# Part II

## Country Studies
## Summaries, Conclusions and Recommendations

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

This part of the report summarizes the main findings, conclusions and recommendations of the country studies. These are based on draft final reports for country studies (Sivamohan et al., 2004 – India; Jehangir et al. 2004 – Pakistan; Ahmad et al. 2004, – Bangladesh; Wang et al. 2004 – China; Arif et al. 2004 – Indonesia; and Tuan et al. 2004 – Vietnam) and inputs from participants in the national workshops in each of the six countries. Some sections here include additional analyses carried out for completeness of analyses in the country reports, based on data and information from primary sources or those presented in the country reports. The summary of the country study material presented here reflects the efforts and contributions from the project leader (Intizar Hussain) and from the country study team leaders and others, particularly M.V.K. Sivamohan and Chris Scott, Waqar Jehangir and Mohammad Ashfaq Ahmad, Q.K. Ahmad and Zahurul Karim, Jinxia Wang and Jikun Huang, Sigit Arif and Mochammad Maksum, and Doan Doan Tuan and Eric Biltonen. This part is subdivided into six parts, one for each country study. In each of these parts, the summary for a country study is organized into three main sections: the first section provides background on irrigation and poverty; the second section outlines characteristics of study settings, data collection and study methods; and the third section presents the main findings, conclusions and recommendations. For more elaborative discussions and technical details, readers are encouraged to refer to the respective country reports.

I. Poverty in Irrigated Agriculture in India: Issues, Options and Pro-poor Intervention Strategies
II. Poverty in Irrigated Agriculture in Pakistan: Issues, Options and Pro-poor Intervention Strategies
III. Poverty in Irrigated Agriculture in Bangladesh: Issues, Options and Pro-poor Intervention Strategies
IV. Poverty in Irrigated Agriculture in China: Issues, Options and Pro-poor Intervention Strategies
V. Poverty in Irrigated Agriculture in Indonesia: Issues, Options and Pro-poor Intervention Strategies
VI. Poverty in Irrigated Agriculture in Vietnam: Issues, Options and Pro-poor Intervention Strategies

# Poverty in Irrigated Agriculture in India: Issues, Options and Pro-poor Intervention Strategies

## Historical and Contextual Frame

Agriculture in India as a whole has made remarkable progress over the past three decades. The average annual growth recorded in agriculture and allied sectors (agriculture, forestry, and fishing) during the post-reform years 1992-93 to 1999-2000 was 3.6 percent compared to 3.9 percent in the period 1980-81 to 1991-92 (at 1993-94 prices). Even if growth in food grains, the most dominant segment of crop agriculture, decelerated from 2.9 percent to 2 percent in the post-reform period (while, the population growth rate is 2.1 percent according to population census of 2001), a high growth has been maintained in wheat (3.6%) and even rice (2.2%) leading perhaps to the problem of the excess stock of food grains (nearly 44 million tons). Robust growth in food grains production, despite below-normal rainfall in some regions, characterized 1999-2000, yielding a record food grains output of 208.9 million tons (GoI 2001). During the last 10 years (1990-2000), the food-grain area has ranged from 123 million hectares to 130 million hectares, the inter-year variation being influenced by weather conditions.

Despite these achievements, the productivity of a large part of irrigation systems remains severely constrained by inadequacy of some or all inputs. Such low-productivity areas are characterized by persistent rural poverty. The distribution of the benefits from irrigation development is thus largely skewed and unequal. While the determinants of low productivity are numerous and complex, they are to a large extent associated with poor performance of many of the established irrigation systems, which causes low, inequitable and unreliable water supplies in those areas.[1]

The overall goal of irrigation development in India had been the improvement of national food security, rural and agricultural development and economic growth. Starting from the First Plan period, huge investments in canal irrigation have been made to achieve these objectives and important results were no doubt obtained. Irrigation has become the “prime engine” in agricultural production and significant strides were made in poverty reduction. Yet, entrenched pockets of poverty persist in many states, raising serious questions about intervention strategies in the face of systemic poverty. Though the importance of irrigation is well recognized by several studies irrigation-poverty linkages have not been studied in greater depth.

However, over time, it is increasingly felt that investments in irrigation systems alone have not been enough: the management of systems has been crucial too. It became apparent that the operation and maintenance (O&M) of the irrigation system and allocation of available water largely determine irrigation performance and thus the extent to which the objectives of irrigation development are being met. Research has shown that irrigation performance of large- and medium-scale irrigation projects in India in general has been poor. Historically, these systems have been managed by the state with little participation of the users. Irrigation administration has

[1] Low-productivity regions are located largely in the tail-end areas of government-managed irrigation systems in most parts of India. However, the level of poor performance varies from Bihar and Uttar Pradesh to the Krishna delta system in Andhra Pradesh and Vishweshwaraiah canal system in Karnataka.

become highly centralized and supply-oriented at the discretion of government agencies. In order to improve irrigation performance in India, irrigation-sector reforms have been taken up since the last decade, decentralizing management and devolving power to the users concerned. The effects of these changes on the efficiency and equity of water use are not yet clear: especially with regard to poverty, the linkages between irrigation performance, management reform and poverty alleviation have hardly been assessed. This study attempts to fill this gap.

The early history of the Indian economy from the colonial rule roughly through the first half of the post-independence period was punctuated with recurring famines, droughts and floods. ‘Vagaries of monsoon’ was the explaining phrase for fluctuations in GDP. From 1970 onwards the scenario changed as the Indian economy was no longer prominently driven by fluctuations in agricultural GDP. Bad rainfall years in 1987-88 and 1991-92 did not negatively affect the GDP like in earlier drought years (1957-58, 1965-67, 1972-73 and 1979-80). To a great measure, this trend was a result of the extensive irrigation infrastructure created in the country through massive investments, and also because of the dwindling influence of agriculture itself on the GDP. The share of agriculture which stood at 55 percent of the GDP in 1950 had dropped to 26 percent in 1999. The GDP growth rate of 3.5 percent per annum before 1973-74 improved to 5 percent per annum thereafter indicating better economic performance in the latter half of the post-independent era. However, this does not undermine the crucial importance of agriculture in the Indian economy. Though lagging behind some of the Asian “Tigers,” India has made impressive strides in the agriculture sector and has achieved self-sufficiency in food grains production. Agriculture is still the mainstay of 60.2 percent of the population living in rural areas and it will continue to be so. About 46.7 percent of the rural population is self-employed in agriculture and allied activities and 13.5 percent are agricultural laborers. However, there is interstate variation among the rural poor: 38.5 percent come under self-employed in agriculture followed by 23.32 percent agricultural laborers (Pant and Kakali 2001). Thus agriculture still contributes to the lion’s share of total employment in India. Some scholars hold the view that the growing disparity between agriculture and non-agriculture sectors in per capita GDP arises primarily from the structural features of the Indian economy. Despite this disparity the population does not move from agriculture to non-agriculture. “Agriculture is the parking lot for the poor” in India (Dandekar 1994).

Growth and equity are well-recognized objectives of national policy as reflected in the Five-Year Plan documents and policy statements. However, one of the most hotly debated issues in the Indian context has been whether the growth process has actually benefited the poor (Panda 2000). The theoretical and empirical explorations in development studies have long engaged the attention of academia on the distributional aspects of economic growth. This was sought to be understood in terms of the interrelationship between economic growth, income inequality, poverty and welfare obtaining among various regions and the constituent socioeconomic groups at the national and international levels. Abundant literature on poverty-related aspects thus sprang up both at macro and micro levels.

The literature on poverty-related issues can be broadly classified into four overlapping time periods: a) the initial decades of independence up to 1968, b) the green-revolution period up to the 1980s, c) the pre-economic reform decade of 1980-1990, and d) the post-economic reform period from 1991 onwards. Contextual developments in the country to an extent also prompt segregation into these four periods during which the literature on poverty-related issues had continued to evolve. The initial period of studies on inequality and poverty had a major focus on the aspects of measurement. “None of them in fact, examined the conceptual issues underlying the definition of poverty or explored the links in-depth between the various factors underlying the phenomenon” (Sastry 1980). Rich statistics have been accumulated on income and consumption ever since the National Sample Survey (NSS) started collecting data. Several of the studies were based on NSS data during that period but had to make necessary adjustments for estimation. Social scientists joined the fray by measuring poverty based on per capita calorie requirements. On the socioeconomic front, the thrust in the initial years was on institutional and agrarian reforms as well as on expansion of the agrarian base. The principles of “Democratic Socialism” saw greater degrees of state intervention for the welfare of the people. The *zamindari* (landlord-tenant) system and the intermediary tenures, which existed during that time covering 40 percent of the cultivated area, were abolished. Tenancy laws were enacted in several states providing security of tenure to the tenant. Roughly two million agricultural cooperatives came into existence and the credit provided by them increased from 8 percent of total borrowings of cultivators in 1950 to 30 percent by the mid-1960s (Radhakrishna 1993).

However, during this period, the underlying trend of growth remained modest and was based more on area expansion than on improvement of yield. While the gross irrigated area increased from 22.6 million hectares in 1950-51 to 32.7 million hectares in 1966-67, the fertilizer consumption per hectare—an indicative index of technological change—was only 7 kg/ha in 1966-67 (Rao 1996). By this time, several studies on poverty attempted to determine the number of people below the poverty line (BPL) based on income or consumption. Ahluwalia (1978) examined the trends in the incidence of poverty for 14 different years for the time period 1956-57 to 1973-74 for India as a whole and for individual states. He adopted both Sen’s poverty index and the traditional head count method in his analysis. Though a significant time trend was not visible, he found a statistically inverse relationship between rural poverty and agricultural performance for India as a whole. The same relationship was also observed for different states.

The next period up to 1980 was broadly the phase of the “green revolution,” which started in 1965 and continued through the early 90s. Following Kuznet’s findings that income equality takes an inverted ‘U’ shape as the economy grows, some scholars claimed that the poor hardly gained from the “green revolution,” while many others found evidence of the “trickle down” phenomenon. Evidence on the distributional changes accompanying growth is mixed but historical evidence for a number of countries shows only gradual change over fairly long periods. In India, the income Gini coefficient remained almost constant from 1951 through 1992, with a mean of 32.6 and standard deviation of 2.0 (Li et al. 1998). The sectoral composition of growth also makes a difference for poverty reduction. Ravallion and Datt (1996) provide evidence for India that faster agricultural growth is strongly and unconditionally associated with both urban and rural poverty reduction.

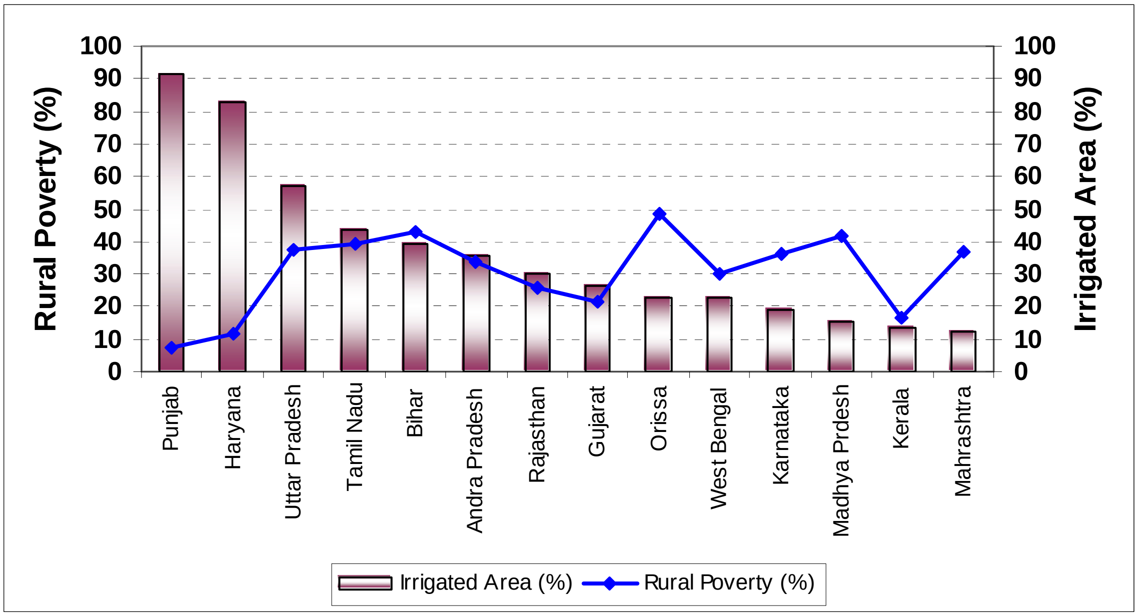
Lipton and Longhurst (1989) cite the example of Indian Punjab to illustrate the dramatic transformations that have occurred with the widespread adoption of green-revolution technologies. They opine that modern varieties do reach small farmers, reduce risk, raise employment and restrain food prices. Yet, the benefit in terms of poverty reduction appears to be modest. They observe that the poor are increasingly land-poor and dependent on wage labor.

