from the requisites of pro-poor growth and the central role of agricultural growth in pro-poor growth.

An analysis of 20 countries shows an elasticity of poverty reduction with respect to an income increase of -2.12 (Bruno et al. 1998). Ravallion estimated the elasticity of poverty reduction (proportion of the population below the poverty line) with respect to income for India as -2.2 (Datt and Ravallion 1998a) and for Indonesia as -2.1 (Ravallion and Huppi 1989). A value of -2 means that starting with 40 percent of the population below the poverty line and a one-percent rate of increase in the per capita income, the ratio would drop to 39.2 percent in the first year. It would drop to 36 percent in the first year with a 5-percent growth rate in the per capita income, and would drop by half in 7 years.

The World Bank uses these average elasticities to show the impact of growth on poverty reduction. But, variation in impact of growth on poverty reduction is so large that it is essential

to choose the structure of growth that is giving a large impact on poverty reduction. Ravallion and Chen (1989) show that using the absolute poverty measure of $1 per day of income, growth only explains 37 percent of the change in poverty. That leaves 63 percent explained by other factors. Obviously, there are other important factors at work. That is the subject of the next section.

The Structure of Growth and Poverty

It is clear from the preceding analysis that there is a large variation among countries and over time in the relation between growth and poverty reduction. That variation is largely due to variation in the rate of growth in the agriculture sector. However, the agricultural impact on poverty reduction is seen in its effect in increasing the demand for labor- intensive nonfarm goods and services produced in rural and market town areas in small-scale enterprises. These goods are of low quality, with high transaction costs in international trade, lending their market to be dependent on domestic sources, primarily agriculture. They are, in the trade parlance, non-tradable commodities.

Poverty and Agricultural Growth

The structure of growth matters very much to the extent of poverty reduction. If poverty reduction is the objective, then certain structures or sectors must conform to that growth. Two recent studies give detailed data on this issue. They confirm similar results from earlier, but much less-comprehensive, data. The two recent studies are by Ravallion and Datt (1996) for India, and by Timmer (1997) for a cross-section of a large number of countries.

The two studies differ in methodology and in source of data, but find the same striking relationship. These studies are reinforced by several individual studies for other countries. While this paper draws on all the studies and highlights the structural issues, it does draw particularly heavily from India. That is advantageous because it does allow the picture to be drawn from a single basic source without the weakness of cutting across very different countries. However, the Indian experience, like that of any one country, has specifics of its own. In any case, the data for India are confirmed by the cross-national study by Timmer, individual studies for other countries, and by theory. Thus, the data on India do end up being compelling.

Preceding the studies of Timmer and Ravallion, Montek Ahluwalia (1978) presented data showing that increased agricultural output per head of the rural population decreased poverty. Dharm Narain furthered this analysis with important conceptual additions (Mellor and Desai 1985). He too shows a major effect of agricultural growth in reducing poverty. Mellor and Desai (1985) elaborate at length on the relations, the supporting data, and alternative views.

For both Ahluwalia and Narain, the data cover a period when both agricultural growth and poverty fluctuated considerably, without any sustained agricultural growth or poverty reduction. Thus, their analyses essentially deal with a situation not of steady growth but of fluctuations in income. In practice, those fluctuations were substantially driven by the varying effect of weather on agricultural production.

The work by Ravallion and Datt (1996) on India is recent enough to include periods with far higher agricultural growth rates than the earlier studies as well as sustained growth beyond previous peaks, and declines in poverty far beyond previous troughs.

Ravallion and Datt relate change in yields of crops to poverty. They show that reduction in poverty is a result of growth within sectors, not the transfer of labor from a low earning sector to a high earning sector. The latter is the basis for the Kuznets J curve. But what is truly striking is that agricultural growth and tertiary sector growth have a major effect on poverty reduction but that manufacturing growth does not. Further, the service sector growth, which has a favorable effect is the small-scale portion of that sector which, we will show later, is itself closely related to agricultural growth

The Ravallion and Datt data show that 84.5 percent of the substantial poverty reduction in India in the period of analysis was due to agricultural growth. These are truly startling data. They also show little effect of the many programs that directly target the poor.

Growth of manufacturing in India has been historically biased towards large-scale capital-intensive industry, so the manufacturing data may be somewhat biased as compared to a market-oriented structure (Mellor 1976). But, the Timmer (1997) data confirm the Ravallion Datt findings for a large cross section of countries.

The various studies show that industrial growth does reduce poverty from the direct effect of income increase but, concurrently, it has an unfavorable effect on the distribution of income thereby reducing the effect on the poor. Agricultural growth, including its indirect as well as direct effects, does not have the unfavorable distributional effect.

Ravallion and Datt show that wage rates are important to poverty reduction and that higher farm productivity is closely associated with higher wage rates. Similarly, food prices are important and higher farm productivity reduces food prices. Thus, it is farm production that drives poverty reduction. In a later section, we will elaborate on this relation of agricultural growth to nonfarm employment and hence to wage rates.

Peter Timmer (1997) uses the Deininger-Squire dataset for poverty and purchasing power for 35 developing countries and relates these data to agricultural GDP per capita. "A one percent growth in agricultural GDP per capita leads to a 1.61 percent increase in per capita incomes of the bottom quintile of the population." (p.3) Unlike Ravallion and Datt, Timmer shows a positive elasticity for industrial GDP but the agricultural elasticity is 38 percent more than the industrial elasticity.

The 27 countries and 181 observations (studies) from 1962 to 1992 in the Timmer sample of the Deininger-Squire data include 3.3 billion people in 1995 or two-thirds of the population of low- and middle-income countries as classified by the World Bank (Timmer 1997). On average, agriculture accounted for 25 percent of GDP and 51 percent of the labor force. Countries are roughly equally divided among regions of the world, with some underrepresentation of Africa.

Datt and Ravallion (1998a) do not find a declining trend in the elasticity of employment with respect to agricultural output. The power of the relationship holds true over time. Thus, the current decline in the rate of poverty reduction is due to decline in the agricultural growth rate and not due to the declining power of that variable.

Gini coefficients for subsectors of the economy tend to be unstable. However, the following data from Sharma and Poleman 1993 corroborate other evidence on the high degree of equality in specific agriculture-related subsectors. They show that increments to crop income alone skew the distribution towards the well-to-do, with a Gini coefficient of 0.86, far above

the national Gini coefficient. That finding is, of course, consistent with early critics of the Green Revolution. See also Adams 1999 on this point.

In sharp contrast to crop income, the Gini coefficient for dairy production, which is very important to the poor in India because of its labor intensity, is 0.11. This is an extraordinarily low Gini coefficient but it is quite consistent with the observation that dairy animal numbers vary little by size of farm and with the well-known impact of increased dairy production on the poor. The Gini coefficient for off-farm work in rural areas is still a low 0.22. This also reinforces the data that show off-farm income of the rural poor is an important source of poverty reduction (Adams 1999). Thus, when rising agricultural incomes are spent in these sectors they redistribute income towards the poor.

The data clearly show that it is growth of agriculture that reduces poverty, not growth in general. One misleading interpretation should be avoided. Typically, high overall growth rates are achieved when agriculture grows rapidly. This is because the resources used for agricultural growth are only marginally competitive with those of other sectors and are so fast that agricultural growth tends to be additive to growth in other sectors, as well as being a stimulant of growth in the labor surplus non-tradable sector (Mellor 1976).

The countries that grew the fastest from 1985 to 1995 experienced a narrowing of the income gap (Timmer 1997). This means that agricultural growth resulted in faster overall growth and an improvement in the income distribution, thus, emphasizing agriculture to improve income distribution does not result in slow growth. The sectors are more complementary than competitive. Conversely, leaving out the forces that accelerate agricultural growth, as has been increasingly the case in the past decade, provides slower growth and leaves out the poor.

The average elasticities cited at the beginning of this section are strongly influenced by high rates of agricultural growth. Thus, it is grossly misleading to think of those elasticities as applying to some average growth rate. Those are predominantly the elasticities when agriculture grows rapidly. In the 1990s, prior to the economic setback in East and Southeast Asia, overall growth rates were high, but agricultural growth rates had slowed, and hence the pace of poverty reduction declined.

Thus, agricultural productivity increase has a major effect in reducing poverty and the effect is relatively greater in its impact on the poorest and the distribution of income among the poor. Industrial growth has much less or even no effect in reducing poverty (Ravallion and Datt 1996; Timmer 1997). Growth in the service sector has no effect on the large-scale portion but has a substantial positive effect on the small-scale portion.

If growth occurs, leaving the agriculture sector out, two onerous burdens fall on the poor. First, the overall growth rate will be lower. Second, the part that reduces poverty will be missing. As we will show later, rapid agricultural growth is more easily achieved now than some decades ago but it does require overt actions by the government.

Agriculture-Led Nonfarm Growth

The circumstantial evidence is strong that the powerful poverty-reducing effect of agriculture comes substantially through its impact on the rural, nonagricultural, small-scale sector. According to the studies done by Liedholm and Meade (1987) there is considerable knowledge

of this sector. They conclude that this sector is large, employment-intensive, expands readily in response to increased demand and is largely driven by agricultural demand.

Nevertheless, the evidence on the size of the sector, the proportion of incremental farm income spent in this sector and the employment intensity is meager. The evidence of its links to agriculture and its importance to employment calls for intensive study. The following paragraphs summarize the current state of knowledge of this sector.

Because the agriculture sector in low-income countries is so large, accelerated growth into the 4- to 6-percent range adds immense purchasing power (Mellor 1995). This is because this growth is substantially driven by improved technology (yield-increasing crops of the Green Revolution) and mobilizes previously underutilized farm family labor resources within agriculture.

Several empirical studies cited above document that farmers spend a substantial proportion of incremental income on locally produced nonfarm goods and services. Liedholm and Meade turn that around and state that the rural nonfarm sector derives a high proportion of its demand from agriculture. Since this is a large employment- intensive sector it is logical to turn to these forces to explain the powerful effect of agriculture in increasing employment and reducing poverty.

This argument is also consistent with the lag in the effect of agricultural growth, the fact that highly skewed distribution of income from land removes the poverty-reducing effect, and the important wage-increasing effect of agricultural growth. Further, the power of this income effect causes a tightening of the labor market that cannot be explained by the agricultural growth alone. Because it is the income growth that drives the process it does not matter that the initial income effect is concentrated in the hands of the middle peasant rather than in those of the poor. The poor benefit in the next round.

Three questions arise from this process. How large is the sector that is driven by agricultural incomes and is it a tradable or non-tradable sector? How employment- intensive is this sector? And, to what extent is it driven by purchase of production goods and to what extent by consumption goods?

Size of the Agriculture-Driven Sector

There are two ways to get at the issue of the size of the agriculture-driven nonfarm sector. One is by surveys of the production pattern and source of demand for output for the sector thought to serve agriculture, and the other is through an analysis of the consumption patterns for incremental income of farmers. Neither type of information is well developed. Data on farmer expenditure rarely give a sufficient breakdown to allow analysis of the relevant parts of expenditure. Surveys of small businesses in rural and market town areas are infrequent and are usually lacking in the necessary details with respect to sources of demand.

Delgado (1998) spells out in some detail why it is the non-tradable sector that is important to the employment-increasing poverty-reducing impact of agricultural growth. The non-tradable (goods and services that do not enter international trade) sector cannot be stimulated to growth by international exports. The labor force and production systems are such that they are not employable in the short run producing goods and services for sectors other than the rural market.

Of course, in the long run, with education and gradual integration of markets, labor will move into tradable sectors. The story of low incomes is the slow pace at which that growth occurs. Meantime, rapid growth in demand for such output provides employment, expands the number of entrepreneurs and creates a favorable environment for the transition to tradables. The interaction between agriculture and this large sector is an important part of the transition to a modern economy.

Peasant farmers spend a high proportion of incremental income on low-quality goods and on non-exportable goods and services. Examples are expanded housing, personal services, increased lower-level education, increased health services, and local transport. Note that where labor is cheap, prospering farmers hire a substantial addition of labor so as to shift family labor away from farm production to education, leisure and marketing activities (Hayami and Kikuchi 1999). These are all non-tradable and are produced primarily by labor with very little capital.

Consumption studies suggest that in middle-income countries, e.g., Egypt, this sector, located in market towns and rural areas, has an initial GDP roughly equal to that of agriculture (Mellor 1999). It is striking that even at this stage of development the sector is large and non-tradable. In Africa, with very low incomes, it may be only one-fifth the size of agriculture (Delgado 1998).

In very low-income societies, with minimal commercial differentiation, as in most of Africa, the multipliers from agricultural growth to the nonfarm sector are much weaker than in more differentiated societies. However, in a careful analysis for sub-Saharan Africa, Delgado points out that marginal propensity to consume non-tradable agricultural commodities is very high.

In middle-income countries, the agriculture-driven nonfarm sector may be as large as agriculture (Mellor 1999). The incremental income in farmers' hands will be spent more than proportionately in that sector. In other words, the income elasticity of demand is well above 1.0.

Employment in the Agriculture-Driven Sector

Employment elasticity in the agriculture-driven nonfarm sectors is high, close to one. Increased output is driven by increasing demand. As long as real wages are constant, there is no incentive to increase labor efficiency. Since very little capital or land is employed in this sector, virtually all the gross income is return to labor.

Empirically, compared to farming, with half as much GDP in the sector, twice the labor intensity, the initial labor force is the same size as for agriculture. Typically, in low- income countries, about half of the base income is spent on production services and locally produced consumption goods (Bell and Hazell 1980; Hazell and Roell 1983).

With an average income elasticity of demand for these commodities of 1.5, employment expands at 1.5 percent of the base year for each percent increase in the rate of growth of agricultural income. With a 5 percent growth rate in agriculture, 2.5 percent population growth, the growth rate of the rural nonfarm sector expands at a rate of 6.25 percent and the addition to employment in the agriculture-stimulated local nonfarm sector is nearly twice that of agriculture.[2] This is the key point about the impact of agricultural growth on poverty.

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[2]With an elasticity of employment with respect to growth of 0.6 in agriculture and 0.9 in the rural nonfarm sector, then 5.0-2.5(1.5) +2.5=6.25. (5.0) 0.6=3.0. (6.25)0.9=5.6. 5.6÷3.0=1.9=close to 2 times.

Agribusiness and Consumption Goods

Fertilizer and other chemical and mechanical inputs to agriculture are in the tradable sector and tend to be imported or produced by capital-intensive processes. Increased demand for such goods does not add much to employment and that demand could have been provided from sources other than agriculture.

In contrast, the local marketing service for these inputs and for output is both labor-intensive and non-tradable, and the increase in demand from agriculture stimulates production and employment that are net additions to the economy that could not come from other sources. This will remain true as long as there is poverty representing inadequate employment opportunity for the wage-earning classes.

Studies of marketing margins suggest that the stimulus to the rural and market town non-tradable sector is equal to about 10 percent of the value of incremental agricultural production since a high proportion of incremental production depends on purchased inputs, and is marketed.

Consumption studies in Asia show that about 40 percent of incremental income is spent on locally produced nonfarm goods and services. These are all highly labor-intensive in their production.

Thus, consumption goods comprise about three-quarters of incremental demand for non-tradables and about one-quarter for production services. It is the consumption expenditure that is dominant (Mellor and Lele 1973).

Rich Peasants and Income Distribution

A substantial literature on the period immediately following the Green Revolution stated that the latter concentrated incremental income in the hands of the landowning classes, including the middle peasant or kulak, to use the Marxian term. Consequently, the poor did not participate in income growth. The concentration of income led to further concentration of landownership. This was the basis for much of the anti-Green Revolution spirit of the 1970s.

This exposition points out that, in fact, increased agricultural incomes in the hands of the middle peasant or kulak have powerful employment linkages but that they take time to operationalize. The initial studies did not allow for that time and, in any case, they were only concerned with the direct effect of income growth.

The important point is that an initial skewing of the benefits of agricultural growth toward the higher income rural people is not antithetical to poverty reduction. The issue is not the initial distribution of the increased income but the expenditure patterns from that income. Middle peasants in low-income countries spend a high proportion of their income locally on non-tradables, thereby providing a stimulus to production, and particularly to employment that cannot be obtained in any other manner.

Delgado (1998) carefully documents that in Africa, incomes and commercial differentiation are so low that the nonfarm goods and services receive relatively little stimulus. However, the increment to demand for agricultural non-tradables is very large, stimulating a large increase in demand-driven production of high-value agricultural products (livestock, fruits and vegetables), and even for some non-tradable basic staples. Thus, an initial stimulus to

agricultural growth from technological change (high-yielding varieties of basic staples) has strong multipliers back to other sectors of agriculture that are highly labor-intensive. The effects are precisely as described for the rural and market town nonfarm sectors.

The Rural and Market Town Nonfarm Sector

The rural and market town nonfarm sector is studied less, with no systematic data on the sources of effective demand for the output of the sector. We do know that the sector typically represents over half of all nonfarm employment (Liedholm and Meade 1987). The sector is largely located in rural and small town areas, the effective demand comes largely from local sources, particularly from agriculture, and the sector expands readily in response to increased demand (Liedholm and Meade 1987).

The sector represents a far higher share of employment than of GDP, even more so than that of agriculture. This is because it uses both very little capital per worker and relatively unskilled labor, and pays low wages. Agriculture uses a substantial area of land per worker with a substantial return to that land. Tradable industry uses far more capital per worker and tends to use more skilled labor.

The small-scale sector is the path out of poverty for the poor who possess little education and are either underemployed or use a substantial proportion of their time in search of jobs. Experience in the small sector then prepares them for movement up to higher- paying jobs in the tradable sectors. Thus, the sector is not only large but also an important zone of transition. Development is a step-by-step process and we see in country after country that steps in the process cannot be skipped without a deleterious impact on the poor.

The growing importance given to microenterprise and microcredit in foreign assistance programs reflects a growing recognition of that importance. What is not yet recognized is that without growth in farm incomes, the demand for this sector's output does not rise and efforts to increase access of some to the sector are at the expense of others already in that sector. Agricultural growth is absolutely essential to this sector, playing its important role in lifting the poor out of poverty (Mellor 1995).

Analysis of farmer expenditure patterns shows that in middle-income countries 40 percent of incremental income is spent on locally produced nonfarm goods and services (Hazell and Roell 1983; Bell and Hazell 1980; Haggblade et al. 1989). In lower-income countries, the percent is much lower because of much higher expenditure on food and lesser differentiation of the economy. The multipliers of agricultural growth on non-agricultural growth in the references just cited are corroborated in macro studies such as those by Rangarajan (1982) for India.

However, Delgado (1998) shows that in such situations much of the farm production is non-tradable livestock and fruits, and vegetables are non-tradable on quality and transport grounds and even much of the grain sector is non-tradable (low quality, high transport costs, and types of grain). In such economies, the demand of farmers for these products is elastic. Thus, in both very low-income undifferentiated economies and in more advanced middle-income countries the bulk of employment growth is in sectors that depend on increments to local demand derived from agriculture, for expansion of demand, production and, hence, of employment.

A simple rhetorical question makes the point about this large, employment-intensive sector: Where else will these goods and services be demanded and what else can this massive number of people produce in the short run? Hossain (1988) shows that if agricultural incomes are not rising, credit for small-scale firms simply expands the ones receiving credit at the expense of those already existing firms not receiving the additional credit. The expansion without effective demand reduces prices and returns to labor. The process spreads the misery.

Analysis of data on Egypt is instructive about the size of this sector in a middle-income country. In a high-growth scenario for Egypt, agriculture and the agriculture-driven nonfarm sector account for 70 percent of employment growth and only 30 percent of GDP growth (Mellor and Gavian 1999). The GDP growth is largely from the tradable sector, and employment largely from the non-tradable sector. The tradable sector provides much of the effective demand for expansion of agriculture, particularly the high-employment livestock and horticultural sectors. Agriculture and its stimulus to the non-tradable sector provide the bulk of employment growth.

Thus for pro-poor growth, the old concept of balanced growth needs to be resuscitated. Yes, open up the economy, play to comparative advantage, follow-up pro-growth macro policy and let the private sector lose. But, at the same time, take the public-sector actions that are needed to move the agriculture sector to provide effective demand for the labor-intensive, non-tradable sector.

Implications for Irrigated Agriculture

The simple summary of the implications of key poverty-reduction measures to irrigation is, do not get diverted from the aspects of irrigated agriculture that result in large increases in farm incomes. It is expenditure of those incomes that drives poverty reduction by expanding demand for the labor-intensive rural nonfarm sector.

Throughout the world, the greatest impact of yield-increasing agricultural technology has been in irrigated agriculture. This is most dramatically so in Asia. Expanding irrigated areas, increasing the control of water and applying high-yield technology in irrigated agriculture have caused massive increases in the incomes of the farmers. That increase in income has been disproportionately in the hands of the larger peasant farmers. They are not the poorest of the poor (although they are generally poor by western income standards). But, it is their expenditure patterns that drive increased employment of those who are the poorest of the poor. The latter have little or no land, benefit little from even agricultural production programs directed most closely to them but they benefit from lower food prices, increased wages and growth in demand for rural nonfarm goods and services.

In the past decade there has been rapid growth in foreign assistance support for micro enterprise and associated micro-credit programs. These are well-directed programs in that these enterprises are the repository of many of the very poorest in rural areas. However, these targeted programs do little for the aggregate of poor if rising farm incomes are not increasing the aggregate demand for those goods and services. This brings us back to the need to raise farm incomes to provide effective demand for those primary sources of employment for the poor.

The first emphasis is maximizing the increase in farm incomes that come from irrigation investment. However, this must be with one important caveat. It is the peasant farmer who lives in the rural area and has locally driven expenditure patterns, which are critical to driving

employment growth and poverty reduction. Large-scale farmers, and especially absentee farmers, have capital- and import-intensive consumption patterns but do not do much for poverty reduction. However, this is more of a Latin American than an Asian or African problem.

Within the context of raising farm incomes much can be done to further impact the poverty-reduction potentials. It is not uncommon for whole geographic areas to be neglected in agricultural investment. This may be because of ethnic reasons or simple low political power associated with low incomes. Diagnosing such situations and concentrating on them obtain the benefits of large increases in incomes and emphasize poor areas. Similarly, some areas may be underemphasized in developing irrigation potentials. A recent article by Hirashima in the Economic and Political Weekly provides data for India that show such under-exploitation in very poor states, such as Orissa. Thus, emphasis on productivity does not rule out working in poor areas. An analysis needs to be made to pick out high-productivity situations.

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Participatory Irrigation Management: Issues from Contemporary China

John G. Taylor[1]

Context

Water shortage is probably the single most important problem currently facing China. Water shortage is beginning to have a serious impact on development in the northern part of the country, where the water overdraft is currently estimated at 30 billion m^3/year. In the north, approximately one-third of the population lives under conditions of "absolute water scarcity."[2] Water usage will rise by 60 percent by the year 2050, as an increasing proportion of the people becomes urban dwellers.[3] Similarly, water shortages threaten food production. Reassuring statistics indicating that China is maintaining its area of cultivated and irrigated land are misleading, since fertile land around eastern cities with a wet climate is being lost to urbanization and replaced with less-fertile land in the arid west, where irrigation will be imperative. Proposed plans to transfer water from surplus areas in the southern to northern areas will be largely palliative and cannot provide a sustainable solution.[4]

In this situation, reform of irrigation management is becoming increasingly important for saving water in irrigation. Farmer participation in irrigation-system management or participatory irrigation management (PIM) has been developed as one of the key means for improving irrigation management.

In working on water projects in several provinces in China in recent years, we have been able to observe the development of PIM. Additionally, in a recent research examining linkages between environmental improvement and poverty reduction in World Bank projects,[5] the impact of water user associations (WUAs) on poverty levels and living standards was examined for several counties in the Hunan Province.

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[1]Professor of Politics, South Bank University, London.

[2]See Gavin McCormack 2000.

[3]This estimate is taken from Holland 2000.

[4]For a detailed and comprehensive assessment of the south-north transfer proposals, see Warren 2001.

[5]John G. Taylor et al. Forthcoming.

This presentation will briefly outline some conclusions drawn from observations. Hopefully, these will have some relevance for IWMI's objective in this project of assessing the role of managerial, institutional and governance factors in "pro-poor" interventions in irrigated agriculture.

Four topics will be covered in this presentation:

1. Background to the development of PIM in China.
2. Development of PIM in China
3. The Impact of WUAs in China—a short summary
4. PIM and Poverty Reduction[6]

Background

A few details on the background of irrigation management in China are given in the following bulleted points:

- Water prices in China are too low to cover the costs of water, resulting in inadequate maintenance and deterioration of irrigation systems.
- Water charges collected are often used for purposes other than irrigation operation and maintenance, discouraging payment of water charges.
- Management of irrigation systems is fragmented between levels of government administration, rather than being unified on the basis of hydraulic units.
- Water charges paid by farmers are levied on an area basis (by mu), and not by volume. This discourages efficient water use and leads to waste.
- Inadequate farmer participation and ownership contribute to low irrigation management efficiency, conflicts between water users, and low collection of water charges.
- Lack of a clear, legal, quantitative water rights system results in insecurity for water users, thus discouraging farmer investment in more efficient technology and water management.

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[6]In examining these issues, I have benefited considerably from discussions with Richard Reidinger, Lead Agricultural Economist, World Bank, Beijing, with Dr. George Radosevich, President of Resources Administration and Development International, Bangkok, and additionally with Dr. Chen Shaojun, National Center for Resettlement, Hohai University, Nanjing.

- Lack of effective water licensing and controls over abstraction results in unrestricted use of groundwater in water-short areas, contributing to water shortages, overdraft of groundwater and falling water tables (notably in North China).[7]

These problems, of course, are not particular to China. Elsewhere too, there exists inadequate cost recovery, poor maintenance, declining infrastructure, poor-quality irrigation services, reductions in irrigated areas, and falling output resulting in farmers' dissatisfaction and unwillingness to pay water charges, the "vicious circle" presented in the project proposal. The transfer of management of irrigation from government bureaus to farmer organizations in China and elsewhere has aimed to break this cycle by:

- reducing costs to government
- increasing productivity, efficiency and profitability of irrigation management
- relating irrigation management more adequately to the actual needs of water users.

Development of PIM in China.

In China, WUAs were first piloted in World Bank (WB) projects in the Hubei Province (in the WB Yangtze Basin Project, 1994–2000). Management was transferred to farmer "water user" groups, with responsibility for local irrigation distribution networks. These formed part of a new concept, Self-Financing Irrigation and Drainage Districts (SIDDS). SIDDs are implemented through water supply corporations (WSCs) and WUAs. The WSCs and WUAs replace existing diverse authorities such as local water resources bureaus, water management stations and townships. The WSCs operate and maintain reservoirs and branch canals, with the aim of providing and regulating supplies of water to farmers grouped in WUAs. The WSCs, owned and funded by water users, sell water to WUAs, based on equitable and accurate standards, aiming at recovery of capital and operating costs. Water is purchased according to the number of cubic meters used and the WSC measures water deliveries at the WUA at the lateral head. Water deliveries to the WUAs by the WSC are regulated by water sales agreements between the two parties, specifying the rights and responsibilities of both. Because water deliveries are charged by volume, farmers in the WUAs have an incentive to use water more efficiently and less wastefully. WUAs collect water charges from their members and buy water from the WSC for their members based on water demand. WUAs are responsible for the design, construction, maintenance and management of water delivery at the farm level. They are registered as legal entities, and can contract, lease or auction the operation of canal maintenance.

[7]For a discussion of these issues, see Reidinger 2001.

Thus far, in China, approximately 250 WUAs and 17 WSCs have been established in eight provinces. They have been supported by the Ministry of Water Resources,[8] and the current drafting process for the new Water Law is seeking ways to further extend their introduction and operation.

The Impact of WUAs

In most of the areas in which they have been introduced (and particularly in the Hunan and Hubei Provinces) WUAs have resulted in marked improvements, notably in:

- reducing wastage
- improving canal maintenance
- improved designs from farmers for physical rehabilitation
- fewer crop failures due to more efficient water use
- economies of scale generated through group action
- reduced flooding
- improvements in soil conservation.

They also appear to have led to a reduction in water costs to farmers although only limited investigation has been undertaken of this area.[9] Similar trends were documented in a more extensive survey of SIDDS undertaken in the Tieshan Irrigation District, Hunan, June 1998.[10]

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[8]See the Policy Circular of the Ministry of Water Resources to Provincial Water Resource Bureaus, 28 July 2000.

[9]For example, in WUAs visited in four counties in Hunan by a World Bank mission in July, 2000, the cost of water to farmers had fallen, on average, from 40 to 32 *yuan* per *mu* since the setting up of the WUAs in 1996 (compared with no reductions in nonproject villages).

[10]See "The First Phase Evaluation on Performance of Self-Financed Irrigation and Drainage Districts and WUAs in Tieshan Irrigation District, College of Water Resources, WUHEE, June 1998.

WUAs and Poverty Reduction

However, in addition to these efficiency dividends, the introduction of WUAs seems to have had further results, important for developing improved frameworks for poverty reduction. We were able to examine these briefly during field visits to WUAs in Longhui County, southwest Hunan, as part of a recent (April 2001) project[11] assessing the experiences of the World Bank in attempting to establish linkages between environmental improvements and poverty reduction in recent projects.

Thus, from the "pro-poor" perspective, the following results are seen:

- The creation of WUAs has been important in ensuring a regular, guaranteed supply of water to farmers, who then allocate water equitably through the user associations. This contributes to improved productivity and security, reinforced by the introduction of legal rights to water. Thus, the fundamental issue of security is addressed.
- The implementation of WUAs has resulted in a marked reduction in the number of disputes over water.
- Additionally, the operation of WUAs has been important in building capacity for increased farmer participation in decision making. WUAs are democratic organizations with elected executives responsible for implementing farmers' choices in the use and distribution of water. During site visits to Longhui County, for example, farmers described in detail their involvement in the short-listing of local candidates based on their expertise, and their organization of the ballot for chair and executive committee members.

Such improvements in security and participation are important bases for addressing poverty but, from our observations, it appears that WUAs may also contribute in more direct ways to poverty reduction.

For example:

In many WUAs visited, water executives consulted with their members on deferral of water payments by poor households. These related particularly to households in which elderly people had little or no family support, to single-parent families, and to households in which migrants had been unable to return remittances.

In resource-constrained poor areas, time formerly devoted to waiting for water, collecting water, and digging wells could now be put to more productive uses. In most villages, farmers interviewed cited newly available labor time as the main reason for increases in productivity and diversification.

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[11]See "Environment-Poverty Linkages...," footnote 5.

Additionally, in many villages, women now have more time available. They no longer have to perform their traditional role of guarding irrigation channels during periods when they estimated that water would be released from upstream villages. Guarding was no longer necessary, since households no longer had any need to fight for water, given the agreed responsibility of the WUA to deliver agreed shares of water on a regular basis.

Indebtedness previously incurred during drought periods had largely disappeared, and the absence of drought had also contributed to increases in productivity.

Improvements in security had led to increased male migration from poor villages, resulting both in increased incomes and, in some areas, greater participation by women in WUAs.

Clearly, these results, based on a brief assessment of a small area, cannot provide any basis for generalization. However, they do indicate that the promotion of WUAs in the interests of dividends in efficient water use appears to have facilitated the development of enabling frameworks for poverty reduction, and to have contributed directly to reducing, in limited ways, some of the adverse effects of poverty. Additionally, they appear to be similar to conclusions reached by researchers working on WUAs and poverty reduction in other regions and countries.[12]

There are, of course, problem areas. Despite World Bank calculations, in all areas visited in our research, whilst farmers could meet operation and maintenance costs, they all felt that they would have difficulties in meeting longer-term capital costs. Additionally, whilst the establishment of WUAs requires a strong commitment from county and township governments, it was clear that, in many areas, only a limited capacity had been built for this.

This reinforces the need for further research into the impact of WUAs. Currently, there is an increasing recognition amongst Chinese researchers and practitioners that forestry management committees and watershed rehabilitation management groups can improve both levels of efficiency and participation, and have the potential to contribute to poverty reduction. It is surprising that research has thus far not attempted to establish this in the case of WUAs, where such links can also be found.

[12]For an outline of some recent work in this area, see, for example, Frank Rijsberman, "Poverty and water management for agriculture: Reflections on lessons for development policy." Presentation prepared for the 2nd Dutch Water Week, Noordwijk, October 2001. For assessments of participatory irrigation systems on issues such as household incomes, gender, participation levels, and equitable distribution, see (respectively): Chancellor and Hide 1997; Zwarteween 1996; Van Koppen 2000; and Bandaragoda 1999. For a thorough and detailed assessment of the introduction of WUAs in one region, see Raju 2001.

Conclusion

In recent years, China has piloted a type of PIM reform, which seems capable of improving irrigation management by promoting farmer participation in system operation, maintenance and management. Thus far, WUAs appear to have produced benefits for farmers and, potentially for provincial and central governments through water savings, increased production, reduction in conflicts over water distribution, reduction in government expenditures, improvements in design and maintenance, and improved access to water. WUAs also appear to have contributed to poverty reduction. As such, they are worthy of further investigation in the interest of devising pro-poor strategies for demand management—one of our shared concerns in this project.

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Part 3

Country Papers

**Bangladesh, China, India, Indonesia,
Pakistan and Vietnam**

An Overview of Irrigation and Rural Poverty Issues in Bangladesh

Nityananda Chakravorty[1]

Introduction and Background

Out of a potential area of 7.56 million hectares for irrigation, the present coverage of major and minor irrigation in Bangladesh is about 4.0 million hectares. The share of surface water irrigation is only 1.15 million hectares while the groundwater share is the bulk of 2.85 million hectares including minor modes of irrigation. The projection for such coverage on the terminal year (2002) of the current Fifth Five-Year Plan (1997–2002) is around 5.0 million hectares.

To put the poverty profile in Bangladesh in brief, extreme poverty prevails among 22.7 percent of rural households and moderate poverty among 29.2 percent. Besides these, another class of the poor with vulnerability to income erosion comprises about 21 percent. This poverty situation has followed more or less a trend of decline in the recent past. Another characteristic development is the decline of malnutrition, which reached the lowest in 1996, especially in agriculture and manufacturing sectors. Irrigation development has played a significant role in causing this decline over time, but has greater potential if technological rigidities of irrigated crop culture could be overcome.

Given the importance of rice production as a prime national objective and as a source of current income and employment for the rural sector in Bangladesh, this will still remain about 67 percent of the potential area and, in addition, the irrigation development will need supportive flood control and drainage provision to allow for high-yielding varieties (HYVs) to sustain in this vast floodplain of the biggest river systems of the world: the Ganges, the Brahmaputra-Jamuna and the Meghna.

One major issue regarding pattern of investment in irrigation projects is that direct public irrigation investment has, in recent years, been much less-important than in the past. In other words, efficiency of private irrigation has increased. The dominant form of ownership is small scale and private in irrigation. This precludes the extension of irrigation at a large scale under the public sector any more because of the much rigidity like slow and cost-prohibitive cost-recovery process, absence of group-management culture, regulated allocation of water and the absence of a notion of a water market. Thus, gradual withdrawal of the public sector from the irrigation sector will require more resources through an appropriate government action like the provision of greater autonomy to public/private agencies for carrying out research for sustained growth of irrigation.

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Large-Scale Irrigation in Bangladesh

The development of large-scale public-sector projects on surface-water irrigation in Bangladesh is mainly the responsibility of the Bangladesh Water Development Board (BWDB). The share of this large-scale irrigation in the total achieved coverage is only about 7 percent through the provision of surface water from large projects (see appendix 1). Although more than 70 percent of the irrigated area is being served by groundwater through deep tube wells (DTWs), shallow tube wells (STWs), deep set shallow tube wells (DSSTWs) and other groundwater modes, the apprehension about groundwater scarcity by the end of 2005 (as warned by the FAP study) has underscored the importance of conserving surface water for irrigation and ecological sustainability. It has been found from the NWP water balance study during the late eighties that only 5 percent of available surface water flow is withdrawn for irrigation during the driest period of a year (March). It is envisaged that without building large dams or barrages across large rivers, this withdrawal can only increase up to 15 percent and it can be further enhanced up to 35 percent only with large barrage interventions. This withdrawal rate has been considered as the determinant of maximum area for surface-water irrigation. And that is why the current Fifth Five-Year Plan (1999–2002) has set high priority for planning and implementation of the Ganges Barrage project in Bangladesh.

As for the efficiency of large-scale surface-water irrigation projects in Bangladesh, it is observed that the realized efficiency of these projects is around 50 percent of its designed efficiency. This fact acknowledges the importance of optimization of irrigation facilities. Reasons for the underperformance in large irrigation projects are summarized below:

1. Technical limitation of the installed irrigation infrastructures including pumps in full- scale operation.
2. Scarcity or unavailability of water at sources.
3. Want of command area development programs within irrigation projects.
4. Dearth of adequate funds for O&M activities on a sustainable basis.
5. Lack of planning and resources for rehabilitation or replacement of relatively old irrigation infrastructures.
6. Lack of appropriate beneficiaries' organization for effective O&M of project facilities.
7. Absentee owners of relatively larger holdings have less response to the needs for increasing irrigation efficiency.
8. Wastage of irrigation water due to suboptimal use and indifference of users about the economic value of water in the context of its increasingly competitive market.

Small-Scale Irrigation in Bangladesh

Privatization and import liberalization caused profuse growth of STWs. Some observers dubbed it as the *quiet revolution.* The DTWs have not been able to win the test of economic viability as was initially envisaged. Even the Grameen initiative on these in northern Bangladesh failed during the late 1990s. It has been the unfavorable economics of DTWs in the agro-ecological context of Bangladesh that started their gradual departure from the farmers' arena. Besides these, hand TWs, force mode TWs, DSSTWs and very deep set STWs also comprise the minor mode with, however, a very modest coverage. The total coverage under groundwater irrigation has been 2.85 million hectares (about 70%) out of the total coverage of 4.2 million hectares under all modes of irrigation in Bangladesh.

A Comparative Assessment of Current Irrigation Status by Major Types

The relative significance of each type of irrigation can be captured by putting the coverage under each mode of irrigation by groundwater and surface water sources. Figure 1 represents the comparative strength of each mode, representing also the economic preferences of users. It is evident from figure 1 that augmentation of surface water and dependence on groundwater from the deeper aquifers for irrigation have been the dominant strategies to sustain agricultural growth.

Poverty Impact of Irrigation Projects: An Overview

Poverty is perennial but irrigation water is not. Poverty does no more bind itself within the walls of food and there are other kinds of food than bread. It is, therefore, difficult to functionally relate poverty with irrigation, which is only a fraction of inputs for food production for alleviation of food poverty.

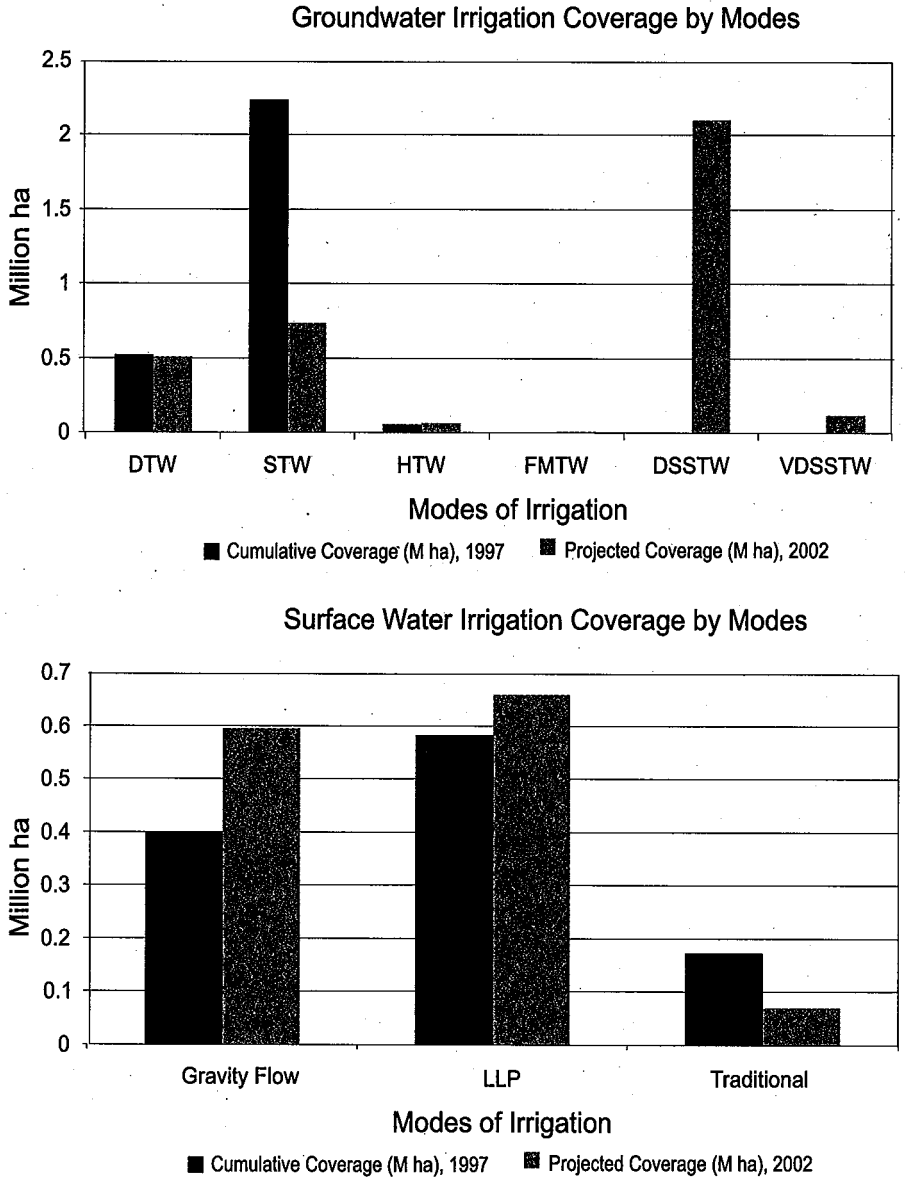
If poverty has its root in income, irrigation can influence it favorably but indirectly through growth projects in the economy. If it has a nonincome root, even then irrigation can indirectly influence it through capacity-raising programs in issues like technological adaptation in agriculture, integrated pest management, etc.