They argue that the benefits to the poor as consumers (low food prices) are captured largely by their employers, who can pay lower wages. The green revolution phase was signified by desperate attempts to make a breakthrough in domestic food production. With the spread of high-yielding varieties (HYVs), agricultural production showed a dramatic upward trend from 24 million tons in 1950 to 31 million tons in 1966, 43 million tons in 1972 and further 54 million tons in 1979. The gross irrigated area increased from 33 million hectares in 1967 to 52 million hectares in 1984 and over the same period fertilizer consumption increased from 7 kg/ha to 45 kg/ha.

Rural poverty in India declined from 56.44 percent in 1973-74 to 53.07 percent in 1977-78. In the 1970s, strategies for poverty alleviation were part of a larger belief in the importance of "growth with redistribution." The production-cum-technology approach was supplemented by several interventions by the government to provide food and employment security to the poor. However, they remained as modest relief measures. In spite of wide-ranging interventions and the green revolution, the poor appear to have continued under considerable economic pressure. The per capita annual availability of food grains remained at 161 kg during 76-80 like in 1956-60 (Rao 1996). Although technology made an important difference for poverty reduction it was not the only contributing factor. Institutional change, sometimes responding to technological change and sometimes to government policy or social pressures, was also important (Bussolo and O'Connor 2002).

From the early 1980s' phase of fiscal belt-tightening and interventions, the policy moved away from redistribution and basic needs towards structural adjustments and market-oriented economies. Poverty as such was given relatively low priority during the 1980s (Gita Sen 1999). There is ample evidence showing that the rate of decline of poverty was higher in the 1980s than in the 1970s. This can be attributed to higher growth in agricultural production, slower growth in food grain prices and the presence of safety nets. The safety nets are in the form of drought and flood relief programs (during the years of natural calamities) and the public distribution system (PDS) for basic commodities during the 1980s. The GDP growth rate increased to 5 percent in the 1980s when an expansionary fiscal policy was adopted together with limited trade liberalization. However, this could not be sustained for long and led to a major balance of payments crisis in 1991. The crisis during 1991 arose out of excessive public spending and large and inefficient public-sector functioning during the 1980s. Gaurav Datt (1999) estimates a mixed picture of moderate decline in urban poverty rates, but relatively unchanging levels of rural poverty after the economic reforms from 1991 onwards, which he surmises was because of differential growth in average living standards in urban and rural areas. Not many studies on poverty are available after 1993-94. However, the latest official statistics shows that rural poverty is coming down compared to urban poverty in states like Andhra Pradesh. There are significant differences in the incidence of rural poverty across states. In general, poverty incidence is low in states with a higher proportion of area under irrigation such as Punjab and Haryana (figure I-1).

Figure I-1. Rural poverty and area irrigated in India by state.




***Irrigation-Sector Reforms***

In 1974, India initiated a centrally sponsored Command Area Development (CAD) program for improving irrigation utilization in the command areas of major and medium irrigation projects. The main objective of the CAD program was to increase agricultural production in irrigated areas by bridging the potential created and its utilization, efficient management of irrigation, water, soil and various inputs, scientific crop planning provision for expansion of marketing facilities, and farmers' participation in the program right from the beginning. For implementation of the CAD program in AP, MP and other states, Command Area Development Authorities (CADAs) were created. With the formation of CADAs the main thrust given was to construct field channels and involve farmers in decisions regarding water allocation and utilization below the outlet level. However, the interventions through the CAD program were seen as administrative and technical solutions to the problems. Though different CAD Acts/Government orders promulgated in different states contain provisions for promoting farmers organizations (FOs), the envisaged partnership of farmers in O&M of the irrigation systems under CAD could not be achieved. The focus shifted towards developing participatory approaches.

In 1984, the Ministry of Water Resources (MOWR) issued guidelines for the formation of water user associations (WUAs) on a pilot basis and then to replicate them. The action research project of the Institute of Resource Development and Social Management (IRDAS) in Andhra Pradesh in the Pochampad Project area demonstrated that PIM was possible on large irrigation systems provided farmers were organized and legal support given. The savings of water, increase in irrigated area and reduction in disputes were all clearly observed where IRDAS interventions were provided (IRDAS 1995). The action research was scaled up with increased area coverage and once again similar outcomes were found.

Though several examples of successful traditional irrigation systems where farmers managed irrigation were available, it was believed for a long time in the government quarters that large systems were not amenable for farmers' management. However, papers submitted at various seminars and workshops mirrored several instances where PIM helped in increasing area under irrigation, productivity, equity, water use efficiency and reduction in irrigation disputes (Singh 1991; Raju and Maloney 1994; Sivamohan and Scott 1994; Joshi and Hooja 2000).

By early 1990s the concept gradually moved to establishing partnerships between the government agencies and farmers and, of late, to the threshold of irrigation management transfer (IMT). A review conducted by GoI in 1995 states that "one of the major causes for this inefficient management of water resources is that there is little or no involvement of farmers in management of irrigation system. As a result the water to the farmers is often unreliable, at variance with their needs inequitable, unsustainable and insufficient."

The PIM and IMT initiatives in India were the sequel of participatory experiments conducted in different irrigation systems; the coalition building of individuals in government and aid-giving agencies and academic circles also contributed to such initiatives. The implementation of PIM/IMT is now seen as a new institutional mechanism to bring equity in water distribution, better cost recovery and O&M in the irrigated areas. This has provided the key institutional interventions, norms and procedures in the management and operation of irrigation systems at the field, project and state levels. These reforms were initiated at a wider scale in AP in 1997 and in MP in 1999. The reforms have brought in a "paradigm shift" in the irrigation sector, introducing new institutional arrangements.

Andhra Pradesh Farmers Management of Irrigation Systems Act (APFMIS) 1997 and MP 1999 Act called Sinchai Prabhandhan Me Krishko Ki Bhagidari Adhiniam (hereafter called MP Act of PIM) are by far the most important Acts in the irrigation sector reforms. Under the Act, the organizational structure is determined according to the size of the system. The WUA forms the basic structure of the organization. The model consists of a single-tier system for minor schemes: WUA; two-tier system for medium schemes: WUA and DC created by federating a group of WUAs on a distributary or distributaries to form a Distributary Committee (DC) and a three-tier system for major systems: WUA, DC and Project Committee (PC) created by federating DCs to form Project Committee (PC).

The main features of the AP and MP Acts are: a) giving water rights in an irrigation system to the farmers through the water user/farmers' organizations (FOs); b) ensuring functional and administrative autonomy to the FOs; c) providing the modalities for the creation of FOs; d) making Irrigation Department (ID) staff accountable to the WUAs, DCs and PCs as competent authority, requiring ID staff to implement the decisions of the FOs; e) encouraging FOs to resolve conflicts themselves; f) enabling proper and adequate maintenance and improvement of the irrigation systems by the FOs, based on resources raised by them or from out of the grants given by the government as a percentage of water charges collected from the water users; g) allowing access to information on scheme operations; h) permitting the preparation of the operational plan and the maintenance plan by the WUAs/DCs/PCs; i) giving freedom of cropping pattern to farmers within the availability of water; and j) providing procedures and guidelines on accounting, social auditing, water budgeting, election procedures and other matters of administration.

As an incentive to WUAs, AP government declared a payment of Rs 50,000 as a special incentive grant to a WUA where all the members of the managing committee are elected unanimously (53 %). For the WUAs where there has been a contest, the government decided to give an advance of Rs 30,000 for meeting the immediate expenses to be adjusted in the maintenance or any other grant to be provided to it later. A sum of Rs 4.042 million was made available to the elected WUAs initially either as an incentive grant or advance. In MP, since the formation of WUAs in April 2000, 1,470 WUAs received Rs 75 million at Rs 50/ha in June 2000, and another installment of Rs 30 million at Rs 20/ ha. In march 2001, in addition, all the 1,470 WUAs in the state were given Rs 5,000 each for administrative and other expenses. In the financial year 2001-2002, the WUAs were given Rs 90 million at Rs 60/ha for major projects, Rs 50/ha for medium projects and Rs 40/ha for minor projects. All the 1,470 WUAs were given Rs 5,000 each for administrative and other overheads (Vibhagiya Prashasanik Prativedan).

The above state-wide initiatives are in line with National Water Policy first developed in 1987 and revised in 2002. While each state government is free to develop its independent approach to water resources development it has nevertheless, to a large extent, been in line with the plan priorities and direction set by the central government in the National Water Policy. The key pro-people, pro-equity and pro-poor dimensions of the newly formulated/revised Water Policy of 2002 that reflect the national thinking and influence the policy environment include the following. However, policymaking is one thing and its effective implementation is another.

- Focus on disadvantaged: Special efforts should be made to formulate projects either in or for the benefit of areas inhabited by tribal or other specially disadvantaged groups such as schedule castes (SC) and schedule tribes (ST). In other areas too project planning should pay special attention to the needs of SC & ST and other weaker sections of the society.

- Participation in project planning: The involvement and participation of the beneficiaries and other stakeholders should be encouraged right from the project planning stage itself.

- Equity: Water allocation in an irrigation system should be done with due regard to equity and social justice. Disparities in the availability of water between head reach and tail-end farms and between large and small farms should be obviated by the adoption of a rotational water distribution system and supply of water on a volumetric basis subject to certain ceilings and rational pricing.

- Management: Management of the water resources for diverse uses should be done by adopting a participatory approach, by involving not only the various government agencies but also the users and other stakeholders in an effective and decisive way in various aspects of planning, design, development and management of the water resources schemes.

- WUAs: Formation of WUAs with authority and responsibility should be encouraged to facilitate the management including maintenance of irrigation systems in a time-bound manner.

The study undertook a detailed review of literature on irrigation, system performance and rural poverty. A summary of the detailed literature survey reported in the full report is outlined below.

1. Though the contribution of agriculture to GDP has been declining over time, which is a natural trend in development, about 60 percent of the Indian rural population is still employed in agriculture. During the first half of the post-independence period where agriculture contributed a major proportion of GDP, the fluctuations in GDP were attributed to the monsoonal vagaries. The increased stability during the later periods is attributed both to decline in the proportion of agriculture of GDP and improvement in irrigation infrastructure, which stabilized agricultural production.

2. One can discern distinct trends in research on poverty-related issues over the years. The measurement of poverty, defining poverty lines and the related tools engaged the attention of researchers for a considerable period of time. Various researches on the Green Revolution experiences provide contrasting evidence about the validity of the trickle-down theory of growth. Though there has been a fall in the overall levels of poverty over time, the rate of decline has been slow. The presence of safety nets in the form of drought and flood relief programs seems to have enhanced the impacts of other interventions on poverty alleviation. Researches on the impacts of economic reforms on poverty reveal that poverty exacerbated during the first years of reforms and no significant effects were experienced at the micro levels. Incomplete and partial reforms seem to adversely affect poverty-alleviation efforts.

3. The investments in irrigation peaked during 1980-90, while they almost doubled from their previous levels during the 1992-97 plan period. Institutional finance for irrigation showed a similar trend. While the potential of major irrigation has always been underutilized, the utilization fell short of potential in the case of minor irrigation only from 1980 onwards. Despite the improvement in irrigation infrastructure and the consequent creation of employment opportunities, it was observed that only households with assets and that were closer to the poverty line were able to cross the line. The composition of growth and the absorption capacity of growth opportunities by the poor are critical for poverty alleviation.

4. In general, the poverty in irrigated areas is lower than in rain-fed areas. It is less intense and less widely spread in long-established irrigated areas than in new ones. There have been no special pro-poor programs/policies in irrigated agriculture.

5. While initial research on irrigation focused on the technical aspects and performance, the subsequent researches took account of the social processes like conflict management and collective action. The major economic impacts of the irrigation interventions have been in the form of increased income generation, mainly through providing additional employment opportunities due to increased intensity of farm management requirements.

The reduction in poverty experienced was mainly through increased agricultural production and adoption of modern farm technologies leading to reduced food prices and generating income through employment. However, there is no conclusive evidence on the impacts of irrigation on poverty. Some studies show that investment in less-favored areas like rain-fed areas would have greater impact on poverty and environment than in irrigated areas.

6. There is evidence to show that irrigation improved the yields and reduced the variation in crop area. It has also contributed to improving the groundwater resources. There have also been changes in cropping pattern to orient to market due to irrigation. Irrigation alone, however, does not seem to bring about any perceptible impacts in income or poverty alleviation. Complementing this with other inputs is very crucial to appropriate the benefits from irrigation. Irrigation has undeniably contributed to improving the carrying capacity of the areas.

7. Large irrigation projects have been largely criticized for their negative impacts, especially in terms of large-scale displacement of population, negative health impacts and environmental impacts in the form of loss of habitat, salinization and waterlogging leading to reduction in crop yields. The costs of reclamation of the affected areas added to the cost of the projects have been generally high, especially with the investments being underutilized, due to the utilization always falling short of the potential created.

8. The major issue of contention has, however, been equity in distribution of benefits of irrigation. The scale bias in irrigation is presumed to have reinforced inequality among users. Though there is evidence that marginal farmers gained in an absolute sense, large farmers gained proportionally more. While the quality of life was found to be better in irrigated villages, the income and asset inequality was also found to be higher in these villages. Irrigation Management Transfer was seen as a mechanism to bring equity in distribution. The success of these initiatives is yet to be tested systematically.

## Study Settings and Data

The research in India covered a total of four major irrigation[2] systems, two located in Madhya Pradesh and two in Andhra Pradesh. This section provides an overview of the key features of the two states.

### *Andhra Pradesh*

Andhra Pradesh (AP) with a population of about 72 million (Census 2001) and a geographical area of 27.68 million hectares, is the fifth largest state in the country. It is located in the tropical region between $13^0$ N–$20^0$ N and $77^0$ E–$85^0$ E. It is bounded by the states of Orissa and Madhya

[2] In India, irrigation projects having a cultivable command area (CCA) of more than 10,000 hectares are classified as major; less than 2,000 hectares as minor and those ranging from 2,000 to 10,000 hectares as medium.

Pradesh in the North, Maharashtra and Karnataka in the West, Tamilnadu in the South and Bay of Bengal in the east with a coastline of 974 kilometers. 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 it is engaged in agriculture. One of the more robust "stylized facts" about poverty in India is that agricultural laborers are highly represented among the poor (Lanjouw 2000). Andhra Pradesh proves to be no exception. The state comprises three regions namely: a) the erstwhile Nizam's territory called Telangana (with 39% of the state population and 42% of the geographical area), b) Coastal Andhra (with 43% population and 34% area), and c) Rayalaseema (with 18% and 24% area). Of the state's geographical area, 47 percent (12.9 million ha) 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 hectare. About 30 percent of the state GDP is contributed by agriculture.

The state has vast water resources with three major rain-fed rivers: Godavari, Krishna and Penna and 37 other medium and minor basins draining the entire state. The total surface water available from these sources is 2,746 thousand million cubic feet (TMC). Groundwater availability is 1,000 TMC. The ultimate potential that can be developed from all the sources is estimated to cover 9.5 million hectares (7.3 million ha from surface water and 2.2 million ha from groundwater). By 1999-00 the total irrigation potential created from all sources is estimated at 6.4 million hectares. The Krishna river, the second largest and next to the Godavari river, in South India traverses Mahaboobnagar, Nalgonda, Kurnool, Guntur and Krishna districts in Andhra Pradesh. It has 19 tributaries, most important among them being Tungabhadra, Bhima and Musi. The river originates in the Sahyadri range of Western Ghats in Maharashtra and flows through Maharashtra, Karnataka and Andhra Pradesh for 1,400 kilometers before joining the Bay of Bengal.

AP has 10 major irrigation projects (out of 16) completed in the state. Three of these projects are quite old (over 100 years), around 9 have been developed in the past 4 to 5 decades and the rest are in various stages of development.

For this study, one project, which is old and another project, which was constructed after the beginning of the post-independence planned era in 1950, have been identified. The first one is the Krishna delta project, which is about 150 years old and the second is the Nagarjunasagar project – left command area (NSLC), which is around 35 years old. The first one (Krishna delta) is a diversion system with a barrage across the river. The second is the Nagarjunasagar Project (NSP), which has a reservoir with storage capacity of 7,058 MCM (200 TMC). It is constructed on the river Krishna. The NSP dam has two main canals, one on the right flank and the other on the right side of the dam and covers a total command of 0.895 million hectares. Both projects are on the Krishna river, which has a catchment area (basin) of 258,948 $km^2$ extending in three states—Maharashtra, Karnataka and Andhra Pradesh.

The allocated quantity of water in the state of AP is apportioned among the various irrigation projects in the basin. The Krishna delta project has an allocation of 5162 MCM or 181 TMC and the NSLC has 3765 MCM or 132 TMC. The major part of the state (around 75%) is covered with red soils with varying soil depth and clay content (alfisols) mostly spread out in the entire state. These are generally undulating with low fertility status. The black soils (vertisols) occupy around

25 percent of the total area, mostly located in the northern part of the state and to some extent in the central portion. These areas are generally flat with medium to low fertility status. The alluvial soils are mostly located in the delta areas of the major river, before their confluence into the sea and extend over 10 percent of the state's area. The balance 5 percent is occupied by sandy soil, laterites and other mixed soils.

The last 5 years have seen the state of Andhra Pradesh making rapid strides in its economic reforms. The irrigation sector has been positively influenced by institutional reforms largely focusing on: a) introduction of a suitable policy and legal framework; b) 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 ID; and d) bringing in significant financial reforms to influence quality performance of users' organizations. Today, the state is leading in its irrigation reforms in India (Raju 2000). Major steps are focused on institutional reforms towards irrigation management turnover all over the state. In this connection, the state has formed 10,292 WUAs and 174 distributary committees.

Figure I–2. Map of India showing locations of Andhra Pradesh and Madhya Pradesh.

### *Madhya Pradesh*

Madhya Pradesh (MP) is located in the central region of India between 18° and 22° north latitudes and 74° to 82° east longitudes. Madhya Pradesh accounts for 7.8 percent of India's population and 13.5 percent of the country's geographical area. Madhya Pradesh is among the poorest states in the country with a per capita income of Rs 4,025 against the country average of Rs 5,530.[3] The state has a literacy rate of around 45 percent.[4] Madhya Pradesh has a geographical area of 44.5 million ha out of which the gross sown area is 25 million ha while the net sown area is 19.8 million ha. Only 5.2 million ha are sown more than once a year.[5]

The state consists largely of a plateau with a mean average elevation of 1,600 ft. above sea level. Madhya Pradesh has three principal varieties of black soil and mixed red soil:[6] a) Medium black soils cover about 20 districts in the west, southern and parts of central Madhya Pradesh. These are rich in humus and are conducive to growing wheat, cotton, groundnut and soybean; (b) Mixed red and black soils cover most parts of the Bundelkhand region of north central Madhya Pradesh. These are light-textured and are devoid of lime and free of carbonates, and support a large variety of crops but need irrigation; and c) Deep black soils cover a major part of the Narmada valley, especially the districts of Hoshangabad and Narsinghpur. With very high humus content, these soils are very good for cotton, wheat and gram cultivation.

The state has a gross cultivated area of 25 million ha out of which the gross irrigated area is 6.2 million ha. Thus the area irrigated is just over 24 percent. Out of the net cropped area of 19.8 million hectares, the area under food crop is 17.5 million ha. Thus over 70 percent of the cultivated area is under food grains. This indicates the prevalent trend of agricultural practice in the state. The principal food crops are wheat and rice, gram and pulses. Mustard, cotton and sugarcane are other significant crops grown in the irrigated areas of the state. The state has eight major irrigation projects. Canal irrigation in the state constitutes 30 percent of the total irrigation; irrigation with tube wells 15 percent; tank 3 percent; wells 39 percent and other sources 13 percent.

In the Ninth Five-Year Plan period (1997-2000) it was planned to invest a sum of Rs 60,300.30 million. A budget provision of Rs 20,920.89 million was made for major, medium and minor irrigation projects for the year 2001-2002. The cost for the development of the canal system has increased from around Rs 10,000/ha in the early 1960s to around Rs 50,000/ha by the year 2000.[7]

---

[3]*Source:* MP Human Development Report 1998.
[4]*Source:* Census of India, Madhya Pradesh 1991.
[5]*Source:* Agriculture Statistics, Directorate of Economics and Statistics (DES), Government of India.
[6]*Source:* Population Atlas of India 1991.
[7]Interview with senior irrigation officials.

## Characteristics of Selected Systems

### *Selected Systems in Andhra Pradesh*

The research study in India covers four major irrigation systems, two located in Andhra Pradesh, Nagarjuna Sagar Left Canal (NSLC) and Krishna Delta System (KDS), and two in Madhya Pradesh, Halai and Harsi. The four systems are diverse in nature and put together to a great measure are representative of irrigation systems in India. Characteristics of these systems are presented below.

The Nagarjuna Sagar Vanal (NSLC), located on the river Krishna, is served by a reservoir with a live storage of 200 TMC. The reservoir has a main canal on the right side with a command area of 453,000 hectares and another main canal on the left side with a command area of 357,000 hectares. The latter is the Nagarjuna Sagar Left Canal (NSLC) project. The NSLC is a contour canal and runs over a length of 298 kilometers. The entire command area is divided into around 31 blocks, each served by a main distributary, which takes off from the main canal based on local minor ridges. The extent of a block varies from 5,000 ha to 38,000 ha.

The Krishna Delta Systems (KDS) project is located in the lower reaches of Krishna river, around 100 kilograms upstream of the confluence of the river with the sea. The river water is diverted into the irrigation system by a barrage built across the river. A series of main canals emanates on both the left flank and the right flank. The command area on the left flank is 295,000 hectares and on the right side it is around 231,000 hectares.

To appreciate the causes for deprivation of irrigation water under major irrigation systems with a very widespread and intensive distribution network in Andhra Pradesh, it is necessary to look into three specific issues relating to the project formulation and development. They are:

a) The planning gap in designing of the system for providing irrigation.
b) Delineation of areas for irrigation and for a specified type of irrigation.
c) The operational procedures adopted for water regulation.

### *Planning Gap*

The difference in the available water in the project and what is actually required to serve the entire command determines the planning gap. The "Commission of Irrigation Utilization" of the Government of AP in its report in 1982 examined the process of planning in detail and said that the planning gap occurs "due to adoption of over-optimistic and unrealistic duties, inadequate water allowance, under estimation of seepage and other losses, over-estimation of dependable yields, etc." In case of the Nagarjunasagar Left command area, the Commission estimated the planning gap as 38 percent, the water allocated for the project being 3,735 MCM, while the requirement for the planned crops[3] stands at 5,550 MCM.

### *Delineation of the Areas for Irrigation*

In the command under NSLC, while delineating lands for the purpose of irrigation, certain areas were deleted, such as those near villages up to about 400 meters as anti-malarial zones and high spots. Some lands were left out for future inclusion. However, in practice, when once irrigation water started flowing, local farmers made their own channels to draw water into all these excluded areas. Even though, technically, their lands are not included in the command, they take water and it is called unauthorized irrigation. The net outcome of this is that the flows are reduced and designed flows never reach the lower half of the system.

### *Operational Procedures*

There are no specific operational procedures, except at the macro-level, where each year before the start of the season a notification is issued by the government indicating the date of release of water into the main canal. The concerned Chief Engineer, after assessing the storage in the project and the inflows, submits a proposal suggesting the date for release of water and then the government issues the orders. At the meso and micro-levels, operational practices are on an ad hoc pattern, and obviously many extraneous factors come into play in this. The above three factors are very much relevant in the NSLC area.