The most recent estimate of the Human Poverty Index (HPI) has dropped more than 20 percent during last 15 years (1981 to 1997). It remains to be examined as to how far irrigated agriculture has contributed to this decline.

The spread of high-yielding varieties of agricultural crops has a strong influence on agricultural growth. How far this influence benefits the poor farming class and the landless households depends upon the rate of higher labor requirement and yield per hectare.

A shift from local to HYV rice culture normally elevates the pattern of labor employment by 45 percent and the yield rate by at least 10 percent. This favorable influence does not speak much about poverty alleviation when consumption data are considered. Moreover, the technological adoption process also incurs some substantial default, which pulls the potential growth rate down to the pseudo-production level. Thus the process of benefiting the poor gets handicapped by technological limitations.

Figure 1. Comparative strength of each mode.



DTW = deep tube well; STW = shallow tube well; HTW = hand tube well; FMTW = force mode tube well; DSSTW = deep set shallow tube well; VDSSTW = very deep set shallow tube well.

Pro-poor irrigation development has offered itself to very limited experimentation for long in Bangladesh. While food self-sufficiency is a national goal, it does not automatically address poverty through irrigation development. This is because withdrawal of subsidies from the agricultural input market (including irrigation water) has put the smallholders in agriculture in unfavorable terms of trade. Irrigation management systems also do not lend themselves to any magnanimous options for involving the poor or the landless people. Nor have the

persistent efforts for strengthening antipoverty institutions and for removing institutional hurdles against social mobility of the poor come out successfully yet. If we look back to the financial and economic performance and potentials for irrigated transplanted varieties of food grains (boro, aus, aman and wheat), we can mark a significant drawdown in financial and economic cash flow, yielding a suboptimal net returns to investments in irrigated crops due to underperformance of technology. Table 1 demonstrates that normal yields, net financial returns and net economic returns (in 1996 prices) are far less achieved in practice than the potential values.

Table 1. Normal and potential yields, net financial returns and net economic returns.

Irrigated food grains	Yields (tons/ha)		Net financial returns (Tk/ha)		Net economic returns (Tk/ha)	
	Actual	Potential	Actual	Potential	Actual	Potential
Boro (HYV)	4.36	5.29	7,697	20,769	13,013	35,000
Aus (HYV)	3.34	3.57	6,479	11,778	8,889	16,000
Aman (HYV)	3.50	5,50	9,550	25,197	12,262	32,000
Wheat (HYV)	2.16	3.04	2,774	8,190	9,256	27,000

Source: Bangladesh agricultural growth with diversification: Prospects and issues.

The above table shows that actual yields are lower by as much as 18 percent, 6 percent and 36 percent for boro, aus and aman rice, respectively. Accordingly, financial and economic returns also show a heavy setback for the actual values when compared to the potential values. The actual yields of wheat are lower by 28 percent.

This raises a serious issue of sustainability of the HYV crop culture in the long run, unless a more commercially oriented crop diversification from rice to other crops takes place. And this is one of the basic reasons why poverty reduction has not been obtained through irrigation of major crops in Bangladesh.

A serious research is, thus, a necessity on broad-based agronomic, economic, social and ecological issues on how winter or *rabi* (dry season) season agro-ecology can be optimized through low-cost technology for crop diversification (from boro to other commercially viable crops) and how the second *kharif* (wet season) season can be tapped for cash crops like cotton, jute, sugarcane, fruits and vegetables.

Tax-Poverty Interface in Irrigation Systems

In the case of surface water systems, market-based allocation of water is often opposed by the farmers who own head water rights (along the main and secondary canal systems) under the initial stage and by those farmers again who have been getting their water for free. In the case of groundwater, the problems of overexploitation from a social point of view and its costly technology handicap its economic use by small and poor farmers in Bangladesh.

Therefore, an appropriate institutional setting is critical for investing in water-conserving and water-conveying technology and for efficiency in water use. By this institutional setting, we mean an institutional system that provides holders of water rights adequate incentives for improvement of the irrigation system.

The notion of "free water" has almost vanished, yielding place for "priced water," where the holders of water rights may have a share in the profit made from the sale of water. Scarcity of water and technological change have started widening the scope of the water market even in the developing countries. Sometime in the future, "marginal productivity" (of a unit of water) rule may soon come up to govern the water market. In that case, poverty reduction as a strategy through irrigation projects may not be relevant. But the underlying strength of the water-market system may help alleviate poverty through cross-subsidization among the cross sections of water users (including poor, small and marginal farmers), if an appropriate institutional setting can be put in place.

Concluding Remarks

Given the poverty reduction syndrome historically observed, the pace of income (consumption)-poverty reduction has been slow (see Bangladesh Economic Policy Paper No 1, ADB, June 2000). Irrigation development has been reasonable during the last three decades. Therefore, irrigation as a passage towards alleviation of poverty, is still hard to conceive except when we consider an indirect influence of increased food production and unskilled labor employment in HYV crop culture stimulating the current income of the poor.

Irrigation, both surface water and groundwater, has its ceiling, beyond which nature's monopoly operates. So, technological innovations for low-cost, equitable and ecologically friendly irrigation systems, and effective institutional development for participatory water management can play an important role in indirectly alleviating income-poverty.

Investment, Conflicts and Incentives: The Role of Institutions and Policies in China's Agricultural Water Management on the North China Plain

Bryan Lohmar, Jinxia Wang, Scott Rozelle, Jikun Huang, and David Dawe[1]

Summary

China's water problems have become well known internationally and could have an enormous impact on crop production, quality of life, and economic development in general. Recently, rapidly falling groundwater tables and disruption of surface-water deliveries to important industrial and agricultural regions have provoked concern that a more dramatic crisis is looming unless effective policies on water conservation are soon formulated. Opinion over how this "crisis" will affect agricultural production, however, varies substantially. Some argue that the current events portend a major crisis that will cause China to import enormous quantities of agricultural goods while others argue that the "crisis" is not too severe and that China can feasibly avoid major disruptions in production.

This paper provides a timely and comprehensive overview of China's water problems focusing on the particular problem of depleting water resources available for agriculture on the North China Plain. This Plain is a major grain producing area that relies heavily on irrigation but is also where groundwater levels have been falling at alarming rates and competition for water from nonagricultural sectors makes the opportunity cost of water delivered to agriculture higher than elsewhere in China. This Plain is a particularly important wheat producing area, and wheat production is threatened more by competition for water resources than by production of other crops because wheat is relatively low-valued and is more dependent on irrigation.

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China's water policies, shortage problems and their potential solutions are complex and multifaceted. The paper thus begins with a short but thorough description of the current water situation on the North China Plain, followed by a description of the institutions and policies charged with managing China's water resources. To provide organization to the analysis of the complex issues involved, we break a more focused analysis of the problems and responses into three sections, each of which is a subset of the larger problem. One subset looks at the falling and poorly targeted investment patterns, the subsequent deterioration of surface-water storage and delivery systems, and the responses to this problem. Another section addresses the overlapping and competing interests of bureaucratic authority, how these problems contribute to unsustainable water management and recent reforms intended to rationalize the water management system. Finally, we look at the set of issues relating to farmers' incentives to learn and implement water-saving irrigation (WSI) practices and technologies. This section discusses water prices and WSI technology extension services. After the three sections, but before a general conclusion, we discuss how the changes underway may affect agricultural production on the North China Plain.

To understand how China's agricultural production may be affected by future competition for water, first, it is important to understand the current state of water depletion and the policies and institutions that govern how China's water is managed. In the first section (Water Scarcity and Water Management Policy in China) of this paper, we document how groundwater levels have been falling at an accelerating rate and how deliveries of surface water have become less reliable. In addition, we describe how the Ministry of Water Resources (MoWR), the main bureaucratic institution charged with managing China's water resources, carries out the water management policy, along with a description of subnational authorities and other government ministries that manage some aspects of water policy. Because the financing of these government offices is often a source of poor incentives to effectively manage water for agriculture, we also briefly describe how water management institutions are traditionally financed.

The overall investment into water recovery, storage and delivery infrastructure is a critical part of water resources management and is the topic of the first of the three sections that break the problem down into subsets. Much of China's water recovery, storage and delivery infrastructure was built under the People's Communes, and when these organizations collapsed in the late 1970s, many assets were left without clear ownership and mechanisms to maintain them. At the same time, national investment priorities moved away form agriculture. As a result, area irrigated fell in the early and mid-1980s, prompting stagnant grain production and higher food prices by the mid-1980s. The national government responded to these signs by increasing national investment in agricultural infrastructure, and the trend of increasing agricultural investment is expected to continue well into the twenty-first century. Private investors have also become an important part of water delivery in rural China in the last decade, especially in developing small groundwater-fed IDs in areas where surface water deliveries are problematic or the water table has fallen below the reach of collectively owned wells.

While physical infrastructure is an important component of water management, the institutions charged with water management must also be given clear responsibilities and incentives that encourage them to manage water effectively. In the section under "Solving Water Disputes among Regions and Users," we address the role of the water management

institutions, and the conflicts that occur within the bureaucratic framework charged with supplying water to the various users. In China, as with many other areas managing scarce water resources, conflicts occur between regions, between different parts of the bureaucracy and between different users, notably agriculture versus industry. We look at how conflicts between regions, part of the bureaucracy and between agriculture and industry have been behind poor water management in the past and describe the steps taken to resolve these conflicts.

Finally, the delivery of water to over 100 million small farm households and the provision of incentives to them to use water efficiently and effectively constitute, perhaps, the biggest water management problem facing water policy makers and local water managers in China today and this is explored in the section under "Farmers' Incentives to Reduce Water Consumption." Pricing water volumetrically, the usual solution offered by economists, would likely generate very high transaction costs in an environment where each farm household irrigates only a fraction of a hectare of land. Instead, farmers are usually charged according to their irrigated area, regardless of how much water they use and, often, they do not know how much they pay for water, even though water fees can be a significant part of production costs. This system generates a variety of perverse incentives and does not encourage water saving. In addition, efforts to introduce WSI practices and technologies have not been entirely successful. Recent efforts to improve pricing practices and encourage more rational water use in agriculture have been established and may ultimately work to encourage the adoption of water saving agricultural practices and irrigation technology.

The effects that increasing competition for water will have on agricultural production are not clear and they depend largely on the extent to which China can avert a more widespread water crisis. Irrigated wheat production on the North China Plain is perhaps the most threatened practice, but if irrigated wheat area declines, what will farmers plant instead? Interestingly, one option that many farmers seem to be moving toward is the cultivation of relatively water-intensive cash crops using a variety of technologies that reduce water loss and improve the effectiveness of water delivery. In the section under "The Effects of Water Scarcity on Agricultural Production," we discuss the possible changes in the structure of China's agriculture that may come about due to increasing competition for water from nonagricultural sectors.

Introduction

Rapidly growing industries, increasingly productive farmers and a large population with rising incomes all compete for China's water resources. The sustained high industrial growth rate over the last 20 years has caused a significantly higher proportion of China's water to be allocated to industrial production. The proportion of water allocated to residential users is also increasing, particularly as the number of urban residents and incomes grow. In addition to the growing demand water for nonagricultural uses, China continues to expand its irrigated area. These trends have resulted in higher demand for water in agriculture that, despite the growing demand by other sectors, is still by far the largest user of water in China.

Does the rapid increase in demand and competition for China's limited water resources add up to a pending water crisis in China? Some observers hold out dire predictions of China's future water problems (Brown and Halweil 1998). Other observers make more moderate predictions but suggest that many agricultural producers may have to forgo irrigation. Still others suggest China's current water problems are only marginally serious and will likely be solved just as China has solved other "crises" in the past. According to some observers, there is significant scope for "real water saving" in China (Barker and Molden 2000; MoWR, IWR& HR 1999).[2]

All observers of China's current water situation agree, however, that the "crisis" has not yet manifested itself in a substantial loss of irrigated area or industrial production. Even the most pessimistic observers characterize the "crisis" as a rapid decline in water availability that, if left unchecked, will lead to a fall in food production in the coming 20 years. Economically, to argue that a true water crisis exists in China, one must show that water deliveries have been disrupted or prices have risen to an extent that actually threatens economic activity. Disruptions of water deliveries have occurred but so far they have been relatively rare events in relatively isolated areas and have not yet affected the aggregate production, both in industry and in agriculture.[3] In other areas, the irrigated area has actually expanded in recent years and leaders have plans to continue expanding the irrigated area. Industrial production has also grown rapidly in the past several years, even in regions where water is relatively scarce. In addition, water prices, while higher than in other parts of Asia, are still well below the marginal value of water use in each sector. Despite the dire predictions of a looming water crisis, water use in China is still relatively wasteful and inefficient, which implies that there is ample room to improve the efficiency of water use and avert a more drastic crisis in the future.

Given the public goods nature of water and the role that the state will play in managing water, the real debate over the future severity of China's water problem may come down to a question of how well policy makers can respond to the various water-related issues confronting them. On the one hand, a review of the past trends of water demand and supply,

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[2]"Real water saving" refers to saving non-recoverable water loss such as through evaporation or inessential transpiration, rather than saving on water loss through seepage, which can be recovered downstream in the water basin.

[3]But water delivery disruptions have affected farmers, industry and residential users in areas where they have occurred.

and extrapolations into the future, may lead to pessimism. If one extrapolates linearly from the record of the annual decline in groundwater from 1980 to 1996, then one could come to the conclusion that groundwater resources on the North China Plain will be depleted by 2030 (Goodwin 1999). On the other hand, the experiences of other water-short societies provide optimism since, as water scarcities grow, users and policy makers adjust to the situation (Nickum 1998b). But policy makers need to know how water users in different sectors and regions will respond as institutions and policies change.

Little work has gone into understanding how well policy has responded to changing conditions in the past, how formal and informal institutions have emerged or adjusted to deal with the current water shortages, or how producers and consumers respond when facing water shortages. For example, few papers focus specifically on the effectiveness of China's water policies, particularly at the local level, nor have researchers examined water management policies at the regional level.[4] Moreover, even less is known about how China's water managers and farmers are responding to water scarcity. Yet it is here that most decisions about water use are actually made. In the face of rising scarcity, formal water management institutions have initiated reforms, and informal institutions have emerged in the countryside to provide more secure water resources.

The overall goal of this paper is to provide a timely analysis of how China has managed water in the past, the challenges that the nation is currently facing, and the measures that have been implemented or are at its disposal to combat water shortages in the face of future rapid economic growth and rising demand for food. To meet this goal, we have three specific objectives. First, we briefly review the state of China's water resources and water policy in the early reform period. Next, we examine some of the main issues that water policy makers in China are facing. These issues include a) the allocation and management of investments in water control infrastructure and maintenance; b) the emergence of interregional and inter-sectoral water conflicts; and c) the provision of incentives for producers and water users to more effectively manage water. Finally, for each set of issues we track both how the actions of policy makers and users have created these problems and how they have responded to them. To address water allocation problems, policy makers have reformed formal institutions and water users have established informal institutions that provide better incentives to use water efficiently. In addition, we provide some insight into further measures at the disposal of water policy makers, managers and users to address water shortages.

In this report we emphasize the role of policies and institutions, particularly *at the regional and local levels*, and the presentation of new data drawn from several field studies and numerous interviews. We explicitly document *both formal and informal* water management institutions found in China. We also consider institutional change, not only as being created by some act of the policy-making bureaucracy, but also as being induced by factor scarcity—in this case water—and the actions of parties that benefit from, and bear the cost of, the (water) scarcities. The material that we use in the paper on the policies, the

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[4]Some papers in the literature, such as Crook 1999, Diao 1999 and Crook and Diao 2000, describe the history and recent changes in policies and institutions affecting water use. The papers, however, focus primarily on national policy and none center on examining how policy changes might affect water availability and usage.

policy making processes and the institutions come primarily from our field work and analyses that have been done over the past 3 years.

China, however, is big, and water policy is complex, so it is impractical to cover all water-related issues in one report. Most of this report focuses on a subset of issues and only one part of the country. We concentrate our efforts on the water-short North and only briefly address issues of flood control and management of the abundant water resources in South China. In addition, we focus on issues that affect water availability for irrigation in agriculture. Agricultural water use is twice as large as all other uses combined, but it is also the lowest-value user, so water availability for agriculture is closely tied to industrial and domestic water demand. In addition, water recovery projects that deliver water for irrigation are usually also used for flood control, so this aspect of water management cannot be fully ignored in a discussion of irrigation policy. While we acknowledge these clear interrelationships, we leave the detailed description and analysis of flood control problems and industrial and domestic water demand to others.

Water Scarcity and Water Management Policy in China

Signs of Increasing Water Scarcity

While China has large water resources compared to other countries, its population is comparatively even larger and its water is not evenly distributed across the country or across important agricultural regions. China ranks fifth in total water resources among the countries in the world, but on a per capita basis, it is among the poorest. The nation's water resources are overwhelmingly concentrated in southern China, while northern China, the area north of the Yangtse river basin, has one-fourth the per-capita water endowment of the south and one-tenth the world average (MoWR 1998).[5] The lower levels of rainfall in North China are also much more seasonal than in the South, with over 70 percent of the rain falling between the months of June and September. Northern China, however, remains an important agricultural region and the site for much of China's industrial production. Although it has only 24 percent of the nation's water resources, northern China contains over 65 percent of China's cultivated land, produces roughly half of its grain (and nearly all of China's wheat and corn) and over 45 percent of the nation's GDP (MoWR 1998; SSB 1999).

Increasing industrial output, expanding agricultural production and rising domestic incomes have all contributed to the depletion of water resources in China. From 1949 to 1998, per-capita use has increased 130 percent and total water use in China has increased 430 percent (Wang 2000). The industrial sector has increased at a much faster rate than the agriculture sector. The average annual growth in industrial water consumption was 8. 6 percent over the period, compared to just 2. 7 percent for agriculture. Hence, over the period

[5]Loosely speaking, northern China includes three main geographic regions according to China's own definitions: Northwest, North, and Northeast China.

1949 to 1998, the share of China's water resources consumed by agricultural producers fell from 97 percent to 69 percent. The share of industries rose from 2 to 21 percent and the share of domestic and other consumption rose from 1 to around 10 percent. Despite a faster growth rate, the amount of increase in agricultural water use is much larger than industrial water use over this period since industries started at a much smaller base.

The effects of the increase in water demand have been most acute in northern China. As demand increased in the industrial and urban sectors, shortages of water resources forced officials to cut back on deliveries of water to farmers in some provinces. In many parts of northern China (for example, in northern Anhui, northern Jiangsu, Shandong, Shanxi, Gansu, Qinghai, and Xinjiang Provinces and the Provincial-level Municipalities of Beijing and Tianjin), agricultural water consumption declined from 1994 to 1998 (MoWR 1994–1998). In other areas (e.g., Liaoning, Jilin, Heilongjiang, Hebei, Henan, Inner Mongolia and Ningxia Provinces), water demand for agriculture increased, but only modestly. In contrast, industrial water use still increased over the period, especially in the industrial centers of Beijing, Tianjin and Shenyang, and Provinces, such as Hebei and Shandong, that have high concentrations of urban and rural industries.

The rapidly rising nonagricultural demand for water is not the only problem facing agricultural water users in North China. Water deliveries to agriculture are also threatened by deteriorating delivery infrastructure of surface water and by excessive withdrawals upstream. Large portions of China's physical water storage and transfer infrastructure, many of which were poorly built during the period of collective agriculture (1950s to the late 1970s), are rapidly deteriorating. Availability of investment funds has lagged and is generally geared toward new projects rather than toward maintenance of older projects. The river systems that supply water to many surface systems also sometimes do not provide sufficient water because upstream users withdraw more water than are supposed to under law. Because of excessive upstream withdrawals, the Yellow river has run dry before reaching the ocean for at least some period every year since 1974 (except last year, 2000, due to new enforcement rules, described in section under "Solving Water Disputes among Regions and Users"). Withdrawals from the Fuyang river, in the upper part of the Hai river basin, almost completely depleted the main river. In 16 of the last 20 years, almost no flow was recorded at the mouth of the river, and Cangzhou Prefecture, which is at the downstream end of the basin, receives only 10 percent of the surface water that it received in the 1970s.

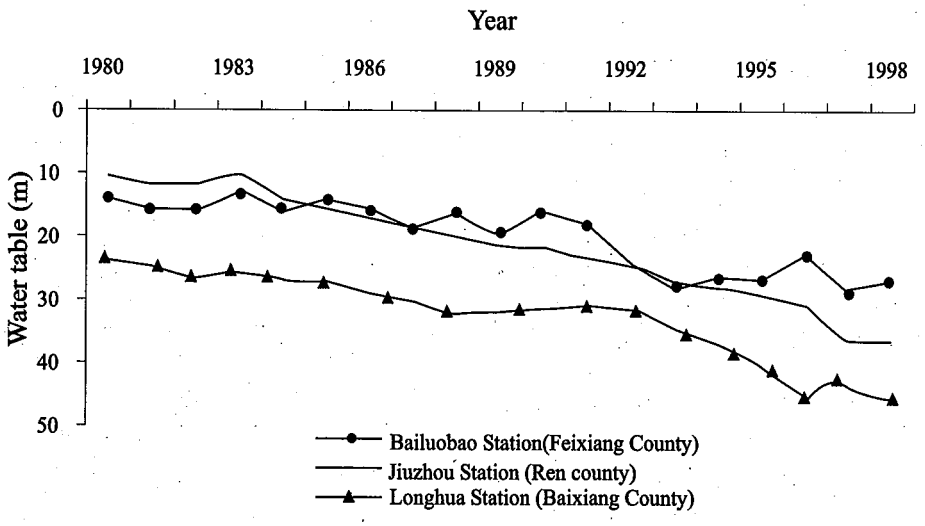
For many areas in northern China, increased agricultural water use and the related production increases have been partly due to easily exploitable groundwater that has allowed farmers to irrigate a winter wheat crop in addition to another crop in the later summer season, usually corn, that relies mostly on the summer season's rainfall (Stone 1993). For example, in 1995, two wheat growing provinces, Hebei and Shanxi, relied on groundwater for more than 50 percent of their total irrigation water consumption (MoWR 1995). In other important wheat- growing provinces, such as Shandong and Shaanxi, the share of groundwater in irrigation use is above 40 percent. The coastal parts of northern China (including northern Jiangsu, Shandong, Hebei and Liaoning) also have seen irrigated area from groundwater exploitation expand faster than in the inland areas where there is relatively less access to groundwater (MoWR 1998).

Groundwater is also the primary source of water used in industry and for domestic consumption in many regions (MoWR 1995). In 1995, the share of industrial water deliveries

that came from groundwater sources was above 50 percent in nearly all of northern China, and was above 80 percent for some provinces, such as Hebei and Shaanxi. Most of China's northern provinces also receive most of their domestic water deliveries from groundwater sources. In two northern provinces, Ningxia and Inner Mongolia, groundwater supplied more than 90 percent of domestic water consumption.

Increasing demand, limited availability and reliability of surface water and rising reliance on groundwater extraction have led to falling water tables and a number of other problems in North China. For example, in Feixiang county, a county located in the upstream part of the Fuyang river basin in Hebei Province, the shallow groundwater table fell at 0. 6 m/yr. in the 1980s and 1. 3 m/yr. in the 1990s (figure 1). Even greater rates of decline occurred in the middle and downstream parts of the basin. In addition, the deep water table is declining at an even faster rate, currently at around 1.7 m/yr. The excessive groundwater withdrawal rates generate large cones of depression under urban areas in six Hebei Province prefectures: Handan, Shijiazhuang, Xingtai, Hengshui, Cangzhou and Baoding municipalities.[6] Land subsidence has also occurred in some predominately rural counties such as in Henshui, Ren and Quzhou counties (Smil 1993; HHB&WEMC 1999).

Figure 1. Trends of groundwater table in Bailuobao, Jiuzhou and Longhua, 1980-98.



[6]A cone of depression is a natural occurrence that forms around a tube well when groundwater is pumped to the surface and it is an area where the water forms an upside-down cone formation because the replenishing rate from the surrounding water table is slower than the withdrawal rate. In areas with heavy groundwater withdrawals, as in urban areas on the North China Plain, they can become large cones that form under entire cities, not just around individual wells.

While the long-run impact of the falling water table in North China is not clear, current rates of extraction are not sustainable given current rates of recharge. In the longer run, areas with cones of depression may even lose their capacity to hold large quantities of groundwater. In this way and others, the subsidence brought on by groundwater depletion may permanently harm the land's capacity for groundwater storage. However, if effective water-saving practices can be implemented or if new water sources can be found in the near future, the present levels of groundwater depletion do not necessarily represent permanent damage because most of northern China's groundwater can be recharged through infiltration of surface water if the withdrawals are sufficiently reduced (Nickum 1998a).

Large groundwater extractions and the subsequent fall in the water table could also affect the *quality* of water, particularly through the intrusion of seawater. A survey carried out in the coastal provinces of northern China in the early 1990s found that over 2,000 km^2 of the formally freshwater table had fallen below sea level (Nickum 1998a). Farmers, industrialists and city water managers abandoned more than 8,000 tube wells and irrigated area declined by 40,000 hectares. While these losses represent only a small part of the overall agricultural production in North China, they do significantly impact residents in the affected regions and some observers predict that unless groundwater sources are allowed to replenish, the problems will increase at an accelerating rate.

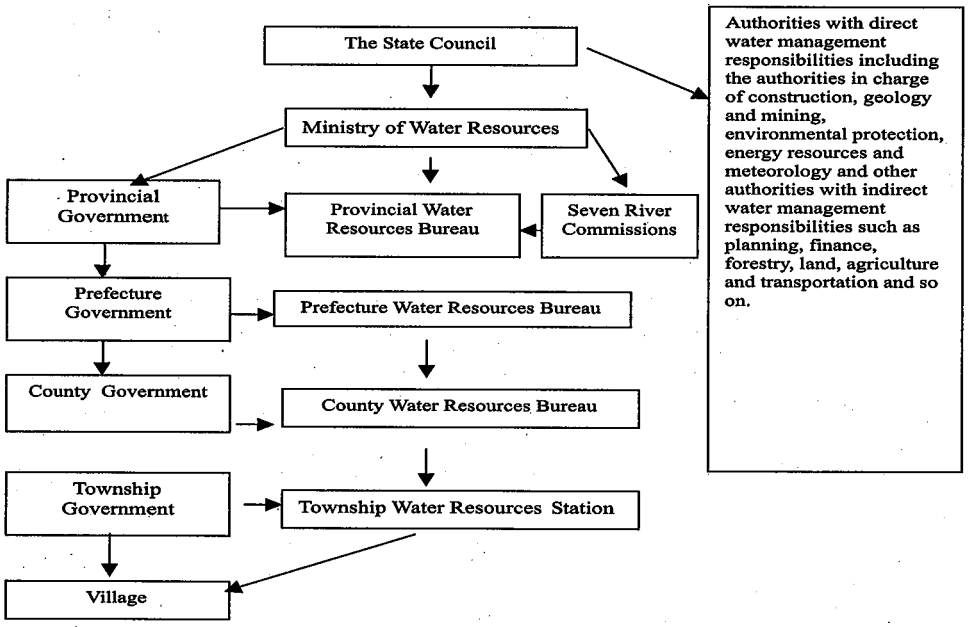
China is starting to see the long-term impacts of excessive water exploitation and is facing water-scarcity problems that might become a serious crisis in the near future, unless, of course, policies are adopted and institutions emerge to avert such an event. Although water scarcity in northern China has been building for decades, it has only recently begun to affect the livelihoods of people and threaten the profitability of economic activity. Unchecked, the problems could develop into catastrophic proportions. China, however, *has begun* to address these problems at nearly all levels, from the national level down to the village and farm levels. In some cases, the progress is difficult to detect, but given the length of time it took to generate these problems, it is reasonable to assume that the solutions will also be difficult to implement and progress will be slow. To understand the actions taken by the government, local leaders and individuals we examine, in the following section, the complex arrangements that govern how China recovers, stores, allocates and manages its water resources.

China's Water Management Policies and Institutions

Over the past 50 years, China has constructed a vast and complex bureaucracy to manage its water resources (figure 2). To understand the functioning of this system, first, it is important to understand that, until recently, water saving has never been a major concern to policy makers. Instead, the system was designed to a) construct and manage systems to prevent floods that have historically devastated the areas surrounding the major rivers, and b) effectively divert and exploit water resources for agricultural and industrial development. Indeed, China's success in accomplishing this latter goal is largely why the nation faces water-shortage problems today.

Water policy is ultimately created and theoretically executed by the MoWR (MoWR 2000). The MoWR has run most aspects of water management since China's first comprehensive Water Law was enacted in 1988, taking over the duties from its predecessor,

Figure 2. The structure of water management institutions in China.



the Ministry of Water Resources and Electrical Power. The policy role of the MoWR is to create and implement a national price and allocation policy, and oversee water conservancy investments through the provision of technical guidance and issuance of laws and regulations to the subnational agencies. The national government invests in developing the water resources from all *large* rivers and lakes and projects that cover more than one province. Local governments are in charge of projects that are within their administrative districts. Historically, investment from national funding sources has been heavily biased towards new investments, while local governments have been responsible for maintenance funds.

Although much of China's water is still used by farmers in agriculture, the nation's water policy is becoming increasingly biased toward industry. Acting according to the direction of the Water Law, the MoWR gives priority to the domestic and industrial sectors (over agriculture) in the allocation of all water. Provincial governments also have the power to allocate water, based on their local priorities, a provision that has led many provinces to give industry a particularly high priority.

Under the 1988 Water Law, the MoWR is not solely responsible for all water-related policies; other ministries in China also influence water policy for both rural and urban areas. The diverse uses of water and diverse objectives and interests of water management agencies often result in conflicts and inefficient water use. In the use of agricultural water, the MoWR shares its duties with the Ministry of Agriculture, particularly in developing local delivery

plans and extending water-saving technology. In urban areas, *chungjianwei* (Urban Construction Commissions or Bureaus) are charged with managing the delivery of water to urban, industrial and domestic users. These Commissions also have taken responsibility for managing groundwater resources that lie beneath the land area of the municipalities. Groundwater levels, both urban and rural, are monitored jointly by the Ministry of Geology and Mining (MGM) and its local associates. In theory, the MGM's information about the groundwater level is used when deciding whether to grant groundwater pumping permits, though our field work revealed that local water bureaus do not always use this information. China's State Environmental Protection Agency (SEPA) has the responsibility for managing industrial wastewater and municipal sewage treatment. Lastly, in the area of price-setting, the MoWR, in conjunction with the State Price Bureau and acting with the approval of the State Council, sets guidelines at the provincial level. Subnational Water Resource Bureaus and Price Bureaus (at the direction of the leaders in the localities) set the final price levels according to local supply and demand conditions as well as according to other economic and political factors.

Outside of the central government, many subnational water management institutions also influence water policy. Linked vertically to the MoWR in Beijing (a tie that is mainly reinforced by the investment funds allocated by the central government), provincial, prefectural and county governments all have Water Resources Bureaus (WRBs), sometimes called Stations at county and township levels). Formally, the subnational offices are charged with implementing the rules and policies advanced by the national authorities. In reality, however, the heads of local WRBs are appointed by, and report to, leaders of their own jurisdictions (such as provincial governors or county magistrates). These horizontal ties frequently dominate the vertical ones. As a consequence, WRBs also create and execute water policy and regulations, based on the needs of their own jurisdiction, making for a considerable degree of heterogeneity in water policies across regions. Most county offices also have established water resources stations in each township that, in turn, interact with local villages. Traditionally, in most villages, the village leader, or a water officer on the village committee, takes charge of the village's water management system and assesses water fees.

Since rivers, lakes and aquifers do not always follow administrative boundaries, there are also institutions that manage water across administrative boundaries. Each of China's 7 major river basins has a National River Basin Commission (NBRC) to manage the basin's water resources. The NBRCs are directly under the MoWR, and when they were set up they were given the authority (at the direction of the MoWR leadership) to approve or reject provincial Water Resource Bureaus' plans to withdraw water from the main stream of the river basin under their charge. Importantly, the NBRCs do not regulate water withdrawals from the tributaries of the main river under their charge—these are regulated by the local WRBs. Moreover, some scholars believe that the commissions were not very effective in the years immediately after they were set up. Provinces were known to primarily implement their own plans, often to the detriment of other provinces and against the plans of the National Commissions.

Below the national level, the irrigation districts (IDs) were developed to administer water resources that span lower-level administrative boundaries. Any given ID always reports to the officials in the WRB that encompasses the district's *entire* command area. For example, if an ID includes two or more prefectures, it is under the provincial WRB, but if it lies in two or more counties within the same prefecture, it is under the control of the prefecture's WRB.

Responsibilities of Local Water Management Institutions

The ultimate duty of WRBs has always been to create and manage water allocation plans, conserve limited water supplies in deficit areas and administer water infrastructure investment (our interviews). In the early years of the People's Republic of China, the WRBs were mainly in charge of the development and management of surface water, working through a system of regional and local IDs. The primary task of local water-policy managers is to translate investment dollars into infrastructure, maintain the system once it is in place and manage the water flows within and among IDs.

More recently, WRBs in most regions of northern China spend more of their time assisting in the development of, and attempting to control, groundwater resources, though control of groundwater resources has been more difficult. One approach has been to control the number and location of wells. In the pre- and early reform years (up through the late 1980s), the monopolization of well-drilling activity gave local authorities a fairly comprehensive control over the access to groundwater since most deep wells (and many shallow wells) were sunk by well-drilling enterprises owned and operated by the WRB.[7] In recent years, however, the rise of private well-drilling companies and competition among locally state-owned (owned by either a township or a village) well-drilling companies has reduced this avenue of control. In this new environment, local WRBs are still charged with controlling groundwater extraction by using their authority to issue *all* well-drilling permits for extraction and management of water.[8] We have, however, encountered many exceptions to this process. For example, Urban Construction Bureaus are notoriously independent and in many cases urban units operate on their own without the oversight of the WRBs.

The WRBs are also charged with overseeing a system of permit rights to draw groundwater in addition to well-drilling rights. This system is intended to allow them to operate a de facto groundwater allocation plan, but it has not always worked in practice. Because of the problems in monitoring groundwater extraction there is little control over the quantity of groundwater extracted once the wells are in operation. In several areas that we visited, groundwater extraction fees from large government-owned wells are not charged by volume, but are rather based on a fixed negotiated amount per year regardless of the amount extracted. In general, except in cases where groundwater tables have fallen so much that they are causing an acute crisis, urban and rural localities are in charge of their own groundwater resources, and little action is taken to restrict groundwater pumping.

Wastewater treatment is the responsibility of the local Environmental Protection Bureau (Sinkule and Ortolano 1995). Because end-of-pipe monitoring technology is still underdeveloped, monitoring of wastewater flows is not a very effective strategy. Instead, China

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[7]Although until recently wells were mostly drilled by enterprises set up and controlled by the local WRB, the wells themselves were often managed on a day-to-day basis by the collective, enterprise or some other agency. Today, many of the wells are drilled and operated by private entrepreneurs.
[8]The control over water permits in urban areas by local WRBs was institutionalized in 1998 by a State Council directive in 1998, although it has not been effectively implemented in all areas.

mostly relies on two measures to enforce clean water standards: regulating enterprises at the investment stage—making initial operational approval subject to the adoption of clean water technologies as part of the firm's production process (Warren 1996) and through a system of water discharge fees and discharge allocations, which are enforced by a schedule of penalties should the firm be caught exceeding their initial pollution allotment. Even this system, however, is subject to interference by local government officials who are in charge of both production and clean-up and clearly have great incentives to expand production (Ma 1997). Given the low share of wastewater that is actually treated, it appears that the benefits of treating wastewater to private firms do not justify the costs. In addition, since the EPBs earn money from fines when water is not treated, their incentive is to not encourage wastewater treatment (Sinkule and Ortolano 1995).

Financing Water Management at the Sub-Provincial Level

Financing activities of local WRBs and the fiscal crisis that many local water agencies face have played a role in shaping the way that WRBs have developed and how they have set their priorities. Operations and investments of local water bureaus are financed by fees for water deliveries, water extraction and well drilling permits and by transfers from the administrative hierarchy above the local bureau. Low water-price limits, however, frequently keep system officials from charging enough to cover their operation and maintenance (O&M) costs (Nyberg and Rozelle 1999). In addition, targeted budgetary allocations from upper-level governments often never arrive in full or are diverted for other pressing matters. The fiscal stress has led to distortions in the way investment funds are allocated among new and existing structures (discussed below). Shortages of current operating funds also have led to innovative, although sometimes distracting, ways of meeting fiscal deficits. To make up the deficit between revenues and expenditures, local water agencies fulfill their financial obligations through a variety of means that we observed during several fieldwork trips. Irrigation officials frequently tapped funds intended for investment in infrastructure or held back payroll expenditures to meet immediate operating expenses. Local bureaus are also often encouraged to allow employees to set up businesses around the use of water resources, such as fish farms or tourism assets in reservoirs, to earn profits that supplement the revenue side of the agency's balance sheet and provide wage payments, making it easier to meet payroll expenditures. A system that relies on individuals to use earnings from a quasi-private business to cross subsidize a difficult-to-monitor policy task, such as the efficient delivery of water to farmers, will likely fail to meet the policy goals.

Due to the recent signs of an impending water crisis, water management policies and institutions have made changes at all levels. On the national level, China's leaders have increased national investment into water delivery infrastructure and passed a reformed Water Law in 1998 that explicitly addresses the need to rein in inefficient water use and poor water management. Provincial, prefectural and municipal governments have initiated policy reform to better manage water resources as well. In addition, farmers are creating new institutions that improve the reliability of water delivery and are beginning to adopt WSI practices and technology.

Increasing Investment and Reversing Deterioration of Infrastructure

An important part of China's overall water management capacity is the state of water recovery, storage and delivery infrastructure. While de-collectivization in the late 1970s and early 1980s led to jumps in agricultural productivity and production, these same reforms led to ambiguous property rights over many local water delivery systems built under the People's Communes and to a fall in the ability of local governments to invest in large infrastructural projects. The ambiguity over ownership of these systems generated weak incentives to invest in and maintain them. Moreover, transfers of investment funds from the national to local governments fell, further decreasing the ability of local governments to invest in maintaining water storage and delivery infrastructure. This lack of strong incentives and ability to invest in the delivery infrastructure of surface water is partly responsible for the fall in the effectiveness of surface water systems, and the decline of these systems was partly behind the stagnation in China's grain production and rising food prices from the mid-1980s to the mid-1990s.

Infrastructural Investment

During the reform era (from 1979 to date), agricultural policy makers have not always given high priority to agricultural investment, and the neglect has slowed output and productivity growth and contributed to current water problems. Investment for irrigation declined in the late 1970s due to both a changed emphasis towards industrial water delivery and the fall in local sources of investment. Although total national investment in irrigation infrastructure rose from 0. 8 to 5. 6 billion (constant 1990) *yuan* from 1955 to 1975, it fell over the next 10 years to 3. 3 billion in 1985 (table 1). During the 30-year period between 1955 and 1985, the share of irrigation in the total national investment budget rose from 2. 3 to 6. 4 percent between 1955 to 1975, before falling to less than 2 percent in 1985 (table 1).

National investment statistics do not tell the whole story, however, since investments by local governments in many smaller IDs have also fallen significantly, especially in the early years of reform. The decline in the share of local government expenditure among all the various components of public agricultural investment was highest in irrigation infrastructure. During the period between 1975 and 1985 when national investments in irrigation infrastructure fell, investment by the local governments declined even further. Some of the actions taken by leaders to correct this problem, such as the encouragement of the commercialization of IDs and other water-control projects may well have made the under-investment problem worse.

An early indicator of the government's waning commitment to water control was the downward trend in irrigated area in the early 1980s. Irrigated area fell from a pre-reform high of 44. 97 to 44. 04 million hectares between 1975 and 1985, a fall of almost a million hectares (SSB 1985). Much of the fall was due to retirement of unprofitable irrigation schemes created under the People's Communes (Stone 1993). The fall in irrigated area was a primary reason behind the passage of China's first national Water Law in 1988.

During the same period, concern also grew about the deterioration of the systems that still remained in operation (Nickum 1998a). Not only had total investment in irrigation

Table 1. National investment in infrastructure and water infrastructure, 1955–1995 (in 1990 billion yuan).