In the Krishna Delta irrigation system, since it is at the end of the river system, the ground is quite different; essentially, it is a "water surplus system" and the entire area is covered with the rice crop in *kharif* (the first season). The only problem faced has been that the transplantation period gets delayed by 6 to 8 weeks as one proceeds to the tail-end areas of the main distributaries. In other words, this delayed planting has its effect on the crop yields and, generally, yields are lower by 300 to 500 kg/acre compared to head-reach areas.

The command area of NSLC covers portions of three adjacent districts, i.e., the eastern part of the Nalgonda district, south and southeastern part of Khammam, and north and northeastern part of Krishna. The Krishna delta area extends in the central, south and southeastern parts of the Krishna district and the eastern part of the Guntur district. A small extent in the northern part of Prakasam also gets irrigation under the delta.

In the command area of NSLC the red soils are the predominant type of soils occupying around 72 percent of the project area. Black soils occupy an extent of 28 percent, mostly concentrated in the lower reaches of the central and eastern part of the command. However, the Krishna delta is predominantly alluvial, around 95 percent, with a few patches of black soils spread out in the upper reaches of the command. The soils in the three reaches of the sample minors are mainly red soils (alfisols) with a small batch of black soils in the lower reaches of the tail-end minor. In the Krishna area, the soils in sample minors are all alluvial.

Under irrigation sources, the main crop during the kharif season is rice. In *rabi* (the second season) also rice again forms the predominant crop with oil seeds (groundnut) and pulses (green gram and black gram). In the sample villages the same cropping pattern is observed. The average productivity of rice in NSLC is 2,748 kg/ha while in the Krishna delta it is 5,550 kg/ha.[8] (Statistical Abstract of AP 2000 for NSLC and brief note on KDS, Office of Superintendent Engineer, Vijayawada circle for KDS).

Reddla Repaka and Gopavarapugudem are selected as non-command/control areas for NSLC and KDS systems, respectively. Reddla Repaka village belongs to the Valigonda mandal of the Nalgonda district, and gives representation to the non-command area of Nagarjuna Sagar Left Canal (NSLC). The selected non-command area village is about 80 kilometers away from the state headquarters, and is situated on the Medak to Chityal state highway. The geographical area of this village is about 8.8 square kilometers. According to the latest census of India, 2001, the population of this village is around 16,600, living in 310 households. Of these, about 60 percent of households are agricultural, and the rest are dependent on nonagricultural activities for their livelihoods. The population according to the caste groups prevalent has indicated that shepherds, toddy tappers and Muslims are major castes dependent on agriculture for their survival. Among others, Harijans are largely dependent on nonagricultural activities for their livelihoods.

A large extent of the crop cultivation in this village is brought under rain-fed conditions. As per the latest minor irrigation statistics the village has a minor irrigation tank and about 150 bore wells in order to provide an assured water supply for crop cultivation, mostly belonging to the toddy tapper community farmers. The availability of groundwater in this village is found at a depth of 200 feet. During dry spells, the majority of the bore wells dry up, the groundwater level falls down further and the discharges come down from 3 to $1^{1}/_{2}$ inches. Paddy is extensively cultivated under bore wells, mostly during the first crop season. Castor, cotton and sorghum crops are cultivated under rain-fed conditions.

Gopavarapugudem is a non-command area village for the Krishna delta system. The total population of the village is 1,650, of which 75 percent are farmers and the rest non-farmers. The literacy rate is 63 percent, the majority (38%) of them educated up to the primary level. About 19 percent and 8 percent have studied up to the matriculation and above the matriculation, respectively. Most of the landholdings (55%) are less than 1 acre, 37 percent between 1 and 5 acres and the rest between 5 and 12.5 acres. About 77 percent of the farmers cultivate their own farms and the remaining 33 percent, in addition to cultivating their own farms, have leased in land at a fixed rent of Rs 3,000 per acre per annum.

Trends in landlessness increased during the last 10 years. About 35 percent of farmers become non-farmers due to dependency on rain-fed cultivation, high-cost agricultural inputs and poor economic returns from crop cultivation. The non-farming activities taken up by these farmers are vegetable selling, dairy development activity and agricultural labor work in orchards. The average wage rates for males and females are Rs 50 and 30 per day, respectively, in both agriculture and non-agriculture. Around 50 percent of the area is under orchards. The other crops are paddy (18%), vegetables (12%), groundnut (8%), red gram (7%), and guinea grass (5%). The major problem expressed by the farmers is drought occurrences. Poverty analysis through PRAs suggests that 68 percent are poor of which 40 percent are always poor and 28 percent are

[8]Statistical abstract of AP 2000 for NSLC and brief note on KDS, Office of Superintendent Engineer, Vijayawada circle for KDS.

sometimes poor. Poverty is associated with inadequate water availability, poor crop returns and landlessness.

A WUA is constituted in the village. Further probing revealed that the village actually falls in the tail end of the command area. But it has not been receiving any water for the past 20 years. The WUA has received a maintenance grant and spent it for improvement of the physical system. However, there is still no water supply in the main canal system, which has made the WUA dysfunctional for all practical purposes. It is perceived that increase in quantity of water (through construction of a Lift Irrigation Scheme) would reduce poverty as agriculture households will have assured water and non-agriculture households can seek employment in agricultural operations and also initiate secondary economic activities.

***Selected Systems in Madhya Pradesh***

One of the selected systems is in the Gwalior district called the Harsi irrigation system located along the Parvati river. In the Harsi system, the gross command area is 68,000 hectares out of which the irrigated command area is 53,000 hectares. The net sown area is 44,000 ha. The major crops sown in Harsi are wheat, gram and other pulses and sorghum. The other system selected for the study is in the Vidisha district and called the Halali irrigation system located along the Halali river. Most of the command area (close to 90%) falls in the Vidisha district. The remaining area falls in the Raisen district. In the Halali systems, the gross command area is 37,000 hectares out of which the irrigated command area is 26,000 ha. The net sown area is 26,000 hectares. The cropping pattern in Halali is the same as in Harsi. Four villages in non-command areas, two each for Halali and Harsi systems, were selected as control sites. They are Salaiya and Suakhedi in the Halali system, and Bamrol and Saaketpura in the Harsi system, with a total of 270 households in the former villages and 123 households in the latter two villages. These are largely rain-fed villages.

## Sample Selection

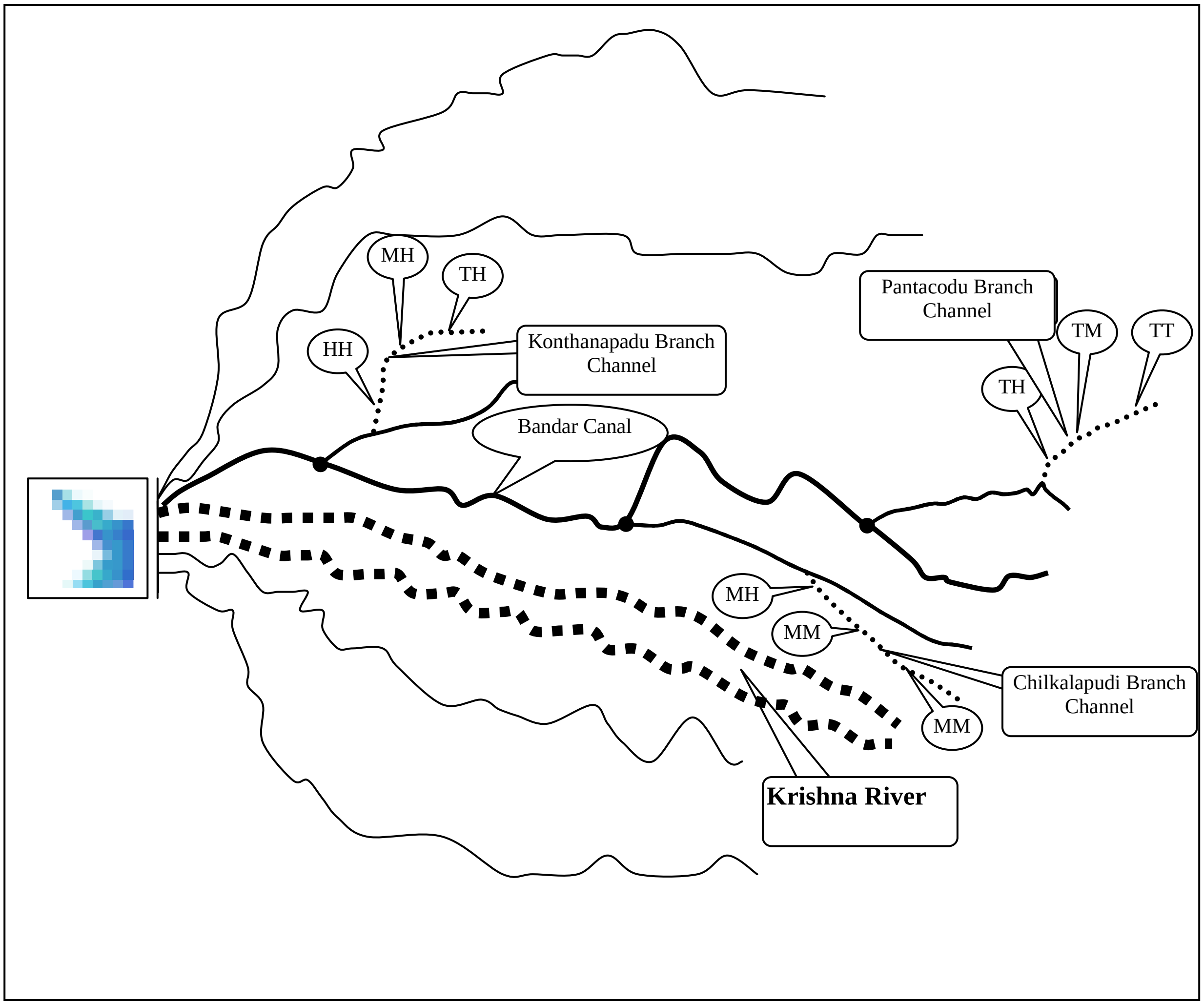
The study areas in MP and AP come under a similar agro-climatic zone (semiarid) of the country and with rivers fed by rainwater. The irrigation projects selected were constructed at different points of time starting from the early nineteenth century to the early twentieth century. The command areas of the irrigation projects vary from 526,000 hectares to 37,000 hectares each in their extent. The soil and other physical and cultural factors vary within each command and as a whole are representative of the greater part of the country. Other major considerations that prompted our selection of these systems are the existence of PIM programs, receptivity of government decision makers and IDs.

A total of 938 households were sampled within the command areas of the four irrigation systems selected. In each irrigation system a head-, middle- and tail-end canal branch was chosen, along which a minimum of three villages were selected. Again, villages were selected according to their location on the canal branch, distinguishing villages in the head, middle and tail reaches. However, in Madhya Pradesh a larger number of villages were selected as the size of the population was not adequate (minimum 30 households on a random basis) in some of the villages selected. For control sites, two villages each adjacent to the two irrigated commands were taken up for the study.

Under the Nagarjuna Sagar Left Command (NSLC) command area three distributaries were taken, first in one-third of the main canal length (Block 6), the second in the middle length (Block 19) and the third one in the tail-end reach (Block 21/9). In the Krishna delta system (KDS) also a similar approach in the selection of distributaries was adopted on one of the long canals on the right flank (Bandar Canal). There are 66 distributaries in the NSLC command area and 13 distributaries in KDS area. The selection of the villages and households along with the identified distributaries/blocks was done as follows: a) each distributary was divided once again into three equal zones, head, middle and tail reaches, b) the head zone in the first sample distributary, the middle zone in the second sample distributary and the tail zone in the third sample distributary constituted the study areas, and c) in each zone a long minor on the irrigation system was identified and villages falling within the area were marked. Among these villages, one in the head reach of the minor, one in the middle and one in the tail reach were selected for the study. Thus three villages located on each sample distributary at head, middle and tail reaches—in all 9 villages in the command area—were identified for the study. Further, one village each outside both the irrigation systems selected were also surveyed for "control" purpose. Around 30 households in each village were selected for the study. Thus the total sample of 600 households from the two systems in AP was used for in-depth data collection in addition to participatory rural appraisal/participatory poverty assessment and key stakeholder interviews and consultations.

In Madhya Pradesh (MP), selection of the sample was on the same lines as in AP following head, middle and tail reaches of the irrigation systems selected. However, some modifications became necessary in view of the local settlement patterns. In this system, Left Bank Canal (LBC) irrigates about 80 percent of the area, i.e., 20,000 hectares while the Right Bank Canal (RBC) irrigates only 20 percent of the area. Hence, most of the sample was drawn from LBC command area. While eleven villages were selected from the LBC command, two were from the RBC command. Control villages selected were one each from outside the LBC areas. In the Halali irrigation system the main canal divides into LBC and RBC. Another branch canal "Sahodara" also bifurcates from LBC further downstream. The entire command was divided into upper, lower and middle reaches of the distributaries. In the Harsi system, there is only one main canal, which is a contour canal and all the distributaries branch out from its left side. A similar methodology was followed in selecting the villages as in the Halali command area. Out of 13 villages selected, 4 were from the head reach, 3 from the middle reach and 4 from the tail end. In addition, two villages outside the command were selected for control purposes. In both systems in MP, a sample size of 497 households was selected for detailed data collection. Figure I–3 shows the selected major and minor distributaries in the KDS.

Figure I-3: Schematic map showing the selected major and minor distributaries in (KDS)



**Summary of Main Findings and Conclusions**

This section summarizes the key findings and conclusions of the study. Detailed analyses and results are presented in the main report. The analysis in the study throws up some common and divergent scenarios for initiating strategic interventions at different levels with a pro-poor slant. Ever since the planned effort the Government of India and the state governments have been carving out several interventions from time to time with the aim to alleviate poverty in rural areas. The area development programs, several employment generation programs and those aimed at the target population along with subsidized food-gain distribution, education and health improvement programs—all have contributed effectively to the reduction in rural poverty. Though it took 20 years initially after the planning, rural poverty has been coming down impressively. Yet, the absolute poverty and the phenomenon of poverty in plenty still haunt the Indian scene.

Special pro-poor programs or interventions are by far few in irrigated areas. One of the reasons for this may be the policymakers' long-held belief that increased agricultural production in irrigated commands would automatically decrease poverty in those areas. Among the irrigation projects studied KDS in AP is the oldest commissioned in 1852 followed by Harsi in 1935, NSLC in 1968 and Halali in 1978. These projects show varying degrees of irrigation performance and implications for poverty. While the older systems like KDS show more deterioration, the others are also showing signs of considerable decay in the physical infrastructure.

In this study, poverty was estimated using income as a measure of welfare, poor households being those that earn less than Rs 3,155 per capita per year (the official poverty line for AP) or less than Rs 3,736 per capita per year (the official poverty line for MP). Income poverty is found to be much greater in MP than in AP. This is in accordance with the official poverty figures, which are much higher for MP. While in AP, only 11 percent of the population is below the poverty line, in MP, 37 percent of the population is below the poverty line. Poverty is higher in non-irrigated villages than in the command area of the selected irrigation systems. This is in accordance with our hypothesis that access to irrigation reduces poverty. Within the two states, poverty is markedly lower in KDS (16%) than in NSLC (33%), and in Harsi irrigation system (62%) as compared with Halali (73%). One explanation could be the period over which irrigation water has been available to households over time: KDS and Harsi were both established before NSLC and Halali, which seems to have triggered a broader development of the regional economy too. Thus the four systems studied form a gradational continuum in all the indicators starting highest from KDS followed by NSLC, Harsi and Halali.

Table I–1. Income poverty indicators for the four systems.

| | NSLC | | KDS | | Halali | | Harsi | |
|---|---|---|---|---|---|---|---|---|
| | Command | Control | Command | Control | Command | Control | Command | Control |
| Headcount (%) | 33 | 63 | 16 | 23 | 73 | 75 | 62 | 71 |
| Poverty gap | 0.11 | 0.23 | 0.04 | 0.07 | 0.44 | 0.25 | 0.30 | 0.22 |
| Squared PG | 0.05 | 0.11 | 0.01 | 0.03 | 0.34 | 0.21 | 0.23 | 0.09 |

In general, households in irrigated areas show a striking contrast to those located in non-irrigated areas. Poverty in the rain-fed villages outside the NSLC is twice the ratio. While the contribution of canal irrigation can be clearly seen in all the systems studied, the extent of non-farm income, landholding size and groundwater use reduces poverty levels to an extent in rain-fed areas. The main impact that irrigation has on household income is through increased agricultural productivity, longer periods of employment with higher wages, higher cropping intensity and choice of HYV food crops as against the traditional varieties in rain-fed areas. Though poverty is all-pervasive to some of the households namely, marginal, small and landless categories, the poorest of the poor are found in non-irrigated areas. Thus the study conforms to the findings of numerous research studies conducted earlier.

Poverty in canal irrigated areas is one of the crucial issues the study dealt with. The characteristics of the poor households in AP and MP are different. In AP though landless households prominently figure among the poor, surprisingly the poorest among the poor are those with some land. Both in NSLC and KDS non-farm income constitutes a considerable share in income (10-54%). Landless households spend all their time in wage earning whereas households with land spend only part of their time in off-farm employment. In MP, not many options exist for off-farm employment as in AP and the landless households that are mostly poor are the poorest too. The contribution of agricultural labor is also significant in the income for the landless households. In the Harsi system, which is double-cropped, the average per capita income of the poor landless is 35 percent more than in Halali and the income between landless poor and landed non-poor is much-less compared to Halali. The other socioeconomic features of the poor and non-poor households can be captured by the type of their dwelling places, education of the head of the household and number of members constituting the household. *Kutcha* houses (not firm, thatched, mud walls and roofs) are more in villages with no access to water and the pucca (concrete/tiled) houses are more in irrigated areas. Further, in areas of established irrigation systems like KDS and also with the non-poor landed households (in all the irrigation systems) pucca houses are of common sight. The average household size is 4 in KDS, 5 in NSLC, and over 7 in Harsi and Halali in MP. However, the number of members in poor landless households is comparatively higher by 1 to 2 members. The difference in education levels of the heads of households is marginal. The heads of landless households, however, spent 1 or 2 years less in schools in MP than their counterparts in AP.

Poverty in NSLC seems to be linked to the accessibility of water. Of the non-poor households 66 percent received water during kharif whereas 30 percent of poor households obtained irrigation during the rabi season. As a result, the cultivated area of poor is less than one-quarter of the area cultivated by non-poor and also the net value of output produced is lower. In KDS, both the poor and the non-poor received water in kharif (poor households even more than non-poor households) and the income is similar in both categories. The productivity of non-poor households in KDS is three times more than that of poor households. In Halali, the difference in average household income between the poor and the non-poor is over 7 times and in Harsi it is 4.8 times. The difference is due to the double-cropping and consequent generation of more employment opportunities in Harsi. Looking at access to irrigation, there is a considerable difference among the poor and the non-poor. In Halali 45 percent of the poor households received irrigation, 72 percent of the non-poor obtained irrigation in rabi. In Harsi, the difference between the poor and the non-poor in accessibility for irrigation ranges between 20 percent and 50 percent in rabi and between 35 percent and 60 percent in kharif. In the Halali command area, groundwater is not used whereas in all other three systems it is used conjunctively to an extent. More groundwater usage is seen in Harsi (36% of households in head reach, 14% in the middle and 32% at the tail ends). Only 10-15 percent of households use groundwater in AP at head and middle reaches.

It is clearly seen that villages located in parts of the canal system with sufficient access to irrigation are less-poor compared to others. Poverty in tail-end reaches is more compared to the middle reaches of the canals because of lack of availability of. and access to, water.

An important determinant influencing poverty in irrigated areas is the landholding size. Historically, measures like abolishment of the zamindari, land ceiling legislations and various tenancy acts have, in several states, redistributed land resources. In fact, the first signs of poverty reduction were seen during those times. However, the disparity in landholdings is not wide now as it used to be at one time in AP or MP. However, several *benani* (factious) holdings, partitions on paper and other methods circumvent the law. Even the reported landholding pattern shows differences between the poor and the non-poor households. In Halali, an average poor household landholding is 1.3 hectares whereas for the non-poor it is 6.4 ha. In other systems the non-poor approximately own double the size of average landholding ranging from 1.38 hectares to 2.85 hectares.

The average size of landholding increases in all the systems, from head to tail ends of the canals; the percentage of landless also generally increases, more in water-scarce systems like NSLC and Halali. This may point the natural settlement pattern of the poor moving to less-productive and water-scarce reaches. The incomes, however, cannot be explained by landholding size alone. The marginal farmers in water-abundant systems like KDS and Harsi are better-off compared to those in water-deficit systems. In water-deficit systems like NSLC the percentage of lands left uncultivated is more than the percentage of land under the second crop.

Land productivity and crop choices have a bearing on poverty. In both the states, in reaches where water is abundantly available, all farmers, irrespective of landholding size, cultivate water-intensive crops. In AP, HYVs of rice are grown during kharif and minor crops like black gram, groundnut, pulses are grown in rabi. In NSLC, rice crop is preferred in rabi wherever water is available and is supplemented by groundwater. In MP systems, high-yielding wheat (Mexican variety) is grown in rabi to an extent of 65-70 percent in both head and middle reaches of Halali. In Harsi, paddy is the main crop (ranging from 90% to 60%) in head and middle reaches. While the tail ends in Halali grow local varieties of wheat, in Harsi, jowar and maize are grown. HYV crops in both the states yield high monetary returns to the farmers though farm-input costs are also correspondingly high. This once again shows that poor farmers have to contend with local varieties and coarse grains, mainly for lack of adequate irrigation to their fields. In MP systems, small farmers are also constrained to use available land in an optimal way as access to adequate credit and other inputs is lacking. The crop choices of farmers thus fall on crops requiring less-expensive inputs.

Our econometric estimations suggest that landholding size, crop productivity, non-crop income non-land assets, location of households in an irrigation system and family size are significant determinants of poverty. Poverty is less among households with smaller family size, larger land size, higher crop productivity, with more diversified sources of income, and among those located in middle parts of the systems. Negative marginal effect on the probability of a household being poor is highest for the productivity variable. The analysis confirms that poverty incidence is significantly less in irrigation systems than in rain-fed areas, suggesting that irrigation has a significant impact on poverty alleviation. Further, there are differences in incidence of poverty across KDS and NSLC, with poverty significantly higher in water-short NSLC systems than in the water-adequate KDS system. The results imply that poverty incidence is significantly less at middle reaches where productivity is high. While poverty is higher at tail reaches, difference in poverty across head and tail reaches is not significant. Contrary to common perceptions, poverty is not necessarily lower at locations closer to the source of water (i.e., head reaches).

An important aspect, which affects both poor and marginal farmers in all the projects, is the quality and reliability of water supply. The unreliable and delayed availability of water for crops adversely affects the output. While large farmers can look for alternative sources of irrigation, small and marginal farmers greatly depend on canal water. With the formation of WUAs and minor repairs undertaken by them, water used to reach the tail end of the main canals in the KDS system 2 to 3 months after release at the head ends; though the time duration varied from project to project all the tail ends in the irrigation canals experience delays and short supplies.

Levy and collection of sufficient water fees from the users are another crucial and long-neglected issue in these irrigation systems. The supply side nature of canal irrigation with heavy subsides for most agricultural inputs including water for increased food grains production deteriorated government revenue collections even for undertaking O&M activities in the irrigation projects. Vaidyanathan Committee appointed by the planning commission in 1992 examined the issue and while endorsing the commonly held view that the revision in water charging should cover the O&M costs and a modest amount of the capital costs incurred, held the view that it should in the long run aim at covering all the recurring and capital costs fully.