	Total National Investment in Infrastructure	Total National Investment in Water Infrastructure	Total Investment Allocated to Water Infrastructure (%)
1955	36. 8	0. 8	2.3
1960	86. 8	7. 5	8.6
1965	37. 7	2. 1	5.7
1970	67. 1	3. 7	5.5
1975	87. 6	5. 6	6.4
1980	107. 3	5. 2	4.8
1985	174. 2	3. 3	1.9
1990	170. 4	4. 9	2.9
1995	431. 6	12.0	2.8

Source: MoWR 1996.

infrastructure been declining over these years but nearly all of the limited investment was being targeted to new construction rather than to maintenance of aging infrastructure. The history of many IDs reveals the problems encountered by lack of maintenance funds. For example, one ID that we visited in Baoding Prefecture, Hebei Province, reached a peak of 20,000 hectares irrigated by the surface water system in 1973, but this area then declined to 4,000 hectares by 1986. According to the ID officials, most of the fall in area occurred either because the faltering infrastructure was unusable in some areas or deteriorating infrastructure in other areas resulted in such poor delivery service that farmers switched to more reliable groundwater sources.

The deteriorating surface irrigation systems in some places have caused many agricultural water users to become reliant on groundwater in North China. As Nickum (1998) points out, one of the key factors that held back the expansion of irrigated area and triggered the fall of groundwater levels was the degradation of the surface irrigation systems, not the urbanization of irrigated land. Water tables in areas with inoperable or inefficient surface water systems have been documented to be lower than in those areas with operable surface water delivery systems (Wang 2000).

Serious attention was finally given to the problem of waning irrigation investment in the late 1980s after several successive years of poor harvests. Post-reform grain production peaked in 1985, then stagnated in the late 1980s (SSB 1989). Some people blamed low investment in agriculture for this decline (Wen 1993). Estimates of the impact of irrigation investment on total factor productivity show that China's irrigation system was losing its ability to increase output and productivity (Huang et al. 2000).

Renewed Commitment to Investment

Falling irrigated area and rising food prices led to a consensus that more attention needed to be concentrated on agriculture and a consequent rebound in investment in the late 1980s. After the 1988 Water Law, investment increased from 4. 9 billion *yuan* in 1990 to 12 billion in 1995 (table 1). Agricultural investment rose by 8. 6 percent per annum in the late 1980s and by 19. 7 percent in the 1990s (table 2). In the Ninth Five-Year Plan (which took effect in 1996), officials increased investment from 8 billion *yuan* in 1996 to 17. 2 billion *yuan* in 1997 (in real 1990 prices, MoWR 1999), and the plan is to increase investment even more in the first decade of the twenty-first century (interviews with MoWR officials).

Table 2. Average annual increase in national infrastructure and water infrastructure investment, 1951–1997 (in 1990 yuan).

	Average Annual Increase in Total National Investment in Infrastructure	Average Annual Increase in Total National Investment in Water Infrastructure	Average Total Investment Allocated to Water Infrastructure (%)
1951-1957	28. 1	20. 1	5. 3
1957-1965	1. 5	2. 4	7. 6
1965-1975	8. 8	10. 1	7. 0
1975-1982	2. 2	-7. 6	5. 9
1982-1986	15. 2	2. 1	2. 7
1986-1990	-1. 3	8. 6	2. 2
1990-1997	17. 9	19. 7	2. 8

Source: MoWR 1996.

While the effects were not immediate, the rise in investment has reversed the trend in irrigated area. Since the early 1990s, irrigated area rose steadily from 47. 4 million hectares in 1989 to 53. 2 million hectares in 1999 (SSB 2000). Using SSB cultivated area figures, the percent of land irrigated has risen from less than 50 percent in 1985 to nearly 54 percent in 1999. The multiple cropping index, one of the main ways that irrigated area affects production and productivity, rose from 1. 55 in 1990 to 1. 65 in 1999.

More importantly, the rise in food output and productivity since the late 1970s can be linked with rising public investment, including investment in irrigation. Recent work by Huang and Rozelle (2000) and Fan and Pardey (1997) show that public investment in research and development (R&D) plays an important role in increasing output, and the new seed varieties developed through R&D investment generally are sensitive to timely water deliveries (Pingali et al. 1997). Huang and Rozelle (2000) have established a direct link between new investment in water infrastructure and China's grain output.

China's officials have also announced that they are beginning to shift their investment priorities from new projects to renovations and maintenance of existing systems (Nyberg and Rozelle 1999). Although it is too early to tell the depth of commitment to this new direction of investment spending, in our recent trip to an ID in Baoding Prefecture, managers had just been granted funding to completely renovate its rapidly deteriorating canal system. Over the previous 20 years, with no support from the fiscally constrained local government, and with artificially low water prices, the system's command area had fallen by more than 80 percent. Many farmers had found the system so unreliable that they had switched to groundwater. Irrigation officials said that the new grant, the first funding they had ever received from Beijing for system repairs, would allow the system to deliver water to nearly 8 times as many customers. Officials in the ID estimated that the conveyance losses would become negligible, down from more than 50 percent losses in the pre-renovated canal system.

More recently, an effort has been started to establish unambiguous property rights to many smaller systems. Many of these systems were built during the period of collective agriculture and formal ownership rights were never transferred to administrative units that were established after de-collectivization (townships and villages). Often, the new administrative units did not want to take formal ownership of the assets because many of these systems needed maintenance and demanded investment in labor and capital. The new organization of agriculture under the reformed economy made it more difficult for the townships and villages to organize labor resources and many had little capital to work with. Therefore, they did not want to take ownership of assets that would draw resources away from the collective coffers. Establishing ownership is seen as an important first step in improving many of the smaller surface water storage and delivery systems.

The Emergence of Privately Owned Wells

As public investment in surface water systems waned and deliveries became more unreliable, farmers in North China began to rely more on small irrigation systems fed by groundwater. The rise of wells during the 1980s and early 1990s drove the growth of agriculture in North China (Stone 1993). In many of our interviews with farmers in areas that can be served by surface water or groundwater, farmers almost always say that, given the current environment in China, they prefer to rely on groundwater. Even in areas where surface water is inexpensive and villages are integrated into its canal network, if groundwater is available, farmers may still sink wells. When surface water is available, they take its delivery many times but almost all farmers complain that it is unreliable. Many farmers that we interviewed across the North China Plain said that they were willing to pay up to twice the cost for groundwater compared to surface water, as long as it was available when needed.

Despite the demand for groundwater deliveries, not all localities have the ability to provide such services. Changes brought on by the reforms in the late 1970 s and early 1980s not only initiated rapid economic growth but also undermined the ability of village governments to invest by leaving them fiscally more independent and without the support of the larger commune or the ability to augment investment by allocating large labor resources as was done under the pre-reform communes. In the 1980s, most wells were built by county well-digging teams with the support of local leaders. Maintaining and increasing agricultural

production constituted an important part of a village leader's performance evaluation and this caused them to put an emphasis on these goals. It was common to use collective investment funds to expand the reach of groundwater and maintain secure water deliveries to local farmers. But many villages, particularly ones without lucrative nonagricultural enterprises, eventually faced serious fiscal shortfalls and were unable to continue sinking wells.

As the ability of the collective to invest fell, however, other investors have begun to take their place. For example, individual entrepreneurs have begun to invest in wells and delivery systems since the early 1990s, and selling the water to farmers (Wang 2000). The lack of attention by the national statistical service makes it impossible to observe what happened at the national level, but our own survey of three Hebei counties shows the speed at which private well use has expanded. Between 1983 and 1998, the share of privately owned and operated wells, and corresponding water delivery systems, in the three Hebei counties rose from 17 to 69 percent (table 3). Across some parts of China, private entrepreneurs have raised the capital needed to sink the deeper wells and install underground, low-pressure piping networks to deliver water to farmer's fields. After making the investments, the entrepreneurs sell the water to local farmers on a commercial basis.

Table 3. The relationship between the property rights structure of groundwater delivery systems, water table exploitation and reliance on surface water over time in three Hebei counties.

	Average Non-Collective Property Rights (%)	Level of the Groundwater Table (m)	Surface Water Used (%)
1983	17	37	12
1990	44	42	16
1997	68	47	2
1998	69	48	2

Source: Wang 2000.

The emergence of private entrepreneurs as water suppliers has allowed many regions to maintain irrigated agricultural production when groundwater levels decline. In one village we visited in Shijiazhuang Prefecture, Hebei Province, farmers had to forgo irrigation in the early 1990s when the groundwater table fell below the level of the village-operated wells. Many farmers switched from wheat into more dryland-tolerant crops, such as millet and sweet potato. Irrigation was ultimately restored after several entrepreneurs and the village government together invested in deeper wells and more powerful pumping systems.

In addition to the better service that farmers say are provided by private well operators, the emergence of private wells may also lead to more efficient water deliveries for on-farm water use for the individual farmer. Results from econometric inquiries into the determinants of water supply suggest that the privately run systems deliver water in a more timely and less costly manner and that this water is used more efficiently on the farm (Wang and Huang 2002). These results may be because a) private enterprises have better incentives to lower costs, b) the volumetric pricing practices (more common with private IDs) give farmers more

incentive to use water efficiently, or c) the more timely deliveries that come with the small, private groundwater districts allow farmers to use less water. The more reliable and timely deliveries provided by private groundwater IDs have also been linked to the cultivation of higher-valued crops, such as fruits and vegetables (Xiang and Huang 2000).

The rise of private wells, however, does not necessarily mean that China will be able to avert a more drastic water crisis in the future. In fact, our data show that in areas with more private wells, the groundwater table is lower. While it could also be reverse causation (that is, it might be that private wells arise when water is relatively scarce), there are many situations in which the tragedy of the commons could occur from private entrepreneurs competing over a free, but limited resource. Thus, while the establishment of private wells has allowed many regions to maintain irrigated agriculture in the face of falling water tables, they may also hasten the coming of the time when pumping from the water table is no longer profitable.

Remaining Challenges

While increasing investment into water recovery, storage and delivery infrastructure will improve the efficiency of these systems, it is important to note that these investments may not generate much real water savings. To the extent that the investment makes water delivery more timely and reliable, they do at least increase the value of water in agriculture. By reducing conveyance loss, investment in infrastructure will also reduce groundwater recharge from the surface irrigation's conveyance. This portion of an irrigation system's inefficiency is not real water loss because it is recovered as groundwater. However, there are benefits to infrastructure improvements, especially when water can be delivered to farmers at a cheaper price or in a more timely and reliable manner. When water deliveries to farmers are measured above the village level, then conveyance loss within the village translates into a higher price per cubic meter of water delivered to farmers. In addition, when infrastructure investment increases the timeliness of water delivery the value of water in agriculture can increase substantially, particularly when farmers can influence delivery schedules. Increasing the reliability of water deliveries can also facilitate investment into WSI technology (Caswell 1991).

Clearly, China's leaders did get the message that their neglect of public investment into agriculture was catching up with them. Rising food prices in the late 1980s and a fall in irrigated area in the early and mid-1980s triggered new investment by the national government. The focus on new construction versus maintenance of older projects, has also been modified. In addition, local leaders and, more recently, private entrepreneurs are investing in small water-delivery systems that rely on groundwater to maintain production. While new investments will certainly help solve some of China's production problems in some areas, the scarcity of water in other areas means that other institutional responses are still needed to manage the inter-sectoral conflicts that will arise. Moreover, policies and regulations will also be needed to create better incentives for users to save water. These topics are addressed in the next two sections.

Solving Water Disputes among Regions and Users

Because of the nature of water and the externalities that arise when water use by one area imposes costs on, or reduces benefits to, another area, conflicts frequently arise among users. The conflicts are sharpest within a given basin and in a water-constrained region. In the following section, we review several of the issues that stem from conflicts among different users. In particular, we will examine two separate sets of conflicts: those between upstream and downstream users in different geographical parts of a water basin and those between industry and agriculture. [9]

Conflicts over water arise for several reasons including the nature of the resource itself and competition for access to it. Conflicts and distortions are, often, due to the system's rigid and bureaucratic nature, which is not ideal for managing a resource where the supply can vary from year to year. The multiple layers in the existing institutions give rise to conflicts between institutions that are charged with similar or, in some cases, outright conflicting, tasks. Still others have to do with weak monitoring arrangements and poor incentive structures.

One of the main problems with China's water management stems from the overall rigidity of the allocation system. [10] Water demand and supply often follow different patterns. Systems have supplies that vary between years and within the year depending on rainfall and other climatic factors. Allocations to the various users, however, follow a different pattern and planning dictates that delivery schedules are made well ahead of the actual deliveries. When supplies are short, there may not be enough water in the system to fulfill the scheduled allocations. Local agencies must then reset the allocations, and at least one sector (usually agriculture) or region will suffer due to policy (e.g., giving priority to industrial users) or rigidities in the system. Without proper coordination, upstream users often withdraw their allocations first and leave insufficient water for downstream users, even though it might be that the most economically efficient use lies downstream.

Improving the flexibility of the surface-water delivery system, however, comes at some cost, which needs evaluation against the benefits before deciding on the preferred policy solution. For example, it is difficult and costly for surface-water systems to develop delivery regimes that match the ease with which farmers can access and apply groundwater. Finding ways to integrate delivery of the two sources of water, surface water and groundwater, often provides additional flexibility and can solve some water delivery problems. Strategies for conjunctive use of water are viable for many areas in China; Nickum (1998) reports that up to 25 percent of all of China may have access to both surface water and groundwater, and the percentage is likely higher on the North China Plain.

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[9]One could also examine conflicts between rural and urban, but because domestic water use is relatively small, we focus on the above-mentioned two sets of conflicts. Urban-rural conflict could potentially be more serious in the future.

[10]This problem is by no means unique to China. It is a problem in nearly all water-management systems throughout the world.

Adding groundwater to a system, however, creates its own set of problems. Water management authorities have difficulties in monitoring groundwater withdrawal and lack of monitoring can lead to overextraction. It is difficult to implement water pricing schemes formulated to correct shortages and when water fees are assessed they tend to be done in a way that does not necessarily lead to more efficient water use (for example, a per hectare charge for water could actually lead to overuse; this idea is developed more in the following chapter). Irrigation systems may require that groundwater users attach meters to their wells, but the obvious incentives to tamper with meter readings discourages most water managers from even trying this policy. Groundwater can also be monitored by limiting the number of wells sunk and the pumping capacity of each well. This practice, however, only limits the draw per hour but places no limit on the number of hours the pumps can operate. The lack of proper enforcement may also undermine this regulatory approach. In many areas, political pressure makes the granting of well permits automatic, while in others it is difficult to monitor the construction of wells. In addition, local water stations receive fees for granting permit rights, so they may have an incentive to promote, rather than restrict, the sinking of wells.

Interregional Conflicts

In China, some of the most serious water conflicts stem from problems that arise when trying to allocate water among regions. The most common example occurs when excessive upstream water use results in downstream users not getting their share of surface water resources. It is also a problem when there are common property water resources, such as a lake or a bay, that are adjacent to two jurisdictional units.

The most high-profile conflicts have arisen on the Yellow river (*Huanghe*), a river that begins in Qinghai Province and traverses Sichuan, Gansu, Ningxia, Inner Mongolia, Shaanxi, Shanxi, Henan, and Shandong Provinces before reaching the sea. During the reform era (the late 1970s to 1999) the Yellow river was running dry for at least some days of the year before it reached the ocean (Wang 1999). Over the period, the problem became increasingly worse, both in terms of the duration and the area affected by the drying up of the river. The flow interruption left users in Shandong and Henan Provinces without their traditional sources of surface water. Upstream urban growth and newly constructed irrigation projects in Ningxia, Gansu, Shaanxi and Inner Mongolia relied on increasingly larger uptakes to meet the needs of their industrial and agricultural users (even though these withdrawals were frequently beyond the limits imposed on these provinces by the Yellow River Basin Commission). In response, downstream agricultural and industrial users either switched to groundwater or went without it.

But this problem is in no way limited to the Yellow river basin. During a trip to southern Hebei, upstream-downstream conflicts were apparent in almost every area we visited. Two upstream counties in Shijiazhuang Prefecture had monopolized the entire reservoir system's capacity and downstream counties in Cangzhou Prefecture had to rely on groundwater despite a clearly unsustainable rate of extraction and deteriorating water quality. Similarly, in the early 1990s lakes were drying up in Baoding Prefecture. Irrigation-intensive cropping systems were being developed in the counties in the Taihang mountains upstream of Baoding. As a result, Baoding municipality's wells were pumping so much, and recharge was so limited,

that the ground was in danger of slumping and destroying a major part of the city and its infrastructure. One can see that nearly all the rivers one crosses when traveling from Beijing to Shijiazhuang by train or car are dry, even during the rainy season.

Agriculture-Industry Conflicts

Similar problems arise in trying to allocate water between industry and agriculture. Although agriculture is the largest user of water, the MoWR and its sub-provincial agencies give priority to the industrial water sector, which is the fastest growing sector, for use at the margin. as China's leaders clearly see the nation's development path as relying on industrialization and take actions that will help promote that goal. Hence, when there is a decision to be made on whether water should be sent to an industrial facility or kept for agriculture, industry generally wins out. Interviews with officials in almost every province, prefecture and county also reveal that urban residents remain privileged in their claim to water, though in areas of severe shortage they may suffer frequent shortages or water rationing as well.

Giving China's rapidly growing industrial users priority over water supplies has led to declining water supplies to agriculture in many areas. For example, Hong et al. (2001) describe an ID in Hubei (with a command area of about 150,000 hectares) where there has been substantial reallocation of water from agriculture to hydropower generation and industrial and domestic uses over the past several decades, especially during the 1990s. From 1985 to 1990, agriculture received 64 percent of the water from the reservoir, but this share fell to 38 percent from 1993 to 1998. Between these two periods, total water supplies available for agriculture (including from sources other than the reservoir) declined by more than half. This sharp decline in water supplies led to a 30-percent decline in irrigated area, and a nearly commensurate fall in production.

The competition for water between agriculture and industry is acute and this competition is partly to blame for depletion of water resources. In many cities of the North China Plain we visited, prolonged extraction of groundwater for industry had greatly lowered the water table in many urban districts. In some places, the overextraction had become such a serious problem that it allowed for intrusion of contaminated water and was threatening to cause subsidence. Faced with crippling shortages, industrial water managers have attempted to purchase agricultural water supplies but they have not been always successful. Upstream agricultural counties that have built their own reservoirs and canal systems have little incentive to provide water to industrial centers, since their own agricultural activities would be adversely affected. In addition, the current water law technically prohibits the transfer of water rights.

Industry-agricultural conflicts can produce inefficient uses of water. For example, even though several major cities in Henan Province have so little water that some industries have had to be shut down, agricultural officials who control the water from new reservoirs, which could feasibly ship water to several of these cities, have expanded rice production and have plans to develop water-intensive horticultural cultivation. Industries in one city in Hebei Province that we visited in early 2000 had to shut down production in many of their factories and could not nearly operate their power generation plant during the peak irrigation season since agricultural officials drew almost all surface water, regardless of the formal water allocation plan.

The actions of industrial water users can also have serious effects on rural users. One of the most serious problems is the release of polluting effluents into the river systems (World Bank 1997). The Urban Environmental Protection Bureau officials treat only a small fraction of China's municipal sewage and industrial wastewater. And, although the capacity of industrial wastewater treatment has grown tremendously, in most cities industrial effluents are still largely discharged directly into rivers. Pollution in many areas is often so bad that surface water cannot be used for irrigation, or if used, leads to soil contamination (Smil 1993). There are many cases in which releases from factories have harmed a region's aquaculture industry (World Bank 1997). Local officials often ignore legislation and regulations designed to curb such pollution to keep local industries profitable.

Resolving Interregional Conflicts

To manage the conflicts and problems that arise from actions of IDs in upstream provinces, prefectures, and counties, China's officials are showing that they can address the allocation problems. The most common solution is to increase the authority of higher-level administrative units so that the unit of decision making is broad enough to internalize the conflict. More recently, a system of water rights is being considered as a potentially more effective means to solve these conflicts.

The best example of China's ability to resolve interregional conflicts is the recent move by the State Council through the MoWR to increase the authority exercised by the National River Basin Commissions, particularly the Yellow River Basin Commission. In response to the decreased flow to downstream provinces, in 1998, the Yellow River Basin Commission was given more personnel, a higher budget and, along with the other NRBCs, more power to resolve conflicts among the provinces that use the water in the river basin. By 1999, the newly empowered commission restricted the upstream provinces' access to water and increased deliveries to downstream ones. During 2000, despite a major drought, the water in the Yellow river flowed all the way to the ocean for the whole year.

In some cases, upper level jurisdictions have even redrawn boundaries of water districts or taken control of reservoirs to make what they believe is a more rational allocation of water. For example, in Hebei, Shijiazhuang Prefecture had built a reservoir that serviced a number of counties under its jurisdiction. When a downstream prefecture, Cangzhou, began to suffer serious groundwater shortages due to falling water tables, the province took control over the reservoir, lined an irrigation canal that went to the downstream county, and allocated water away from Shijiazhuang to Cangzhou.

Resolving Agriculture-Industry Conflicts

Even more drastic moves are being taken to rationalize the allocation of water between industry and agriculture. Most regions have attempted to deal with emerging problems by defining more clearly the priorities of different users. In a recent trip to five provinces around China taken by two of the authors, provincial and sub-provincial government officials told us industry had priority over agriculture.

When water shortages become serious and chronic, then stronger and more permanent solutions to conflicts are necessary. To resolve problems, with officials from competing ministries working to divert as much of the scarce resource for their constituents as possible, many provinces and municipalities are promoting reforms to merge the functions of different water management units into a single authority. Although such units have different names in different places, most commonly they are called the *shuiwuju* (Water Affairs Bureau [WAB]). At the extreme, the WABs merge the personnel, resources and duties of the local WRB, the Urban Construction Commission (UCC) and the water protection division of the local Environmental Protection Bureau (EPB) into a single unit (MoWR 1999).

Although water pollution and other environmental considerations were the trigger (and not water shortage per se), an example of the establishment of an effective WAB is found in Shenzhen Municipality, one of the first prefectures to create a unified water authority (MoWR 1999). Shenzhen's mayor created the WAB after the municipality's rapid growth during the 1980s and early 1990s. Industrial and urban building expansion created a serious shortage of potable water in the city, shortages that threatened to slow down Shenzhen's economic activity. A series of subsequent floods exacerbated the problems and were, in part, connected to the hasty construction of canal and wastewater treatment plants without coordination with other parts of the water system.

Responding to these events, the local government passed an emergency water law and created the municipality's WAB, which immediately took charge of all construction of water-related projects, including clean drinking water plants, wastewater and sewage treatment plants, dikes for flood control and other infrastructural projects. The bureau also took responsibility for creating *and* executing all of Shenzhen's water-related activities including those for industrial supply, wastewater cleanup and agricultural use.[11] Deliveries to agriculture, industry and urban residents were all under the control of a single entity. By all accounts, shortly after the creation of the bureau, Shenzhen's water supply and flood prevention improved dramatically.

Since the success of the establishment of the WAB in Shenzhen, the MoWR has encouraged the plan throughout China (MoWR 1999). Through mid-1999, 160 counties had established WABs, although the extent of the authority and success that have been realized vary. For example, Hebei Province decided to unify the WRB and the Urban Construction Commission in 2000. The deputy provincial governor, who described his work that had created the province-wide WAB, told us that the reform was proceeding smoothly. The hope was that by controlling all water resources from a single agency, the transfer of water from agriculture to industry would be quicker, more rational and accomplished with less conflict. However, it is unclear how well this reform will work in practice. Officials affiliated with the divisions created from the former WRB were afraid that the new unit would take too much water from agriculture, while those from the former UCB believed the new system was promoted to remove water revenues from their control. These types of conflicts may prevent the development of well-functioning WABs. City officials in Zhengzhou, Henan

[11]Urban jurisdictions in China usually include surrounding agricultural land.

Province, introduced reforms based on the Shenzhen model in 1994, just after the successful adoption of this system in Shenzhen but, on a recent trip, officials conveyed that the reform had yet to be completed due to numerous unresolved bureaucratic issues.

While unifying urban and rural water management is difficult, the benefits of the system can be striking. In Baoding Prefecture, where such a reform had already occurred in 1997, the WAB had built a 30-kilometer 1. 5-m pipeline from a former WRB reservoir to the UCC's clean water plant. In this case, the reform created a win-win situation. The city got the much needed, high quality water. The ID, that was having trouble using all of its water for agriculture due to a decaying delivery system, was happy to have the new investment and a new cash-paying customer. Farmers, who sometimes had been implored into taking water deliveries from the ID, focused their attention on groundwater sources, which in this particular area were relatively abundant.

Broadening the authority of a single regional water authority also has helped address certain environmental problems. For years, many ID officials were unwilling to draw down their reservoirs in certain seasons, preferring to keep them full until the rains were assured. Similar actions by all IDs and increased industrial waste ended up affecting the ecological balance of Hebei's largest lake, Baiyang Dian. In the early 1990s, the lake was severely polluted, unable to support either large-scale aquaculture or tourism. Counties below the lake were also reluctant to use irrigation water during certain seasons because of high concentration of toxic chemicals. In response, the provincial WRB took administrative control of the lake and intervened in the water allocation plans of three prefectures that affected or were affected by the lake. A new canal was constructed leading from one of the large reservoirs, which actually had seen its command area shrink over the years (because, according to farmers, it was inefficiently operated). With access to new flows of water, the province greatly improved the quality of the lake and the fishing and tourism industries rebounded. Provincial officials claim that although only a small part of the newly raised revenues from the lake were used to pay for the additional water flows, the ID was revitalized by the payments.

Options for Further Reform

While reforms that unify water management authority have helped allocate water more rationally among users, the formal extension of water rights may provide for even more effective water allocation. Presently, the transfer of water licenses or water use rights is prohibited in China. But with the rising water shortage and the need to allocate water more rationally, the MoWR is considering modifications to the law that will permit water right transfers under certain conditions. Following through with reforms that establish more secure rights, and making these rights tradable, will further increase the flexibility and rationality of water allocation in China.

Farmers' Incentives to Reduce Water Consumption

Despite the improving water management environment in China, the fact remains that in many parts of northern China groundwater sources are being depleted and current water use levels are not sustainable with the current water supply system. As already noted in this paper, agricultural users will not be given priority to any additional sources of water that become available. Indeed, while it is the stated goal of China's leaders to increase irrigated area, they also explicitly acknowledge that this expansion will occur without any additional water allocations to agricultural users. Thus, using water more efficiently is the only method to increase irrigated area and effectiveness without increasing total agricultural water demand in North China.

Even with what seems to be an impending water crisis, farmers have hardly begun to adopt water-saving technologies or practices. The reasons for this are found in the nature of the incentives faced by China's farming community (and those in other sectors). Until the 1970s, water was considered abundant in most parts of China and was not even priced for agricultural users so there was no incentive for users to save water. [12] Collectives had de facto rights over the water in their communities: water underground, in nearby lakes, rivers or in canals. Facing low or free water prices, farmers naturally used as much water as they wanted. Even today, most farmers "save" water only when their deliveries are curtailed.

Water-Price Incentives

Shortly after the agricultural reforms that began in 1978, the central government sanctioned a system of volumetric pricing of surface water. This system did not begin all at once in all locations but instead was allowed to diffuse gradually as experience was gathered. Hence, the current structure of prices exhibits substantial variation across the country, and takes into account both scarcity and the ability to pay. Typically, for a specific end use (agriculture, industry or domestic) in a specific province, prices are uniform, although there is flexibility for local exceptions. In terms of ability to pay, agricultural users pay lower prices than domestic users who, in turn, pay less than industrial users. For example, in Hubei Province, the price for agricultural users is 0. 04 *yuan* per cubic meter, while domestic and industrial users pay 0. 08 and 0. 12 *yuan* per cubic meter, respectively. In terms of scarcity, different prices prevail in different provinces, with prices increasing substantially as water scarcity becomes severer (generally, as one moves from south to north). For example, in the late 1990s agricultural surface water was priced at around 0. 01 *yuan* per cubic meter in the southern province of Guangdong, 0. 04 *yuan* per cubic meter in the central provinces of Hubei and Henan, and 0. 075 to 0. 10 *yuan* per cubic meter in the northern province of Hebei, where water shortages are most acute.

Since the onset of price reform for agricultural water, officials have raised water prices in many areas a number of times, although the rise in the *real* price for water has not increased

[12]Farmers generally had to volunteer labor, however, to construct and maintain water storage and delivery infrastructure during this period.

much, if at all. For example, in one county in Hebei Province, the nominal price of surface water for agriculture was 0. 02 *yuan* in 1985, 0. 045 *yuan* in 1990, and 0. 10 yuan in 1997. Taking into account the effects of inflation by dividing by the rural consumer price index shows that, in real terms, the price of water was almost exactly the same in 1997 (0. 023) as it was in 1985 (0. 02). In almost every place that the authors visited over the past few years, real prices for agricultural surface water have largely remained constant over time.

The Water-Price Debate

Currently, China's leaders are embarking on water price reforms to better match water prices with the benefits of using the water, but this focuses on the domestic and industrial users; whether water prices will be raised for agricultural users is hotly debated. There is widespread agreement that water prices are too low in China, and well below the marginal benefit of water in all sectors including agriculture. Water prices will certainly increase for domestic and industrial users, but may not for agricultural users. Many policy makers believe that raising water prices to agricultural users is the only effective way to get farmers to implement sound water-saving measures. While in theory this may be true, in practice this will be difficult due to the logistical problems involved in volumetric pricing at the farm level. Others claim that raising water prices to farmers will only further burden poor farmers facing low grain prices and, in many cases, high local taxes. This extra burden would directly counter another important policy goal in China: raising rural incomes and reversing a rising rural-urban income gap. The fact that water costs already comprise a major share of farmers' total costs and cash outlays serves to support the argument that substantially higher water prices will adversely affect farm incomes.

Even if the government is committed to raising prices and charging for water on a per unit basis to encourage water savings, the fragmented and small-scale nature of China's farms poses a significant problem. It is common to measure water for volumetric pricing at the point of entry to an irrigation group and the size of these groups varies substantially. Some groups are as small as 30 households (such as in the Zheng He ID in Hubei Province) but others are as large as the whole township (such as at the People's Victory Irrigation Canal in Henan Province). Water fees charged to individual households are usually a prorated amount, based on the size of the household's irrigated land endowment and of the total fee paid at the point of delivery (plus additional costs to cover the collection effort of the water officers and other water managers).[13]

Under this pricing system for surface water, farmers have little incentive to reduce their water use since they will be charged for it anyway. Indeed, there is an incentive to use more than one's share of the water, the classic free-rider problem, especially in large irrigation groups that are more difficult to monitor. Upstream users have more opportunities to "free-

[13]There is some true volumetric pricing for individual farmers but this is relatively rare in surface systems and is restricted to farmers near the head of main canals who have intake pipes directly from the main canal into their fields (groundwater deliveries, however, are often priced volumetrically).

ride," using more water than they pay for, to the detriment of downstream users. When this happens, downstream users who pay the same water fee per hectare as upstream users actually pay more per unit of water because their deliveries fall as the upstream farmers extract more than their share. Interviews generated repeated stories of how upstream users, after opening channels to deliver water to their fields, have no incentive to close them. In extreme cases, users at the end of the lateral canals do not get any water and refuse to pay water fees.

Not only is most surface water priced in a way that does not take volume into account, but price collection practices are such that most farmers in China currently do not know exactly how much or when they are paying for water. Many IDs use a system that in essence bills the village for the amount of water it provides to the village. This fee is often transferred to the ID through the administrative bureaucracy (e.g., the township and/or the county). In turn, the village accountant undertakes separate transactions with the ID (making payment for the water) and the farmers (collecting fees). Since the accountant must also settle accounts with farmers on a number of other transactions, including local taxes, education fees and collectively provided services (such as running water and plowing or spraying), water fees are frequently lumped together in a single bill for all services and taxes. The clearing of accounts is often done only once or twice a year, and so, in many cases, the water that a farmer pays for had actually been applied as much as 9 to 10 months earlier. In a recent survey of more than 1,200 farmers across China by one of the authors, less than 20 percent of them could tell enumerators the prices they paid for water, either per *mu* or per cubic meter.

In the absence of transaction costs, a system of volumetric pricing for individual farms would be preferable to the current system. The high transaction costs of measuring water intake at hundreds of millions of small parcels throughout China and collecting fees on a farm by farm basis, however, would likely not be the most cost-effective solution. Moreover, joint accounting practices instituted to minimize the transaction costs involved in fee collection have further divorced the farmer's production decisions from the value and amount of water that they apply. Research to understand how large these problems are, and what the optimal group size might be, is important for water prices to effectively encourage water saving at the farm level.

Although farmers do not always know the exact fees they pay for water, in cases that we have observed in which water prices are high and water shortages serious, farmers do have a qualitative understanding that the more water their irrigation group uses, the higher their fees will be. In some areas water fees are clearly not trivial for farmers. For example, a survey of farmers conducted in two villages in Hubei Province demonstrates that irrigation fees (for surface water and groundwater, including pumping costs) account for about 10 percent of the farmers *total* production costs and 18 percent of *cash outlays*. While these costs are significant, pricing policies are such that, often, farmers cannot reduce these costs by reducing water use and, therefore, they have no direct incentive to save water.

The cost of water to farmers, while substantial, may not be high enough for price policy to induce significant water saving. Indeed, even if water costs account for 10 percent of production costs, as reported above, if irrigation increases yields by 30–50 percent or allows for cultivation of high-valued cash crops, then these costs may be the best investment a farmer makes. Farmers may be willing to spend even more to maintain the same water deliveries. Some scholars argue that water costs are so low, due to years of using water as a subsidy to

agriculture and that the price is very inelastic so increasing water prices will generate more revenues for water managers but will not generate much water savings.

Given that pricing policy does not currently provide a direct incentive to save water and this will not likely change in the near future, another approach to reduce water use in agriculture could be outright restrictions on water deliveries. When water deliveries to agriculture are cut, farmers do tend to use the remaining water more efficiently. For example, in the ID described by Hong et al. (2001) where agricultural water supplies fell by more than half between the years 1985 and 1990 water use declined much more than did irrigated area or production, thus water productivity increased. The rise in productivity is probably due to improved water management at both farm and system levels. It is important to note that these improvements were not nearly enough to stem the fall in production, but this is an example of a significant fall in deliveries in only 5 years. Over time, and with better management of agricultural water use, agricultural production could be potentially maintained. Cuts in agricultural water deliveries would have to be carefully coordinated with improvements in water use efficiency to minimize the potential adverse impacts on farm incomes.

Promotion of WSI Technology

In addition to providing farmers with an incentive to save water or use water more effectively, policy makers could also provide farmers with irrigation technology alternatives and education on water-saving practices. This component of the larger policy effort to reduce agricultural water use is being pursued in China but hurdles remain. Even when farmers face a strong incentive to save water, they may be unaware of their options for doing so. In addition, several of the options made available to farmers, such as drip or sprinkler irrigation, are expensive and may not be suitable to cultivation of some grains.

The extension system for encouraging the adoption of WSI technology also does not effectively reach many farmers for a variety of reasons. Just as it is difficult to devise a method for pricing water by volume, the millions of farm households with small landholdings in China also make it difficult to design an effective extension system. The primary means to promote WSI technology adoption is to set up model villages with WSI technology and have farmers come to see how the technology works and how effectively it reduces water use or increases yields (Diao 1999). These demonstration projects are usually funded by grants, at least part of which comes from central and regional governments, but are also often heavily subsidized by the village itself, rather than the farm households. During a field trip in June 2000 by four of us, we saw an example of how the central government promotes the adoption of WSI technology, in this case, a package of subsidies for investment into sprinkler technology. The central, provincial and county governments each contributed 30 *yuan* per *mu* (a total of 90 *yuan* per *mu*) to help defray the investment in sprinklers of 200 *yuan* per *mu* (meaning the producer had to invest 110 per mu). But the county's water bureau could not find individual farmers willing to make such an investment. Instead, they found some villages willing to collectively invest in the sprinklers for the entire village, and manage the entire purchase and installation of the sprinkler system.

While effective in getting technology into the field, there are several problems with this approach for promoting widespread adoption. One problem is that there is little village-to-village interaction, and the mechanisms for getting farmers or village leaders from other areas to visit the village and see the technology demonstrated are not clear. Another problem is that the villages that adopt are often so unusual (e.g., the village we visited had more than 3 million *yuan* per year in total village revenues) that there is little basis for assessing the potential of the technology for further adoption (Diao 1999). Moreover, the extension system has little connection with the needs of farmers; instead it tends to develop and promote technologies that are instigated at research institutes, rather than responding to the concerns of farmers who will actually use them. Perhaps because of this disconnect, extension services tend to promote WSI technologies rather than teaching farmers and village leaders water saving practices, such as careful timing of water application and monitoring soil moisture, that require little or no investment at all.

While farmers have yet to adopt many water savings practices in China, there are some exceptions. One of the most obvious strategies to save water, or increase the value of water in agriculture, to anyone who has visited China's countryside over the last several years, is the widespread establishment of greenhouse production. Greenhouses are established primarily to grow vegetables in the winter when the price is as much as ten times the summer price. But greenhouses are efficient water users and effectively raise the value of water delivered to agriculture. The greenhouses are covered with plastic to prevent evaporation and other WSI technologies are usually used in them, such as drip irrigation or micro-sprinkler systems. While national statistics do not cover the rise of hothouse agriculture, it is clear from the personal observations of the authors that greenhouses have become a common feature in the Chinese countryside, particularly over the last few years.

Other WSI technologies and practices are also becoming common in rural China. Farmers have increased the use of furrows for field crops and vegetables. Furrows not only allow for more uniform water delivery in the field but also deliver water closer to the crop's root system, increasing the amount of plant water intake per unit delivered. Plastic sheeting to cover crops after watering is much more commonly practiced than it was 10 years ago. Plastic sheeting not only prevents evaporation but also raises soil temperature, which can promote plant development at early growth stages. In some rice-growing regions, alternating wet and dry farming has been adopted in many regions. Alternating wet and dry agriculture is an example of a WSI practice that is based on timing and takes little capital investment other than teaching the farmers how to carry out the technique.

Reform of ID Management

The timing and reliability of surface water deliveries greatly affects agricultural production. Often untimely deliveries or the risk of no delivery is due to deteriorating surface water infrastructure, or the poor incentives facing water managers outlined in the section under "Increasing Investment and Reversing Infrastructure Deterioration. " But these problems are exacerbated when there is poor communication between ID managers and farmers. Water that is delivered at times when the crop does not particularly need it is more or less wasted,

while well- timed water can greatly increase agricultural production and has a much higher value in agriculture.

To improve water delivery services, fee collection services and communication with farmers, many IDs have developed more flexible and responsive ways to deliver water. Although the institutional response varies from village to village, we observed many examples of how ID managers have begun to try to win back the confidence of farmers and more effectively deliver surface water. In one Henan village, the ID hired teams of three people to be the liaison between the ID and the farmers. Called an "irrigation" association, they serve to provide better information to the ID, so that deliveries can be more timely and farmers do not switch to groundwater. In these villages, it is interesting to see how the increasing use of groundwater has led to competition in the delivery of the village's water, forcing the surface system to improve its water delivery services.

The Role of WUAs and WSCs

Several IDs have also established Water User Associations (WUAs) and Water Supply Corporations (WSCs) to provide more effective delivery services of surface water. WUAs are groups of farmers, with the same legal status given to individuals, organized to manage local water delivery in a unified way and to collect water fees. The WSCs are legal corporations, generally associated with a main canal in a large ID, that buy water from the ID volumetrically and sell it volumetrically to local WUAs. If the WUAs that are formed are smaller than existing irrigation groups and provide better incentives for the group to manage water efficiently, then free-rider problems are likely to decrease as farmer participation increases. If this happens, then volumetric pricing, even at the village level, will be more effective and irrigation infrastructure is more likely to be maintained. The system of WUAs and WSCs also circumvents the previous system of water-fee payments that went through the village-township-county bureaucracy before being delivered to the ID and subsequently reduces the amount taken out at the various bureaucratic levels. Thus, farmers in WUAs pay less and the IDs receive more money for water deliveries.

An example of a successful WUA is the Hong Miao WUA in Hubei Province organized in 1995 as a response to poor irrigation service and frequent conflicts between upstream and downstream users. Predictably, the downstream users were sometimes unable to irrigate their crop. Since the formation of the WUA, however, conflicts have lessened, irrigation services have improved and irrigated area has increased from 200 to 325 hectares. Because of better coordination among the water users, the entire area can now be irrigated in 4 days (compared to 2 weeks earlier), thus reducing uncertainty to farmers regarding the timeliness of water deliveries.

Irrigation groups and WUAs can also facilitate the promotion of WSI technology and practices. Nearly all the ID management reforms being tried in rural China separate water fees from other local fees so that farmer associations are more aware of their water costs than under the system where water fees are collected along with other village fees and taxes. The gains from saving water, therefore, are more easily seen. Moreover, the groups and WUAs can assure that the gains from aggregate savings are passed on to member farmers. Meetings

of user groups can also be used to introduce WSI technology or teach WSI practices, such as measuring soil moisture and irrigation timing techniques.

Options for Further Reform

There are several ways that China could provide more rational incentives for farmers to save water in China that will not adversely affect rural incomes. One option is to give farmers saleable rights to the water. Under these circumstances, farmers can establish ways to use less water, then sell the surplus water to nonagricultural users to earn money. The money could then be used to establish more sophisticated water delivery systems that increase the value of water in agriculture. Increasing the supply to nonagricultural users would bring the value of water down in the nonagricultural sectors and the smaller water supplies to agriculture would bring the value of water up. This could be a win-win scenario, an overall economic gain where the losing side (the farmers because of decreased production) could access some of the gains to industry because they sell the water that allows for increased industrial production. Both sides would be better off.

Another way to promote water conservation in agriculture while protecting farm incomes is to raise water prices and find other ways, rather than low-cost water, to subsidize farmers. Since water is delivered to farmers well below its value in other sectors and often below the costs of delivery, the system represents an indirect subsidy to agriculture via water. Therefore, a system where farmers receive direct subsidies and then are charged a high water price, would generate incentives to save water without hurting farm incomes. Exactly how to implement such a system without running afoul of WTO rules or inviting corruption by local officials, however, may prove difficult. One method may be to incorporate such changes into larger fiscal and tax changes being considered to lower taxes levied on farmers.

Effects of Water Scarcity on Agricultural Production

Water is a critical factor to agricultural production in China and without the easily exploitable water resources in the North China Plain and the expansion of irrigated agriculture in that region, China could not come near to meeting its grain self-sufficiency goals.[14] The changes China's leaders, water managers and farmers need to make to maintain sufficient water resources for agriculture and increase the efficiency of water use in the sector will change the way water is allocated to agriculture in many ways. To successfully adapt to limited water resources for agricultural production, not only will water prices have to increase but water will have to be delivered to farmers in a more reliable and timely manner. This will greatly enhance the value of water to agricultural users, but in return agricultural users will likely have to either pay more for the water or accept cutbacks in their overall water allocations.

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[14]China's leadership is committed to maintaining 95 percent grain self-sufficiency. Among the three major grain crops, rice, wheat and corn, only wheat has fallen under this percentage (in the mid-1990s), and wheat production, more than any other crop, depends on irrigated agriculture in the North China Plain.

Adapting to higher priced water or smaller allocations of water (or both), farmers will likely shift production patterns. One of the most likely shifts in production that higher water prices and smaller deliveries might encourage is in North China's wheat-corn rotation, the most common in the region (Huang and Rozelle 1998). Currently, farmers first plant winter wheat, which is planted in November and harvested in June, and second plant corn, which is planted in June and harvested in September or October. During the corn-growing season, rainfall is sufficient and irrigation is usually unnecessary. During the winter wheat season, however, rainfall is scarce and the crop relies heavily on irrigation from surface water and groundwater systems. Thus, if water prices increase or deliveries are reduced, farmers will likely move out of irrigated wheat production, which will decrease yields substantially. If projections that show the price of wheat falling more than corn due to trade liberalization are true, then many farmers may go out of a wheat-corn rotation to focus on a full season corn crop.

As China's farmers move out of irrigated wheat production, the production of other crops will likely increase, but predicting which crops will increase in production as water becomes more expensive and limited is difficult because it depends on many factors. First of all, farmers may choose to maintain the wheat-sown area but forgo irrigation. This would result in a lower wheat crop but not much change in other crops. Alternatively, farmers may switch into other crops. Economically, one might think that farmers will switch into water-saving crops, such as millet, as water becomes scarcer, and this has happened in the past.[15] On the aggregate level, however, these changes will be limited by the demand for such alternative crops. Farmers could also abandon wheat production and concentrate on a single crop of corn, which with the longer growing season could show significantly higher yields.

But if farmers learn to use water better and can take full advantage of increased timeliness and reliability of water deliveries, then water can become much more productive in agriculture and the price of water is less of a concern. There are a variety of practices and technologies that could be used to save water in wheat production, but since wheat is so land-intensive, it is not particularly suitable to many of the most effective WSI technologies, such as drip irrigation, micro-sprinkler technology or hothouse production. Other crops, such as the fruits and vegetables being grown in the hothouses that are increasingly common in China's countryside, are better suited to take advantage of modern WSI technologies. These crops also tend to be labor- rather than land-intensive and, therefore, better match China's comparative advantage, so farmers will increasingly turn to these crops anyway as China opens its agricultural sector to international competition.

It is somewhat counterintuitive to think that water scarcity will ultimately encourage the production of relatively water-intensive crops such as fruits and vegetables, but there are a variety of forces at play in this decision and a number of preconditions must be met

[15]On a trip in June 2000, we visited a village where the wells had dried up and irrigation was lost in the early 1990s. Some farmers in this village switched to millet and sweet potatoes rather than wheat due to the loss of irrigation water. Ultimately, a consortium of private investors and the village collective invested in a water supply company that sank a powerful pump 165 m down to supply water for irrigation, and wheat production was restored.

for this to happen. The first is that the water delivery system gets the investment and institutional reform necessary to ensure timely and reliable deliveries of water to agricultural users. If a high level of uncertainty remains in the water delivery system, farmers will not invest in the WSI technologies necessary to produce high-valued crops. Econometric evidence supports the idea that reliability of water delivery encourages cultivation of high-valued crops in China (Xiang and Huang, 2000). The second is that China's grain self-sufficiency policy is relaxed in some way and that farmers are not under pressure to deliver a fixed grain quota to the state. Under the present system, an important part of local leaders' evaluation is the continued high level of grain production, and this may cause local leaders to resist movements away from grain into high- valued crops. The third is that farmers have access to inexpensive and appropriate WSI technology. Last is that prices must be such that high-valued crops are truly more profitable. It is assumed, because of their labor-intensive nature, that increasing exposure to international markets will cause the relative prices of grain over high-valued crops to change so that high-valued crops are clearly more profitable than grains.

Conclusion

China's successful development of water resources to fuel increases in agricultural and industrial production is now starting to show signs of serious stress on water resources in important agricultural areas. It is fair to say that present irrigation practices are not sustainable. What is less clear is whether China can adapt to a world where water is relatively scarce and still maintain high levels of agricultural production and increase industrial production. To do so, China will have to reform its water management system at all levels, from the policies put forth by upper-level water managers in Beijing, down to the technologies and water-saving strategies used by the smallest farmers in the countryside.

In many respects, solutions to the problems outlined in each of the above four sections will not work unless progress is made in the other two areas as well. For example, increased infrastructure investment and resolution of conflicts will generate better incentives for saving water at the farm level. When water deliveries are more certain, farmers are more likely to invest in WSI technology (Caswell 1991). Alternatively, if progress is not made at the farm level, then water will still be wasted regardless of whether the infrastructure is well maintained or conflicts among users are resolved.

China has a wide variety of mechanisms that are being, or could be, established to save water in agriculture, all of which will either require, or will be made more effective through, investment. Improving the storage and delivery capacity of irrigation systems will allow for better surface water management that will, in turn, reduce the dependency on groundwater, provide incentives for WSI technology adoption and reduce the true cost of water to users at the end of the canal system. Investment at the national level will be the most important part of this effort, but it must be matched by investment at the local level as well.

Thus far, increasing investment is perhaps the most successful component of China's effort to bring about more rational water allocation policies in agriculture. Since the early 1990s, national leaders have committed to increasing investment in water management infrastructure. This commitment will increase in the first decade of the twenty-first century as well. Local-level governments are also finding ways to increase investment into water

delivery infrastructure, though perhaps not as much as the national government. In addition, new investment into water management infrastructure puts more emphasis on maintenance rather than on building new projects.

But investment in physical infrastructure may be ineffective without changing the institutions that, while having served a productive purpose in the past, are now becoming part of the problem as water becomes scarcer and conflicts arise. A primary benefit of infrastructure investment is not that the newer systems "save" water, since much of the conveyance losses under the older systems return to the water table, but that water can be delivered much more economically and efficiently, greatly increasing the value of water in agriculture. But this benefit could be lost if parties mismanage or compete over water resources in ways that increase the uncertainty over future water deliveries. Thus, establishing an institutional and policy framework that reduces conflicts and brings a more rational management of water resources will be an important part of the overall effort to avert more serious water shortage in North China.

China has embarked on a series of institutional reforms intended to address the problem of conflicts between users, but most of these reforms are new, experimental, difficult to actually implement and, therefore, still have a long way to go before offering solutions to China's water problems. Since many of these reforms involve taking away authority over water deliveries, or more importantly, water fee collection, from some part of the traditional bureaucracy, they are generally resisted and are only imposed with a great deal of political effort from higher levels. But because of the severity of China's water problems in some areas, institutional and policy reform to internalize conflicts, or increase communication between users and suppliers, have taken hold in many regions, with varying degrees of success. China could be stronger, however, in promoting the importance of strong unified water authority in local areas and promoting the development of WUAs and WSCs in the countryside.

Ultimately, both increased investment and institutional reform must conspire to create an environment whereby farmers benefit from adopting WSI practices. Creating timely and reliable water delivery systems will facilitate the adoption of WSI practices, but it will not be enough. Farmers must know that they will pay less if they reduce their water demand. This implies a system by which farmers are charged for water volumetrically, or nearly volumetrically. Alternatively, farmers' water allocations could be cut, so that they have little choice but to learn to use effectively the water that is allocated to them. This will avoid the adverse effects that raising water prices will have on farm incomes. If deliveries are cut, however, farmers will likely want to purchase WSI technology, and this will be expensive. Well-functioning extension services to encourage, and in some cases perhaps subsidize, the adoption of WSI technology and practices will therefore be an important part of the policy regime to encourage WSI in agriculture.

Because of the millions of dispersed farm households cultivating small plots in China, implementing effective policies to encourage water saving at the farm level is perhaps the most difficult component of the whole policy effort to increase water saving in agriculture. The cost of pricing and extension policies that interact with individual farmers in China are likely to be too high to make them workable in reality. Instead, pricing and extension services will have to focus on the village level, or with groups of farmers at best. Without the direct interaction with water users in agriculture, second best solutions can still be achieved with

effective allocation and extension policies that interact as closely with individual producers as is economically feasible.

Most important to note is that there is room for improvement in all aspects of water policy in China and that it has made a clear effort to aggressively address water shortages and develop ways to maintain, indeed increase, irrigated area without increasing the water allocated to agriculture. It will take time, however, for the policy and institutional changes to spread, develop and actually result in increased water use efficiency in agriculture in a significant way. But China has begun in the right direction and, given a history of resolving crises in the past, it is reasonable to believe that the barriers to further reform will fall as the water crises becomes more acute. If this happens, then there is a good chance that the current water crises in China will pass.

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Participatory Irrigation Management in Andhra Pradesh, India[1]

K. V. Raju[2]

Summary

The State of Andhra Pradesh has been leading in economic reforms in India, particularly within the irrigation sector. Major steps are focused on institutional reforms towards irrigation management turnover all over the state. In this connection, the state has formed 10,292 water user associations (WUAs) and 174 distributary committees. As a major positive change, the state government has done away with contractors for all maintenance and repair works. All irrigation lands in the major and medium irrigation projects in the state receive equal financial and physical attention for their improvement. Both farmers and officials have realized benefits in the process. With some modifications in the present approach, the state can become a model state both within and outside the country. This paper looks at the promises made, the actual practice and future potential of the whole approach.

Introduction

The last 5 years have seen the State of Andhra Pradesh make rapid strides in its economic reforms. The irrigation sector has been positively influenced by institutional reforms largely focusing on a) the introduction of a suitable policy and legal framework, b) the formation of WUAs across all types of irrigation systems in the state, c) implementation of large-scale training programs for farmers and staff of the irrigation department, and d) bringing in significant financial reforms to influence quality performance of users' organizations. Today, this state is leading in its irrigation reforms in India. This paper, based on field visits, looks at what has made the Andhra Pradesh experiment work by examining a) the promise made through i) the Andhra Pradesh Farmer-Managed Irrigation Systems Act, 1997 (APFMIS Act); ii) document on "Vision 2000: Swarna (Golden) Andhra Pradesh," and iii) Government Orders issued over time to encourage the formation and functioning of WUAs; b) the practice, and c) key lessons.

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[1]This paper is based on a short study, commissioned by the Indian Network for Participatory Irrigation Management. The study was prepared with the cooperation of Raymond Peters, Commissioner, CAD and the Ex-Officio Secretary, Irrigation and Command Area Development Department, currently Executive Director of INPIM, The World Bank, and Irrigation Department staff across the State of Andhra Pradesh and the farmers. The author is grateful to all of them for willingly sharing their experiences and actively participating in discussions. He is also thankful to Douglas L. Vermillion for useful comments on the earlier version of this paper.

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The Promise

Background

Irrigated agriculture in Andhra Pradesh. Andhra Pradesh with a population of 72.7 millions (2001 Census) and a geographical area of 27.68 million hectares, is the fifth largest state in the country. About 73 percent of the population live in rural areas. The labor force constitutes about 45 percent of the total population and about 65 percent of laborers are engaged in agriculture. Of the state's geographical area, 47 percent is under cultivation and the net area sown is about 11.04 million hectares (4.88 million ha irrigated). The dominant pattern of landownership in Andhra Pradesh is small private farms with an average of 1.56 ha per holding. Irrigated holdings have an average size of 0.88 ha.

The state's three major rivers, Godavari, Krishna and Pennar drain 70 percent of the state's land area (see annex table A-1). The water potential of Andhra Pradesh is estimated to be 7.78 million hectare-meters (ha-m) or 2,746 thousand million cubic feet (TMC). The major rivers are seasonal with more than 90 percent of the total flows occurring between June and December depending on the rainfall, which greatly varies from year to year. The ultimate irrigation potential from all sources is estimated to be 9.50 m ha (million hectares). It includes 7.30 m ha from surface water and 2.20 m ha from groundwater. The performance of the irrigation sector in the state is poor, particularly in the case of major and medium irrigation projects. Inadequate budget allocations for the O&M of irrigation systems have led, over the years, to poor maintenance and unsatisfactory service. This has resulted in poor irrigation service, low yields, and low farm incomes, leading to farmer dissatisfaction and political pressures affecting the allocations for O&M in the state irrigation budget. This vicious circle is observed in most of the Indian states (Gulati et al. 1999).

The Irrigation and Command Area Development (I&CAD) Department provides water and services to a) the farmers for irrigation purposes, b) the municipalities and villages for human and domestic uses, c) the state electricity board for power generation, and d) the industries. Water charges for irrigation, levied on a per ha basis, were increased by more than three times from 1997 (see Finance section, p. 142). Current O&M budget allocations for the various irrigation schemes are made on the basis of a uniform flat rate of Rs100/ha, and about Rs47/ha for special repairs. These values are about 50 percent of the tenth Finance Commission recommendation and about 30 percent of the actual needs of about Rs 500/ha assessed for the purpose of the irrigation component of the AP Economic Restructuring Project (APERP). Therefore, in effect, the current O&M budget allocations neither cover the full O&M cost nor the full establishment cost estimated at about Rs200/ha. As a result, no funds are available for the requirements of the actual O&M works. The deficits in establishment financing are covered to a small extent under special repairs by budget allocations for planned works and O&M works.

Minor irrigation tanks. The state has 12,294 tanks under the irrigation and CAD department covering 1.25 m ha in 27,379 villages. The overall performance of most minor irrigation tanks is more sensitive to droughts and cyclones due to their small size. Their deficient maintenance under the irrigation and CAD department has resulted in losses and decline of irrigated areas. Till May1999, tank-WUAs (8,180) constituted 81 percent of the total WUAs in the state. In

the Rayalaseema region, some 23 tank-WUAs have not used tank water for irrigation, yet they are listed; farmers use their own well water, which is recharged from tank storage. For example, in Chandurti mandal (a smaller revenue zone below the district/province) some 20 km from Sircilla, a few tanks have closed (6–7 years back) their canals to recharge wells during two crop seasons. These WUAs just maintain tanks and not the distribution network.

Percolation tanks. In the Chittoor division area, some 80 percent of the 60 tanks has been converted into percolation tanks over the last 10–15 years, due to fast depletion of groundwater table and siltation of the tank bed. Gradually, farmers have shifted to groundwater usage from the earlier practice of tank irrigation. During the last 8–10 years, tank sluices have been completely closed to influence continuous recharge of groundwater. Farmers argued that direct tank water usage would empty the storage within 1 to 3 months, whereas groundwater usage would help irrigate up to 10 months. This is also because most of these tank command areas are under sugarcane crops.

The major problem with most of these more-than-a-century-old Zamindari tanks, is siltation of the tank bed and thereby, a loss of more than half of their storage capacity. The ID staff strongly feels that desiltation is very costly and it is better to opt for construction of new tanks. The percolation tanks are located in the northwestern part of the Chittoor revenue division, and are spread over 2–3 mandals. But towards the extreme south, east and northeastern part of the district, tanks are still sluice- and canal-operated surface irrigation systems. Many farmers of the command areas of these percolation tanks are debating whether to pay the water fee or not, owing to complete dependency on groundwater.

Policy Framework

The state irrigation policy has kept user involvement in irrigation management as the central theme and all concerted actions revolve around this. The need for reform became essential owing to the following:

- The low performance of the irrigation sector, despite massive investments on the latter. Traditionally, the sector (irrigation and drainage) has been the largest user of the planned funds; and even in the Eighth Plan (1992/93 to 1996/97), expenditure has amounted to Rs 25,000 million, or 24 percent of the planned expenditure.

- Infrastructure is in disrepair and irrigated area is declining. From 1991/92 to 1993/94, the gross irrigated area dropped from 4.3 m ha to 3.9 m ha. Currently (in 1998), out of 4.8 m ha of net irrigated area created only 2.8 m ha are actually irrigated.

- Low agricultural productivity. Growth in productivity has declined in recent years to less than 2 percent per annum. A major factor has been the weak performance of irrigated agriculture. On average, rice yields are only 2.6 t/ha (see annex table A-3).

- Cumulative impact of inadequate maintenance of infrastructure. For instance, expenditure on O&M in 1995/96 was only Rs 99/ha, as against the recommendations of the Tenth Finance Commission (1997) of Rs 300/ha for major and medium irrigation projects. Further, because of inflation of wage bills, over 75 percent of

O&M expenditure went to wages, leaving a negligible amount for actual maintenance works. Low maintenance has been compounded by a purely government approach to the sector despite the limited capacity for the government to intervene, especially at the lower levels of the systems, and by an extremely low cost recovery. With the threefold increase in water charges made effective from the 1996/97 rabi season, for the first time in many years, revenues exceeded O&M expenditure. As O&M expenditure has remained far too low, revenues remains inadequate to cover their entire needs. Further, to make up for the cumulative neglect, significant additional expenditure is required to rehabilitate the system.

- Rehabilitating and sustaining irrigation and enhancing agricultural productivity are of paramount importance. About 40 percent of the state's gross cropped area is irrigated. Irrigation's contribution to state agricultural production is about 60 percent.

Policy Initiatives

New initiatives in policy reform began with a diagnosis of the situation and subsequent issuance of a white paper on irrigation, outlining the performance of the irrigation sector over the years. This was debated in the legislative assembly and the following major actions were taken:

- Threefold increase in water charges from the 1996/97 rabi season.
- Passing of the APFMIS Act in 1997.
- Creation of WUAs across the state.
- Commencement of a massive campaign to make WUAs functional.
- Constitution of the water charges review committee in December 1997.

Policy Objectives and Strategy

It is from Mexico and Turkey that the idea of forming WUAs had been borrowed to a large extent. Both countries are international "success stories" in irrigation reform. The major increase in water charges, traditionally a politically sensitive aspect, required extensive public consultation and agreement by all parties. These steps are nevertheless acknowledged as only a start of the difficult actions that must follow. These must be seen in the broader context of Andhra Pradesh's long-term vision for the water resources sector within which irrigation, though important, is only one component. The core elements of the long-term vision are discussed next. They encompass two areas: reforms in ownership, financing and management of the state's irrigation systems, and progressive development of comprehensive multisectoral water resources management.

Democratic decentralization, farmer management and financial autonomy. These are considered vital to change the past "vicious circle"[3] of influences to a "virtuous circle," where these constraints were tackled systematically to generate mutually reinforcing improvement with in-built incentives to achieve this. The objective was to build rapidly form the WUAs at

a minor level to federated WUAs at the distributary and then at the project (scheme) level. The (ultimate) objective was to have self-financing and autonomous irrigation schemes managed by WUAs. An apex committee of farmers at the state level will provide a forum for statewide decision making. The government's role will progressively reduce as provider of technical assistance to manage the headwork of larger systems.

This process was accompanied by institutional and financial reforms and capacity building to create the respective autonomous entities. The short-term objective was that WUAs and the irrigation and the I&CAD should become financially autonomous for O&M and revenue and expenditure. They would generate their own revenue from water charges and finance O&M, thus giving them financial independence and being cost effective as well as quality effective, which were critically lacking in the past. WUA members have to contribute to the interest-earning reserve fund accounts, to progressively build up the financial capacity to reinvest or undertake improvements. New investment will continue to be financed by the government but with users or prospective users contributing through appropriate cost-sharing arrangements.

For I&CAD there was radical change in its role as the above progress took place. One of the major transformations was to switch staff orientation to the role of a service provider to WUAs. Rehabilitation of systems and upgrading maintenance were the responsibilities of the newly constituted Water Charges Review Committee (WCRC). The key need was to ensure the necessary direct financial link between revenue and expenditure and the availability of funds for this purpose.

Sustainable water resources management. Major principles for development and management of water resources are a) comprehensive water resources management, b) environmental management, c) water as an economic good, and d) technology development. To achieve these objectives several steps were suggested.[4]

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[3]A purely governmental approach, wherein poor system performance has led to farmer dissatisfaction, low fee payment and low cost recovery, and underfunding of O&M is common (for more details see Gulati et al. 1999. *From top down to bottom up: Institutional reforms in Indian canal irrigation.* A collaborative study of IFPRI-NCEAR-IEG-ISEC).

[4]The important steps are a) the establishment of a state multisectoral water resources board or committee to guide development of actions; b) the development of multisectoral river basin plans and environmental management plans to provide guidance for management and future development, c) continued development of watershed management practices and integrated conjunctive use of surface water and groundwater resources, d) promotion of technologies for greater water use efficiency, with emphasis on irrigation; e) progressive development of institutional and human resource capabilities in water resources management, and f) public awareness campaigns on water resources management issues to foster an environment for change.

Strategy Implementation

The immediate priority was to provide a follow-up to the change process already initiated in 1997 by the FMIS Act (for key provisions, see annex), the threefold increase in water charges, and the statewide elections for WUAs. This was followed in November 1997 by statewide elections for the second tier of WUA management structures. If they were to succeed and generate further reforms, these actions required urgent follow-up like restoring and improving the productivity of the existing irrigation systems; assuring their sustainable management by transforming management to farmers through the new WUAs and putting the sector on a sound financial footing. Concerted actions in the following areas are being launched such as a) the creation of a farmer–government partnership, b) consolidation of irrigation management transfer to farmers, c) maintenance and rehabilitation, d) agricultural extension, e) cost recovery and financial sustainability, f) expenditure prioritization, and g) institutional reforms and capacity building.

Long-Term Vision

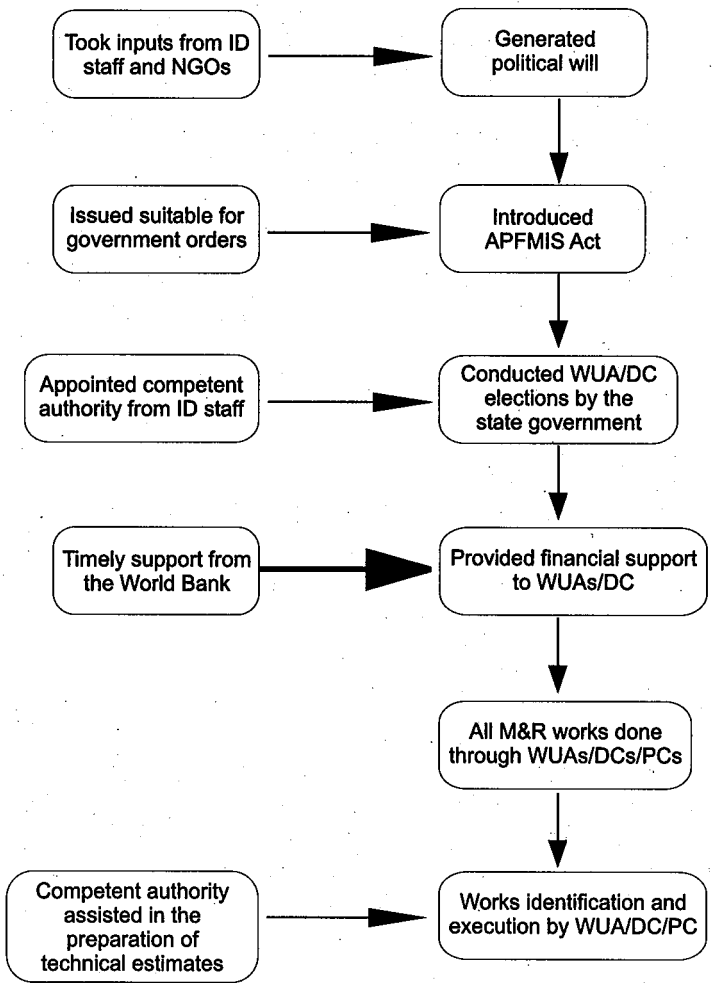
Andhra Pradesh is the first state in India to put forth a long-term vision through the document Vision 2020: Swarna Andhra Pradesh. Both the irrigation policy and the legal framework were in tune with the long-term vision evolved by the state. The vision document (GoAP 1999) has set ambitious goals to achieve them through a) building capabilities, b) focusing on high potential sectors of the economy, and c) transforming governance. As a part of building capabilities, the Vision document highlights involving people to manage services as a key area. It states that, an effective way to provide quality and responsive services is to decentralize them and ensure that the people have a role to manage them. Andhra Pradesh's own experiment in water management demonstrates the power of people's participation. Also, the state's own legislation (like the APFMIS Act, 1997) in relation to local bodies provides some basis for people's participation.

Investment in the irrigation infrastructure has been a priority. Successive five-year plans have emphasized the need for greater investment in the irrigation sector. Plan outlays on irrigation have increased from Rs 620 million in the Second Plan to Rs 31,860 million in the Eighth Plan. This has expanded the net irrigated area from 150,000 ha to around 5.9 million ha and has greatly increased the productivity of land, leading to a substantial impact on agricultural and industrial growth, incomes and employment. However, to achieve the long-term vision, more was required, such as a) realizing the maximum irrigation potential, b) improving the efficiency of the existing irrigation network, and c) managing water resources better through stakeholder participation. In the absence of funds from the Andhra Pradesh Economic Restructuring Project (APERP) supported by the World Bank, Participatory Irrigation Management (PIM) activities could have had little impact. Good blending of the APFMIS Act and timely assistance from APERP has made a distinct difference in the state. APERP has assisted WUAs through a) minimum rehabilitation of the canal network, b) regular O&M, c) scheme improvement and farmers' turnover (SIFT), d) agricultural intervention program (AIP), e) institutional support for project monitoring unit, and f) human resources development.

Implementation

Overall, the PIM process followed in Andhra Pradesh was as shown in the figure 1. In the process of implementation and learning, 110 government orders were issued by the I&CAD till January 2001 to amend and clarify the APFMIS Act, 1997 and to facilitate better functioning of the WUAs and DCs. To help in physical and financial plan estimates and approvals, a junior engineer in the case of a WUA and an executive engineer in the case of a DC were appointed as the Competent Authority (CA). The main focus was construction-oriented system rehabilitation, repairs and adding essential structures. Many canals are 10–20 years old and have never been maintained. Stress is on cleaning shrubs, desiltation and strengthening bunds.

Figure 1. Participatory irrigation management process in Andhra Pradesh.



Training

The state had launched a massive training program on WUAs and the program aimed at covering the entire state, by having local training camps for a fixed period (ranging from 2 to 3 days per batch). A trainer's handbook containing the subjects, irrigation engineering, agriculture and revenue, was prepared by August 1999 for ready reference by the trainers.[5] Fifteen members from each district comprising I&CAD, agriculture and revenue departments of the state were selected to undergo training as trainers at the WUAs at district level. Outside agencies had collaborated to prepare the training material in the local (Telugu) language. The reading material was widely disseminated to participants. As of November 1999, all WUA presidents and TC members had attended the training program. WALAMTARI (Water and Land Management Training and Research Institute, located in Hyderabad) had become a live partner in the whole training process and dissemination of publications. The institute had shifted its focus from earlier engineering-oriented programs to WUA training programs. To bring in a practical perspective to classrooms, WALAMTARI had trained middle- and junior-level officials of the agriculture, revenue and irrigation department, as trainers under the Training of the Trainers program.

Monitoring

From mid-1998, every district had a PIM coordinator, who was primarily a member of the middle-level staff of I&CAD and transferred to this position. These coordinators were expected to coordinate all PIM/WUA/DC training programs, activities and meetings with district collectors. Currently, they were not dynamic owing to inadequate training and supportive staff. Some 25 PIM coordinators were positioned at the district level, mainly owing to problems in career promotion in the I&CAD. The PIM coordinator was responsible for computerization of WUA details; assigning 9-digit code numbers for each WUA (as of now only for major and medium projects), supervising training, planning and its implementation, communicating to all WUAs, and sending letters and publishing in local news papers.

All ID people have to report to the district coordinator on a regular basis. Because of the weekly (every Thursday) teleconference meetings, the district collector, along with ID senior staff have to discuss ID, WUA activities with the chief minister. At these teleconferences the chief minister receives all newspaper reports (from all district editions of some newspapers) for discussion. This had kept all collectors and, in turn, all staff of ID on tenterhooks, to regularly keep track of newspaper reports and answer them.

In some WUAs, the president and/or the executive committee has mismanaged the funds. Though the FMIS Act provides sufficient insulation, the Irrigation Department has not taken sufficient preventive measures. The Upper Manor Project is a medium irrigation project with a command area of 13,000 acres. It has seven WUAs, and no DCs or PCs as per the Act. In the first year, these WUAs got Rs 50/acre and in the second, Rs 100/acre. So far, three cases of misappropriation of funds have been booked against the presidents for utilizing the funds for nonspecific purposes.

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[5]A separate handbook for WUAs and field functionaries on participatory irrigation management was also prepared, by IRDAS (Institute of Resource Development and Social Management) and WALAMTARI.

The Practice

In this part the study team had looked at the actual practices of WUAs in the three regions of Telangana, Coastal Andhra and Rayalaseema.[6] In each region, major, medium, and minor irrigation systems were visited and how the WUA functions, its advantages to members and the irrigation department were observed. Also the financial support received and the viability of WUAs in the present form have been explored. Many WUAs indicated how the current experiment is playing a pivotal role in the development of the command area. Some WUAs also expressed their demands and views on the whole exercise initiated by the state government. The number of WUAs visited (given below) varies across the region and the type of irrigation system.

Number of WUAs visited

Region	Major	Medium	Minor	Total
Telangana	4	1	2	7
Coastal Andorra	7	2	3	12
Rayalaseema	3	2	14	19
Total	14	5	19	38

Formation and Structure of WUAs

The main role of the government was to promote farmer participation. The structure of users' organizations was given from the top. Each WUA was formed, based on the hydraulic boundary for 500–8,000 acres, and with four to six Territorial Committee (TC) members in each. Each TC will have an area in the range of 500–1,300 acres. The elected presidents of WUAs will become members of the Distributary Committee (DC) at the distributary level. WUAs and DCs were formed through elections in 1997. Till January 2001, Project Committees (PCs) were not formed. Elections were held for each of these tiers of the organization, as per the government order and all processes were formally handled by the government agencies. Till 31 May 1999, the total number of WUAs formed was 10,292; it includes, 1,699 major, 413 medium, and 8,180 minor projects (see table1. Also see annex table A-4 and A-5 for district-wise details). Elections were conducted for 9,797 WUAs (in minor projects, only for 7,749 WUAs). In the case of 495 WUAs, elections were not held for various reasons. The recall clause in the Act is a large booster for members; so far, seven presidents have been recalled due to misappropriation of funds. Wide publicity of this information in the farmers' newsletters has sent warning signals to others.

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[6]a)Telangana region has 39 percent of the state population and 42 percent of the geographical area, b) Coastal Andhra, 43 percent population and 34 percent area, and c) Rayalaseema region, 18 percent population, and 24 percent area.

Table 1. Distribution of WUAs by type of irrigation systems and method of elections.

Type of irrigation	Unanimously elected	Contested	Elections not held	Total
Major	649	935	89	1,673
Medium	118	179	07	304
Minor	4,714	3,110	491	8,315
Total	5,481	4,224	587	10,292

Since the formation of WUAs, more emphasis has been laid on meeting the president, conducting training courses, short workshops and keeping him/her as a contact person of the WUA. This has helped the president understand the internal process. In case of many WUAs, TCs and ordinary members have little access to the information flowing from the higher-ups and to the CA. With increase in size of funds and powers, WUAs have become more influential. For water allocation, farmers go to the WUA president and not to the staff of the Irrigation Department. In some places, there are efficient WUAs mainly owing to good senior officials and their efforts (e.g., in SRSP project, Karimnagar; Sri Kakulam and West Godavari). Poor WUAs are mainly because of political interference (e.g., in Cuddapa, Chittoor and Mehboobnagar). WUAs are categorized (informally by officials) based on the complaints and progress heard from the presidents of WUAs. However, WUAs and DCs face opposition from senior and junior staff of the Irrigation Department, since they have lost money and power.

Court case of lascars. A lascar is primarily a system-level canal operator and water regulator for approximately 800 hectares. In the Srikakulam district, there were 574 WUAs, and 180 lascars. The services of lascars, originally employed by the state government, have now been transferred to WUAs. They are under the functional control of WUAs and receive salaries from the government. Some 3,500 lascars in the state have opposed this government order and a legal battle is still on. There was also opposition from the engineers' association regarding the transfer of roles and responsibilities to WUAs. The government gave them three choices: a) a voluntary retirement scheme; b) work according to government instructions, or c) punishment by government of erring staff. For now, the staff has agreed to work according to government instructions.

Trendsetters. The Srikakulam district claims to be a forerunner in the WUA movement in the state. In this district, WUAs maintain schedules and conduct meetings on time while the Irrigation Department disburses funds regularly to WUAs and responds to government orders regularly. Newsletters are published in Telugu (local language) regularly. The Superintendent Engineer (SE) and his staff take a keen interest in all the activities and works. But the middle- and lower-level officials have complained that their workload has increased. The Krishna district is a trendsetter in the delta region leading both in area coverage and expenditure incurred by WUAs and DCs.

The WUA movement in Andhra Pradesh has gained its momentum. With all visible physical benefits, the spirits of the farmers were high because they felt that the system belonged

to them. Farmers had felt that if users take an active part in system maintenance, it brings them better flows and improved yields. Developing the sense of ownership was getting established in many places. WUA members unhesitatingly and with pride said now water is ours; we have a right on that. In the reform process, farmers made no (or in some cases, little) monetary contribution, and they were involved in decision making and work execution, and hence, the quality of work was better and farmers felt the structures belonged to them. A septuagenarian (a freedom fighter, and president of WUA-47, in Manthani village) said "earlier government officials were saying and holding important roles; now that is lost. Users have got a major say in all irrigation-related aspects; this is a good trend in the state."

WUA Meetings

The APFMIS Act clearly delineates roles and responsibilities at each tier of the organization. User organizations take pride in saying, "This is the first time, in the state's history, that a chief minister is directly writing to organizations at the village level. So, we feel, we can communicate directly with the chief minister and that is a large achievement for us." Over the last 2 years (1998–2000), general body meetings have been initiated through CAs. Twenty to 50 percent of the members attend these meetings; in a few cases, this has exceeded 60 percent. Otherwise, the WUA/DC president and TC members call small group meetings (6–20 farmers) on their own, as and when required; more specifically, to endorse identification of works and their execution and to discuss funds received and expenditure incurred. Informal meetings are held to discuss if voluntary work is required to clean canals and water regulation across the reaches. For calling a meeting drum beating is common across the state. For small group meetings, the WUA/DC president informs through oral communication. Unfortunately, WUAs and DCs have not focused on a) water acquisition, b) equity in distribution, and c) efficiency in water use. The CAs had not stressed these issues and WUAs have not discussed them seriously in their meetings.

WUAs v. Village Panchayat

There is a growing dissent in some village Panchayats on the WUAs control of resources, which until now was in the hands of these Panchayats. They feel that there are too many organizations. The village Panchayat, in some places, felt that it could have handled water management since farmers belonged to the same village. But in many places, with a separate organization like the WUA, farmers feel that they have done better work and have greater freedom to do what is actually required. Water fee can be used for WUA works and functions. In some WUAs (including tank-WUAs) which are close to urban areas and headed by an absentee landlord, there is noncooperation from member farmers. In the case of tank-WUAs close to urban areas, members have only a secondary interest in tank management.

Physical Works

In Andhra Pradesh, as elsewhere in India, the emphasis till 1970s was on creating infrastructure. From the 70s onwards, the state faced a financial crunch leading to a lack of management and maintenance. System delivery was weak and system efficiency was down to 40 percent in major projects. Hence, in May 1998, many works were taken up. most being repairs to canals and structures and addition of some new structures, below the distributary level. The number of works carried out over the last 3 years are shown below:

Number of works carried out by WUAs.

Year	Number of Works	Expenditure in Rs. Million
1998–1999	21,406	118,562
1999–2000	17,185	16,957
2000–2001	9,289	5,155

By 1999 a new trend had started; i.e., contract being farmed out by local officials (who are CAs) to WUA presidents. Some presidents have taken the work on behalf of WUAs and then subcontracted it to their territorial committee (TC) members, who are basically subcommittee members. In the register of administrative approvals, only TC names figure (e.g., medium-irrigation project UMD, WUA-1–4). Most of these presidents are contractors by profession and the WUA work came as an opportunity to get involved and gain confidence at the local level to execute these works. Around 30–40 percent of the WUA presidents in the state have been involved in this kind of processes.

The last 2 years (1998–2000) have seen the following practice. The WUA president, one or two TC members and some farmers identified the required works via a walkthrough survey. These works were then discussed in an executive committee meeting and then passed on to the CA for preparation of technical estimates. An agreement was signed between the CA and the WUA president. Funds were released at the rate of Rs 50 per acre in the first year and Rs 100 per acre in the second year. During the second year, for tank-WUAs the rate was Rs 90 per acre (Rs10 per acre was given to the village Panchayat). Forty percent of the fee was paid in advance and the remainder on completion of the works. But in a majority of the cases, even after completion of the works, the balance amount was not paid. Whatever funds were released went directly to the WUA account. The ID staff had no role in handling the funds. Proximity to the process of technical and financial estimates, funds disbursements, works execution by local farmers have all brought more transparency in WUA dealings. Contractors are almost out of the picture and the saving on this alone is about 30 percent.

The government has given clear instructions that there will be no new structures or alteration of original designs. So, the major emphasis is on restoring the original designs. Repairing and strengthening of structures, addition of missing structures, desilting canals, installation of water regulation structures wherever damaged or not installed earlier, strengthening canal bunds and construction of drop-structures are some of the major works that WUAs have carried out. In the Godavari and Krishna delta areas, in addition to these works, emphasis was on drainage works. In the tank systems, in addition to the above works, the major focus was on repairing and strengthening of surplus weir and apron, raising and strengthening tank bunds to the original designs, and improving sluice structures.

In the process of the users identifying and executing works, much attention has been paid on users' needs like cattle pathways, washing steps for women in canal systems, removal of encroachments, and clearing shrubs and silt for the smooth flow of water till the tail reach. In most places, farmers have contributed their labor for additional working days, as part of their earlier practice of *shramadana* (voluntary work)[7].

Problems of Execution of Works

One of the problems in the execution of works is the rate approved by the government for various works in 1999–2000. The rate for a Proclainer machine is Rs 16.24 per cubic meter and from this 15 percent is deducted as farmers' contribution. This becomes Rs13.50 per cubic meter, for which no machine owner is willing to work. Also farmers are not willing to pay this 15 percent. With 40 percent of grants (disbursed as the first installment), work was carried out to the extent possible. Hence, many WUAs and DCs are not taking up any work. The new work masters like the WUA and DC presidents got trapped in difficulties owing to poor planning of both materials and manpower. Meanwhile, the CA is unable to attend to all works and, hence, work is badly affected in some places.

Water Management

Across the state, unauthorized outlets have retained their status quo. However, WUAs have ensured that water traverses to tail reaches by canal cleaning, or and by rotation of minors, as in most problematic areas. Across the state, WUAs have a neeradi (a water distributary, hired locally on a temporary basis by the ID) for water distribution; earlier the neeradi was accountable to an informal group/association of farmers; now, he is answerable to the WUA, as a formal setup. Some WUAs have hired neeradis on their own for the irrigation period and pay them salaries.

Water regulation in the Tungabadra High Level Canal, Stage I (in the Ananthpur district) had undergone changes owing to the WUA's active role. Owing to the WUA's continuous demand for better water regulation across the reaches, the ID devised an alternative system. Accordingly, from 1998, distributaries are closed every Monday. Sluices below the distributary are operated on a rotational basis. In 1999, with the consent of the WUAs, distributaries were closed once a week and thus the approximately 6 TMC water saved were supplied for the second crop in the rabi season to 52, 631 hectares. For the first time in the project history, such a large area was irrigated without any additional supplies. Field officials felt that gradually this may increase to 72,874 hectares.