The study findings show that the collection of water charges in MP is 33 percent in Halali and 21 percent in Harsi. The corresponding charge for KDS in AP is 55 percent. This reflects on the systems' poor financial self-sufficiency and wide O&M financing gap based on recovery. However, in both the states (and in the country as a whole) there is no direct link between irrigation performance and water-fee recoveries. Budget allocations are made at the state levels every year, irrespective of the quantum of water fee charged and collected. The collections made by the revenue department (AP) or irrigation agency (MP) go directly to the government exchequer's general pool. Yet another related aspect to the issue of water fee is lack of relationship between the O&M requirements and the decision on the level of irrigation charges to be collected. For example, the annual O&M expenditure in Halali and Harsi are Rs 29 and Rs 31 million, respectively. Most of this, however, goes into payments of salaries and overheads. Even if 100 percent of present water charges are collected it would meet only 25 percent of the O&M costs. Moreover, currently, only Rs 50/ha is actually spent on the O&M work in the canals. If a more reasonable amount (Rs 500/ha/year) is spent on O&M, which is the minimum amount needed given the current state of the canals, according to the engineers, the current revenue from water charges as a proportion to the O&M requirement becomes even more insignificant. Political considerations perpetuate the downward levels of charging. The introduction of PIM envisaged the collection of water charges by WUAs. But the WUAs have not yet started this function on both states. However, the work on assessment of water charges under joint *ajmaish* (supervision) of both the ID and WUAs in AP has been initiated. The full responsibility of assessment and collection is not handed over to WUAs; the WUAs are not accepting this willingly because of the social sensitivities involved in collection and enforcement.

It is seen that both MP and AP systems, which are more efficient in terms of reach (proportion of area irrigated to the total area) and timely delivery of water, had better cost recovery rates and also a good administration system. Although this could prove the research hypothesis to be true, the causal relationship, in fact, seems to be the reverse, with better system performance inducing farmers to pay. Since water charges are the same irrespective of the amount of water a farmer gets, farmers who get little water are reluctant to pay the water charges. To improve the performance of the irrigation system involved, initial investment in system O&M might need to be made to induce farmers to contribute to the costs. Although the issue resembles the question of which came first, chicken or the egg? Addressing the critical threshold level for cost recovery and system performance will be critical to address system performance issues in a structural way.

It is well known that if proper institutions are in place it would improve the performance of the irrigation systems and also the lot of the poor, by many times than attempting improvements merely in physical systems. The earlier interventions through the CAD program and irrigation modernization programs were seen as administrative and technical solutions to the problems. A major intervention strategy attempted starting with AP in 1997 and MP in 1999 was the introduction of PIM and handing over management of irrigation to the FOs. This was part of the overall sectoral reforms the country was engaged in. This has brought in a "paradigm shift" in the irrigation sector, introducing new institutional arrangements. The institutions had hitherto been "control" oriented by the government. Water allocation and distribution are worked out at the top; their implementation is worked out at the top; and their implementation is in the hands of irrigation agencies of the government. The IMT is expected to bring in changes in several customs, norms and rules governing irrigation management.

The introduction of PIM in both the states (although AP has completed 5 years) is relatively new and as such it is perhaps too early to assess its impacts on the irrigation system performance. The impact assessment undertaken in this study presents a mixed picture. Data gathered from the field indicate that the introduction of PIM did have a positive impact on the irrigation system performance. Data from both the states suggest that after the introduction of PIM water flows faster to the lower reaches and covers an increased area. In AP, the initial 3 years with World Bank funds saw maintenance and repairs undertaken by WUAs, which had a positive impact on water flowing to lower reaches further.[9] The time usually taken for a tail ender in KDS to receive water used to be around 2 to 3 months for transplantation after the head-end farmers received irrigation. Now, the water is available within 1 to 1.5 months for transplantation after the head-reach farmers are done. During 2001-2002 nearly 90 percent of the transplantation was completed in July and the rest was completed in the first week of August. In the year under reference there was no change in the cropping pattern but the perception of WUA office bearers and also of

[9] The World Bank provided Rs1,336/ha to support the program from 1977 to 2000. From February 2001, 50% share of the water tax collected is made available from the government to the FOs.

farmers was that the improved drainage and timely irrigation helped improve the production as follows (table I-2).

Table I–2. Crop productivity before and after PIM, Andhra Pradesh (kg/ha).

| Crop | Prior to the PIM (1997-1998) | After the PIM (2000-2001) | Remarks |
|---|---|---|---|
| Paddy | 4,631 | 5,557 | +926 (early transplantation) |
| Sugarcane | 111,150 | 123,500 | +2,470 (assured water supply) |
| Maize | 6,300 | 7,410 | +1,235 (reliable water supplies) |

The minor repairs undertaken by WUAs in both the states and also the drainage works in KDS no doubt have resulted in the availability of more water to the tail ends, which in itself is a pro-poor contribution. In KDS, the WUAs are convinced that less irrigation water to paddy fields give more production. Last years' drought and the effects of the leaders of farmers in convincing the farmers thus generated showed that even a less number of waterings to the rice fields (about 4) can yield better outputs. The growing awareness or belief among farmers would also certainly help improve water deliveries to the tail ends giving rise to the evolution of new institutions. Successful learning experiences of farmers spread the message faster than the usual extension methods.

Small farmers mostly rely on canal water, which is less costly than other sources for their agricultural production. The O&M works undertaken after the implementation of PIM generally benefited small landholders than the large farmers by creating more opportunities for agricultural wage earning. Gradually, when more representations on MCs for small farmers materialize, in the long run PIM is certainly likely to benefit the poor more than the rich.

Table I–3. Impacts of PIM in AP and MP systems.

| | Halali | Harsi | NSLC | KDS |
|---|---|---|---|---|
| Awareness of WUA among farmers (%) | 40 | 40 | 60 | 70 |
| O&M works<br>a) Spread<br>b) Quality<br>c) Costs | <br>More extensive<br>Better<br>NA | <br>More extensive<br>Better<br>NA | <br>More extensive<br>Better<br>Less | <br>More extensive<br>Better<br>Less |
| Water charges collection | Marginal improvement | Marginal improvement | Marginal improvement | Marginal improvement |
| Presidents elected | Mostly large landholders (LL) | Mostly large landholders (LL) | Mostly large landholders (LL) | Mostly large landholders (LL) |
| Area under irrigation | Improved | Improved | Improved | Improved |
| Water delivery to lower reaches | Reduced time | Reduced time | Reduced time | Reduced time |
| Availability of required number of waterings | na | na | Adequate | Adequate |
| Participation of farmers in selection and execution of O&M works. | Fair | Fair | Good | Good |

In the MP systems, farmers have strategically elected large and powerful farmers as presidents from tail-end reaches to ensure that water reaches the tail end. The choice of generally large and influential people as presidents was driven by the desire of farmers to have someone strong enough to negotiate with the irrigation agency and the outside world. Further, such people are believed to have the capacity to spend money for organizing meetings, receiving outside people and also traveling to represent farmers' concerns to the authorities.

The other critical thing on which farmers were more or less unanimous is the improved quality of O&M works and their cost-effectiveness. Farmers' surveys indicate that the selection and execution of physical work have been much better under the WUAs. Data from PRA exercises suggest that in both the selection and execution of works, there has been a good amount of participation among farmers, which was totally missing before PIM was introduced. Unlike in AP, the relationship between the farmers and irrigation officials is not very cordial in MP. Though the signs of improvement are clearly perceptible in the relations between officials of the ID and WUA presidents, the control of the irrigation agency is still strong. Without proper sanctioning of the competent authority (an Engineer from the ID) no physical work can be undertaken. Thus, the relationship between the WUA and the irrigation official becomes critical. In the Harsi system, for instance, due to lack of good relationship between a number of WUA presidents and irrigation engineers, more than 50 percent the sanctioned budget for the year 2001-2002 remains unspent.

The O&M works undertaken after the implementation of PIM generally benefited small landholders more than the large farmers by creating more opportunities for agricultural wage earning. Gradually, when more representations on management committees (MCs) for small farmers materialize, in the long run PIM is certainly likely to benefit the poor more than the rich. The WUA leaders in all the irrigation systems opined that, on average, there was a reduction in disputes (mainly related to water distribution to the fields) to an extent of 15 percent only. Many of the small farmers felt that after the IMT, some forum is now available to approach for redress if required.

However, the study and fieldwork also suggest that both the general bodies and the management committees of WUAs have been focusing their attention on maintenance than on water regulation and improving water-use efficiency and productivity. Activities like allocation plans, water budgeting and efforts to use water efficiently and equitably were missing in the functions of WUAs. None of the WUAs could generate funds from the water users apart from the funds given by the government except in KDS. The tail-end villages (WUAs) and some DCs were said to have collected money to supplement government allocations for clearing of drains in the early phases of IMT implementation. Though empowered, no WUA has taken penal action against earning by defaulting members. It is also opined that some of the WUA presidents and DC presidents are operating more like contractors forming an unholy nexus with irrigation officials and competent authorities.

The Acts do not provide for reservation of poor farmers and women representatives on the MCs. High-caste domination is shown among MCs of WUAs both in AP and MP. Further, the representation of poor farmers is marginal in both states. This reinforces the observation of earlier studies (Barbara Van Koppen et al. 2002; Jasveen Jairath 2001) that the small and marginal farmers are by and large excluded from decision making and opportunity for negotiations with the leaders. The consensus candidates were encouraged by the Government of AP by providing financial incentives to the respective WUAs choosing them. Promoting contest through elections is more rewarding as a democratic process and also the context of devolving powers at the grass-roots level. The poor farmers will have a chance to exercise their franchise through the ballot.

Institutional measures like *warabandi* (rotational water supply method) in north India and localization (restriction of water-intensive crops in designated areas from head to tail end, prohibiting cultivation in some zones, etc.) were devised to ensure equity in water distribution in some areas. Laws were also enacted, but their implementation (in MP and AP) remained difficult. Localization in name of equity tended to introduce inequity of another kind. Warabandi as an administrative measure became target-oriented and lost the social importance it is supposed to carry. Other methods like rotation of canals and permission of a second crop in the command area though successful could not bring the expected equity. One of the objectives of IMT is to enable the farmers to evolve equitable distribution practices and their implementation. The WUAs in both the states have not yet addressed these issues of water planning, budgeting and equitable distribution. Their functions during the last 4-5 years have centered on construction and repair activities; and water management is yet to figure as an important activity they have to attend upon.

In water allocations, emphasis is on bureaucratic allocations at all levels. Current water allocation and distribution practices call for clearly defined water rights. Lack of such institutional arrangements and flow of transparent information regarding their rights affect the efficiency in water management. More so, the poor are adversely affected in such a situation than the non-poor farmers. In general, the PIM acts are silent on “water rights.” Though several customary rights have performed well before, the need for evolving water rights still remains. The IMT can be seen as a first step in creating “group water rights;” yet landless are out of the purview and poor landholders are not represented in the decision-making bodies like management committees.

Our analysis of water allocation and distribution systems suggest that some of the water allocation institutions addressed the advantage and betterment of tail enders and the poor are in place but are not implemented due to a variety of reasons not only because of gross inequity by the head-end farmers but also because of the cropping pattern, nature of very perpetuated large systems and several technical reasons involved.

The role of caste institutions almost working like “bounded labor” is still operative in some areas in MP. Sharing of irrigation water has, to a great extent, come out of the clutches of the caste system in AP. While, on one side, the farmers feared reinforcement of old social structures at the beginning of IMT in MP, the overall feeling of WUAs in AP and in MP in electing rich landlords or coincidentally influential high-caste farmers as presidents was backed by prudence. The farmers opined that such a person would be able to carry weight and can negotiate better with the government and members. Project-level committees in both the states have not yet been formed leaving a wide gap in planning and implementation. The experience of IMT as seen from the empirical data calls for institutional learning and capacity building among all stakeholders backed up by several amendments in the Acts.

In sum, of the four irrigation systems, the two older systems, KDS in AP and Harsi in MP, are more stabilized and, over a period of time, the farming communities have gained more experience in adjusting to the irrigated agriculture. Poverty in these command areas is less than the relatively recent command areas like NSLC in AP and Halali in MP. But there is also a possibility that if the irrigation system is not efficiently maintained because of neglect or lack of resources and other institutional deficiencies, as a result of which there is instability in irrigation supply and higher risk for marginal and small farmers, poverty may still persist at higher levels. The overall picture that emerges from the two older systems shows that KDS in AP reflects positive features of longer experience while Harsi in MP appears to have experienced more neglect and decay due to inadequate resource mobilization for O&M. Cost recovery so far was not directly linked to O&M of the systems, yet it clearly shows that better maintenance of systems lead to better collection of fees. The initial impact of IMT has shown encouraging results. Further, research in this area is needed as the introduction of IMT is of recent times and the institutional development is a slow process.