However, some constraints as shown below had remained as reported by the farmers during our interviews:

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[7]Owing to these induced works, WUA members of Elabotharam village in SRSP project in the Telangana region feel they have come together and can take more collective action now. In the Narmala village of Upper Manor dam, desiltation of canals was done after 14 years. In Thotapalli tank-WUA, farmers contributed carts and tractors for desilting at a lower rate of Rs 100 per trip, which is Rs 30 less than the market rate. The Bajjipuram tank in Coastal Andhra had three surplus weirs at different levels; now there is just one and this helps in having more storage.

- Several WUAs and DCs were demanding for grants since in some places political leaders had made false promises about liberal grants for the construction of office buildings.
- Power supply in rural areas is limited to a total of 5–9 hours per day, supplied in 3–4 slots. This affects the cultivation of commercial crops and increases the dependency on canal water.[8]
- In many places, the water supply had not reached the designed discharge levels at regulation points, even after some structural repairs and desilting by WUAs.
- WUA and DC presidents were not very clear about their future activities and the potential of these organizations to carry out allied activities.
- Government grants have remained the sole source of funding for most of the WUAs with little (or no) efforts having been made to mobilize own resources.
- Most of the WUAs have not made serious attempts to mobilize contributions from the farmers to meet the prescribed 15 percent of the estimated costs of works. Hence, physical works have been carried out from the government-allotted funds (i.e., 85%).

Rayalaseema Region: Acquiring and Regulating

In this region surface irrigation sources are limited and groundwater has to be extracted from the deep bottoms. Increasingly, this region has shifted towards mango orchards, citrus fruits and other long-gestation and long-term yielding tree products. Farmers prefer this option because of better insulation from the vagaries of rainfall and labor availability and, yet, receive promised returns over the years. More farmers have opted for low-water-consuming crops. But, within the authorized command areas, demand for canal irrigation is high owing to rice cultivation. Most of the tanks in the Rayalaseema region, are 100–450 years old. Owing to good physical features, most of them are free from major maintenance problems; bunds are leak-proof, even after 200 years. But, they are constrained by siltation in the tank bed, and reduction in the inflows.

Coastal Andhra Region: Delta and Drainage

This region consists of two deltaic areas, Krishna and Godavari where the irrigation systems are centuries old (with some additions and modifications in recent decades) and well tuned to rice cultivation. The region has been named as the "rice-bowl" of India. Over the years, urban-pull and rural-push factors have led to more large landholders shifting their base to urban areas; in addition, the next generation showed little interest in farming activity. This trend has

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[8]In spite of cheaper power rates, many farmers have not paid up the bills. Because, the Congress party has promised in their electoral manifesto (of Parliamentary elections, held in October 1999) that they would reduce the current rates, and abolish all arrears. These arrears range from Rs 4,000 to Rs 35,000 per farmer, with a burden of about Rs 3,000 million per year on the state exchequer.

pushed many farmlands (more than 75%) into the hands of sharecroppers. Production sharing varies from 25 to 50 percent, depending on soil quality and water availability. Since the owners can do little with soil quality, they have taken a keen interest to improve the acquisition and distribution of water. The WUAs then came as a boon to execute essential works and check the system O&M. Farmers (mainly landowners) have taken an enormous interest in WUAs and their activities, mainly to boost production levels.

Another major problem in the deltaic region is drainage. Being a deltaic region and close to the sea (distances ranging from 20 to 60 km) the gradient is low, 1 foot per 5 km. During the rainy season, a sheet of water covers the whole area with a depth ranging from 1 to 3 feet. Inadequate drainage facilities were major problem. Funds for WUAs, DCs, and PCs came as a large boon to this region. During the last 2 years, all over the deltaic region, heavy machines were used to desilt main canals, branch canals and distributaries. Essential structures were constructed in some places and repaired in many places. This massive work was visible to landowners and sharecroppers. All this facilitated a smooth flow of water, advancement of transplantation (by 2 to 3 weeks) before the arrival of the monsoons, and yield levels went up by 20–40 percent. Now, water flows regularly and drains easily. Hence, there are improved yield levels, and farmers are happy too. This has helped to grow a second crop.[9] In the Nagarjuna Sagar Right Bank canal system, owing to a weak database, the project-level data could not be collected for season-wise benefits accrued due to WUA activities. In all these (Krishna, Godavari, and Nagarjuna Sagar) projects, the constraint is more in canal regulation and their carrying capacity, rather than in water-supply levels. The main advantage, as many farmers mentioned was, "after several years, for the first time the deltaic region did not got submerged in the monsoonal period; otherwise, by August, one could see all lands covered by a sheet of water." The study team did not find (during its visit at the end of August 1999) any submerged rice fields and most of the transplantation, including that in the tail reaches, was completed before the onset of the monsoon.

Telangana Region: Sustain Current Development

Traditionally, the Telangana region had less experience in canal irrigation; however, many surface irrigation projects are close to the completion stage (some of them have been ongoing over the last 20–30 years). The SRSP project, which had created a large irrigation belt, had induced social and economic development in this region; the project is yet to attain its full potential. Hence, the irrigated area (one-third of the designed command area) had surplus water. But the carrying capacity of the distribution system had been declining over time owing to the lack of maintenance and repairs. Under these circumstances, funds through WUAs, DCs became handy to carry out works of their choice. This had boosted the local farmer's confidence in WUAs.

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[9]Farmers of the Duggirala and Emani WUAs in the Krishna deltaic area have honored WUA presidents and ID staff for their tremendous efforts in water supply and cleaning canals. They had conducted public functions and honored these guests by presenting shawls on their shoulders; now some farmers jokingly say, if they do not perform well, the same farmers will take back the shawl.

Finance

The government was saving about 20 percent on works (which earlier went as rent- seeking at various levels) more as cost effectiveness. Some money was spent but presumably more works were done. The main idea was not to save money (by avoiding contractors) but to increase the area under irrigation. At the WUA level, contributions were set at only 15 percent (unlike the 30% under Janmabhoomi schemes). Unfortunately, only a few WUAs had contributed their 15 percent share. Neither the CA nor the project-level ID office had records to indicate the WUA's contributions.

To begin with, the ID was expecting part of the work (as prioritized from the walkthrough survey) from the current maintenance grant of Rs 40 per acre, which was supposed to be given to the WUAs. Based on the rate of Rs 40 per acre for maintenance and repairs, the SRSP project received Rs 63 million per year (out of the state Rs 1,500 million); nearly 85 percent of it was spent on staff costs. This amount was planned to be given to the WUAs in mid-1997, soon after the WUA elections. Meanwhile, (3 months after the WUA formation) observing the formation of WUAs and the state's long-term plans, the World Bank expressed interest to support some activities. The Bank was ready to fund, initially, minimum rehabilitation and then O&M activities. The detailed costs worked out to Rs 1,300 per acre in major and medium projects (minor projects were excluded at that time, but for no reason) for minimum rehabilitation. O&M costs worked out to Rs 500–600 per acre. From this bank grant, the department provided each WUA with Rs 50 per acre during the first year and Rs100 per acre during the second year. Grants were given from 1998 to all WUAs in the state for a total of 5 years. These grants were meant for the non-SRSP projects under the APERP project of the World Bank.[10]

Proposed sharing pattern of irrigation revenue across the schemes.

Level	Major	Medium	Minor
Water charges/acre[a] (in Rs)	200	200	100
Allocation in (Rs)			
WUA	50	60	90
DC	20	-	-
PC	20	30	-
Local government (Gram Panchayat)	10	10	10
ID	100	100	-

[a]One hectare = 2.47 acre.

[10]The World Bank funding for WUAs through the Andhra Pradesh Economic Restructuring Program (APERP) arrived after the whole process had started. Under APERP, major items of expenditure (during 1998–99) totaled Rs 1,114 crores, and it included: a) minimum rehabilitation, Rs 336 crores, b) SIFT, Rs 120 crores, c) O&M, Rs 600 crores, d) Management Information System, Rs 29 crores, and e) Human Resources Development, Rs 29 crores.

In the reform process, the state budget is not touched. After the APERP project period, WUAs were expected to collect fees, which would be given to all tiers of the organization, the local government and the ID as shown above. But this sharing pattern was approved only in February 2001. During the first year (1998–99), each WUA and DC got Rs 50 per acre, and during the second year (1999–2000) Rs 100 acre as maintenance grant. Of the Rs 100 per acre, minor-level WUA had 60 percent, DC 20 percent and PC 20 percent of the share; since PC was yet to be formed, ID had taken 20 percent till PC was formed. In this process, Rs 1,070 million was spent during 1998–99 out of which some Rs 1,030 million was spent during 45 days. Every bill of ID had to be passed by the accounts officer, before going to WUA. This was a hindrance owing to the delays and rent-seeking attitude at that level. The annual demand raised (based on water fees) was Rs 1,400 million, while actual collection was only 50–60 percent of this. However, water fee collection had increased to 65 percent during 1998–99, from 54 percent during 1997–98.

The financial component had played a pivotal role in expediting the whole WUA exercise in Andhra Pradesh. To begin with (during the APFMIS Act formulation), the financial map was not clear; the introduction of the APERP project (as part of the world bank funding for economic reforms in the state) during the latter part of 1997 had changed the scenario. The focus shifted to fund allocation for physical rehabilitation. Till 1997, the main problem was the lower level of grants for O&M at Rs 40 per acre, of which Rs 25 was spent on staff costs. With the remaining money, a few essential works were carried out. Now, WUAs receive Rs 50 per acre during the first year and Rs 100 per acre during the second year and it is free from staff costs. In the process, farmers were realizing benefits from the WUA's function in the present pattern.[11] Some farmers as well as field officials have agreed that, "the government investment is less than one bag of paddy [unhusked rice] per acre (i.e., about Rs 400 per bag of 75 kg, as per the minimum support price); while the return is 5–10 bags per acre (additional yield per acre). That is the real benefit of formation and funding of WUAs." In some places, funds were also promised for WUA and DC office buildings. Every year, WUAs in the major canal irrigation projects receive Rs 200 per acre (100 for WUA and 100 for DC). During 1999–2000, the Krishna delta received approximately Rs 123.6 million; NSLC Rs 60 million; medium projects Rs 3 million and minor projects Rs 10.4 million. Under APERP, the Krishna delta got Rs 40.2 million (during 1999–2000) including project committee works on main canals and drainage works.

One of the key factors attracting the WUAs to function is the size of funds ranging from Rs 700,000 per WUA in Coastal Andhra to a mere Rs 12,000 for the tank-WUA in the Rayalaseema region. The former focuses only on O&M and repairs of the distribution system in its command; while the tank-WUA has to take care of both the source (including tank structures) and distribution system. There was an imbalance in the fund allocation pattern, as most of the tank-WUAs in all regions have complained. Indeed, minor field officials of the ID endorsed this view and suggested modification in the present allocation pattern to encourage tanks rehabilitation.

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[11]For example, at division level (in the deltaic area), Rs 20 million (at Rs 40 per acre), nearly Rs 13 million goes to salaries. At the subdivision level (at Duggirala in Krishna delta) the Rs 40 per acre grant was Rs 6 million, out of which work-charge staff salaries are Rs 3.5 million, leaving a balance of Rs 2.5 million for works. In 1999, this subdivision got Rs 26 million for minimum rehabilitation through WUAs. Clearly, a four times increase in the allocation of funds and all these without any salary component.

As of 2000, collection of water fees and assessment of area were done by the patwari (a field staff of the Revenue Department) and, in few places, WUA president and TCs are involved when they jointly endorse the figures. About 70 percent of farmers have paid, the remaining 30 percent were mostly large landholders who delay or do not pay quickly. If fee collection was the responsibility of the WUA, it could have been easier, since they can cut off the supplies to the fields. Otherwise, there was no record as to who had paid or defaulted. WUAs can raise this issue in the general body meeting and, owing to social status, people will pay up; this cannot be done by the revenue patwari. On the other hand, WUAs are not focusing on resource mobilization nor has the ID stressed this point. In some places, farmers were willing to invest on lift irrigation. Priority may be given to such villages, where villagers were willing to contribute a major portion of the investment. This would influence more villages to mobilize their own resources.

Fishing Rights

All tank-WUAs think that fishing rights should be given to them. Currently, fishing rights given to the local fisherman cooperative societies on a 3–5 year leases at much lower rates are unfair, e.g., in Srikakulam's Bajjipuram tank, the fishing rights were sold for only Rs 2,000, while it could have fetched Rs 50,000. Many of the fishermen cooperative societies belong outside the WUA boundary and even outside the village boundary. Local WUAs feel very strongly on this matter because these contracts could have boosted their resource mobilization.

Maintenance of Records

The FMIS Act, 1997 has suggested the maintenance of 12 types of registers at the WUA level; registers ranged from the work register to the WUA property register. The field staff of the ID report that most WUAs/DCs being in their early stages, maintain just three or four registers pertaining to the minutes of meetings, payment of bills, physical works, and cash dealings. There were a few WUAs, promoted as models, which have all 12 registers, e.g. Elabotharam WUA in SRSP and Yenubilli tank-WUA in coastal Andhra. Interestingly, many members of the field staff were not aware of the 12 registers. In a few cases, the members of the department staff have got registers printed in the local language. Many WUAs (and field staff) are not clear whether they can spend the grant allocated for administrative expenses for this purpose. Even the CAs in many places were not clear about the nature of registers to be maintained. The training programs have not incorporated bookkeeping by the executive committee as a main activity, as informed by WUA presidents. All WUAs, except a few, maintained only a cashbook, administration approval, minute's book and a bank passbook. Field staff of the department wrote these registers/records. In a few cases, locally hired persons wrote them. Only a few "model" WUAs had task-specific printed (as prescribed by the Act) registers. In spite of providing Rs 10,000 for administrative purposes to all WUAs (many WUAs had not even entered this in their cashbook till August 1999), neither they nor the local A.E/DyE.Es had printed task-specific registers.

Area Irrigated Records

Till November 1998, the Revenue Department, with the help of the Agriculture Department used to assess the irrigated area at the end of each season. Owing to an understanding between the farmer and field staff, reported irrigated area values and, in turn, water fee levels were less

than actual. "Discounted" figures vary from 20 to 40 percent less than the actual. By involving WUAs in the assessment process, irrigated area values had gone up by 20–40 percent owing to correction in the documentation process. During field interviews, farmers reported that, in several schemes, they had no command area maps and information on water fee defaulters; till October 1999, either the concerned WUA or ID staff had records to indicate actual levels of water fee collected in their jurisdiction. The revenue staff felt it was not obligatory on their part to share this information with WUAs or ID staff; the village agricultural officer also expressed similar feelings.

Information Diffusion

The major advantage of having WUAs was quick information flow from farmers to senior officials and vice versa. Before the formation of WUAs, the process of information flow from bottom to top, used to take a week to 10 days and sometimes even longer. Reporting activities of WUAs in local newspapers and state-level newspapers had contributed significantly to information dissemination. In other states, local newspapers are area-based, and restrict their coverage to the local area (mostly town/city/district level). In Andhra Pradesh, particularly in recent years, the state-level newspapers in the Telugu language have started having editions at the district level. Indeed, these newspaper reports have also become inputs for the Chief Minister's teleconference every Thursday morning.

Forum of District-Level Tank-WUAs

In Karimnagar, the district-level WUAs' President's Forum was started on 20 April, 1998, to provide a link between WUAs and the government in order to solve problems of funds and grants. Until the end of 1999, this forum had 7 meetings. The forum demands were the following:

- Provide allocation of Rs 250 per acre instead of Rs 100 per acre (no basis for this value.
- Neeradis should be under WUAs, rather than under the mandal revenue officer. Of the WUAs, 80 percent have neeradis and their salary should be given by the government.
- Of the funds accrued through fishermen coop societies 50 percent should be transferred to WUAs.
- Revenue collected from toddy tappers (mainly from palm trees) through leasing out trees, on canals or tank catchment at Rs 11 per tree, should be given to WUAs.
- WUAs should receive revenue records, a map of command and a list of voters.
- The Act should enable WUAs to punish or decontrol encroached lands in tank command and catchment areas.
- Presidents are expected to do a lot of work, including record keeping and cash maintenance. WUAs need one accountant per mandal.

- The responsibility of CAs is biased; some CAs have 45 tanks each under them; even if he visits one tank per day, he cannot inspect all tanks in a month (this problem is not there in major projects).
- The District Pay and Accounts Officer gives account-payee checks payable at the Karimnagar town and it takes 20 days for their realization. Alternative arrangements (like demand draft) should be made at the local level.

The Ananthapur District Tank-WUAs' Association was formed in July 1999 and had met once in 3 months. Its focus was mainly a) to fight for auction rights of fish and trees on the foreshore and tank-bunds area, b) since many WUA presidents are illiterates, and not fully aware of the WUAs' rights and responsibilities, the district tank–WUA association would like to help them, and c) through this association, the fight for funds from various district offices. However, so far, the association has not discussed problems of siltation and possibilities of increase in storage capacity. Most tanks help recharge groundwater downstream, in some cases up to 10–15 km.

Support from Officials

A large number of field staff and senior staff of the ID had realized how WUAs and DCs have positively facilitated their functions. The CA a) sanctions estimates of DC works and approvals up to Rs 100,000 and enter into an agreement for the execution of works, b) resolves water-acquisition- and distribution-related constraints and supervises works, given to DC. In most cases, CAs feel that, in spite of more work, they are enjoying it, especially, since the reform process has facilitated more interaction with farmers. Problems are aggregated at the DC level and become easy to handle. The distributary committee necessitates farmer's participation in O&M of canal network.[12]

During the field interviews, the senior officials reported that officials like the executive engineer (EE), superintending engineer (SE) and chief engineer (CE) should have direct contact with farmers of various reaches and the top officials should frequently visit the sites and have open dialogue with the users and personally observe the sites. The SE brings out the district-level newsletter on WUAs. This newsletter is quite regular and is released during the first week of every month, reporting the progress made, funds disbursed, and results of interviews held with one or two farmers on WUAs. Every month, a thousand copies are printed and distributed to all WUAs. The SE himself edits the newsletter (till now, four issues) and receives a monthly supportive grant of Rs 5,000 from the ID.

Some field officials shared their disappointment owing to WUAs. These have cut into their additional earnings, which may further decline. A deputy executive engineer expressed that, owing to too many WUAs everywhere, a new breed of contractors, WUA presidents, have emerged and they charge a commission of about 10 percent. They would like to have all

[12]For example, according to one of the CAs in SRSP project, after DC and WUA formation irrigated area increased to 3600 acres from 2000. The CA said, additional 30 per cent owing to revision of revenue records, and 70 per cent owing to better structures and improved maintenance. The SRSP would gain additional 20 per cent of irrigated area, if staff could reconcile groundwater irrigated area (now groundwater area is not recorded, properly).

monetary details with them. Many territorial committees are against the practice both of the 10 percent commission and of presidents holding most of the financial control. Many presidents do not even discuss these monetary aspects during the general body meetings. On the other hand, engineers are hesitant, since they are losing their additional earnings and have to answer to the public. Earlier, they were answerable only to the government.

In Ananthpur, the SE of the minor irrigation department, and the SE of the major Irrigation Department said that before formation of WUAs in major projects, farmers used to have protest marches. During emergencies, tractor loads of farmers would barge in to the local department office to demand water and some essential physical repairs. By 1999, all that had stopped. Farmers address the WUA president with their problems. Even officials direct farmers to route their complaints through WUA presidents. In effect, for any problems of the command area, only one or two persons meet or call upon the officials. According to these SEs, major achievements are a) water reaches the tail end, which is a large achievement, b) WUAs look after all O&M, and c) ID is relieved of regular O&M problems. In the Rayalaseema region, the situation of water regulation was terrible, before the formation of WUAs. From 1998, there was a forum of WUA) to whose presidents the ID officials can speak about the emerging issues. In turn, these WUA presidents, brief their members and arrive at consensus.

Benefits

Large sums have been spent through users associations ranging from Rs 5,000 to Rs 900,000 per WUA. Users have identified works and executed them. They have also carried out their long pending essential physical works. Physical benefits are accrued in a short time, and they are distinctly visible. Across the state, our field observations had indicated that WUAs were happy for the same reason. Wide awareness on WUAs created by the government and the media has surely raised the users' aspirations, and thereby pressurized the WUA presidents and TC members on the one hand while, on the other, pressurized the ID staff to execute the works. It is hard to dispute visible benefits. However, some researchers in the state have a different opinion. The solid benefit across the state is water flowing to the tail reaches. Some of them had been deprived of water for years and now receive water for the first time. Minimum physical rehabilitation works had definitely facilitated better water flow, both across the reaches, and for the length of time, as the study team had observed in various places. This has enhanced crop yield levels by almost 20–30 percent across the state. Every WUA that the study team had visited has vouched for both yield increase and water flow to the tail reach.

Crop Pattern

By and large, the irrigated area had expanded owing to improved water supplies and cleaning of the canal network. This had largely benefited the tail-end areas. All this had increased the production and productivity levels due to better water distribution practices by the WUA. In most areas, the shift was towards rice cultivation in both kharif and rabi seasons. For example, in Bannuvada village-WUA area, in the kharif season, rice was grown in 3,011 acres while the total rabi crop area was 3,000 acres. There was no open or bore wells owing to loose and

sandy soil, and mainly close to the seacoast. In the Duggirala-WUA area, the net profit from kharif rice is Rs 8–10,000 per acre, according to farmers. In rabi, the entire 6,727 acres are cultivated; the area under rice cultivation has increased from 600 acres before WUA, to 2,500 acres after carrying out all physical works. The records of field officials show all 6,727 acres of the command area as wet (paddy) area, plus 1,000 acres of non-rice area. In Emani-WUA in the Krishna delta, during kharif all 5,700 acres are cultivated for rice. The command area has some 100 filter points; the groundwater from these wells was used for preparation of seedbeds; thus some 200 acres use water from borewells. In the rabi season, the cultivation of 3,700 acres of rice and 2,000 acres of blackgram was made possible only after the WUA works.[13]

Even the ID officials are convinced about the benefits. According to one of the executive engineers of the Vamsadhara project in Coastal Andhra, the following benefits have accrued from WUAs:

- Carrying capacity of main, distributary and minor canals has increased by 20–30 percent.
- Irrigated area has increased mainly in tail reaches by 10–15 percent.
- Number of complaints has been drastically reduced.
- The EE and SE have quick access to information. Before that, information was available only from the AE and Dy EE. Presently, it is from all WUAs.
- Users prioritize works and carry them out with technical approval from the CA.
- Now users have a role in works identification, prioritization and execution.
- Collective action among users is increasing.
- In the future, WUAs have to collect fees and do all O&M works; but this will emerge gradually.
- WUAs are more beneficial in minor irrigation tanks and medium projects, since source and control can be seen and separated. In major projects, mainly O&M can be carried out by WUAs.
- In the Vamsadhara project, the problem was water-carrying capacity and not water availability. WUAs solved them since most of them are river-diversion schemes and run of the river channels. Canals run continuously from end of July to December.

[13]The study team also looked at cost of rice production in Dharmavaram tank-WUA. In this command, generally only one crop is cultivated; rice in kharif and no crop in rabi. According to local farmers, one acre of rice produces some 25–30 bags (each bag of 70 kg of unhusked rice), a gross value of Rs 15,000, labor costs of Rs 7,000 (5,000+2,000); chemicals and pesticides of Rs 2,500 and a net profit of Rs 6,000.

In some places, the star gains were the removal of encroachments, particularly in tank-bed areas. Godavari and Krishna deltaic areas had gained a leading edge in cashing in the WUA movement, and its associated financial allocations. Because of the sheer size of the command area (altogether one million acres), and large size WUAs (average is 9,000 acres) work components and benefits were large. Their prime focus on improving drainage facilities and desilting the distribution network of earthen canals had paid rich dividends. Even officials concur with user pride. Some major benefits in the Krishna delta were reduced canal breaches, building of much-awaited bathing and washing stone steps, construction of cattle ramps, desiltation of minors and distributaries and equity in distribution from tail to head reach. In some distributaries, owing to desiltation and canal- protection walls, water easily flows till the tail reach. Hence, water distribution started from the tail to the head, unlike earlier when it started from the head to the tail, owing to less water and difficult flow. The yield level of the rice crop has increased by 10 bags of unhusked rice in the tail reaches (from 15 to 25 bags per acre) and by 5 bags (20–25 to 30 bags per acre) in the head reaches.

The top officials said that the initial motive was to do away with contractors, involve farmers and spend the whole money on works. The few PIM coordinators in the recently created posts and appointed at the district level, were in full support of WUA activity. Some of them have never worked on WUAs and were close to retirement. These coordinators confirmed to us during our interviews that, owing to PIM, they were able to see returns such as expansion of irrigated area, increased yield levels, reduced or almost no protest marches and agitation by farmers, and active involvement of users in irrigation management.

Reduction of Staff Size

At a circle level (i.e., SE level), since the formation of WUAs, all maintenance and repair works were carried out by WUAs. This had some impact on the size of the ID staff and the workload of this staff. For example, the SE (major irrigation) in Ananthapur has confirmed that his circle was supposed to have 149 assistant engineers. In reality, 60 posts were vacant. The system was still running without any hitch. The SE said "this is mainly owing to the involvement of WUAs and is really beneficial to the department." Even at the middle level there were vacant positions for six deputy engineers (the sanctioned number being 35) and at the level of executive engineers there were 50 percent vacant posts (the sanctioned number being 8). In the Sri Ram Sagar Project, reforms led to the following staff scenario as in 2000.

Staff size in Sri Ram Sagar Project as in 2000.

Level	Pre-1998	2000
Chief engineer	2	1
Circles	7	5
Divisions	36	25
Staff position sanctioned	2,953	2,078
Working	2,391	1,740

In the Chittoor division, the percolation tank–WUAs have focused on improving the inflow channels and strengthening surplus weirs and aprons. They had also strengthened tank bunds and cleared shrubs and weeds. To improve storage levels and, in turn, improve their groundwater recharge levels in the command area, most of these tank commands grew sugarcane as a traditional crop.

The Commissioner of Irrigation and Command Area Development clearly identified two major benefits due to WUAs and DCs, which were a) simplified payment procedures and b) introduction of simple monitoring procedures. Further, he gave a list of some major achievements:

- Empowerment of farmers who are more articulate now.
- Emergence of young leadership in rural areas.
- Teleconferences for effective monitoring (every Thursday, of the first 3 weeks of the month, with all district collectors and department officials).
- Awareness on both WUAs and the Act is good.
- Farmers and their organizations have a role to maintain the system.
- Hardly any complaints on system damages in any project area.
- Faction leaders demand collective action in poor areas.

He also identified some major strengths of this experiment, some of which were effective, innovative and quick action for monitoring and follow-up. Since the state has evolved this process many irritants have been removed, there has been regular field inspection and, to a large extent, rent-seeking levels have been removed. In recent months (early 1999), WUAs have been assigned a nine digit code for better monitoring and follow-up at the district and ID levels. The state keeps tab on these inputs and, hence, at all levels, it becomes easy to access data and report progress made and problems if any. Formats are being developed for this.

In Andhra Pradesh, strong political will has made a major difference to the whole WUA exercise, followed by continuous bureaucratic support at the top level. This has led to the empowerment of farmers and greater awareness among farmers who have even been able to question the local officials and field staff.

Economic Benefits

Some of the economic benefits accrued owing to PIM in Andhra Pradesh are:

- Additional 5.21 lakhs of acres came under irrigation. In the SRSP project, the reported area has increased from 95,000 acres to 237,000 acres in the first year (1997–98) and to 345,000 acres in the second year (1998–99).
- In spite of heavy rains in Coastal Andhra, there was minimum loss owing to drainage works carried out by WUAs. Besides, rice transplantation was advanced by 15 days.

- The yield level of unhusked rice has increased from 2.5 tons per acre to 3.5 tons per acre. Farmers reported that they obtained 45–60 bags of unhusked rice per acre (70 kg/bag). Before WUA formation, this value was 30–35 bags per acre.
- The worth of the total additional production per year was estimated at Rs 6,140 million

Economic benefits are enormous at the state level,[14] and expenditure was more productive-oriented. Wasteful expenses were reduced and resource mobilization at the local level were increased. Rent-seeking had reduced. O&M grants can be reduced and they may be spent on works.

Perceptions of Government Officials

Interestingly, across the state and across the levels, officials of the I&CAD echoed different tunes on their involvement in the PIM-related activities. The following are some key perceptions of officials interviewed by the study team:

- The present course of events would lead to a major shift towards decentralizing the perceived power structure of local officials, both lower and middle. At this speed, officials feel that even senior officials may lose their "powers."
- However, there was a growing understanding across the state and across all levels of officials that the WUA movement had helped both in a large way in system O&M and, to a large extent, in influencing farmers' involvement in irrigation management. Officials at all levels and in all places (more in major irrigation systems) feel that their major burden is reduced in O&M of the system.
- Officials feel that local engineers should have powers of signing bank checks along with the WUA president and TC members. Unfortunately, none of the WUAs were in tune with this view. WUAs feel, this was another tool for arm-twisting and they pleaded "this should not be encouraged; if any WUA presidents and TC members have misutilized the funds, the ID staff can always take stringent action on them."
- Minor irrigation officials argue that present grants (Rs 50 or 100 per acre) were grossly inadequate for tank systems; in the absence of any DCs and PCs for tank systems, WUAs have to take care of both main system (reservoir, sluices, regulation points) and distribution systems. Since recent grants were proportionate to the size of the area, tank systems receive much lower grants (in many cases, in the range of Rs 12,000–25,000) while major irrigation system WUAs receive grants in the range of Rs 300,000–900,000 or even more. Tank systems need different levels of grant. They need completely one-time allocation of large amounts to completely rehabilitate the tank systems to their original standards, and then WUAs can receive the present level of grants.

[14]But exact values were not readily available.

- Some senior irrigation officials felt that, during the next 5 years, WUAs should completely a) operate and maintain the system, b) regulate water supplies, and c) collect water fees.

- In the APFMIS Act, according to the SE minor irrigation, Ananthapur, some changes such as the following are required: a) recalling of WUA president should be made more effective, b) CA should have control over the funds disbursed (because, the WUA president and TC members of the area are misusing funds, he feels), and c) the Act should provide a clause to take back funds from the WUA, if it does not execute agreed works.

- In the process of reforms, members of the government staff, particularly those at the level of service delivery and have direct links with the users (like lascars, assistant engineers, deputy executive engineers) feel threatened, primarily because they lose their undisputed powers, the prestige attached to their positions, no more endless requests from the users for their services, and thereby a major loss in their additional earnings. Indeed, the absence or reduction in these additional earnings affects the upper hierarchy too, owing to the lack of demand for such positions, and no grease money involved in transfers and appointments. These positions, termed as "wet" positions, have now become "dry." They have to be more accountable and transparent in their dealings.

Key Lessons

This part of the paper focuses on some of the critical issues and key lessons of PIM in Andhra Pradesh. The issues deliberated are based on observations, discussions with the ID officials and WUA members, and on experiences of other states in India. At the outset, there is no road map as such to drive the WUA movement in the state during the next 5 or 10 years. But the ID has kept irrigation management transfer as its main goal. Towards that direction, the formation of WUAs, DCs and PCs is perceived as most important. "We do not have any blue print; we wanted to build as it grows" says the Commissioner of I&CAD who was the key driving force in the ID for the WUA movement.

Members of both top-level and field staff are making efforts to learn while they do things. The chief engineer of the SRSP project would like the following as a future plan to give a boost to the WUA movement in the state by a) linking water fee with revenue, b) ultimately, making WUAs responsible for collecting water fees, c) future releases of government funds to be proportionate to fee collection of WUAs, and d) development of financial management systems for farmer groups at WUA and DC levels.

Andhra Pradesh has made a beginning in large-scale PIM whose chief features are the following:

- For the first time, in the state and also in the country, a suitable legislation has been enacted. The administrators and senior engineers, with plenty of field experience, have crafted it. Users across the state and field staff hail the legislation.

- The state has mounted awareness and training camps in different parts and for different levels.
- Continuous and effective monitoring mechanism both at lower and top levels.
- A strong political will laced with administrative acceptance.

Though the state has made a good beginning it has to go a long way to claim all-round success. Even sustainability becomes crucial in the long run. The state has to gear up the process to emphasize the following key issues. Recommendations are also indicated in the appropriate places.

Necessity to Strengthen Performance Monitoring

The key question here is "what is the criterion for the performance measurement of WUAs and DCs? The performance evaluation formats (quarterly and annually) should have been devised when WUAs were formed. These formats should be on season-crop basis, covering problems, area covered, production and yield levels in their jurisdiction, activities undertaken, resources mobilization and item-wise expenditure incurred. It requires focused planning and frequent appraisals and upgrading to keep up with the growth of WUAs, their functions and allied activities.

Provision of Access and Control to WUA Area Records

WUAs and DCs should have access to revenue records related to the collection of water fees and land acquired on either side of the canal and distributaries. They should be able to grow plants and auction them or lease them periodically to mobilize resources. Thus, canal bunds would be protected and organizations will have a regular source of income. This would also help reduce silt accumulation in the canals. In each WUA, one or two TCs should also be trained in bookkeeping and their skills upgraded over time, as WUA/DC/PC activities expand. Training should focus on function-specific aspects. If one or two TC members are not willing to shoulder the responsibility, locally hired educated unemployed persons can be trained. WUA/DC/PC should agree to pay their salaries and costs. Copies of all official records[15] should be given to WUAs. This would help remove the encroachments and improve the storage level and the carrying capacity in canals of all types of irrigation systems. WUAs would be able to receive more funds on a per acre basis and collect more water fees. This would help strengthen the resource mobilization capacity of WUAs and reduce disputes relating to authorized and unauthorized areas.[16] The process of rectification, and thus revising area records, needs to be done before asking WUAs to collect water fees on their own. It was a common demand across all WUAs in the state.

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[15]These records should include information on storage levels, reservoir size, tank-bed area, canal boundary, catchment area, authorized command area with survey numbers, structures, and other irrigation and revenue details.

[16]For example, in Vamsadhara project some 40,000 acres are receiving unauthorized canal water through the use of private diesel engines. This practice had gone on for several years; yet, official records do not indicate this.

Restructure the Capacity-Building Mechanisms

In any given project area, at any time, there should be a minimum of 60 percent staff trained on PIM-related aspects. Their skill needs to be upgraded regularly. Organizers have to conduct need assessments on contents, timings and locations of the training programs. The staff needs to be reoriented to prepare case studies, design effective training and use innovative teaching methods for task-specific and level-specific programs. They may need to forge an alliance among NIRD-IRDA-HRD agencies.

The training institute WALAMTARI, under ID control, needs to be restructured, preferably on the lines of recommendations made for WALMI-Gujarat[17] to design and offer more demand-driven training programs, to recruit more productive persons on time-bound and incentive-based scales and to bring in output orientation to the institute. Currently, in spite of a strong WUA movement in the state, WALAMTARI has a few faculty members with good social science, organization behavior and management skills. This institute needs to respond to the changing needs of the state and its activities. It has to a) play a pivotal role in capacity building for the WUA movement, b) essentially, track down its road map for the next 5 to 10 years in order to be a productive partner in the WUA movement, and c) be a truly autonomous organization, free from the ID control. Its staff skills[18] should be upgraded since the training materials currently used for WUAs presidents and CAs training programs are designed by outside agencies.

Forge Institutional Alliance

As of now, the WUA movement has been mainly confined to the ID. To utilize the available expertise both within the state and outside, this movement needs to forge an alliance with NGOs and research institutes. To draw a road map, with clear milestones and financial implications, and potential outputs and inputs, it may be worthwhile to collaborate with mutually beneficial reputed institutes (e.g., the International Water Management Institute, Colombo). All these would enable better: performance measurement, appraisals and mid-course corrections, evaluation and learning from mistakes.

Focus on Organizational Principles

WUAs should be directed from the present orientation towards physical works and meetings. They should shift towards water management and productive functioning of the organization in terms of resources mobilization, long-term plans, member education, member participation, water and related activities, value-added functions, and strengthening the rule-making process and rule-enforcement mechanisms. The current method does not focus on the organizational design of WUAs. The experience with creating user organizations, especially in gravity flow

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[17]For details see Report of the Small Study Group appointed by the Government of Gujarat to evolve a plan for restructuring the Water and Land Management Institute, Gujarat, April, 1999 (draft).

[18]The Institute needs to utilize the services of all those staff trained under USAID assistance, both within and outside the country (currently most of the trained staff are posted elsewhere in the state).

systems, is still formative and are yet to yield firm design principles which will ensure that the user organizations will be capable of self-governance and self-management. The WUAs will be in jeopardy unless they begin with valid assumptions about the design principles that need to be followed to catalyze participatory user organizations. Designing energetic member organizations involves understanding their working through focusing on the interactions between their three constituent subsystems: members, the governance structure (board or management committee) and the operating system that provides the services.

Extensive research in member organizations in various fields suggests that robust self-governing user organizations achieve high levels of goal-cohesiveness, governance effectiveness, and member-need responsiveness by satisfying four design principles: a) Member-Centrality of the Goal; b) Goal-Cohesive Governance; c) Receive the Right Operating System; and d) Secure and Retain Member Faith and Allegiance.

Developing Model Projects

The AP-FMIS Act is a trendsetter for the country and also for south Asian countries. The Act remains the same for the whole state while the government orders have to make provisions for regional variations. For users, and also field staff, seeing is believing. As of now, the state has no pilot site/project to show as the model and from which to learn lessons. The state has to have demonstration sites/projects, wherein the total irrigation management transfer has taken place. Good documentation and lessons learnt will be a good guide during the training programs and for replication in the state. In the absence of that, both water users and field staff are riding on wish-horses. For demonstrative effect, in each of the three regions (Telangana, Coastal Andhra and Rayalaseema) one full major project (or a hydraulic boundary of 50,000 acres or above), one medium project, and two minor irrigation projects (or two tanks) should be taken to bring all WUAs and DCs, and form one PC. Farmers should be involved in selecting the pilot sites for full turnover.

First, bring these sites on to a dynamic function in tune with the Act and establish a true organic link across all tiers in their functions, responsibilities and roles. Each tier, wherever applicable, should be accountable both upward and downward. Gradually, in a phase-wise manner, as the tiers are strengthened, the ID should be withdrawn from all projects (under this experiment). Each tier or concerned organization level should have an office space in the regular ID office and use it for regular liaison purposes. As the number of ID staff is reduced, the WUA/DC/PC should, if they feel, increase their staff. If the user organizations are made to pay staff salaries, they will be in a better position to judge the need-based staff. Just as, today, the lascar is accountable and works under WUAs, so AEs and DyEEs should work under DCs. Gradually, this should move up to EE and SE levels.

The state has to design and attempt three different approaches, one each for the three levels of projects: minor, medium and major. While the existing Act serves a good purpose at the macro-level, in practice, for effective implementation, problems are mainly technical and social. Feasible approaches have to be evolved, designed region- and type-wise. To test the feasibility of these approaches a period of two crop seasons should be considered. Geographically, the experiment should cover three districts in three regions. In each region, it should cover a minor, medium and a major project. During the second year, the approach may be modified and extended to two more districts, and during the third year onwards it may be replicated all over the state.

Expediting the Transforming of Technocracy

In the state, the focus is on transforming technocracy. Owing to the Chief Minister's teleconferences and district collectors' frequent meetings, countless formats have to be sent to the I&CAD secretary regularly. As part of the transforming technocracy, the present setup of the organization may be restructured on the following lines. The proposed federal structure will have the WUA at the bottom and the ID at the top. The federal structure will be as follows:

- It will be self-supporting with initial corpus fund from the government.
- It will hire professionals at all levels, and will have own staff rules and incentive schemes for high performers.
- It will have rights to raise funds and loans at all levels and it will have a four-tier structure: WUAs at the bottom, DCs at the second tier, PCs at the third tier (project level) and the state-level federation at the top level.
- Each level will be self-supporting with autonomous powers, with clear rights and responsibilities and, yet, vertically and horizontally well integrated (e.g., for water acquisition, water distribution, system maintenance and fee collection). The study team feels that the federal structure as shown in figure 2 may be useful.

Separate Scheme for Tackling Tanks

The management of tanks necessitates an altogether different approach. Tank users' associations have control both of source of water and its entire distribution system. Compared to major and medium irrigation systems, tank systems are pretty old.[19] But present O&M grants at Rs 100 per acre are inadequate for any tank rehabilitation work. The growth of weeds (ipomea and others) in the tank-bed area had increasingly affected around one-third of the storage capacity, particularly in Coastal Andhra region. Farmers have reportedly said that for permanent removal of weeds, they are willing to share up to 30 percent costs. Tank-WUAs need different financial disbursements. First, they require physical rehabilitation. Prior to that, tank-WUAs should be made vibrant and responsive. This needs a special task force both at the state and regional level.[20] A time-bound plan has to be evolved in consultation with the existing tank-WUAs and, in some cases, (wherever available) district-level tank-WUA associations.

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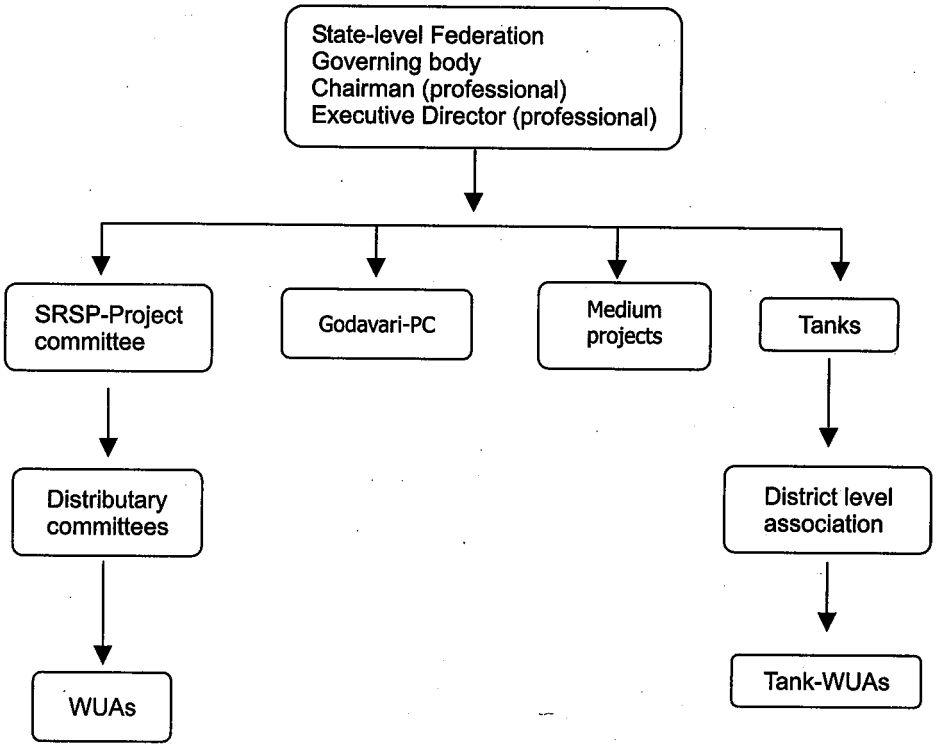
[19]A large number of rain-fed tanks in Vishakapatnam district are of the preindependence vintage. Most of them have a designed command area of 150 acres and more. In 1953, the ID took over these tanks, which had hardly undertaken any repair and maintenance works. Some of them have silt close to their surplus weir level. Most of the silt comes from nearby hillocks owing to flash floods, high slope, deforestation in the upper stream and lack of treatment of the catchment area. What is required is to desilt for sustainable irrigation and increased irrigated area.

[20]For example, Karnataka, a neighboring state, has mounted a separate project to rehabilitate 5,000 minor irrigation tanks on the community-based approach. The project has taken an integrated approach for the tank system as a whole for forming the stakeholders' association, which is quite different from WUAs in major- and medium-irrigation projects.

Figure 2. Suggested federal structure.



Facilitate Additional Resource Mobilization

The WUAs should be encouraged to attain financial independence. Towards this goal, gradually, WUAs have to increase their resource mobilization capacities through (besides the collection of water fees), auctioning rights on fish, grass, trees, silt and grazing, and they should be able to undertake allied activities. Most tanks have potential to cultivate fish and sell them for Rs 10,000 to 200,000 per year. But, until 2000, they were helpless to make use of this opportunity, owing to rules. The rules permit fishing only by fishing cooperatives at the local level, who pay some nominal amount to the Department of Fisheries. In turn, the Department of Fisheries pays some nominal amount to the WUAs. According to the Bajjipuram tank-WUA, it can receive Rs 50,000 per year as fishing rights, while presently it receives only Rs 2,000 per year from the Department of Fisheries. To improve the resource mobilization capacity of WUAs, rules need to be revised. The fishing community also does not receive any benefits. As of 1999, middlemen have profiteered.

To have more effective integration of WUAs at all levels, they need to be federated into a four-tier structure. The tiers are primary (present level), secondary (distributary or DC level), project (PC level) and apex (state level). This would enhance the coordination of various aspects (organizational, financial and manpower). This would also facilitate focusing on essential activities like water acquisition, water regulation and distribution, and moving towards equity within the WUA level and across the reaches in a project. The apex body has to take full responsibility for all these functions. It should plan and execute its activities on its own; generate funds and be able to borrow funds and receive grants on its own. The organization should lay emphasis on member-controlled WUAs, DCs and PCs. The apex body and the four-tier organization should function as vibrant and truly member-controlled organizations.[21]

Need to strengthen local and traditional approaches of labor-sharing and community efforts. Before the WUA formation, local informal committees or groups (both in tanks and canal systems) used to collect both men (one per acre or household) and money (Rs10–50 per acre or household) for essential works like cleaning canals (before the crop season began), desilting and some essential repairs. After the formation of WUAs, the perception of all farmers is that since the government is giving money the WUA president and TC members should do all the works. In general, farmers contribute neither labor nor money. The new initiative of the government has weakened the local initiatives and participation. The new initiatives are defined to be participatory but the approach is different. The new approach was imposed from outside and has little member-contribution and control while the traditional approach was locally evolved and member-controlled.

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[21]In India, such member-controlled organizations and their success stories have proved that it is possible to effectively function that way. e.g., three-tier milk societies in many states, which have created a white revolution in the country; apple growers' cooperatives in Himachal Pradesh and Uttaranchal, which have strengthened growers and, at the same time, delivered apples round the year all over the country. Locally, Andhra Pradesh can look up to the Mulkanoor Multipurpose Cooperative Society for its effective member-controlled and good servicing society.

The new approach should have taken local approaches into consideration. In this new approach local farmers should contribute first and the government may give a matching grant of twice the amount of that contribution. Local contributions should have been made compulsory on an acre basis. As many WUAs have mentioned a rate of Rs 30–50 per acre per year is ideal. Thereby, members would develop stakes in the organization and its functions. Some WUAs have suggested that the accumulated money may be deposited in a commercial bank and the interest accrued may be spent on other activities.

Replicability

The Andhra Pradesh program on WUAs is a good example of how an impossible task can be made possible. To surge ahead in a similar and a better fashion, any new state has to muster the following strengths.

- *Focus on key areas.* Emphasis should be laid on getting rid of middleman, i.e., the system of employing contractors in O&M and the users should be responsible for identifying and executing essential works for repair and maintenance. The ID's role in O&M has to be reduced.

- *Building capabilities.* Training should be given at all levels. The focus should be more on middle- and lower-level field staff. The ID staff may be trained as trainers while for the users training should be conducted in all centers. Wide dissemination of specifically prepared training material in the local language is essential. Similarly, the Act should also be made available in the local language and needs to be distributed widely all over the state.

- *Good governance.* Strong political will at the top level (at the level of the chief minister and irrigation minister) will make a positive difference. The right kind of bureaucrats needs to be identified to head the department/divisions.

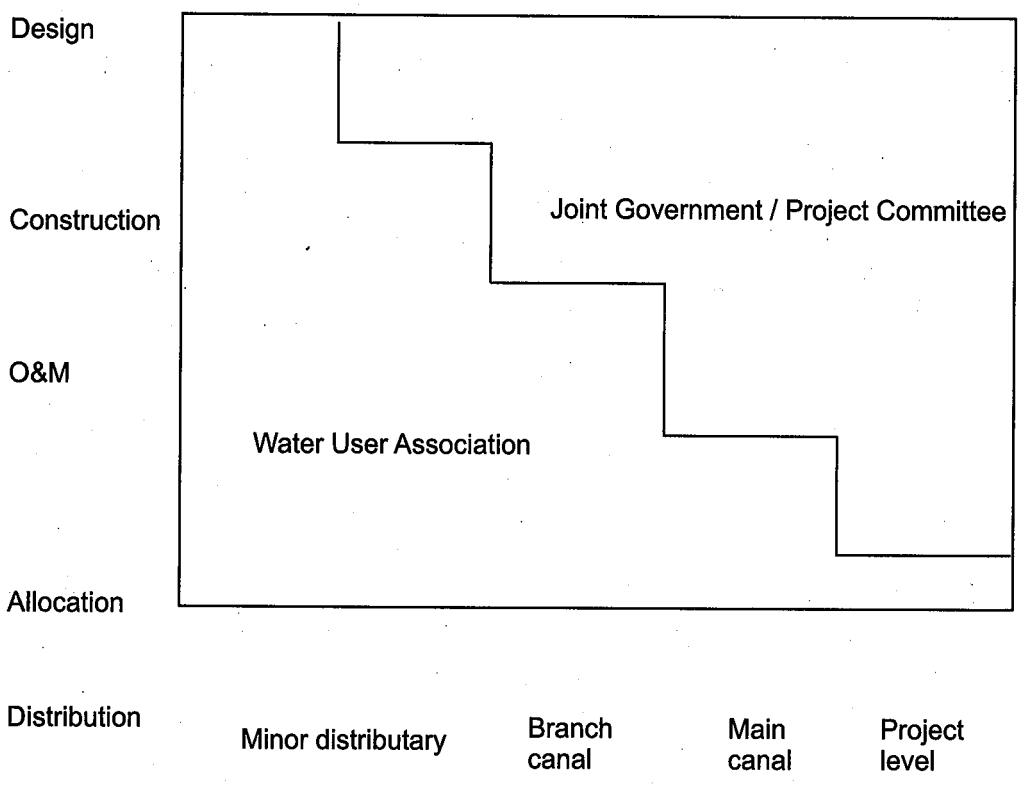
- *Effective monitoring.* Tele-conferences are required at the top level, with all district collectors and senior officials of the ID. Regular monitoring through specially designed formats by filling and filing to higher level offices and quick consolidation at the top level would help in the necessary decision-making process.

- *Institutionalization.* The PIM in Andhra Pradesh was evolved through the government setup. While in most states of India, WUA movement came through a nongovernmental or semigovernmental agency (SOPPECOM in Maharashtra, and in small scale through WALMI's in some states). In Andhra Pradesh, the ID has taken the present initiative and, thereby, it has become part of the regular ID work. It is one of the statewide department's initiative and main activity. The Competent Authority (CA) for WUAs and DCs are regular ID staff and currently they are responsible for preparing technical estimates and for authorizing work completion.

- *Large-scale operation.* This has four key features like a) do it in one shot, b) massive scale, c) learning by doing, and d) modify through government orders and continuous monitoring. Anything large is visible and will have wider implications at all levels. Large operations also demand a larger human-power effort

and related operational and organizational efforts. Large-scale operations are mounted to achieve larger outputs in one shot. If operations are spread out both in space and time, there is scope to learn by doing. If the framework is flexible to achieve the given targets, then one sees variations across regions and levels. Indeed, flexibility over time provides opportunities to modify the process. Senior officials understand that the reform process is moving towards receiving it right: learning by doing. To support the process, government orders, circulars and guidelines are issued regularly.

Figure 3. WUA and government responsibilities in the process of irrigation management. Transfer for adoption in demonstration sites in Andhra Pradesh and replication in other states.



Impressed by the performance, some states have made a modest beginning to replicate the experiment. Madhya Pradesh has already formulated legislation, mostly in tune with the AP-FMIS Act. Tamil Nadu seems to have started an internal exercise to move towards this direction. Officials of the Andhra Pradesh ID strongly feel that the states interested in replicating the experiment should have taken the Andhra Pradesh State personnel during the initial years of WUA formulation. This state could share its rich experience with other states.

Demonstration sites in both Andhra Pradesh and other states have to make well-designed and constant efforts to move towards total irrigation-management transfer. To begin with, as shown in figure 3, responsibilities of the joint government/project committee have to be minimal at the lower level of the canal distribution network. These responsibilities have to be gradually increased towards main-canal and project levels. The above chart indicates the kind of responsibilities of WUAs and the joint government/project committee across different levels of the irrigation system.

What is also essential is that both the Planning Commission and the Command Area Development wings of the Government of India should make such Acts and internal changes as a precondition for any assistance, including financial disbursements from the central government. This would help build pressure to expedite the process. In spite of having a separate component on farmers organization and turnover in the Water Resources Consolidation Project, three states (Haryana, Orissa, and Tamil Nadu) have made little progress in that direction. These three states had started their exercise, much earlier than Andhra Pradesh. On the other hand, the Indian Network for Participatory Irrigation Management (INPIM) should play a more active role at two levels: central level and state level. It should help restructure all state training institutes (like WALMI's) to respond to the emerging needs of the state irrigation sector. At the state level, the INPIM can facilitate the formulation of policy and legal frameworks, guidelines for monitoring and evaluation of WUAs and irrigation management transfer activities, and training of farmers and officials at various levels.

Annex 1

Key Provisions of the APFMIS Act of 1997

- The Andhra Pradesh Farmer Managed Irrigation Systems Act came into effect in Andhra Pradesh in April 1997. Under this Act, till July 1999, some 10292 WUAs were constituted and elections were held in June 1997. Further, 174 distributary committees for the major projects in the state had also been constituted and elections held in November 1997.

- The Act facilitates: a) the formation of WUA on the basis of a hydraulic boundary; b) the inclusion of landowners and tenants; c) making a person eligible to become a member of more than one WUA boundary; and d) the right to vote to only members (owners or tenants).

- The Act has made provisions for the election of president and members of the managing committee for a period of three years at three levels: a) WUA level, b) distributary level, and c) project level. Members have a right to recall the elected president and managing committee after one year, based on their performance.

- The Act also stipulates that the elected members are progressive. The Act says, "a person having more than two children shall be disqualified for election or for continuing as a Chairman or a President or a member of the Managing Committee;" in addition, "the person shall be disqualified, if he/she is a defaulter of land revenue or water tax or charges payable either to the government or to the WUA; and if he/she is interested in a subsisting contract made with, or any work being done for, the gram panchayat, mandal parishad, zilla parishad, or any state or central government or the WUA." Such clauses are rare to find in other Irrigation Acts of India.

- The FMIS Act has clearly underlined the objectives, functions and resources of WUA; to provide clarity, the Act also holds the government officials and WUAs responsible.

Table A-1. Water resources of Andhra Pradesh.

Sl. no.	*River system*	*Drainage area in the State in '000 km*	*Ratio of drainage area to the total area of the State (%)*	*Assessed annual yield in the State (million ha)*	*Remarks*
1	Godavari	73.201	26.45	4.23	Assessed
2	Krishna	74.382	26.88	2.30	Allocated
3	Pennar	48.111	17.39	0.28	Assessed
4	Nagavalli	4.833	1.75	0.14	Assessed
5	Vamsadhara	1.934	0.70	0.04	Allocated
6	Other minor rivers draining into the sea	74.239	26.83	0.79	Allocated
	Total	276.700	100.00	7.78 (2746TMC)	

Source: NWMP Phase II: Vol. I Project profile, A.P. State.

Table A-2. Andhra Pradesh profile of plan expenditure and irrigation potential created.

Sl. no	Period	Amount spent (million RS)			I. P. created (million ha)		
		Major & medium	Minor	Total	Major & medium	Minor	Total
1	Pre-Plan Period 1951	-	-	-	1.332	1.372	2.704
2	First Plan (1951-56)	374.7	35.2	409.9	0.079	0.025	0.104
3	Second Plan (1956-61)	574.3	43.8	618.1	0.181	0.016	0.197
4	Third Plan (1961-66)	915.2	186.0	1101.2	0.368	0.050	0.418
5	Three Annual Plans (1966-69)	608.7	108.1	716.8	0.078	0.037	0.115
6	Fourth Plan (1969-74)	1187.1	181.5	1368.6	0.190	0.063	0.253
7	Fifth Plan (1974-78)	2691.1	388.2	3079.3	0.213	0.092	0.305
8	Two Annual Plans (1978-80)	2576.9	237.9	2814.8	0.154	0.057	0.211
9	Sixth Plan (1980-85)	7295.9	411.0	7706.9	0.305	0.082	0.387
10	Seventh Plan (1985-90)	13064.0	1314.0	14378.0	0.089	0.067	0.156
11	Annual Plan (1990-91)	2827.5	477.7	3305.2	0.006	0.009	0.015
12	Annual Plan (1991-92)	3339.2	485.8	3825.0	0.009	0.007	0.016
	Total	35454.6	3869.2	39323.8	3.004	1.877	4.881
Eighth Plan (1992-1997) anticipated		22653.2	1869.2	24522.4	0.042	0.040	0.082
Grand Total		58107.8	5738.4	63846.2	3.046	1.917	4.963

Notes: a) The above values do not include expenditure on CADA up to the Seventh Plan.
b) These above values have been adopted from the eighth Five Year Plan (1990–95) AP-F&P (PLG) Department, Oct.'90 Vol.11, Sectoral Programme.

Table A-3. Average yield per hectare, area and turnout of principal crops, 1993–94.

Sl. No.	Crop	Region	Estimated average yield (kg/ha)	Area under the crops	Production ('000 tonnes)
(1)	(2)	(3)	(4)	(5)	(6)
1	Rice*	Coastal Andhra	2,952	2,249	6,417
		Rayalaseema	2,622	293	752
		Telangana	2,381	1,005	2,393
		Andhra Pradesh	2,759	3,547	9,562
2	Jowar (Sorghum)	Coastal Andhra	945	55	52
		Rayalaseema	1,037	215	223
		Telangana	763	783	597
		Andhra Pradesh	828	1,053	872
3	Bajra (Millet)	Coastal Andhra	943	62	59
		Rayalaseema	1,034	32	33
		Telangana	374	49	18
		Andhra Pradesh	778	143	110
4	Ragi (Finger millet)	Coastal Andhra	1,059	79	84
		Rayalaseema	1,775	29	51
		Telangana	874	32	28
		Andhra Pradesh	1,164	140	163
5	Maize (Corn)	Coastal Andhra	2,497	30	75
		Rayalaseema	2,292	2	4
		Telangana	2,562	272	697
		Andhra Pradesh	2,554	304	776
6	Sugarcane	Coastal Andhra	72,837	187	8696
		Rayalaseema	79,048	50	2348
		Telangana	75,590	68	4013
		Andhra Pradesh	74,464	305	15057

Source: Directorate of Economics and Statistics, Andhra Pradesh.

* Paddy is 1.5 times the weight of the finished product of rice.

Table A-4. District-wise/Sector-wise WUAs in Andhra Pradesh (as on 20 May 1999).

Sl. No.	Name of the district	Total no. of WUAs notified			Total Notified
		Major	Medium	Minor	
1	Adilabad	35	27	221	283
2	Ananthapur	46	7	305	358
3	Chittoor	0	51	644	695
4	Cuddapah	74	8	276	358
5	East Godavari	106	12	225	343
6	Guntur	245	8	81	334
7	Karimnagar	249	10	586	845
8	Khammam	50	4	183	237
9	Krishna	189	12	288	489
10	Kurnool	116	12	153	281
11	Mahabubnagar	21	31	478	530
12	Medak	0	12	585	597
13	Nalgonda	91	45	538	674
14	Nellore	110	58	695	863
15	Nizamabad	78	13	267	358
16	Prakasam	124	5	317	446
17	Ranga Reddy	0	3	165	168
18	Srikakulam	37	28	459	524
19	Visakhapatnam	28	18	375	421
20	Vizianagaram	0	25	439	464
21	Warangal	29	18	683	730
22	West Godavari	71	6	217	294
	Total	1,699	413	8,180	10,292

Table A-5. District-wise/Sector-wise WUAs (as on 23 March 2000).

Sl No.	Name of the district	Major	Medium	Minor	Total notified (3+4+5)	Major	Medium	Minor	Total elections conducted (7+8+9)	Stay by court	Stay by govt.	Other reasons	Total elections to be held (11+12+13)	Total No. of WUAs (10+14)
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1	Adilabad*	35	27	221	283	35	27	212	274	3	0	6	9	283
2	Ananthapur	46	7	305	358	46	7	302	355	3	0	0	3	358
3	Chittoor	0	51	644	695	0	48	616	664	1	15	15	31	695
4	Cuddapah	74	8	276	358	74	8	259	341	8	4	5	17	358
5	East Godavari#	106	12	225	343	106	12	215	333	7	0	3	10	343
6	Guntur	245	8	81	334	239	8	76	323	3	6	2	11	334
7	Karimnagar	249	10	586	845	249	10	571	830	4	0	11	15	845
8	Khammam	51	5	181	237	50	5	180	235	0	2	0	2	237
9	Krishna	189	12	288	489	166	12	256	434	1	20	34	55	489
10	Kurnool	116	12	153	281	114	12	145	271	4	2	4	10	281
11	Maha-bubnagar	21	31	478	530	21	29	473	523	1	6	0	7	530
12	Medak	0	12	585	597	0	12	551	563	2	0	32	34	597
13	Nalgonda	91	45	541	677	91	44	541	676	0	1	0	1	677
14	Nellore	110	58	695	863	100	57	612	769	22	72	0	94	863
15	Nizamabad^	78	13	267	358	78	13	228	319	3	0	36	39	358
16	Prakasam	124	5	317	446	113	4	291	408	16	11	11	38	446
17	Rangareddy	0	3	165	168	0	2	165	167	0	0	1	1	168
18	Srikakulam	37	28	459	524	37	28	442	507	6	1	10	17	524
19	Visakha-patnam**	28	18	375	421	28	18	369	415	0	1	5	6	421
20	Vizia-nagaram	0	22	439	461	0	21	422	443	0	0	18	18	461
21	Warangal	29	18	683	730	28	18	623	669	1	0	60	61	730
22	West Godavari	71	6	217	294	70	6	205	281	1	0	12	13	294
	Total	1,700	411	8,181	10,292	1,645	401	7,754	9,800	86	141	265	492	10,292

*Includes 9 WUAs under Vattivagu & Chelamalavagu.
**Includes TANDAVA (part only).
#Includes 12 WUAs under TANDAVA.
^Includes 7 WUAs under Koulasnala.

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Paradigmatic Change in the Indonesian Irrigation Development: From Rice-Based to People-Based Policy

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Introduction

The economic crisis that Asia has been experiencing since 1997, following the depreciation of the Thai Baht, has resulted in a unique crisis in Indonesia. The uniqueness of the crisis can be seen in multidimensionality and the extent of the crisis. The latter has left the Indonesian rupiah comparatively the most affected local currency by the Asian crisis, with the longest impact.

The crisis in Indonesia actually began months before the Asian crisis came. The Indonesian macro economy at that time was disturbed by serious natural calamities in the forms of extensive forest fire destroying a large forest area and a very long drought destroying agricultural production. Before the country fully recovered from the natural crisis, Indonesia joined several countries that faced the Asian financial crisis by the end of 1997. While Indonesia is still in the middle of facing an economic crisis, it suddenly faced a sociopolitical crisis. Soeharto who had governed Indonesia for more than three decades was forced by the students to step down as the president of the country, 2 months after receiving the mandate of the People's Assembly (MPR).[3]

It is globally admitted that this crisis significantly originated from the economic development model adopted by the authoritarian government, which was very fragile and had no strong economic foundation. A reformation movement following the economic crisis has been sociopolitically anticipated by the *newly established* democratic government under Habibie, Wahid and Megawati as the third, the fourth and the fifth Presidents of Indonesia, respectively, to review overall national development policies and conduct necessary policy reformation at all levels.

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[3]Maksum 2001.

The country's irrigation development policy was not an exception. This development sub sector had been very strongly positioned to support the rice-biased agricultural development for the sake of self-sufficiency in food. Radical reformation of the national irrigation policy that has been well drafted and socialized strongly indicates the need for having a more comprehensive and socially sensitive development policies. Otherwise the agriculture sector would be dampened deeper into its sectoral and structural poverty in the *next crisis.*

Marginalized Irrigated Agriculture

The Indonesian experience in the crisis means many things for the agriculture sector. It is now nationally accepted that the agriculture sector of Indonesia has been impoverished within the country's economic development model characterized, among others, by a) the adoption of the top-down development model, b) development based on foreign capital and foreign input, c) industry-biased development, and d) rice-biased development in agriculture.[4]

Such a development model has successfully improved the living standard of the country but with a very limited attention to the need of attaining the *growth-equity-sustainability*[5] objectives of the country's development. The first three characteristics have been able to provide an average annual growth rate of about 7 percent to the country's economy for the last decade by abnormally concentrating on high-technology-intensive industry (HTI), capital-intensive industry (CII), and skilled-labor-intensive industry (SLI). The abnormal bias in these industries has resulted in a favorable economic growth at the expense of other industries, namely, natural resources-intensive industry (NRI) and unskilled-labor-intensive industry (ULI), the two industrial sectors shouldering the economy of the majority of the citizens.

This policy bias to HTI, CII and SLI, which penalized NRI and ULI, could be observed in many cases. Industry-biased credit distribution, industrial development and local currency protection, among others, had made a robust growth in the three industries but at the same time made NRI and ULI to be extremely high cost, inefficient and less- competitive industries. Through this mechanism, the Indonesian agriculture sector has been structurally impoverished for the last decades.[6] Poverty incidence dominated in rural areas could be partly attributed to this policy bias.

The implication of sectoral poverty to the country's irrigation development is very clear. As far as agricultural development is concerned, the rice-biased and industry-biased development policy had made the agriculture sector marginalized for the sake of rice production *at all cost.* Nationwide agricultural development in the country before entering into its reformation era was completely designed and dedicated for delivering production-oriented rice development. Consequently, overall supporting systems, including irrigation, have been developed for producing rice.

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[4]See Maksum 2001.

[5]The critical triangle as cited by Maksum 1997.

[3]See Maksum and Arif 2001.

Because of agricultural and irrigation development the country has been very successful in attaining self-sufficiency in rice, which attainment has been significant since 1984. However, this success in rice was not very well accompanied by proportional improvement in the people's welfare in agricultural and rural areas. Table 1 shows poverty trends in Indonesia for the period 1976-1999.

Table 1. Poor population in Indonesia, 1976–1999.

Year	Rural Poor (in millions)	Urban Poor (in millions)	Total Poor (%)	Poor Population
1976	44.2	10.0	54.2	40.08
1979	38.9	8.3	47.2	32.3
1980	32.8	9.5	42.3	28.6
1981	31.3	9.3	40.6	26.9
1984	25.7	9.3	35.0	21.6
1987	20.3	9.7	30.0	17.4
1990	17.8	9.4	27.2	15.1
1993	17.2	8.7	25.9	13.8
1996	15.3	7.2	22.5	11.4
1998	31.9	17.6	49.5	24.2
1999	32.3	15.6	48.0	23.4

Source: Recalculated from the Central Bureau of Statistics.[7]

This "rice-biased agricultural development" has, to some degree, the same damaging impact as the other characteristics of the country's development model on agricultural development. Among other impacts are: a) its production approach has allowed the farmers to remain poor; b) input dependency of rice farming has made the sustainability of rice questionable; c) rice-biased agricultural policy has left almost no incentive to other agricultural commodities; d) non-rice economic development, including R&D, was very minimal; e) diversification of crops has been discouraged; f) more MNCs are dependent of the non-rice production system; and g) the food-security profile tends to depend on a single staple food, which is rice, instead of diversified staple foods as previously practiced by Indonesians. In turn, due to sectoral mal-development, the agriculture sector in general, including forestry and fishery, has hardly gained any global trade advantage during the crisis.[8]

[7]From various papers published by the Central Bureau of Statistics (CBS) of the Republic of Indonesia. This poverty statistics however, according to Dillon (2001), leaves approximately 50 million people classified as a near-poor community, which is very fragile to any poverty line changes. For details see Dillon 2001.

[8]Export development of the agriculture sector showed minimum growth in 1997 and 1998, while some industries in this sector showed even a negative growth. When local currency depreciated, this negative or minimum growth of domestic-based sector should not have been the case if sectoral development has been normal.

In criticizing this agricultural and irrigation development paradox, a national workshop on structural poverty in irrigated agriculture conducted in the Center for Rural and Regional Studies, Gadjah Mada University, 1999[9] recommended that the poverty incidence in irrigated area in Indonesia was very much influenced by structural problems. Therefore, it must be considered as structural poverty[10] by any development intervention. Otherwise, any intervention policy formulated would never be very sensitive to poverty alleviation needs.

It has been well mentioned in the introductory part of this paper that irrigation policy reform within the period of political reformation was initiated in 1999. Since then the Irrigation Policy Reform Committee has been working hard to socialize its policy draft to stakeholders in irrigation for consultative and enrichment purposes. Though it does not solely guarantee the success of irrigation development in the country, people may hope that it might serve as the basis to better develop the country's irrigated agriculture with a more proportionally humanistic consideration.

Irrigation Management Policy Reform

The preliminary draft of the Irrigation Policy Reform, which has been strongly supported by the Gadjah Mada University, has been subjected to public revision. Based on public consultation and socialization, that preliminary draft has been intensively revised. Since its initiation, several experiments of this policy reform implementation have also been executed at the grassroots level to search for possible lessons that could be learned.

Basically, the previous irrigation development policy was, in fact, designed for poverty alleviation purposes through the improvement of agricultural production. To attain that objective, three basic strategies were adopted: a) infrastructural development, b) provision of incentives to farmers, and c) institutional development.[11] In accordance with this strategy, therefore, irrigation development was very strongly concentrated on a) target-oriented physical development, b) an engineering approach with engineering-economic considerations, c) a very centralistic approach, and d) homogeneity of the implementation approach.

Based on this strategy, coupled with the fact that the country's macroeconomic policy has been strongly dominated by an industry-biased and a growth-oriented economic policy, irrigation development has been very successful only in providing rice-self sufficiency without proportional consideration to the need for considering a humanistic approach in attaining development objectives. Sociocultural jumps have significantly characterized irrigation development because irrigation development was centralistically planned without prior understanding that irrigation development is, in fact, a sociocultural phenomenon closely related to social change. This is presented in figure 1.

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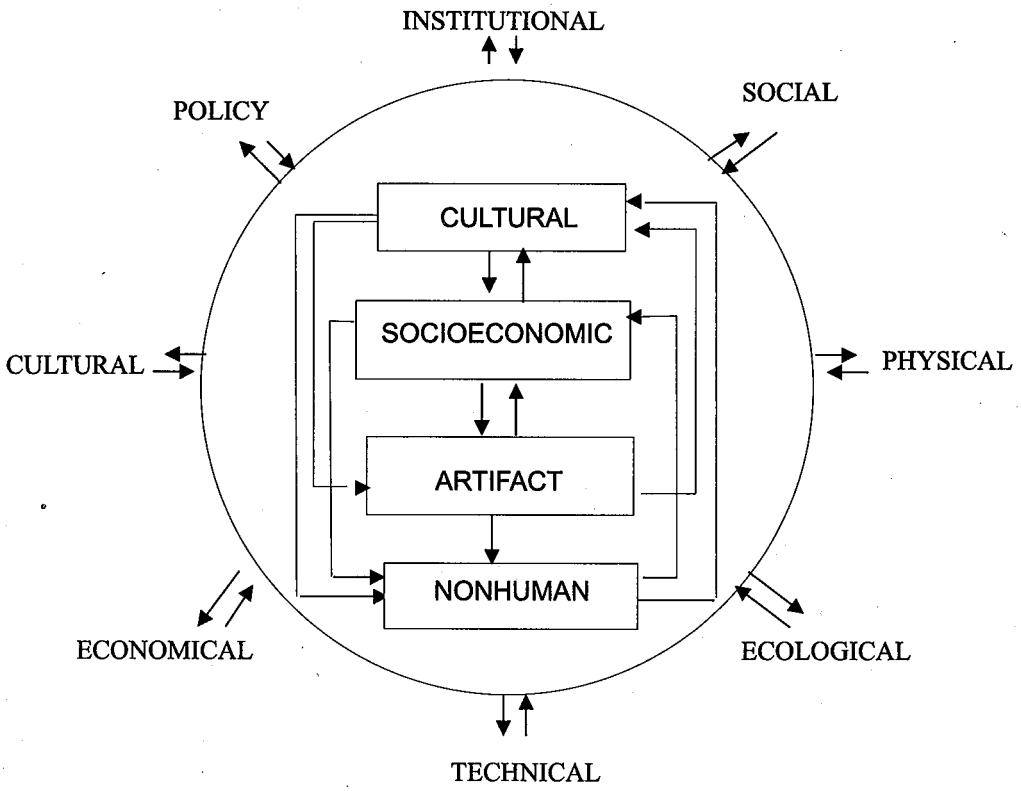
[9]That workshop was conducted by the Center for Rural and Regional Development Studies (CRRDS) of Gadjah Mada University in cooperation with KIKIS, Percik and AUS-Aid. December, 1999.

[10]Several basic problems connected with structural poverty in irrigated agriculture recommended by the KIKIS workshop are summarized in Maksum and Arif 2001.

[11]This is elaborated by S. S. Arif in his keynote address delivered at the International Seminar on Water Resources for Sustainable use in Indonesia. Bogor, 29 October-1 November, 1992.

Figure 1. Irrigation management as a sociocultural system of the existing community in equilibrium with the surrounding environment.



In anticipating the need to consider and understand that irrigation development is a process of sociocultural changes, the Government of Indonesia, in a formal Cabinet meeting in October 1999, formally recommended the application of participative approach in any stage of irrigation development. In addition to this, the government established a Working Committee to intensively review existing policies and to formulate necessary adjustments in water-resources policies. For the case of irrigation, the committee was then formalized on 26 April 1999 with the issuance of the Presidential Decree No. 3/1999 on Pembaharuan Kebijakan Pengelolaan Irigasi, PKPI (Irrigation Management Policy Reform-IMPR).

Substantially, the primary principle of this IMPR-1999 is community empowerment translated into its five principal policies, namely: a) redefining the duty and responsibility of irrigation institutions, b) institutional capacity building of water user associations (WUAs), c) turning over of irrigation management to WUAs, d) the collection of irrigation fees, and e) irrigation system sustainability.

Right after the formulation of IMPR-1999, implementation programs have also been executed and socialized to both the district and the provincial governments all over the country. At present, the provincial governments are preparing for the implementation of the irrigation management transfer (IMT) to WUAs.

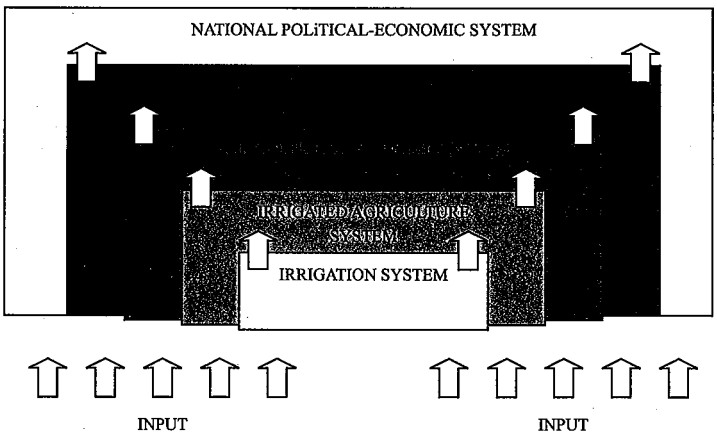
Implementation Constraints of IMPR

The initial period of implementation of IMPR-1999 could be considered very transitional, and therefore, potential constraints could be easily observed in the field. Empirical findings connected with the implementation of Presidential Decree No. 3/1999 could be summarized, among others, as follows: a) limited support of macro-level policy, b) human resources capacity constraints, c) sociocultural heterogeneity, d) limited availability of data and information, e) weaknesses in the management function, particularly connected with the coordination of institutions concerned, and f) limited financial availability.[12]

To illustrate the macro-level problem, it would be easier to understand by considering an irrigation system as a nested system as shown in figure 2.[13] IMPR has been formulated at the top level and has been empirically experimented at the grassroots level. However, the top and the grassroots level are connected by a large *gray area* of many systems between the two, which are not favorable to agricultural development. Overall trade policies in this country are still biased to the off-farm sectors as compared to the agriculture sector.

The second constraint, human resources problem, is closely related to the development model that has been adopted for decades. The monocentric and authoritarian development model has marginalized and domesticated the participation of the community in all aspects of development. Local initiative and capacity have not gained any accommodation and, in turn, have resulted in community apathy and passivity. Under the changing government system towards polycentricity and autonomy, community empowerment is urgently needed. The understanding of sociocultural heterogeneity of Indonesia is constraining the IMPR

Figure 2. Irrigation system as a nested system.



[12]For further discussion of this, see Arif 2000.

[13]The figure is adopted from Small and Svendsen 1992

implementation during transition from production- oriented agriculture towards people-based development.

Lessons Learned from IMPR Implementation

Just after the national irrigation policy reform was launched in April 1999, the World Bank supported implementation of the reforms in four provinces in Java under the Java Irrigation Improvement and Water Resources Management Project (JIWMP)-Irrigation Development and Turnover Component (IDTO). In this connection, Gadjah Mada University has done some research on those five policy reforms. For the first policy, redefinition of role and task of irrigation institutions, the university conducted research with the same title in East Java Province. The objectives of the research were a) to gather public opinions on the role, task and structure of irrigation institutions at provincial, district and irrigation-system levels and b) to develop strategy and implementation programs on restructuring irrigation institutions at all levels of management. Ten districts were selected as case study areas based on the historical and cultural background of the districts, size and complexity of irrigation schemes and performance of irrigation institutions.[14]

Results of study showed that most WUAs in the study area were ready to manage irrigation up to the secondary level, with some conditions, i.e., a) O&M in the secondary level is done by the WUAs, but farmers still need some technical assistance and subsidies for heavy maintenance and rehabilitation of irrigation infrastructures. WUAs also want that government subsidies should go directly in cash to WUAs and they will construct the structures by themselves instead of contracting the project to any company, b) WUAs are proposed to be members of the irrigation committee at district level, so they have enough power to control and access decision-making process in water allocation, c) WUAs should be involved in all stages of management including planning, construction, monitoring and evaluation, and decision making, and d) irrigation fee is managed by WUAs and not to by district governments, as previously done, and farmers agree that some parts of the fee will be submitted to the government as irrigation service fees.

According to farmers, the role of government should be limited. At the district level, the government role in irrigation management should be only in a) O&M at primary levels, b) providing technical assistance and subsidies if necessary, c) facilitating training and empowerment of farmers and farmer's institution, d) facilitating the information system, especially in water availability and market, e) facilitating dialogue on water allocation among users in river system, and f) facilitating dialogue when conflicts occur either among farmers or between farmers and the government in irrigation schemes.

At the provincial level, the role of the government is almost the same as that of the district government and these roles are necessary whenever the district government is unable to do their tasks. The provincial government is also responsible for developing a planning and macro strategy of irrigation management in the province.

On the other hand, bureaucracy at all levels is still worried about the capacity and ability of farmers to do all of their tasks as have been proposed. One reason to support their opinion

[14]This finding is elaborated in UGM 2000.

is that irrigation management had been implemented under monocentric management with strong government dominance for a long time. As a result, farmers seem to be not ready to accept the change.

However, this is not true for all parts of Indonesia. For example, farmers have been able to manage their irrigation schemes appropriately in Papah Irrigation Scheme in Kalibawang Irrigation System of Yogyakarta Province and Pehngaron Irrigation Scheme of East Java. In Papah, for example, the success story starts with a good collection rate of the irrigation-service fee. About 100 percent of the fee could be collected from the farmers. The turnover program at secondary level has already been implemented since 2000. WUAs in the scheme are responsible for irrigation management at the secondary level but they also contribute some funds for minor repairs at the primary level in the irrigation system. In Pehngaron, gate tenders are no more needed as most of the works are done by the farmers themselves.

In the second policy, empowerment of farmers and farmer's institutions, Gadjah Mada University (GMU) is one of the institutions that introduced the participatory approach in irrigation management. This approach has been introduced to the government by the GMU since 1995 and it has given good results, especially in changing mindsets of the irrigation bureaucracy at the national level, from a technical approach to a holistic management approach.

The socialization of the participatory approach to lower levels of the irrigation bureaucracy was done quite intensively; however, it did not show significant results. In the past, the bureaucratic community adopted a technical approach ignoring sociocultural aspects of irrigation management. They were not interested in developing a social approach to understand the social aspects such as the application of the participatory approach. The second constraint faced in applying the new approach was that the district government has been rarely involved in decision-making processes and planning. Mostly, they were only involved in implementing programs. So, it has made most bureaucratic peoples at district levels to face difficulty in developing an appropriate development planning process, especially during the era of polycentricity and autonomy.

Prior to implementation of the new concept, a committee established by the local government collected irrigation service fees directly from the farmers. The committee consisted of several members from various institutions including WUA members. Then the committee submitted all the collected fees to the local government treasury. Some part of the fee was allocated for O&M works without any consultation with farmers. Seemingly, this procedure was not transparent and accountable. It made farmers not to pay fees any longer. Considering this, the government changed the procedure of fee collection. Under the new procedure, WUA collects the fee directly from farmers and then part of the fee is allocated for O&M of infrastructure in their own scheme. It appears that farmers feel satisfied with this procedure, for example, farmers in Papah Irrigation Scheme and also in other schemes in Kalibawang Irrigation System now pay 100 percent of the irrigation service fee.