The study brings home several findings and lessons of generic importance which call for strategic interventions at government/policy (macro), project (meso) and field/operational (micro) levels. While initiating these interventions it should be ensured that all of them are connected and have a logical linkage from policy to operational levels. These interventions triggered simultaneously would achieve more than the piecemeal approaches. In the past, the government in its wisdom encouraged macro economic growth, human capital development and also provided safety nets for the poor. At times, the trade-off proved very favorable and also unfavorable. In this wider context, the following are some of the findings of generic importance in irrigated agriculture as reflected in the study.

**Conclusions and Recommendations**

1. Tail reaches of the irrigation canals have low productivity levels causing high poverty incidence. Head reaches consume more water and the conveyance systems are incapable of delivering water required to the tail ends. The main reasons for this are a) excess withdrawals and overuse of water by head-end farmers; b) glaring design and planning deficiencies in the irrigation systems. In NSLC, for example, earlier studies shown in the original project estimates of command area and water supply were overestimated by 36 percent and the construction of canals is continuing in spite of deficits at the tail ends. In the same project, it was estimated that in different places of head and middle reaches a quantity of at least 12 mm of water is lost daily on account of deep percolation in paddy fields. The localization specifications are flaunted by the users and the changes acquired legitimacy; and c) at the time of design of projects there were many lacunae like the nonavailability of sufficient and reliable information, operation of pressures to conform to the technical and financial criteria of appraisals and compulsions to include extensive areas in the project. This is an important cause, which led to several inconsistencies. In addition to the questions of planning and implementation the ***question of equity comes to the fore.*** In MP, among villages that are homogenous (landholding-wise) there is greater equity in sharing of water.

2. The performance of established (old) irrigation projects is better compared to the new projects constructed after independence, showing a "stabilization" effect on the economy of households. In both the older projects, KDS and Harsi, poverty levels are less when compared to the overall poverty of the respective states. The hegemony of castes and landholding sizes is relatively less compared to the other projects in the respective states. There were quick adaptation to change (farmers' management) and attempts to adopt to the new initiatives through required institutional arrangements (formation of federation of WUAs, initiatives to prepare water allocation plans and budget good cooperative functioning of the ID and FOs, and in KDS, initiatives of the DC president to arrange releases of water to the tail end by working out agreements between head and lower reach WUAs). Among old irrigation systems, better equity in distribution, higher output/ha at tail ends, employment of labor for long periods and higher wage rates can be seen. The trend can be explained because of the existence of ***better institutional development and functioning.***

3. Irrigation yields are comparably low in the water-scarce reaches of the projects. This was, to an extent, due to the crop choice of farmers in the head reaches. In all irrigation areas, rice is the preferred crop of the farmer. Absence of water regulation and ***farmers' preference for rice cultivation*** are the basis for inequity in sharing water among farmers. Sustained efforts to wean farmers away from rice cultivation are lacking. There is no encouragement for ***diversification of crop*** from policy to operational level. The farmer's preference in the case of rice cultivation to an extent is also conditioned by externalities of rice cultivation itself in the neighboring "field, especially for the downstream farms."

4. Fixation of water charges and the basis for fixation remained top-down. The collection mechanisms have not changed even after IMT. This is an issue well discussed in India. While in AP the institutional structure has been created to revise water rates periodically the procedure for fixing and collection are still ambiguous. In the changing scenario, after the introduction of IMT the poor service mode remains. There are no clear-cut water-delivery schedules, no volumetric devices, no definite water allocation plans prior to the agricultural season. Further, there is no farmer involvement in any of these issues. ***While fixation of rates is one aspect that can be used effectively in policy development in favor of the poor, collection of water charges is an "important" issue that calls for attention in view of the misappropriations inherent and also mounting dues pending from the users***. Water charge collection has been very poor in both states, but better recoveries are evident in systems (KDS) where irrigation performance is better. The issue of water charges is also linked to the question of its viability being related to land and crop.

5. The management change in the irrigation sector calls for a great deal of institutional learning and ***capacity building*** of the actors involved. The capacity building involves not only training of irrigation officials and farmers but also both of them working together in evolving plans and implementation strategies. The irrigation agency has a major role in providing "hands on" guidance to the WUA leaders in the management of irrigation. Though the IMT has successfully created farmer collectives, the focal officer (competent authority) from the ID has not devised institutional mechanisms for capacity building

among different actors. These findings have implications for evolving and developing institutions at operational level with appropriate policy support.

6. Though waterlogging and salinity were not reported in the study area the degradation of land (non-research resource) is on the increase in irrigated areas. Signs of waterlogging are seen at KDS and Harsi in the head reaches. These ***externalities*** have to be addressed both at policy level and WUA level.

7. The ***gender participation*** in WUA management is meager in MP and AP. In AP, except for a few elected women representatives, many of them were brought into the management bodies as proxies for their husbands or as a strategy to get financial support from the government. A few women representatives, however, made an excellent imprint on the functioning of WUAs. This is an issue which has to be addressed at the operational level.

8. By far, IMT is the major step that ushered in several ***institutional changes*** that, in turn, showed positive results. Yet the ***law is silent*** on many aspects affecting the poor and the landless. Several other institutions are to be evolved and nurtured by both farmers and the government before the synergic effects could be evaluated.

# Literature Cited


Ahluwalia, M.S. 1978. Rural poverty and agricultural performance in India. *Journal of Development Studies.* Vol.14.

Bussolo, M.; O' Connor, D. 2002. *Technology and poverty: Mapping the connections in technology and poverty reduction in Asia and the Pacific*. Development Centre Seminars, OECD.

Dandekar, V.M. 1994. *The Indian economy 1947-92 agriculture.* New Delhi: Sage Publications.

Datt, G. 1999. Has poverty declined since economic reforms? Statistical data analysis. *Economic and Political Weekly*. December 11.

Government of Andhra Pradesh, Bureau of Economics and Statistics. 2001. Statistical abstract.

Government of India. 2000. *Report of the National Commission for Integrated Water Resources Development Plan*. Ministry of Water Resources. New Delhi.

Government of India. 2001. *Report of the National Commission for Integrated Water Resources Development Plan*. Ministry of Water Resources. New Delhi.

Jairath, Jasveen. 1985. Technical and institutional factors in utilization of irrigation: A case study of public canals in Punjab. *Economic and Political Weekly* 20 (13).

Li, H; Squire, L. Zon, H.F. 1998. Explaining international and inter temporal variations in income inequality. *The Economic Journal*, 108, January.

Lipton, M; Longhurst, R. 1989. New seeds and poor people. Baltimore: John Hopkins Vnic Press.
Pant, D. K.; Patra, Kakali. 2001. Rural poverty in the early 1990s. *Margin* 33 (2&3).

Radhakrishna, R. 1993. Indian agricultural growth, employment and equity. In *Nature man and Indian economy*, ed. Tapas Mazumdar. Oxford University Press.

Rao, V.M. 1996. Agricultural development with a human face: Experiences and prospects. *Economic & Political Weekly.*

Ravallion and Datt. 1996. How important to India's poor is the sectoral composition of economic growth? *World Bank Economic Review* 10(1).

Sastry, S.A.R. 1980. A survey of literature on poverty, income distribution and development. *Artha Vijnana.* 22 (1).

Sen, Gita. 1999. Endangering poverty alleviation: Challenges and opportunities. *Development and Change.* Vol 30.

Sivamohan, M.V.K.; Scott, Christopher; Hussain, Intizar; Bouma, Jetske; Ganguly, Ujjal; Thikawala, Sunil; Wijerathne, Deeptha. 2004. C*ountry Final Report — India: Pro-poor Intervention Strategies in Irrigated Agriculture in Asia: Poverty in irrigated Agriculture in India — Issues and Options*. Colombo, Sri Lanka: International Water Management Institute.

Van Koppen, Barbara; Parthasarathy, R.; Safillow, Constantina. 2002. *Poverty dimension of irrigation management transfer in large scale canal irrigation in Andhra Prasesh and Gujarat, India.* Colombo, Sri Lanka: International Water Management Institute.

Yoko, Kijima; Lanjouwl, Peter. 2003. *Poverty in India during the 1990s*. World Bank Policy Research Working Paper 3141. World Bank.

# Poverty in Irrigated Agriculture in Pakistan: Issues, Options and Pro-poor Intervention Strategies

## Historical and Contextual Frame

Pakistan's agriculture depends mainly on irrigation, as the annual precipitation in major areas of the country does not exceed 10 inches with heavy concentration in the monsoonal months of July-August. Realizing the importance of irrigation, 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 kilometers and nearly 100,000 watercourses, with a total length of 1,621,000 kilometers (Gill 1996). In addition, more than 530,000 tube wells are also currently pumping groundwater for irrigation. In spite of all this, the available water supplies fall much short of Pakistan's crop-water requirements. According to the required amount 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).

The agriculture sector in the country is now facing the dual challenges of increasing food demand and looming water scarcity. The country's population is estimated at 146 million in 2002 (GoP 2002), and is projected to increase to 183 and 243 million in 2013 and 2025, respectively. The corresponding irrigation requirements for years 2013 and 2025 would be 26.53 and 34.21 million hectare meters (MHM), respectively. To overcome these problems, the country must increase the available supply of irrigation water and improve efficiency of water use. The overall water use efficiency is reported to be 59 percent and most of these losses occur at the secondary and the tertiary levels. In addition, there is significant inequity in distribution of water at all levels of the systems; within a watercourse command irrigation water delivered to farm households located at the tail reaches is usually less than those located at the middle and head reaches; the quantity of water that the outlets on a minor receives is different from that the outlets on a distributary receives. Over time, these conditions have aggravated the problems of waterlogging and salinity in the country. To mitigate these problems, the Government of Pakistan introduced various interventions such as Salinity Control and Reclamation Projects (SCARPs), On-Farm Water Management (OFWM) Program, Irrigation System Rehabilitation Projects (ISRP), and National Drainage Programs (NDP). Some of these programs/projects achieved their objectives only partially.

The current situation in irrigated agriculture in the country is characterized by: a) highly skewed land distribution; b) high population growth, and increasing number of smallholdings; c) high illiteracy rate; d) low crop yields; e) lack of information-sharing; f) centralized bureaucracies and political interference; g) lack of transparency and accountability of officials; h) inequity in distribution of water; and i) inadequate maintenance of irrigation infrastructure, and lack of effective implementation of operational rules. All these factors have contributed to worsening the poverty situation in rural Pakistan during the 1990s, and substantially reducing antipoverty impacts of irrigation.

The latest poverty scenario in Pakistan presents a very gloomy picture. As per official statistics, poverty is estimated to be over 28 percent in 2002. Poverty incidence is higher in rural areas (32%) than in urban areas (19%). Analysis of poverty trends over time shows that the poverty situation improved significantly during 1969–70 and 1987–88, when poverty incidence decreased from 46.5 percent to 17.5 percent. These improvements in poverty, however, could not be sustained for long. The poverty situation worsened during the 1990s, when poverty incidence rose to 33.5 percent in 1999–2000, with a relatively higher incidence of poverty in rural areas than in urban areas. More than 12 million people were added to the poor in Pakistan between 1993 and 1999. The rise in poverty was the result of poor governance and slow economic growth (Asian Development Bank 2002). The situation appears to have been gradually improving since 2001-2002. However, there is a considerable difference in poverty incidence and progress in poverty alleviation across regions and provinces in Pakistan. A province-wise breakdown of poverty reveals that the highest incidence of poverty is in NWFP and the lowest in Balochistan. The latter is due mainly to lower population density in Balochistan, although it has one of the driest, and water-scarce and fragile environments. Poverty patterns in Punjab and Sindh are fairly similar and are more or less in keeping with that of the country as a whole.