Arif et al. (2000) conducted a study on sustainability of irrigation systems in three large irrigation systems in three locations close to the capital of three provinces in Java, i.e. Yogyakarta, Bandung, and Surabaya. In this study, irrigation system sustainability was classified into four categories, i.e., physical, social, economic and environmental. Results of study showed that there were no serious threats to the physical sustainability in all irrigation

systems. It was only in East Java (in Sidoarjo that is located closed to Surabaya, the capital of province), that area index slightly decreased due to land conversion. However, serious threats in terms of economic and social unsustainability occurred in all systems studied, in terms of low economic and financial returns from farming. Most farmers in all the study areas were moving towards off-farm activities. In West Java, pollution due to industrial waste was very severe

Concluding Remarks

The economic development model of Indonesia was strongly concentrated on its capital-accumulation strategies with strong support for state-building measures. Industrial choices have made the natural-resources-intensive industry and unskilled-labor-intensive industry marginalized and trapped into its sectoral and structural poverty (table 2). The irrigation sub sector as supporting input to agriculture suffered about the same structural marginalization. Based on the fact that its structural incidence has never been taken into account, the poverty alleviation program in rural areas showed limited progress.

Table 2. Basic problems connected with structural poverty in irrigated agriculture.

No.	Basic Problems	Observed Problems
1	Power relation	Top-down development Low bargaining power in input and output market Input-dependent farming Low profitability Unclear rights on production input (water)
2	Institutional infrastructure	Government-oriented rural institutions Village Unit Cooperative (KUDs) functioning more in favor of input companies and local capitalists Low credit availability, Bank Plecit is more favorable Farmer union is a wrong representation of the farmers Low agriculture and irrigation research
3	Constraining policies	Industrial-biased economic policy Rice-biased agricultural development Pricing policy in favor of urban community Capitalist-oriented export policy Diversification technology availability Production-based agriculture and irrigation
4	Environment	Water availability, certainty, reliability Higher input dependency of agricultural land High land conversion Lower carrying capacity Higher population pressure and rural dependency of the economy
5	Cultural constraints	Apathy of the majority of farmers More fragmented land Women's role limited Subsistence-oriented farming

Irrigation has been designed and developed to support agricultural development of the nation in delivering self-sufficiency in rice without proportional consideration to the farmers. Consequently, under successful attainment of national self-sufficiency in rice, overall aspects of human development were minimally attained. It is ironical that farmers remain very poor within regions that are self-sufficient in rice. In addition to this, local initiative, indigenous capacity, participation of men and women in development, and other aspects of human development have been degraded due to the adoption of centralistic, authoritarian and a locally insensitive development model.

Sociopolitical reformation, which has been initiated by the country for the last few years, has made the country busy in reviewing its developmental policies. Irrigation and agriculture sectors are not exceptions. For the case of irrigation development, an irrigation policy reform committee has been established since 1999. Through intensive consultative and socialization activities, the Irrigation Management Policy Reform (IMPR) has been soundly produced and implemented at the grassroots level on an experimental basis. However, empirical evidence shows that necessary interventions are still unnegotiably required to bring more prosperity to the people.

Empirical evidence also shows that the existence of an intermediate-level policy, such as: financial policy, limited credit provision, poor extension activity, crop diversification technology, agricultural research and development, etc., has limited the attainment of IMPR implementation at the grassroots level. To have a more effective IMPR, reform of the intermediate policy is also needed as a poverty alleviation support system.

Several years of IMPR field experience connected with paradigmatic changes in irrigation development proved that it is not an easy task to shift from the centralistic and authoritarian towards a polycentric and autonomous development model, or particularly in this case, from a rice-biased irrigation development towards a people-based one. Strategic interventions in approaching this people-based development should, therefore, cover empowerment measures towards the expected sociocultural changes.

We have to admit that, for the case of irrigated agriculture in Indonesia, intervention strategies for poverty alleviation at the grassroots level, through crop diversification, input provision, irrigation efficiency, and the like, are very far from enough. Intermediate policy measures in the forms of favorable market policy, better credit provision, market information, technology development, and agricultural R&D are very important in supporting the effectiveness of any pro-poor intervention program at the farm or community level.

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Irrigation and Poverty in Pakistan: A Review of Policy Issues and Options

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Introduction

It is gospel truth that no life, human or otherwise, is possible without water. It is because of scarcity of water that the world's major deserts with inadequate rainfall have little or no vegetation. The annual precipitation in major areas of Pakistan does not exceed 10 inches and is heavily concentrated in the monsoonal months of July–August (Pakistan 2000). Thus the possibility of any crop production would critically depend on the availability of irrigation water, which can truly be regarded as the lifeblood of Pakistan's agriculture. Realizing the significance of irrigation water, Pakistan has built a huge irrigation system comprising 3 earth-fill dams for storage of water, 19 barrages, 12 link canals, 43 irrigation canals extending over a length of 58,500 km and nearly 100,000 watercourses with a total length of 1,621,000 km (Gill 1996). In addition, more than 530,000 tube wells are also currently pumping underground water for irrigation. In spite of all this, the available water supplies fall much short of Pakistan's crop-water requirements. According to the required delta of water only about 75 percent is available from various sources of irrigation and the situation is likely to worsen by 2010 when Pakistan will be able to meet only 55 percent of its requirements (WAPDA 1997). This state of affairs has tended to constrain Pakistan in terms of scarcity of water, inability to expand the irrigation frontier, low agricultural production and high unemployment rates and endemic rural poverty. If allowed to persist indefinitely, Pakistan will soon be caught up in a helpless economic crisis.

To overcome these problems, Pakistan must resort to either increase the available supply of irrigation water or raise its use efficiency. While there is large scope for the latter, little can be accomplished through the former option. This is because sustainable use of water is governed by the fact that withdrawal of water from reservoirs, barrages or other sources cannot increase faster than it is replenished through the natural hydrological cycle (Bhatti et. al 1997).

In light of these constraints, it is the purpose of this paper to highlight the salient features of Pakistan's irrigation system with special emphasis on a) history of irrigation water development and current status of irrigated agriculture, b) evolution of different irrigation policies along with their implications for the poor, and c) macro-economic policies and their impact on poverty. Given this outline, we proceed to exhaust its subcomponents in detail.

History of Irrigation and Current Status of Irrigated Agriculture

The history of Pakistan's irrigation system spans over many centuries. The use of floodwater for crop production involves the entire history of the human race. Archaeological remains testify to the great antiquity of controlled irrigation by wells as far back as the Indus civilization. Tanks and inundation canals were important sources of irrigation during the ninth and tenth centuries (Habib 1963). While wells, tanks and uncontrolled flow canals were increasingly used during the entire Mughal period, the Persian wheel became another novelty of the period (ibid.). However, with the decline of the Mughal Empire, most of these canals closed down due to silting and poor maintenance.

Development of Surface Irrigation

Although inundation canals continued to flourish, a new era of irrigation development began under the British rule with the construction of the Bari Doab canal (now in India) as the first canal having permanent masonry head-works. This was followed by the construction of a number of weir-controlled canals in the Punjab and the North-West Frontier Province (NWFP). These included the Sidhnai canal, the Lower Chenab canal, the Lower Jhelum canal in the Punjab and Kabul and Swat canals in NWFP.

The program of irrigation development was sharply expanded beginning with the twentieth century. The major canals built in the Punjab included triple canals, Sutlej Valley canals, Thal canal, Taunsa barrage and a number of link canals. The triple canals involved the construction of the upper Jhelum, the upper Chenab and the lower Bari Doab canals. The Sutlej Valley canals now falling in Pakistan territories involved such canals as Fordwah, Pakpattan, Bahawal, Quimpur, Mailsi, Panjnad and Abbasia. The Thal canal from Kalabagh on the Indus river and the Haveli canal from the Trimmu head-works at the confluence of the Chenab and Jhelum rivers also went through the completion process. In addition, three link canals, namely Bambanwala-Ravi-Bedian-Dipalpur (BRBD), Balloki-Suleimanki (BS) and Marala-Ravi (MR), were also undertaken for improvement of supplies to various areas (West Pakistan 1963).

In NWFP, a multipurpose (irrigation and power generation) canal was taken out from the Swat river to irrigate the plains of Dergai and Mardan districts between 1990 and 1930. The Paharpur canal was constructed to irrigate parts of the D. I. Khan division.

Until 1920, the province of Sindh still depended on inundation canals for irrigation. To bring it at par with other provinces, the need was to start a more vigorous program. As a consequence, the construction of the Sukkur barrage and seven canals followed. The canals that originate from the Right Bank are Northwest, Rice and Dadu canals and those originating from the Left Bank are Rohri, Easter Nara, Khairpur West feeder and Khairpur East feeder canals (West Pakistan 1963).

In the period following independence in Pakistan irrigation development was pursued with even more renewed vigor than under the British rule. Right at the time of independence in 1947, Pakistan decided to take up the construction of the Kotri barrage for irrigation of lower Sindh. This barrage involved the construction of the Katri Beghar feeder, Panyari, Fuleli

and Akram Wah (lined channel) canals. As work on this barrage reached its final stage in 1955, all formalities on the initiation of the Guddu barrage were in order. The project involved digging of three canals, namely, Begari Sindh feeder, Desert feeder and Ghotki feeder to be completed by 1963. Beginning in 1954, a weir across the Kurram river was constructed for irrigation canals of the Kurrum upper main canal, the Kurram lower main canal and the Marwat canal (Ahmad and Chaudhry 1988).

Under Indus Water Treaty signed in 1960 with India, huge replacement works were carried out in major irrigated areas of Pakistan. They mainly centered on link canals, barrages, siphons and earth-fill dams, the Rasul-Qadirabad link, the Qadirabad-Bulloki link, the Bulloki-Suleimanki link, the Taunsa-Panjnad link, and the Chashma-Jhelum link came into existence. Chashma, Rasul Qadirabad and Sidhnai along with the Mailsi siphon were the new barrages. Mangla and Turbella (world's largest earth-fill dam) were part of replacement works under the Indus Water Treaty. More recently, the Chashma and Hab dams have also been converted into earth-fill multipurpose dams. Apart from regulating irrigation water supplies, these dams also provide secondary benefits of power generation and flood protection.

Although it is difficult to extend irrigation water to major areas of Baluchistan, part of the Hab dam water has been used for irrigation in the Bela district. Canals have been dug to supply irrigation to the Nasirabad district from the Indus river.

Tapping the Underground Aquifer

As indicated earlier, wells and Persian wheels have been historically used for mining underground water resources for irrigation purposes. However, the full potential of these resources could not be exploited due to manually or animal-operated systems. With the availability of motorized power in the 1960s, tube wells revolutionized the entire system, which began to increase at a rapid pace. Within a decade and by 1970–71, the number of tube wells had reached 98,000. The number rose to 200,000 by 1980–81, to 340,000 by 1990–91 and exceeded half a million in 1999–2000. As the number of public tube wells has been on the decline since 1989–90, the increase in the total number of tube wells in the 1990s must be largely attributed to private tube well development (Pakistan 1975, 2000).

Current Status of Irrigated Agriculture

With the passage of time, the development of irrigation has significantly changed the status of agriculture. Although historical data beyond Pakistan's history are not available, farm-gate supply of irrigation water has increased from 58.74 million acre-feet in 1960–61 to 133.28 million acre-feet in 1999–2000. This, in other words, implies that the total increase over the 39-year period was nearly 127 percent, which would correspond to an annual growth rate of 2.04 percent in irrigation water resources. As a result of expanding irrigation supplies, Pakistan's agriculture has become increasingly irrigated both in terms of total and proportionate irrigated area. Looking at the expansion of irrigated areas shows that only about 22.6 million acres were irrigated during 1950–51, which rose to 26.0 million acres in 1960–61, and further to 32.0 million acres in 1970–71 and 38.8 million acres in 1980–81. The values for 1990–91 and 1999–2000 corresponded with 41.4 and 44.7 million acres,

respectively. In terms of irrigated area as a proportion of the total cropped area, there was a stagnation of the ratio at 71.0 percent between 1950–51 and 1960–61. It rose to 77.9 percent in 1970–71 and to 81.2 percent in 1980–81. However, the percentage fell to 76.8 and 79.5 percent for 1990–91 and 1999–2000, respectively (Pakistan 1975, 2000).

In spite of these positive developments, Pakistan's agriculture continues to suffer from low productivity relative to world levels (Pakistan 2000). Agricultural growth rates have dwindled down to 2–3 percent per annum from 1994–95 to 1999–2000, which fell further to minus 2.5 percent during 2000–2001 (Pakistan 2001). Poverty in agricultural/rural areas has been on the increase as a consequence of adverse trends in rural employment and income distribution. Although these adverse trends may be attributed to a large number of factors including low fertilizer-application rates, high incidence of pest attacks and inclement weather conditions, many of them may be associated with uncertain supply of irrigation water or management of the irrigation system as follows.

First, it has been pointed out that groundwater has been a major factor in agricultural production over the last 40 years. Because of flexibility of tube-well water to match crop-water requirements, the resource perhaps stands overexploited and poses the threat of excessive lowering of the water table and intrusion of saline water into the freshwater aquifer (Bhatti et al 1997).

Second, due to age, overuse and poor maintenance, the Indus Basin Irrigation System has developed into a low-delivery and use-efficiency system. For example, the delivery efficiency of the canal system ranges between 35 and40 percent from the canal head to the crop-root zone. Thus, in practical terms, this means that most of the surface water is currently lost en route.

Third, the canal water supplies are highly inequitably distributed between canals, watercourses and head- and tail-end users. The situation is worsened by frequent thefts of water by influential farmers in collusion with irrigation officials. This inequitable distribution results not only in inefficient use but also in reduced agricultural production.

Last, the prices of surface irrigation water in Pakistan are kept low and have no relationship with the amount of water supplied. The low water prices have contributed to poor maintenance of the irrigation system and deteriorating canal water supplies. The water supplies to a farmer are determined by his canal command area but the charges are levied on the basis of cropland. The farmers, especially the large ones, have a tendency to minimize their water bills by cropping the minimum possible area with available supplies. It is such practices that, in quick succession, have often led to the twin menace of waterlogging and salinity.

Interventions in Irrigated Agriculture

The above discussion has already referred to irrigation policies that were aimed at the expansion of the irrigation system. Being a necessary evil, artificial irrigation, although necessary for improvements in agricultural production, can also lead to many attendant undesirable side effects especially on the poor. To the extent that these effects may prove to be counterproductive and defeat the very purpose of irrigation development, their minimization remains a central issue of a comprehensive irrigation policy. The following

discussion lists some of the emerging problems, and evolving policies needed to rectify these problems.

Major Irrigation Interventions

Among the first of these problems, which Pakistan encountered, has been the recurring twin menace of waterlogging and salinity. As the menace has been associated with excessive seepage from the irrigation system and rise of water table close to the soil surface, its effective solution involves no less than lowering of the water table and reduction in seepage. Pakistan has been alive to the problem and has attacked it at both fronts.

To lower the water table, a program of vertical and horizontal drainage was chalked out as early as 1960 and has been under implementation since then. While vertical drainage involved the installation of public tube wells in the severely waterlogged and saline water areas designated as SCARP (Salinity Control and Reclamation Project), at last, 18 such projects have been completed or are in various stages of completion (Bhatti et al 1997). In the fresh groundwater areas, rapid development of private tube wells has been instrumental in keeping a check and lowering the water table. The horizontal drainage is being practiced in the form of tile drains on a limited scale and open drains on a large scale. While the National Drainage Programme (NDP) is a replication of open drains on a countrywide scale, the creation of PIDAS is likely to take the program a step further. The massive projects of Left (LBOD) and Right (RBOD) Bank Outfall Drains are an attempt at the disposal of effluent water into the sea.

As a measure of controlling excessive seepage from the irrigation system, a beginning was made with lining of certain canals but the program being extremely costly could not be extended to the entire system. As a result, the emphasis shifted to reduce watercourse conveyance and field losses under such programs as Command Water Management and On-Farm Water Management Programme (OFWM), respectively, through watercourse improvement/lining and precision land leveling (Gill 1996). Although still in the experimental stage, some of the components of Command Water Management (CWM) also include lining of canals (minor) and watercourses, and land leveling for water conservation (WAPDA 1997).

A second policy area concerns not only flood protection to curtail losses of life, property, infrastructure and crop production but also to use available supplies of water more productively. The provincial irrigation departments run a normal program of flood protection. Works of an emergent nature are undertaken on a priority basis. A comprehensive program for construction of spurs along vulnerable reaches of Indus River and its tributaries has been in operation for a number of years under Prime Minister's River Management Programme. Likewise the construction of earth-fill dams has enabled Pakistan to store flood water and reduce the down-stream intensity of floods.

Thirdly, in response to deteriorating shape of irrigation system, a number of policy actions followed. Beginning with 1967, a policy of periodic increases in water rates was initiated which followed a number of rate increases subsequently. A program of Irrigation System Rehabilitation (ISPR) was started in 1982 to take up rehabilitation of badly deteriorated selective irrigation and surface drainage works. The privatization of public tube well in most of old SCARP areas was increasingly pursued in the 1990s to rid the public

exchequer of immense costs of O&M. Finally desilting (Bhal Safai) of the entire canal system was completed in 2000–2001, for rehabilitation of the system and somewhat equitable water distribution among the head and tail enders.

Finally, in the light of worldwide experience and experiments in Pakistan, a revolutionary approach to resolve major institutional problems is being groomed for implementation. It involves restructuring of Provincial Irrigation Departments (PIDs) to form Provincial Irrigation and Drainage Authorities (PIDAs), creation of Area Water Boards (AWBs) at the canal command level and formation of WUAs at watercourse level and their federation at minor and distributary levels. The WUAs and federations will be fully responsible for operational maintenance of the canals in their jurisdiction, allocation of available water supplies and assessment and collection of water rates. The experience to date has shown that WUAs have been instrumental in promoting equitable distribution of water, checking water thefts and in reducing burden on the government exchequer (Gill 1996). The fact that WUAs have resorted to supplying and charging water on the basis of canal commanded area would rid the small farmers of onerous cropping-intensity-based water rates (Chaudhry et al. 1993).

Implications for the Poor

It should be clear from the foregoing that the major objective of the evolving irrigation policies has been to add to farm-gate water supplies, raise agricultural productivity and enable small farmers to have better access to canal water supplies at fair prices. All these novel objectives are intimately and positively related to raising the standard of living of the poor or to poverty reduction in agriculture and elsewhere in the economy.

For example, the additional supply of irrigation water at the farm gate often involves excavation of new canals or expansion, desilting, remodeling and lining of existing canals and watercourses. Being highly labor-intensive, these activities can be expected to generate tremendous employment opportunities for the poor farm and nonfarm households. The routine work of strengthening the canal banks to prevent breaches and of river embankments and spurs for flood protection can be similarly classed. The availability of additional water at the farm level is a source of intensive land cultivation and adds to labor intensity of agricultural operations. For example, it has been shown in Pakistan that average labor input per acre in the Barani areas varied between one-fourth and one-third of that in the irrigated areas (Khan 1978). Similarly, additional supplies of water from tube wells have been noted to raise cropping intensities and labor input by as much as 57 percent (Kaneda and Ghaffar 1970).

The latter, however, depicts only the direct employment effects of tube wells and ignores their indirect effects. It may be noted that the development of farm-level tube wells has been associated with the emergence of tube-well-related small-scale manufacturing industry, sale and repair-shop business, tube-well-installing teams, electric-transmission lines, diesel-distribution centers and transportation services. More specifically, tube wells have strengthened forward and backward linkages between the farm and the nonfarm sectors. Although the total indirect employment effects of tube wells may not be quantifiable, some anecdotal evidence may be cited to pinpoint their significance. Ignoring all other indirect effects, the tube well manufacturing industry alone, it has been noted, provided more than 106,000 year-round jobs at the end of the 1960s (Johnston and Kilby 1975). While there

were only 87,000 tube wells in 1969–70 in contrast to 531,000 at present, the current employment potential of the industry on proportionate grounds may not be difficult to estimate at around 600–700,000 (Pakistan 1975, 2000).

The irrigated agriculture and appropriate policy formations have a definite role in raising agricultural productivity and promotion of agricultural growth. Relative to irrigated areas, crop production in Barani areas is uncertain and yields are only half (Pakistan 2000). Similarly, assured supply of water, as from private tube wells, can result in the doubling of crop yields and farm incomes (Chaudhry 1982) and contribute significantly to the growth of agricultural output.

There is a general consensus in the literature that rapid economic growth and poverty reduction may be mutually nonexclusive for obvious reasons. For example, most of the developing countries like Pakistan may be too poor to fund the massive outlays needed for direct reduction in poverty. Similarly, the mere redistribution of incomes without enlarging the available "pie" would not at all be effective (Chaudhry 1996). This follows from such succinct arguments as "poverty abatement policies are unlikely to show an actual decline in poverty if agriculture is doing badly, or that when the level of per capita food production is rising, the level of poverty is declining" (Mellor 1988). Mellor has further argued that an employment-oriented labor-intensive growth strategy pursued in Pakistan's agriculture has resulted in sharper declines in rural poverty than in India. Much the same follows from a recent study, which remarked that because the poor live mostly in rural areas and generally depend on the farm sector for their incomes, growth that stems from agricultural productivity and that raises the incomes of the small-scale farmers and landless laborers is particularly important in reducing poverty (Rosegrant and Hazell 2001).

Apart from general effects of irrigation policies on the poor through employment and productivity growth, the participatory irrigation management may also be characterized by specific pro-poor effects. For example, participatory approach, as also the *warabandi* practice, is likely to stop water thefts by the well-to-do farmers and ensure more water for small farmers than was possible previously. To the extent that WUAs will have full control of water supplies, rent seeking by the irrigation officials from the small farmers will be eliminated (Gill 1996). To the extent that WUAs supply water and levy charges on the basis of the canal commanded area, small farmers with 150–200 percent cropping intensities, no longer have to pay onerous cropping intensity-based water rates (Chaudhry et al.1993).

While it is clear that irrigation development and participatory management have the potential to contribute to poverty alleviation, the key question is how to exploit this potential to enhance the role of irrigation for poverty alleviation. It is well documented that input subsidies and price supports worked more to the advantage of large and well-off farmers, and the overall institutional support in the past had benefited the minority of the these well-off farmers. This has contributed to worsening of the highly skewed resource distribution pattern in the country. The current situation in irrigated agriculture in Pakistan may be characterized as:

- highly skewed land distribution
- high population growth, and increasing number of smallholdings
- high illiteracy rate

- stagnant crop yields
- lack of information sharing
- centralized bureaucracies, political interference
- lack of transparency and accountability of officials
- inequity in distribution of water
- inadequate maintenance of irrigation infrastructure, lack of effective implementation of operational rules.

All these factors are contributing to worsening the poverty situation in rural Pakistan, and substantially reducing antipoverty impacts of irrigation.

Poverty Situation in Pakistan

In spite of the pro-poor nature of the evolving irrigation policies, poverty in Pakistan, after falling to the lowest levels in the 1980s, has been on the increase throughout the 1990s in the urban and the rural areas. Poverty is a multidimensional complex phenomenon with many underlying causes including the macro-economic policies. The following sections review the trends in poverty and some of its underlying causes as envisaged in the government's macro-economic policies.

The study of poverty trends involved inter-temporal comparisons of quantitative estimates, which must be based on consistent and clear definitions of poverty. As is usual, we would stick to the most commonly used and understood measure of head count ratio defined as the proportion of households or population below a given poverty line for the purposes of this study. The poverty line, in turn, refers to the minimum real income needed to purchase a basic food involving daily intake of 2,450 calories per adult equivalent in the rural areas and 2,150 calories in the urban (World Bank 1990). Although other alternative measures are also available, it matters little in practice as to which poverty measure is used for measurement of trends (Tabatabai 1995). To ensure somewhat more valid inter-temporal comparisons, dependence on poverty estimates reported in the economic survey (Pakistan 2001) seems to be inevitable and are reproduced here in the form of table 1 as follows.

It should be clear from table 1 that there was consistent improvement in poverty between 1969–70 and 1987–88 on a Pakistan-wide scale as also in the rural and urban areas. The trend, however, was reversed since 1987–88 as the proportion of the poor population below the poverty line continued to rise throughout the 1990s. To be more specific, 46.5 percent of Pakistan's total population was poor in 1969–70, which in a decade's time fell to 30.7 percent. The proportion was reduced to 24.6 percent by 1984–85 and only 17.5 percent of the people were poor in 1987–88. These drastic improvements in poverty levels, however, could not be upheld in the 1990s as the percent of the poor rose to 22.1 percent as early as 1990–91. The incidence of poverty registered a sharp increase between 1990–91 and 1996–97 to lie at 31.0 percent during the latter period. It continued its upward trend, in a gradual

Table 1. Poverty incidence (head count ratios) in rural/urban Pakistan for selected years since 1969–70.

Year	Total	Rural	Urban
1969–1970	-46.53	49.11	38.76
1979–1980	30.68	32.51	25.94
1984–1985	24.57	25.87	21.17
1987–1988	17.32	18.32	14.99
1990–1991	22.11	23.59	18.64
1992–1993	22.40	23.35	15.50
1996–1997	31.00	32.00	27.00
1998–1999*	32.60	34.80	25.90
1999–2000*	33.50	NA	NA

Sources: Amjad and Kemal 1997; Qureshi and Arif 1999.
*Social Policy and Development Center (SPDC) 2000.

manner, during the rest of the 1990s as poverty rose to 32.6 percent in 1998–99 and to 33.5 percent in 1999–2000. Although the trend in rural and urban poverty was the same as in total poverty, the levels of poverty were somewhat higher in the rural areas relative to those in urban and total poverty.

The changes in growth, employment, income distribution, and inflation as reported in table 2, are the trendsetters in poverty. The improvement in poverty was associated with high growth rates exceeding a threshold level of 6.0 percent per year. By contract the degree of poverty accentuation varied with the level of downward deviation from this growth rate. For example, the slower the growth rate of a year the higher its poverty level. The slowdown in growth was caused by generally falling or stagnating investment rates of nearly 20 percent in the late 1980s to 16 percent in 1999–2000 (Pakistan (2001). Similarly, the unemployment rates, which did not exceed 2–3 percent during the 1960s, 1970s and 1980s, gradually rose to 5–6 percent levels, respectively, during the early and late part of the 1990s. The recessionary situation of the 1990s created by near stagnation in per capita incomes and growing unemployment rates was bound to result in deteriorating income distribution. Although the Gini coefficients improved consistently through the 1980s and were never in excess of 0.37, they began to assume values greater than 0.40 beginning in 1990–91. To the extent that these values are historically the highest in Pakistan, they point to the fact that income inequalities in the 1990s have peaked at the worst possible level. Finally, inflationary tendencies affect the poor more adversely and determine the prevailing poverty levels. As the 1990s, in general, were characterized by double-digit inflation, high and rising poverty levels would be a normal expectation.

Table 2. Growth, unemployment, Gini ratios and inflation rates 1969–70 to 1999–2000.

Period	Annual Growth Rate	Unemployment Rate	Gini Ratio	Inflation Rate
1969–1970	9.5	1.9	0.386	4.1
1978–1979	5.5	3.55	0.376	6.6
1984–1985	8.7	3.72	0.369	5.7
1987–1988	6.4	3.13	0.348	6.3
1990–1991	5.6	6.22	0.407	12.7
1992–1993	2.3	4.73	0.410	9.8
1996–1997	1.9	6.12	0.400	11.8
1998–1999	4.2	6.12	-	5.7
1999–2000	3.9	6.00	-	3.6

Impact of Macro-Level Policies on Poverty

A government can monitor changes in growth, employment, income distribution and inflation by direct interventions or indirectly through the use of policy. Pakistan has exercised both of these options.

Some of the more important direct interventions are: price controls, procurement and food subsidies, public investment and extension of credit to raise investment for accelerated growth, public works programs for employment generation, the Zakat system for improvements in income distribution and restriction on trade, foreign exchange and exchange rate for control on balance of payments and trade. More recently, the Khushal Pakistan Program, cash support for a nutritionally vulnerable, micro-credit scheme and social-sector spending have emerged as leading direct interventions by the government. It may be noted that the impact of these approaches may be highly limited in view of the growing worldwide emphasis on deregulation, privatization and liberalization. In fact, the government has been forced to curtail public-sector employment and, since 1988, a ban has been in force on fresh employment. In addition, it is also questionable if the resource-constrained government made worse by the prevailing credit crunch, would allow expanded government expenditure for direct intervention. Already, the government-development expenditure has fallen to less than 3.0 percent in 1999–2000 against 9.3 percent in 1980.

Like direct interventions, even monetary and fiscal policies had perverse effects on poverty. For example, the monetary policy during the 1990s was increasingly used for financing budgetary deficits and, as noted above, it has contributed heavily to inflation with regressive impact for the poor. In view of high tax-evasion rates, poor tax compliance and weak tax administration, heavy reliance on indirect taxes has been a cornerstone of Pakistan's tax policy. Being regressive in its incidence, high tax burdens of the poor were a natural phenomenon. The free-float exchange rate policy has resulted in continuous depreciation of the Pak. Rupee, which promotes inflationary tendencies in an import-dependent and trade-liberalizing economy.

In addition to the above, policies pursued in agriculture have even more adverse effects on poverty. First, for one thing, there has been, and continues to have, considerable underpricing of domestic (support prices) agricultural commodities relative to world levels (farm-gate parity price), causing immense resource transfers from the relatively poorer agriculture sector to the urban consumers, middlemen and industrialists with incomes four to five times those in agriculture (Chaudhry 2000). What is more. it is a fact that agricultural commodity markets often fail and prices that farmers receive are generally lower than government-fixed support/procurement prices. Second, a policy of subsidy withdrawal has been in vogue. The implementation of the policy is likely to discourage modern input use, intensive land cultivation, technological breakthroughs and, above all, employment, productivity and output growth in agriculture. It will also hurt the finance-constrained small farmers more than the large rich farmers. Third, in view of steeper increases in input prices than those in agricultural commodities, farmers have to face low profit rates than elsewhere in the economy. This induces receding investment incentives in agriculture and outflow of investable resources to other more profitable sectors. Fourth, the imperfections in input and output markets place agriculture in a highly vulnerable position. It often faces rent-seeking in the disposal of commodities and blackmarketing, adulteration and use of underweights for purchase of agricultural inputs. Fifth, despite attempts at reforms, Pakistan's agricultural tax system remains oppressive and highly regressive in its incidence. Last, Pakistan has made three serious attempts at land reforms but without any success. To the extent that poverty levels may be associated with land distribution, failure of land reforms in Pakistan may have been a reason for the high incidence of rural poverty.

Conclusions and Policy Recommendations

The main objective of this investigation was to review and analyze Pakistan's historical experience in Pakistan's irrigation system and relate it to poverty reduction. The analysis springs from historical irrigation developments and leads to the present state of irrigated agriculture in Pakistan, how the irrigation policies currently in vogue evolved and how they have affected the poverty levels. Although the policies in the 1960s, 1970s and 1980s were favorable to poverty reduction, the 1990s have seen a reversal of most of these policies. As a consequence, poverty levels were adversely affected. The deteriorating parity trends were caused by slower growth, high unemployment rates, skewed income distribution and double-digit inflation. The misuse of monetary, fiscal and trade, and exchange rate policies and direct state interventions were the major causes. To a large extent, the state of affairs at the national level was caused by stagnating conditions in agriculture.

The major causes of the poor growth performance of agriculture in the 1990s were associated with a) under-pricing of agricultural commodities vis-à-vis sharply rising input prices, b) heavy tax and transfer burdens of the agriculture sector, c) increasing physical intervention of public and private monopolies in commodity and input markets and trade, d) deteriorating quality of modern inputs like water, seeds, fertilizers and pesticides and their inadequate supplies during peak demand periods, e) poor performance of research, education and extension services, and f) continuing problems within the land tenure system.

It was also found that income distribution and poverty are positively associated with growth, and growth can be accelerated by concentrating on the following factors.

First, technological change is at the heart of a high-growth strategy. To this end, there is a need to evolve and disseminate new HYVs of crops, new breeds of livestock and to develop new cultural practices suited to Pakistan's resource endowment and climate. To accomplish these tasks effectively, the importance of sharply stepped-up efforts at education, research and extension cannot be underestimated. Also the introduction of a basic course on agriculture, including crop agronomy and livestock husbandry at primary school level, should be an integral part of the efforts. The Field Assistants should be given additional responsibility for teaching such courses in their duty areas. Apart from imparting knowledge to school children as prospective farmers, the added responsibility should ensure the presence of Field Assistants in the duty areas and improve accessibility to farmers for advice on day-to-day agricultural activities. Further, the arrangement of joint refresher courses for teachers, researchers, extension agents and farmers would be highly instrumental in creating viable links and ensuring rapid breakthroughs in agriculture.

Second, from the growth maximization viewpoint, the efficiency of the input delivery system should be enhanced. Although the government's strenuous efforts are already underway, the menaces of blackmarketing, using underweights and selling substandard and fake fertilizers, pesticides and seeds should be declared nonpardonable social crimes, punishable by rigorous imprisonment and heavy penalties. In addition, efforts should be made to reduce the intensity of the problem by open market sales, by breaking up government and registered dealer monopolies, and by ensuring the supply of inputs at the right price, time and place and in adequate quantities. The same should apply to livestock feed, forages, medicines and insemination stock and materials. Improvement in range management in the dry regions of Pakistan, especially in Balochistan and NWFP, should be given highest priority. In view of the high incidence of fatal animal diseases, there is immense need for establishing a widespread network of veterinary hospitals, dispensaries and medical stores in the public as well as in the private sector. The veterinary doctors, like medical doctors, should be encouraged to operate clinics for advice and treatment of seriously infected animals and for day-to-day animal health problems.

Third, for efficient use of irrigation water, there is a need to a) restore a direct relationship between amounts of irrigation water supplied to individual farmers and the prices charged, b) ensure transfer of irrigation management to WUAs, c) promote equitable water distribution among canal commands, and d) extend all possible help for land leveling and improvement/lining of watercourses and minors.

While most of the above are straightforward recommendations, the implementation of the first one may be problematic. To resolve this problem a direct relationship between the volume of water delivered and chargeable water rates could be established even without the installation of meters if the water charges, like canal-water supplies, are also assessed on the basis of the canal-commanded area. Since, on average, farmers receive a specific amount of water per canal commanded acre, charges thus levied should boil down to a charge per unit of water supplied.

This concurrence of the two bases would be highly desirable in many respects. It would, unlike the current cropland-based charges but like strict volumetric pricing, encourage an efficient use of land and water since it would leave the planting decision to farmers, given

the available supplies and opportunity costs of irrigation water (Chaudhry 2000). It would also relieve many small farmers of onerous water rates imposed under the present cropland-based system of water rates because of their relatively higher cultivation intensities and would induce positive changes in the distribution of income. Also, investment in private tube wells would be encouraged because of the elimination of double charge for running tube well water in watercourses that were originally constructed for delivering the canal water. It may also lead to improvement in the cost effectiveness of the system by eliminating the staff needed for crop records. This is especially important as IDs in Pakistan are overstaffed by nearly 50 percent compared to those in other countries in Southeast Asia.

Furthermore, while a change in the water-rate base is a primary requirement, water use efficiency can also be enhanced further by achieving a more equitable distribution of water across the watercourses. Irrigation officers may be made more accountable to WUAs and empowered to ensure the delivery of the due share of water and the collection and spending of water receipts. Budgets should be so prepared as to present a more realistic picture of receipts from, and expenditures on, irrigation. There is a growing consensus in Pakistan on recovery of full O&M costs of the irrigation system and removing subsidies as currently reflected in low rates charged for canal water. While full cost recovery is highly desirable, it must be accompanied by right-sizing of PIDs and eliminating of overstaffing. In addition, as the benefits of irrigation extend beyond the irrigators, farmers alone may not be held responsible for cost recovery of O&M.

Fourth, it should be noted that the interventionist government policy pursued in Pakistan has adverse consequences for investment, production, employment, income distribution and poverty in agriculture. In view of the heavy dependence of the national economy on agriculture and the importance of some of the above variables, an indefinite pursuit of such a policy is neither desirable nor sustainable and must be discontinued.

By way of recommendations of this paper, the current price policy needs to be modified in at least three important respects, as follows.

First, in order to end underpricing of agricultural commodities effectively, the fixation of agricultural commodity prices must be undertaken on the basis of corresponding import and export parity prices of various commodities. It may be noted that this type of fixation of commodity prices does not involve government intervention but their delivery might, which is the task of a regulated marketing system to be defined shortly. Since parity prices tend to be higher than procurement prices favorable incentive effects of the recommended policy on investment, production, trade, employment, income distribution and poverty should be noted. Although higher domestic prices of food may be hard on some consumers, they should not unnecessarily tax most urban consumers, while providing "safety nets" for the poorest of the poor, as they are the minimum prices that would prevail in the country in the absence of domestic production. As, however, parity prices are likely to vary directly with highly fluctuating world prices, the stability of agricultural commodity prices at home can be ensured if they are based on 5-year moving averages or trend lines of the past parity prices. In so doing, domestic prices would be higher than parity prices in the years of low world prices and lower than them in years of high world prices. As cyclical fluctuations around the trend would be cancelled out over time, the desired result would be marked by the absence of any implicit taxation on agriculture. Therefore, it would be unnecessary for government involvement by setting up and maintaining a price stabilization fund, as was proposed in the

recent strategy document of the Ministry of Food, Agriculture and Livestock. Farm-gate prices of milk can be sharply improved by disallowing dried milk imports by milk plants and by promoting competition among them for procurement and processing of fresh milk supplies. There seems to be little justification for milk plants to charge Rs 32 for one kilogram of milk when fresh milk prices in the rural areas do not exceed Rs 10–12 per kilogram. The recommendation, if implemented, should result in drastic reduction in poverty of may rural landless families

Second, there is no doubt that most of Pakistan's parastatal organizations suffer from gross inefficiencies with immense costs to producers, consumers and the government exchequer. To save on these costs and to promote the cause of privatization, the government would be well-advised to desist from active and direct engagement in procurement, storage, distribution and external trade on a massive scale and leave these tasks for the regulated private marketing system operated by market committees with membership from farmers, market functionaries and associated government officials. While the restrictive trade policies such as licensing and bans on interregional movement of commodities should be discontinued, severe penalties backed by law, should be imposed on illicit trade practices. The government, in its new role, must be watchful of private sector activities, ensure competition in agricultural commodity markets, and discourage private sector monopolistic tendencies, excessive profiteering and price hikes. The experience in Pakistan suggests that the recommended private markets should operate quite competitively.

Third, apart from the implicit taxes, the agriculture sector is also subject to immense resource transfers to the government exchequer through indirect taxes. Due to the government's already large and growing dependence on indirect taxes, taxation on agriculture seems to have become highly oppressive. Therefore, the system should be replaced by direct taxes in agriculture. The often-made recommendation is to move to the extension of a general income tax to agriculture and the efforts to implement such a tax at present, as pointed out earlier, have their own difficulties. This is what should be expected in view of the many inherent limitations of the suggested income tax policy on agriculture. For one thing, agricultural incomes are difficult to quantify and the concept remains meaningless. For another, the implementation of agricultural income tax requires honest and efficient administration. Lacking such administration, enforcement of the policy is most likely to fail. For still another, being income and price inelastic, the agriculture income tax is no better than land tax in terms of revenue generation. In fact, it would be worse than land tax in terms of its narrower tax base because of exemptions and falling government revenues over time due to subdivision of agricultural holdings on account of inheritance laws and fictitious transfers in collusion with revenue officers. For yet another, taxes based on cultivated and cropped area coupled with higher tax rates for orchards and cotton tend to distort efficient land use and optimal cropping decision of the farm sector. Finally, despite a progressive rate structure, the income tax policy based on cropland and self-assessed incomes may turn out to be regressive in its impact as intensity of cultivation exceeds 130 percent for under 12.5-acre farms but is only 60 percent for farms exceeding 150 acres. This likelihood is greatly increased as most of the large farmers have the ability to evade taxes especially under rising tax rates of agricultural income tax. To ensure fair prices in the livestock markets, animal sales on the basis of live-weight should be introduced.

If equitable taxation of agriculture is desired, progress in agricultural taxation has to be achieved in an indirect way. This being so, a combination of a proportional land tax and a tax on marketed output seem to be more appropriate under Pakistan's conditions. Furthermore, this two-tier system of agricultural system has all the desirable characteristics of a rational tax policy and would largely be consistent with the theory of optimal taxation. For example, a proportional land tax based on owner's farm area (cultivated or uncultivated) is preferable to the graduated land tax because, as was argued before, it will keep the tax base stable and relatively broader, reduce the temptation for undue subdivisions of landholdings, avoid the possibility of declining absolute tax revenues over time, ensure efficient use of resources and, above all, will be easy to administer.

A proportional land tax, although in line with optimal tax rules, is inherently handicapped by its inequitableness, income and price inelasticities and is risk-prone. A tax on the marketed produce is best suited to overcome these deficiencies of agricultural taxation. For example, the incidence of such a tax, as distinguished from that of land revenue, will be appropriately heavy on the large landholders. While the small landholder, to the extent that his crop is consumed and not sold by him, will not have to bear the tax at all. Similarly, the tenants will not be subjected to heavier tax rates along with the large landholders, the largest producers of marketed surplus. The tax base will be widening and the revenue from the tax on marketed produce.will be expected to grow at the rate of growth of the marketed surplus plus the rate of increase in prices of agricultural commodities. In the case of crop failures and market gluts, tax payments by farmers will be automatically reduced for relief against unforeseeable events. This tax-sharing arrangement thus reduces the farmer's vulnerability to risk and makes the tax more desirable in terms of optimal tax theory. The tax may be implemented through the administration of local bodies to avoid any additional cost as the local bodies in the recent past were collecting a similar tax on agricultural commodities and have now been given additional powers under the current government's devolution plan. In addition, it will avoid tax evasion, as the farmers will be easily approachable at the market place. Moreover, there will be less corruption because the tax collectors will be closely supervised.

To a certain extent, a tax on marketed produce may be accompanied by deleterious effects on farm and marketed outputs. This can be expected because no system of taxation can be perfectly neutral with respect to allocation (World Bank 1988). However, it may be noted that the disincentive effect of the policy on output and marketed surplus can be considerably reduced by the presence of a heavy land tax, especially on unused lands.

In view of the above, it is but natural to conclude that the combination of the two taxes would be Pareto-efficient, administratively feasible and income and price elastic, ensuring risk coverage, greater and rising revenues and price stabilization.

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Institutional Arrangements for Irrigation Management in Pakistan

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The term "institutions" is vague and means different things to different people. In sociology, the concept of institutions is defined as "an organized, established procedure" (Bandaragoda 2000). In institutional economics, the term "institutions" is defined as "the rules of the game in a society or more formally the humanly devised constraints that shape human actions (North 1990). In that sense, institutions are frameworks within which human interactions take place. The institutions set the ground rules for resource use and establish the incentives, information and compulsions that guide economic outcomes. The main purpose for the creation of institutions is to reduce uncertainty in the society by establishing stable structures for human interactions. Generally, institutions may be considered as combinations of policies and objectives, laws and regulations, organizations and their core values, operational plans and procedures, incentive mechanisms, accountability mechanisms, norms, traditions, practices and customs (Bandaragoda 2000). The main irrigation-related institutions include legal, social, political, economic and organizational components and can be divided into three categories, i.e., formal rules, informal rules and organizational structures. This paper will focus on the institutions that influence irrigation management at the primary, secondary and tertiary levels.

Formal Laws and Rules

The irrigation-related formal laws and rules in Pakistan were devised to allocate and distribute water on an equitable basis to irrigated areas with a minimum maintenance burden. The first irrigation and drainage law, The Canal Irrigation and Drainage Act, was enacted in 1873 and was amended and extended occasionally to meet the emerging needs. Derived from the provisions of this law, various management procedures were devised to operate and maintain canals, allocate and distribute water and resolve the conflicts. According to this law, the provincial government was the owner and manager of the canal water and drainage infrastructure at the primary and secondary level. The farmers were considered as "beneficiaries" and had responsibilities of distributing and using water supplies at the farm level. The management at the tertiary level was the responsibility of the farmers and the state could only intervene if asked to do so.

The Canal and Drainage Act of 1873 is the main legislation relating to the irrigation and drainage system at the provincial level. Under this Act almost the entire irrigation network is entrusted to the provincial government through the officials of the irrigation and revenue departments and the judicial officers. Several amendments to the 1873 Act have been made to deal with the specific requirements but the Act remained the major law throughout the irrigation history of Pakistan. Subsidiary legislation provided room for various operating rules, manuals of procedure and water rates. These manuals form the second component of the formal rules. Under the law, the management of the system is centralized, with no user involvement. The multiplicity and complexity of the formal procedures makes their implementation in the field quite difficult and impractical. The system of detailed record keeping provides several opportunities to the lower staff to indulge in rent-seeking practices. Therefore, the law has lost its relevance with the changed sociopolitical and water scarcity conditions.

For groundwater management, the Punjab Soil Reclamation Act was enacted in 1952. The objective of the law was speedy reclamation and improvement of waterlogged and saline areas and to prevent further damage to maximize agricultural production.

The Punjab Water User's Association Ordinance was promulgated in 1981. The Ordinance provides room for the involvement of irrigators in water management at watercourse level through the WUAs. Under the law, the field officer, i.e., the Director, On-Farm Water Management (OFWM), has control over the WUAs. He has the authority to register or refuse to register WUAs. Under the Ordinance, more than 50 percent of the water users of a watercourse may form an association and apply to the field officer for registration. The WUA does not have any management powers related to canal water. The field officer may entrust the maintenance of a watercourse to the association but this must be carried out to the satisfaction of the field officer. Under the law, WUAs are subsidy-oriented entities. There is no provision for continuous maintenance of infrastructure and resolution of disputes. Since the field officer is given the power to form WUAs basically to carry out maintenance work, the WUA members remain unable to internalize the essence of collective action for water management. As a result, most WUAs formed are defunct now.

The Punjab Irrigation and Drainage Authority Act (1997)

The Government of Pakistan is in the process of implementing the institutional reforms in its irrigation and drainage sector. In 1997, the Provincial Assemblies passed the Provincial Irrigation and Drainage Authority (PIDA) bills in all the four provinces. The reforms aim at decentralizing the irrigation management system through public and private partnership, farmer's participation and resource governance. The new institutional framework consists of three entities with restructured roles: Provincial Irrigation and Drainage Authority (PIDA), Area Water Boards (AWBs) at the canal command level, and Farmer Organizations (FOs) at the distributary level. The framework is to be tested in one pilot canal command initially. The PIDA has defined the functions of the AWB and FOs, though these are only meant for managing surface water. The rules, which regulate formation and functioning of the FOs, are listed below.

- Punjab Irrigation and Drainage Authority Pilot Farmers' Organizations Rules, 1999
- Punjab Irrigation and Drainage Authority Farmers' Organizations Registration Regulation, 1999
- Punjab Irrigation and Drainage Authority Pilot Farmers' Organizations Election Regulations 1999
- Punjab Irrigation and Drainage Authority Pilot Farmers' Organizations Financial Regulations
- Farmers Organizations Conduct of Business Regulation 1999
- Irrigation Management Transfer Agreement
- Scheme for Transfer of Irrigation Management: Farmer Organizations in Punjab

Informal Rules

In irrigated areas of Pakistan, the informal norms, values and practices form a strong institutional basis for organizational and social behavior at the grassroots level. The *biradri* (caste and kinship systems), landholding and farm sizes, tenancy, etc., determine the rural power structures, which influence water management at the tertiary level. Occasionally, these variables also influence the management of canals at the secondary level. The level of collective action for effective water management depends on the relative power structure, and the caste considerations. The informal rules of the society and the irrigation management go hand in hand in terms of various forms of *warabandi*[1] at the tertiary level of the irrigation system in the canal command areas. Various forms of water distribution practices adopted about a century ago with the common understanding of the irrigators have evolved in today's' warabandi System.

Evolution of Warabandi

Water distribution at the tertiary level was primarily the responsibility of farmer beneficiaries at the watercourse level. Irrigation communities experienced social organization processes and established their own water distribution arrangements among users. Water distribution took place through warabandi or an irrigation roster, primarily determined by the amount of irrigated land owned by each member. The farmer-managed warabandi was called *kachcha* (flexible, informal) warabandi. Later, the government had to intervene due to the increasing number of water disputes, or when farmers requested additional water for increased intensities, particularly to nurture their fruit orchards in arable land.

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[1]Warabandi refers to the irrigation roster, a system of fixed water turns proportionate to the area of each user. For a comprehensive account, see Bandaragoda and Rehman 1995.

State intervention increased when farmers were exposed to new opportunities to acquire more water. Special allowances for orchards and other nontraditional needs were often misused. Sometimes, when a special allowance had been sanctioned, farmers exceeded the limit several times over to get more water. At other times, farmers obtained special allowances without actually owning an orchard. This flexibility was often the result of an alliance between lower cadre staff of the ID and more influential farmers. Invariably, such instances were unacceptable to the other, less-privileged water users. Disgruntled farmers either approached higher officials for some redress, or sought mitigation of these disputes through the judicial system. Successful settlement of disputes through this process encouraged more farmers to lodge complaints with the authorities.

Apart from these allocation-related disputes, farmer-managed water distribution at the watercourse level often resulted in conflicts among farmers, which sometimes culminated in violence. The main origins of these disputes were two interrelated social factors. The first was the existence of a number of heterogeneous groups in terms of caste, baradari, or kinship, political affiliation, etc., along the same watercourse command. The coalition and conflict of interests of various subgroups in the community fostered inequity in water distribution. The second was the kachcha practice, which became prone to manipulation by the more influential water users.

Confronted with growing problems of disputes, and inequity in water distribution caused by kachcha warabandi, some aggrieved water users expressed their preference for a fixed irrigation roster. Leading petitioners in such cases were mostly from the tail or middle reaches of the watercourses (Mirza 1975) who were more affected by actions of upstream users. Other affected water users usually agreed to sign the petition to formalize the irrigation roster.

In the Punjab province, the ID's interventions in water distribution, by fixing formal water schedules (*pakka* warabandi), started somewhere during the 1960s. By now, most of the watercourses in the area have switched over to pakka warabandi, and have discarded the flexible form of kachcha warabandi. This widespread phenomenon of switching over from the kachcha to pakka warabandi reflects the limited formation of social capital among the farming communities in Pakistan.

Types of Warabandi

The term *warabandi* is derived from two local words *wahr* and *bandi,* meaning "turn" and "fixed," respectively (Bandaragoda and Rehman 1995). Thus, this term translates into fixation of irrigation turns for the landowners along a particular watercourse. Essentially, warabandi is a rotational method to equitably distribute available water supplies in an irrigation system. Turns are fixed according to a predetermined schedule specifying the day, time and duration of supply to each irrigator, in proportion to the size of his landholding in the outlet command (Singh 1981; Malhotra 1982). In consideration of "fixing" water turns, this definition seems to apply only to the officially sanctioned pakka warabandi schedule, which is determined and "fixed" by the ID.

Pakka Warabandi

A pakka warabandi generally follows a cycle of one week, or 10 1/2 days. Furthermore, the 12-hour pakka warabandi rotation is alternated every year, generally after the annual canal closure in December-January, so that farmers who had been irrigating at night during the previous year will irrigate during daytime hours during the next year. This warabandi is sanctioned by respective Executive Engineers of the ID, and also serves as proof of water rights for shareholders along the watercourse (Bandaragoda and Rehman 1995).

Kachcha Warabandi

Unlike pakka warabandi, farmers distribute water entering their watercourse by following an agreed irrigation roster without the formal involvement of the governmental agency. This type of warabandi is generally referred to as kachcha (ordinary, unregulated, informal) warabandi (Bandaragoda and Rehman 1995). This type of warabandi provides turns that are generally fixed and predetermined, but the day and timing of each turn is flexible and depends on the availability of water in the watercourse.

Water Management Organizations

There are several agencies involved in managing the irrigation supplies and drainage in the irrigated areas of Pakistan. These include:

- Water and Power Development Authority (WAPDA).
- Punjab Irrigation Department (PID).
- On-Farm Water Management Directorate (OFWMD).
- Salinity Control and Reclamation Projects (SCARP) staff.
- Punjab Private Sector Ground Water Project (PPSGWP).
- Agricultural Development Bank (ADBP), etc.

Water and Power Development Authority (WAPDA)

WAPDA, linked with the Federal Ministry of Water and Power, was created in 1958 as an autonomous agency to supervise the construction of large-scale infrastructure in the Indus Basin Project. It remains as an agency responsible for the dams and interprovincial link canals, and operates these facilities with the consultation of PIDs according to water rights and the seasonal allocation of the provinces. In the irrigated areas of Pakistan, WAPDA was

responsible for the planning and installation of tube wells for the SCARP and for the tile drainage projects.

The Provincial Irrigation and Drainage Authorities (PIDAs)

The PIDAs, transformed from the PIDs are autonomous bodies responsible for policy formulation, legal enactment and overseeing the overall management of the irrigation and drainage systems in the respective provinces. The PIDAs are responsible for the O&M of the irrigation systems extending from the headworks to the main canals, distributaries, to the outlets in the watercourses in the provinces. The role of a PIDA is defined in the already-mentioned different Acts, rules and manuals.

Currently the PIDA is in transitional stage and, ultimately, it will be a financially autonomous body with independent revenue collection and spending authority with proper accountability. Below PIDA in each province, financially self-accounting AWBs are to be created on an experimental basis. And below AWB, FOs will be formed, again on a pilot basis, along the distributary level (secondary level). The AWB will receive water from PIDA and deliver it to FOs and the latter operate and maintain the distribution channel with financial autonomy and management. An FO is formed and owned by the farmers of the command area of the distributary.

PIDA manages primary and secondary network of canals, drains, and public tube wells through its irrigation circles, divisions and subdivisions. The main responsibility of O&M lies with the Executive Engineers, Subdivisional Officers, and the Subengineers. Most of the maintenance is undertaken through contracts. The revenue assessment is carried out through *Patwaris* and *Zilladars*. The collection is the responsibility of the Revenue Department that collects the water charges through village-based *Lumberdards*. The revenue and spending on irrigation and drainage are not linked to each other.

The Area Water Board (AWB)

The pilot AWB in the Punjab province is established in the Rechna Doab subbasin on the Lower Chenab Canal (LCC) East. The AWB covers about 0.4 million hectares. The LCC AWB is responsible for the irrigation and drainage management of the primary level and supplies services to around 100 distributaries where FOs are being formed. In 43 canal commands of Pakistan, altogether 43 AWB will be established. The AWB will have functions similar to those of a utility company. The AWB will be in charge of a particular area and will comprise the representatives from FOs, the PIDA, the Agriculture Department, and some technical members. The AWBs will operate through their management board. For the canals where AWBs have yet to be formed, the canals are being managed through irrigation and drainage circles, divisions and subdivisions. The responsibilities of PIDAs in such areas extend up to the head of the watercourses, and dispute resolution within the watercourses. A PIDA also assesses the revenue.

Farmer Organizations (FOs)

The FOs are being established at the distributary canal command level. The FOs will receive water from the AWBs and distribute the same to various watercourse farmers and other users. The FOs will operate and maintain distributary canals and assess and collect revenue. About 40 percent of the collected revenue will be given to FOs for O&M of the channels. The FOs will have to sign an Irrigation Management Transfer (IMT) Agreement with PIDA to take over management. So far, some 20 FOs have been established but the management is yet to be transferred. However, in the southern Punjab, IMT Agreements have taken place between three FOs and the PIDA.

On-Farm Water Management (OFWM)

The OFWM program implemented in 1976 has 20 years of experience. The Agriculture Department is in-charge of the program. Primarily tertiary level construction works such as land leveling and watercourse lining have been undertaken through this program. Farmers' participation is an important element of the program, since farmers can gain a sense of ownership and undertake better quality work. The staff first organizes the water users into a WUA and registers them and undertakes the works. In all OFWM works, farmers contribute 50 percent of the total cost, in both cash and kind. To ensure farmers' participation the department assists in organizing WUAs. After informal activities of WUAs, from 1976 to 1981, the WUA Act was enacted in 1981 and WUA became a formal group. Most of these WUAs became defunct after completion of the construction work. Now, the OFWM is attempting to organize farmers into FOs for distributary management.

Salinity Control and Reclamation Projects (SCARPs)

Waterlogging and salinity have been major problems in Pakistan's irrigated agriculture. In Rechna Doab, waterlogging was first noticed a few years after the opening of the Lower Chenab Canal in 1892. At that time, the water table in other parts of the Doab was fairly deep and irrigation applications were quite adequate for crops and for the leaching requirements of the soil. During the period 1912–52, various institutional arrangements and works were carried out in an attempt to solve the problem. These include the establishment of the following:

- Waterlogging Board, 1912
- Provincial Drainage Board, 1917
- Waterlogging Inquiry Committee, 1925
- Rural Sanitary Board, 1925
- Waterlogging Board, 1928

- Land Reclamation Board, 1940
- Soil Reclamation Board, 1952

The Groundwater Development Organization of the Punjab Irrigation Department, subsequently named as Water and Soils Investigation Division (WASID), was established in 1954. After the establishment of WAPDA in 1958, WASID was transferred to WAPDA. The objective was to investigate the water and soil resources of the Punjab plains to better understand waterlogging and salinity problems, and to provide basic data for reclamation planning (Khan 1978).

To reduce the problem of waterlogging and salinity, the Government of Pakistan also started the vertical drainage scheme as SCARP projects during the 1960s. The basic aim of the salinity control and reclamation program was to reduce the culturable waste areas under waterlogging and salinity. The scheme was thought to be beneficial in two aspects, providing vertical drainage to waterlogged areas and augmenting the water supplies through deep tube wells available for use along with surface supplies.

The SCARP was considered effective in eliminating waterlogging, controlling salinity and providing additional irrigation water to increase cropping intensities and yields. However, in the mid-1980s, the following problems were identified, which were resolved through the SCARP transition and improvement projects:

- With the deterioration of the operational efficiency of SCARP tube wells over time and the consequent reduction in pumpage, the water table started showing a rising trend in most parts of the area.
- With increasingly high power tariffs, rapid depreciation of tube wells and low water rate for tube-well supply, the O&M costs of SCARP tube wells were becoming both high and an unsustainable financial burden on the irrigation sector of the O&B budget.
- Replacement of a large number of aging tube wells was needed.
- Farmers were generally dissatisfied with the performance of the SCARPs but accepted the services because of highly subsidized rates of water supply from SCARP tube wells.
- With frequent repairs and fault removals needed by aging tube wells, the ID had limited capacity to manage and operate SCARP tube wells

In the late 1980s, a pilot project for the transition of SCARP tube wells in the Khanqah Dogran scheme of the first SCARP was launched. The basic concept was the involvement of private sector pumping for irrigation from shallow groundwater generally falling within freshwater limits to balance the drainage requirement of the pilot project area where public-sector operation of SCARP tube wells was terminated.

The objectives of transferring fresh groundwater pumpage were to meet irrigation and drainage requirements more effectively and to increase agricultural production and farm incomes through conjunctive use. The objectives were to be achieved by electrification and installation of private tube wells, irrigation/ drainage improvement works (e.g., lining of minors and watercourses) and institutional developments. Under the pilot project, 213 SCARP tube wells were transferred and replaced by 2,100 private tube wells by providing necessary financial incentive and technical guidance to the farmers (ACE-NESPAK-NDC 1997).

The successful implementation and enthusiastic response from the farmers of the SCARP Transition Pilot Project led to the development and execution of the Second SCARP Transition Project. The transition activities were expanded to the remaining schemes of the first SCARP by replacing 1,353 SCARP tube wells through the installation of 4,700. comparatively, shallow private/community tube wells operated by farmers/groups of farmers (ACE-NESPAK-NDC 1997). Included in the project was a hydrogeological study to collect and update data forming a basis for analysis of the long-term sustainability of groundwater withdrawals and its use in the project area without causing any undesirable effects on the hydrogeologic regime and environment. The study concluded that the distribution and pattern of pumping did not indicate significant vertical or lateral movement of groundwater of undesirable quality in future at large scale and recommended to regulate the number and distribution of tube wells in the project area by a public agency.

On the successful culmination and enthusiastic reception by farmers of SCARP transition projects, the Government of the Punjab is executing and cofinancing with the World Bank the Punjab Private Sector Groundwater Development (PPSGD) Project in the province for a 5-year period (1997–2002). The project lies in the fresh groundwater areas of the Second SCARP (including Shahpur), The third SCARP (Rangpur Unit) and remaining SCARPs within Rechna Doab (Fourth-Muridke Mangtanwala and Fifth-Shorkot Kamalia). The PPSGD Project also covers saline groundwater areas of the Second SCARP and saline groundwater pockets within, and at the boundaries of, fresh groundwater areas (PGC 1999). The project envisages disinvestment of 4,230 SCARP tube wells and establishment of 6,360 private tube wells owned by individuals/groups of farmers.

The SCARPs Monitoring Organization (SMO), a subunit of WAPDA is responsible for monitoring the changes in the groundwater. It monitored the results of the vertical drainage strategy adopted by WAPDA. Its mandate is to collect data on the depth to water table through a network of observation wells located in the selected locations in the irrigated areas of Pakistan.

Planning and Scheduling of Water Deliveries in the Irrigation Command Areas

Planning and scheduling of the water deliveries in the main canals and the secondary canals are the PIDA's responsibility. The planning is done for each cropping season (kharif and rabi). The PIDA staff schedules water for a particular subdivision based on the culturable command area and is responsible for delivering the scheduled water to the main canals and to the

secondary canals in that subdivision, subject to the availability of water in the upstream system. The supplies depend on the release of water from the storage reservoirs by WAPDA.

At the tertiary level the farmers manage the distribution of water through the weekly warabandi system. The water users are also responsible for the maintenance of the watercourse and for implementation of warabandi but, if there is some dispute, the PIDA intervenes at the farmers' requests to resolve the problem.

Resolution of Water Disputes

As mentioned earlier, under the Canal and Drainage Act of 1873, there is provision to resolve the disputes among water users. The Subdivisional Canal Officer (SDCO) is responsible for allocating the warabandi and to resolve warabandi-related disputes. He is also responsible for implementing the orders of the Divisional Canal Officer regarding new sanctioned watercourses and to adjust the claims from the joint users. Under the PIDA Act of 1997, there is a built-in mechanism to resolve the disputes. The responsibility for resolving disputes regarding the formation of the association, election of office bearers, framing of bylaws, etc., is entrusted to the FOs. In case of any dispute of this kind an appeal can be made against the decision to the "Appellate Board" of the WUA. In case of disputes relating to the operational aspects of irrigation they are referred to the AWB and PIDA and are settled under the laws relating to irrigation.

Summary

In the canal command areas of Pakistan the irrigation institutions performed well under different irrigation rules till about two decades ago. The increase in demand for grains and the population pressure forced the cropping intensity to increase threefold than the intensity on which this system was designed. It has resulted in a situation where inequities appeared in the system. On the one hand, the farmers were facing problems of acute shortages of irrigation supplies and, on the one hand, they experienced problems of waterlogging and salinity. The problem of waterlogging originated due to seepage from the irrigated canals and to lack of drainage infrastructure to drain out the water seeping out of the irrigation canals.

To rescue the farmers from the waterlogging problem the government introduced the SCARP project in early 1970s. The SCARP achieved some success in solving the problem of waterlogging but it led to the problem of secondary salinization due to poor-quality water of deep tube wells installed under the SCARP project. At a few places, sodicity is also posing a high threat to the irrigated agriculture in the Rechna Doab. The farmers at the tail ends of the systems suffered due to the exploitation by the farmers of the head reach. The huge investments of the SCARPs have also taxed the budget of O&M for the canal system. Most of the maintenance budget is now directed to SCARPs, impinging on the physical health of the canal system.

Farmers complain about the delays in O&M of the system and the PID complains about the scarcity of funds required to undertake the necessary O&M in the irrigation structures. To improve the situation the Provincial Government has passed the PIDA Act of 1997, which is expected to help improve the situation in the canal command areas.

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Integrating Irrigation into Poverty Reduction in Vietnam

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Poverty Reduction in Vietnam

Achievements

Vietnam is located in the tropical, monsoonal Southeast Asia. The mean annual rainfall ranges from 1,700 in the northern part to 2,000 mm in the southern part and the temperature ranges from 13 to 35 °C, which are favorable conditions for agricultural production, especially rice cultivation. Vietnam's territory measures 333,000 km^2 and holds a population of approximately 77 million people. The country is officially divided into seven socioeconomic zones: The Red river delta, Northern Mountain and midlands, North-central coast, South-central coast, Central highland, Southeast and Mekong river delta

Heavily affected by several wars and constrained by a central planning policy, Vietnam had a very poor economic performance during the late 1970s and early 1980s. With a reduction of support from former socialist countries after country reunification in 1975, Vietnam soon faced food shortages. During the 1980s, 70 percent of the Vietnamese population lived in poverty. Surprisingly, the following decade witnessed a dramatic reduction of 50 percent in poverty. From 1993 to 1998, the poverty rate was reduced from 58 percent to 37 percent as measured by the overall poverty line, and from 25 percent to 15 percent as measured by a food poverty line (table 1).

Table 1. Poverty head-count index in Vietnam, in urban and rural areas (%).

Year	All Vietnam	Urban	Rural
	Food poverty		
1993	24.9	7.9	29.1
1998	15.0	2.3	18.3
	Overall poverty		
1993	58.1	25.1	66.4
1998	37.4	9.0	44.9

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The reasons for this dramatic success in poverty reduction have been highlighted as rapid economic growth and the positive impact of economic growth on poverty reduction, the main source of which has been agricultural liberalization and diversification (Poverty Working Group 1999). Since the introduction of *doi moi* (Reforms) in 1986 and with land reallocation to farm households, agricultural output and productivity have risen dramatically, increasing agricultural incomes by 61 percent contributing significantly to the rapid growth of the national economy at 8.4 percent.

Hunger Eradication and Poverty Reduction Program in Vietnam

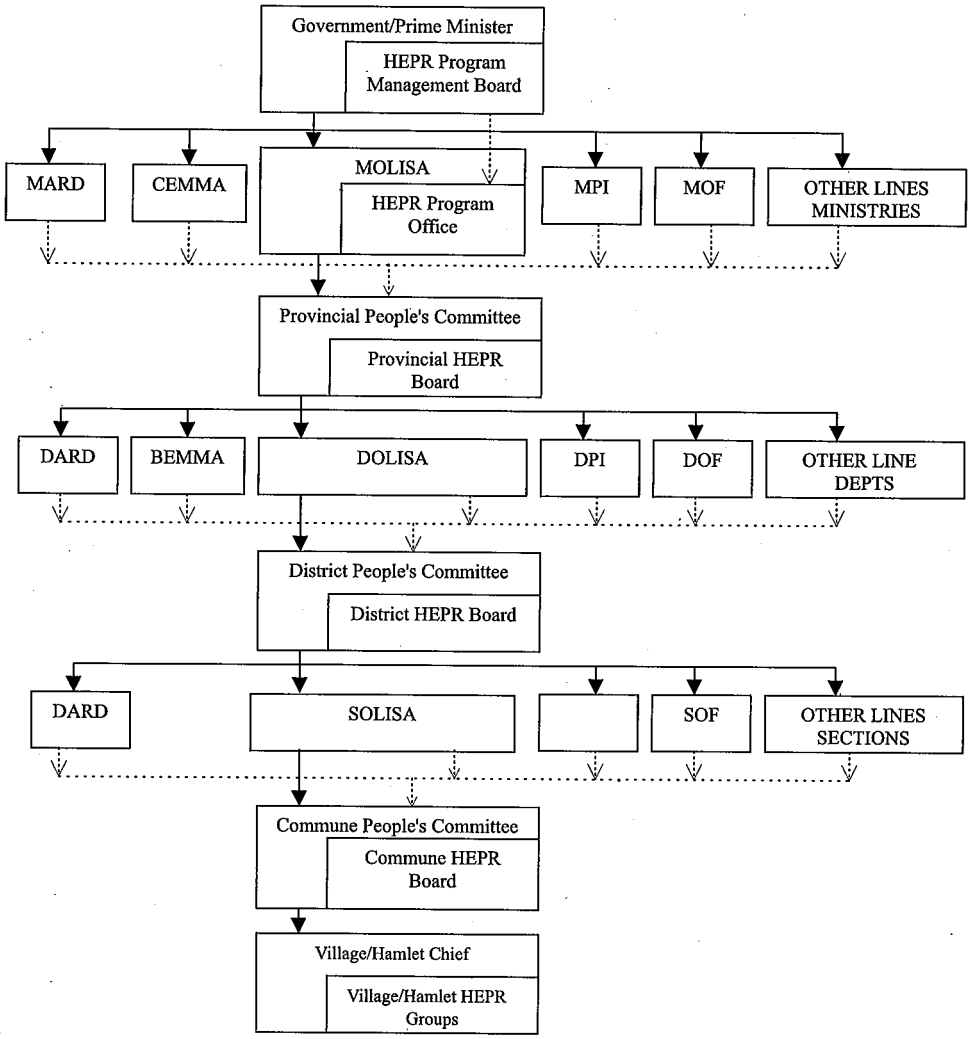
In addition to the rapid economic growth and its high impact on poverty reduction, the success in poverty reduction has also contributed to a fundamental principle of the Government of Vietnam for development that promotes economic growth with equity. To assist those left behind by economic growth, brought about by the economic reforms, public safety nets and targeted programs have been implemented. In 1998, the Hunger Eradication and Poverty Reduction (HEPR) program was established. This program integrated current local initiative pro-poor programs. HEPR involves many stakeholders in its implementation. The organizational structure is illustrated according to administrative divisions from the central government down as well as by the function of the entities involved (figure 1).

The HEPR framework embraces nine components and aims to eradicate hunger and reduce the incidence of poverty to 10 percent by 2000. The nine program components are:

- Resettlement and new economic zones (implemented by the Ministry of Agriculture and Rural Development [MARD])
- Infrastructure development in poor communes and resettlement (CEMMA)
- Promotion of agriculture and off-farm production (MARD)
- Extension services for agriculture, forestry and fisheries (MARD) and income generation (MOLISA)
- Training for HEPR staff (MOLISA and CEMMA)
- Assistance to ethnic minorities facing extreme difficulties (CEMMA)
- Credit and savings for the poor (SBV)
- Education for the poor (Ministry of Education)
- Health for the poor (Ministry of Health)

The total investment for the HEPR program during the period 1992 to 1997 was VND 10,927 billion. The HEPR funding has been integrated with other socioeconomic development programs, such as the family planning program, anti-illiteracy program, primary-school universalization program and the clean water program (Nguyen Thi Hien 2001). The HEPR provides a framework to address some of the most pressing needs of poor households. It creates opportunities for employment, access to credit, long-term land use, clean water, etc.,

Figure 1. Structure of the national target program for HEPR,



Note: Administrative Management and Supervision
Functional Management.

Source: Nguyen The Dzung and Nguyen Xuan Nguyen 1999.

for the poor. This integration of HEPR with other programs has served to further increase the positive effects of the HEPR on the poor.

Issues of Future Poverty Reduction

Although Vietnam has made considerable progress in reducing poverty over the last 5 years, poverty remains widespread and the poverty rate is still high. For the year 2000, the poverty rate was estimated at 30.5 percent by the overall poverty line and at 10 percent by the food poverty line (table 2). The poverty reduction rate in the future might not be as high as in the past due to several factors. First, the achievements in poverty reduction brought about by a high economic growth rate and the high impact of this growth on poverty during 1993–1998 are now under threat. In the future, the previous relationship between the level of growth and the impact on poverty might not hold, as Vietnam might not be able to replicate the land-based, agricultural diversification success story of the last 5-year period, which is now having its constraints. Finally, the HEPR has been evaluated as having a narrow scope, focusing mainly on the provision of subsidized credit and exemptions from health costs and school fees. Thus, the efficiency and impact of HEPR are limited and considered not as efficient as expected.

Table 2. Poverty rate in Vietnam 1996–2000.

Region	Rate of Poor Household (%)						
	Food poverty			Income poverty			
	1998	1999	2000	1993	1998	1999	2000
Northern upland	22.4	15.5	13.5	79.0	59.0	55.5	52.1
Red river delta	8.4	6.5	5.3	63.0	29.0	24.1	20.1
North-central	24.6	20.2	16.1	75.0	48.0	43.5	39.5
Central coast	17.8	15.9	11.2	50.0	35.0	32.4	30.0
Central highland	25.7	15.7	13.1	70.0	52.0	48.8	45.8
South east	4.8	4.1	3.5	33.0	8.0	5.4	3.6
Mekong delta	15.4	13.7	11.1	47.	37.0	35.2	33.5
Whole country	15.7	13.0	10.0	58.0	37.0	35.5	30.5

Source: MOLISA 2001.

Can Irrigation Help?

How Irrigation Helps Poverty Reduction in Vietnam

In Vietnam, 90 percent of the poor live in rural areas and 80 percent of them are farmers. Since most of the poor are farmers, what happens to agriculture will have a significant effect on the lives of the poor. Rural poverty is associated with monoculture practice and low yields due to a lack of water resources or water-control infrastructures. A survey by MOLISA, in 2000, showed that a lack of safe water supply and irrigation is the most significant issues related to the poor and that infrastructure development focusing on irrigation, schools and clinics will improve the status of the poor.

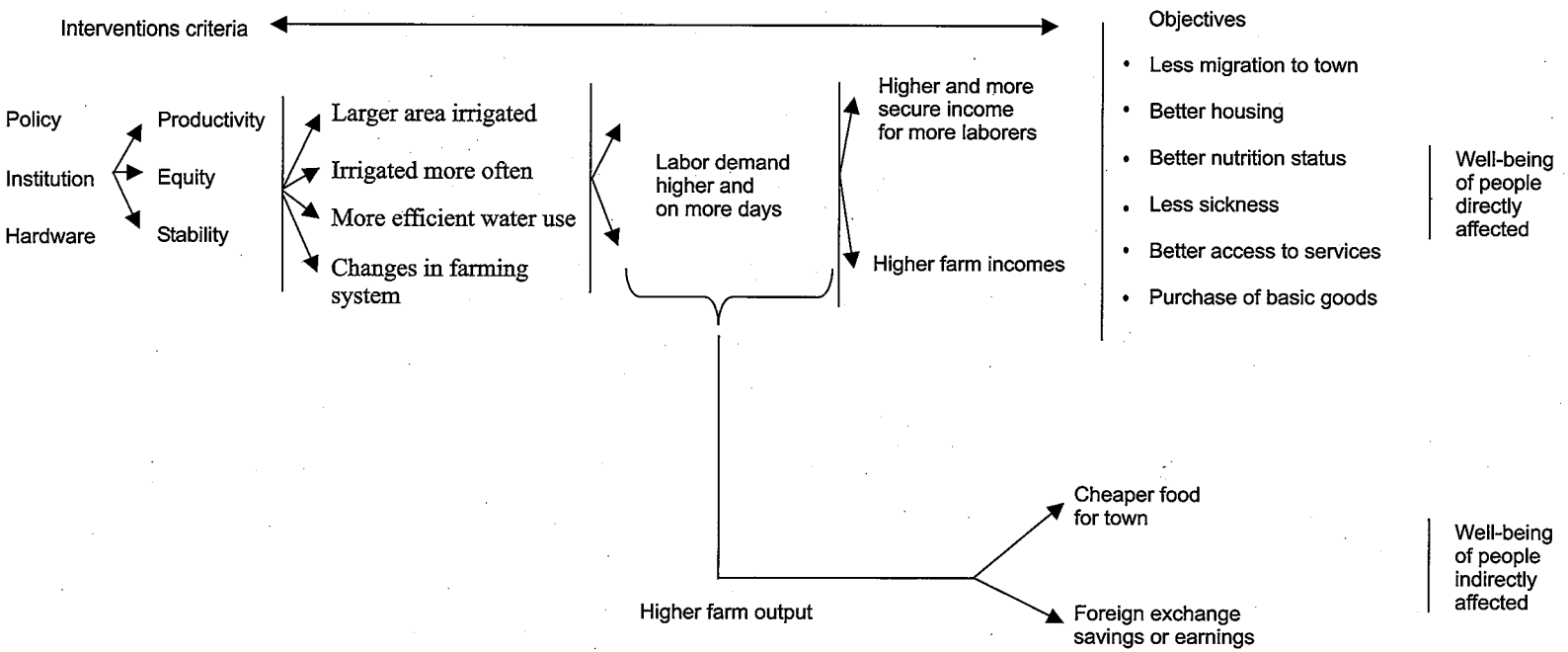
As a rice-based country, land and irrigation are two of the most important factors affecting farm production in rural Vietnam. Cropping intensity on irrigated land is 5.4 times higher than in the rain-fed areas. Many studies have indicated strong correlations between the status of farm size, farm irrigated area and farmer welfare across the country. Generally, the better-off the expenditure group the larger is its landholdings and irrigated land area (World Bank 1995).

Irrigation is an important component of increased agricultural productivity. As has been affirmed by Vietnamese farmers, "the first is water, the second manure, the third industriousness and the fourth variety." Statistics and research have shown that, together with other factors, water contributes 16 to 35 percent to rice productivity and 18 percent to maize yields. In the Mekong river delta, irrigation development, since the unification of the country, has increased yields from 4.5 tons/ha in 1975 to 9.5 tons/ha in 1990 and then to 10 to 12 tons/ha in 1999.

Irrigation can raise farm income by increasing the cultivable land area, enhancing crop choice, increasing cropping intensity, allowing the use of HYVs and improving conditions for land grouping to boost labor productivity. Irrigation also brings many spillover effects through increased and more evenly distributed farm labor opportunities and improved wage rates, reduced emigration, improved security against impoverishment, lower food prices, better nutrition throughout the year, growth in nonfarm employment, greater urban-rural contact and new social networks, and more water for nonagriculture uses (figure 2).

Five underlying causes of poverty in Vietnam were identified by UNDP as a) isolation (lack of access to markets, production and sociocultural services), b) high risk (the changes of market, crop failure, natural calamities), c) lack of access to available resources (land and credit), d) unsustainability (household economy, economic and natural environments, etc.), and e) weak participation (in planning and decision-making process). Poverty reduction efforts in Vietnam have thus focused on the reduction and elimination of these causes.

Figure 2. Irrigation interventions, criteria, objectives and beneficial causal chains.



Source: Modified from Chambers 1988.

Table 3. Poverty reduction and irrigation interventions.

Reduction of Poverty-Causes	Interventions
Reducing isolation	*Policy, law, regulation, programs, support system*
Physical, locational	Decentralization
Social and cultural	Privatization
Communication and access to information	Financial autonomy
Broadening access	Farmer involvement
Land and technology	*Institutions*
Credit and finance	Structure, function and tasks of provincial,
Vocational skills	system and field-level organizations and
Markets	linkages among them
Reducing risk	Autonomy, accountability and transparency
Market changes	Water allocation, conflict resolution, system maintenance
Harvest	Resource mobilization (water fee, structure for investment)
Natural calamities	IMT, PIM, WUA
Increasing participation	*Irrigation infrastructures*
in economy	Head works, main canal and regulators
in planning	Distributaries
in other decision making	Field-level structures
Sustainable resource use	
Higher productivity	
Better management	
Greater awareness	
Appropriate incentives	

The irrigation components and causes of poverty displayed in the above table show several different ways that irrigation can help the poor to overcome poverty. Irrigation can have a direct impact on some of the causes and indirect impact on others. Changes in the different irrigation policy factors will have different indirect impacts on the water resources variables that will, in turn, directly or indirectly impact the poor situation. For example, as far as the poor have less access to irrigation water, compared to the better off, increasing water access for the poor will help to definitely increase their production. The equity in water allocation will thus increase the income-generating capacity of the poor by improving land quality, reducing risks by ensuring good harvests, and allowing crop diversification, which can cope with market fluctuations. Changes in the structure of irrigation management organizations with a PIM orientation will increase farmer participation in the decision-making process, which will improve the management of the irrigation system.

Integrating Irrigation into HERP

The Government of Vietnam has realized the importance of irrigation in economic growth and the state budget for investment in irrigation development has received high priority. For example, during the period 1996–2000, 14.1 trillion VND was invested in irrigation development. As a result, in 2000, the irrigated area rose by 3.3 million hectares, the drainage area rose to 1.4 million hectares, salinity prevention rose to 700,000 hectares, and water supply for industrial and domestic use rose to 5 billion cubic meters (m^3) of water. The annual irrigated rice area is 6.870 million hectares. The area of irrigated upland and industrial crops amounted to 808,000 hectares.

Irrigation has also been added as a tool into the HEPR program. During the period 1999 to 2000, approximately 600 billion VND were invested in irrigation in poor regions. Irrigation activities alone have built 240 hydraulic structures. These irrigation projects have successfully developed 14,670 hectares in the wild for developing agricultural production, to ensure the stability of 368,000 hectares of summer crop and 88,000 hectares of winter crop. The efforts have also helped solve the problem of domestic water shortages of more than 1 million people. Moreover, the efforts have helped build 390 small- and medium-sized hydropower stations to supply 32,200 kW of electricity to the mountainous areas where the national power grid has not yet been extended (Nguyen The Ba 2001).

Except for approximately 10 percent of the total annual funding allocated directly to poor regions in the HEPR program, the emphasis for irrigation development has been on technical and production aspects. In irrigation development projects, the emphasis is placed mainly on the capacity of the headworks, conveyance canals and area to be irrigated. Policies and institutions are mentioned less often while the poverty dimension is almost missing entirely. Thus, despite heavy investment in the irrigation sector, the total irrigated land of 3 million hectares represents less than 70 percent of the total designed capacity of the irrigation systems. Many irrigation schemes need rehabilitation after only a few years of use. On average, hydraulic works are used at only 50 to 60 percent of the designed potential. Many small works utilize only 25 to 30 percent of the designed potential. In some places, the hydraulic works have been destroyed (Nguyen Xuan Tiep 2001). Yields and cropping intensity are low and crop diversification is constrained because of inadequate irrigation and drainage in the

peripheral areas of irrigation systems in even the most heavily irrigation-invested regions. There is great potential for increasing the irrigation performance of existing irrigation systems and thus the well-being of the rural poor by identifying and adopting appropriate political, economic, financial, institutional, governance and technical interventions in the irrigation sector.

Poverty reduction through interventions in the irrigation sector is a crucial part of the overall national poverty reduction program. Irrigation interventions should be carried out in such a way that the national poverty reduction program is most effective. Despite the fact that Vietnam has considerably reduced poverty during the last decade and the knowledge that irrigation plays a very important role in economic growth and poverty reduction, there is currently no poverty reduction program for the irrigation sector. Additionally, it is widely believed that irrigation has not been well incorporated in the HERP program. In the near future, as the fight against poverty in Vietnam becomes more complicated, the great potential for poverty reduction through irrigation interventions needs to be better recognized and incorporated into the HEPR program.

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