The changes in growth including growth in the agriculture sector, employment, income distribution, and inflation were the major trendsetters in poverty. The improvement in poverty situation during the 1970s and 1980s was associated with high growth rates exceeding 6.0 percent per year. However, in the late 1980s, the economic growth rate slowed down, mainly 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 during the 1990s. 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. Overall, the country's fundamentals remain quite weak: population continues to grow at 2.5 percent per year, gross national income and per capita income continue to be at low levels (estimated at US$ 59.6 billion and US$420 in 2001, respectively), and other indicators such as life expectancy of 63 years, under-five child mortality rate of 110 and adult literacy rate of 57 percent are also not very encouraging.

Agricultural economy, which forms the backbone of the broader rural economy of the country, is presently facing three major interrelated problems: a) increasing water scarcity, b) degradation of land and water resources, and c) low levels of agricultural productivity. Over 67 percent of the population lives in rural areas. Rural households depend directly or indirectly on agriculture for their livelihoods. The bulk of the rural non-farm activity, supporting mostly the non-farm population, also depends on agriculture. Overall, agriculture contributes around a quarter of the country's gross domestic product, engages 44 percent of the labor force, and contributes significantly to export earnings. Any economic or climatic shock to agriculture affects the entire country, with the poor being hit the first and the hardest. The government has identified agriculture as one of the four major drivers of economic growth along with oil and gas, small and medium enterprises and information technology. Therefore, any rural poverty reduction strategy in Pakistan must focus on the rural agricultural economy and help address its specific problems, which include inequitable distribution of resources; degradation of land and water resources; and low agricultural productivity.

Agricultural land, a key rural resource, is highly unequally distributed in Pakistan, and land inequality in the country is the highest in the Asian region, with the Gini coefficient as high as 0.769 (Adams, Jr. 1995). Almost 50 percent of rural households are landless. Among 5.7 million land owners/farms, 7 percent large landowners control 40 percent of the total agricultural land owning holdings of 10 ha and above, and 93 percent share the remaining 60 percent of the land area, and among these, 27 percent of marginal landowners own less than one hectare each. Recent observations and analyses show that inequitable landownership has a substantial negative impact on agricultural productivity, and also indirect negative effects on the natural resource base and the environment. For example, inequality in land distribution cuts against the smooth working of land-lease markets, promotes friction among owners and tenants, withholds investments in irrigation, resource-conserving technologies, on-farm infrastructure, land-improvement measures, and promotes unsustainable use of irrigation water and production practices, and impedes technological change, all contributing to worsen the poverty situation through negative impact on productivity. Inequities in land distribution prevail in all four provinces in the country. However, inequities in agricultural lands are greater in the Sindh Province. In the Indus basin, there is a geographic pattern in land inequities, which increase progressively towards downstream of the basin. Recent analyses suggest that such mass-scale landlessness and huge inequities in land distribution are among the prime causes of poverty in rural Pakistan. The government undertook land reforms in 1959 (prescribing a ceiling of about 200 hectares for irrigated land and 400 ha for non-irrigated lands; only 5,000 landowners declared land in excess of ceilings, and only 1 million ha of land were resumed and distributed among 85,000 tenants and smallholders). The 1972 reforms reduced the ceiling to about 60 ha for irrigated land and 120 ha for non-irrigated land; only 0.5 million hectares were resumed and distributed to 71,000 beneficiaries; the reforms attempted again in 1977 remained largely unimplemented. As per official estimates, by the end of 1999, 0.857 million people benefited from land redistribution, though partially due to lack of follow-up support to the beneficiaries. About 0.291 million hectares of land resumed from landlords over time and 0.886 million ha of public lands of varying quality are available for distribution.

The government has developed and adopted a comprehensive poverty reduction strategy in 2002-03, which has the following main components: a) engendering growth by correcting macro-economic imbalances, which has five subcomponents—tax reforms, expenditure management, monetary policy, external adjustment and debt management; b) broad-based governance reforms—devolution of power, civil-services reforms, access to justice, and fiscal and financial transparency; c) improving income-generating opportunities—empowering people by creating opportunities for improving livelihoods through improved access to assets including housing, lands and credit; d) improving social sector—particularly improving health and education; and e) reducing vulnerability to shocks by providing social safety nets. The three year (2001-2004) poverty reduction plan aims to fight against poverty on the following four fronts: i) increasing economic opportunities for the poor; ii) empowerment of the poor; iii) increasing the poor’s access to physical and social assets; and iv) increasing their access to welfare and support through the development of social safety nets. These are to be achieved through: a) economic reforms; b) physical assets creation for the poor; c) social assets creation for the poor; d) social safety net mechanism; and e) good governance.

In line with the new poverty reduction strategy, a number of antipoverty projects and programs have recently been initiated to improve the conditions of the poor. These include Khushaal Pakistan program for community level public works, Food Support program for the poorest of the poor, Zakat Rehabilitation Grant and the Micro-credit program. Another major program is the Social Action program with four target areas—elementary education, basic healthcare, family planning, and rural water supply and sanitation. These initiatives, if implemented effectively, can be expected to contribute to improving livelihoods of the target groups. In the water sector, the government has recently reinvigorated its efforts to provide irrigation facilities to marginal areas, not yet served by the canal network. Priority areas identified in water resources development plan for the next decade include: a) raising of Mangla dam, construction of Mirani dam, Gomal zam dam, Thal canal and other small and medium reservoirs; and b) efficient use of stored water through construction of new irrigation schemes like Rainee canal, Kachi canal, greater Thal canal, and modernization of barrages in Punjab. According to the estimates presented in the government's 10-year perspective plan (2001-2011), these developments would augment irrigation water by 6 million acre-feet by 2011. These initiatives, if successfully implemented, can be expected to contribute to at least partially addressing the problem of growing water scarcity in the country.

### *Irrigation Sector Reforms*

Since the late 1990s, the government initiated reforms in the water sector, with a focus on improving institutions and overall governance in the water sector. In the irrigation sector, the reforms aimed at decentralizing the irrigation management, improving farmers' participation in management, and improving sustainability (physical, financial and environmental) of irrigation systems. The reforms were initiated with the formulation of new Irrigation and Drainage Authority (PIDA) Acts passed by the Provincial Assemblies in 1997. Under the reforms, a three-tier structure was proposed for irrigation management: a) provincial irrigation and drainage authorities (PIDAs) at the province level – which replaced the former ID –financially autonomous bodies responsible for policy formulation, legal enactment and for overseeing the overall management of the irrigation and drainage systems in the respective provinces. The PIDAs would be responsible for the O&M of the irrigation systems extending from the head-works to the main canals, distributaries, and the outlets in the watercourses in the respective provinces. Currently, PIDAs are in a transitional stage and, ultimately, they are expected to be financially autonomous bodies with independent revenue collection and spending authority with proper accountability; b) an Area Water Board (AWB) at the canal command level covering an average of about 0.4 million ha. Each canal command would have one AWB, which would be responsible for about 120 to 140 distributary systems. In Pakistan, there are 43 canal commands and altogether 43 AWBs would be established. Area Water Boards are envisaged to have functions similar to those of utility companies. AWB would be composed of the representatives from farm households' organizations, the PIDA, the Agriculture Department, WAPDA, etc. According to the PIDA Act, the farm households' representatives should include the head- and the tail-end farm households, as well as large and smallholding farm households. This is an important pro-poor dimension of the proposed reform structure. One FO would represent one distributary and one WUA would represent the farm households below the *mohga* (outlet) and along a watercourse; and c) an FO at the distributary canal command level, which would be established at the distributary canal command level. The FOs would receive water from the AWBs and distribute the same to various watercourse farmers and other users. The FOs would operate and maintain distributary canals and assess and collect irrigation charges. About 40 percent of the collected revenue is planned to be given to FOs for local O&M works, with the rest to be used by AWBs for upstream O&M works. The FOs will have to sign an Irrigation Management Transfer (IMT) Agreement with PIDA to take over management responsibilities. So far, some 20 FOs have been established but the management is yet to be transferred, except in one system, Hakra - 4R in southern Punjab, where management was transferred to farmers on an experimental basis in 2000.

In 2002, the government formulated a first ever National Water Policy (NWP) draft document. The draft NWP recommends for promoting efficiencies in conveyance of irrigation water and ensuring sustainability of irrigation infrastructure through a) raising awareness among farmers and government service-delivery personnel, b) increasing the level of cost sharing, and c) increasing community and farmer participation in the management decisions related to infrastructure. The draft policy document suggests: a) modernizing the irrigation network by enforcing high maintenance standards for irrigation infrastructure to avoid system deterioration; b) ensuring equity in water distribution mainly for tail-end farmers through institutional support; c) encouraging and supporting the development of additional storages to meet demand-based needs of crops; d) promoting transfer of management of irrigation systems to AWBs and FOs, with prior infrastructural rehabilitation, and establishment of independent regulators to ensure equitable water distribution while facilitating conflict resolution; and e) promoting empowerment of FOs to collect O&M charges and to impose fines for nonpayment. Regarding water rights and water allocation between the provinces, the draft NWP put emphasis on ensuring water rights of the provinces in accordance with the 1991 Water Accord. In addition, improving the functioning of Indus River System Authority (IRSA), an apex body set up for national water resources planning and allocation, to harness and develop more water resources in economically and socially desirable ways to reduce water shortages, especially during the critical periods of crop growth, is emphasized in the draft document. With respect to the economic and financial issues in irrigation management, the draft NWP endorses the concept of realistic charging/pricing of water in all subsectors, and to promote appropriate water charging systems that would ensure the collection of O&M costs and an increasing portion of the capital costs. Regarding groundwater use, the draft NWP recommends developing a groundwater regulatory framework to control groundwater overexploitation. In the case of institutional and legal aspects of irrigation water management, the draft NWP suggests to create a high level inter-provincial permanent body at the federal level, composed of part-time members, to be responsible for all water resource matters. The proposed body would be composed of concerned Ministers/Secretaries of Federal Governments, Provincial Representatives and other stakeholder representatives as members, and may be headed preferably by the Prime Minister or his nominee. The draft NWP is based on sound principles and has important pro-equity, pro-poor and pro-market dimensions. However, its successful implementation and effectiveness remain to be seen.

## Study Settings, Data and Methods

The study was conducted in medium- and large-scale irrigation systems in the upper part of the Indus basin in Punjab Province covering areas in: Upper Chaj Doab (comprising Gujarat and Mandi Bahauddin districts) irrigated by the Upper Jehlum Canal (UJC); Lower Chaj Doab (comprising Sargodha district) irrigated by the Lower Jehlum Canal (LJC); Rechna Doab (comprising Jhang and Toba Tek Singh districts) irrigated by the Lower Chenab Canal (LCC) East; and the tail part of the Hakra irrigation system (comprising Bahawalnagar district) irrigated by the Hakra canal system (figure P–1). The total geographic area of the Chaj Doab, Rechna Doab and Hakra is reported to be 1.2, 2.98 and 20,000 million hectares, respectively. The salient features of the selected irrigation systems studied are presented in table P–1.

Table P–1. Salient features of the selected irrigation systems.

| System | Distributary name | Perennial/Non-Perennial | GCA (100 ha) | CCA (100 ha) | Length (km) | Outlets | |
|---|---|---|---|---|---|---|---|
| | | | | | | Number | Discharge (cusecs) |
| UJC system | 9-R | P* | 61.9 | 59.5 | 10.24 | 29 | 39 |
| | 10-R | P | 45.3 | 43.7 | 11.05 | 23 | 25 |
| | 13-R | NP** | 30.4 | 28.7 | 13.81 | 18 | 26 |
| | 14-R | NP | 241.6 | 221.8 | 47.94 | 135 | 193 |
| Gujrat system | Kakowal | P | 97.9 | 92.7 | 38.68 | 50 | 84 |
| | Phalia | NP | 299.1 | 269.1 | 75.24 | 152 | 289 |
| LJC system | Lalian | P | 486.4 | 444.8 | 59.80 | 195 | 351 |
| | Khadir | P | 520.0 | 474.3 | 89.05 | 166 | 235 |
| LCC system | Khikhi | P | 419.7 | 329.4 | 53.30 | 158 | 341 |
| Hakra system | Hakra 4-R | P | 201.9 | 178.5 | 36.08 | 131 | 189 |

GCA: Gross command area.
CCA: Culturable command area.
* P=Perennial, supplying water all year-round.
** NP=Non-perennial, supplying water for only part of the year.

## Sample Selection

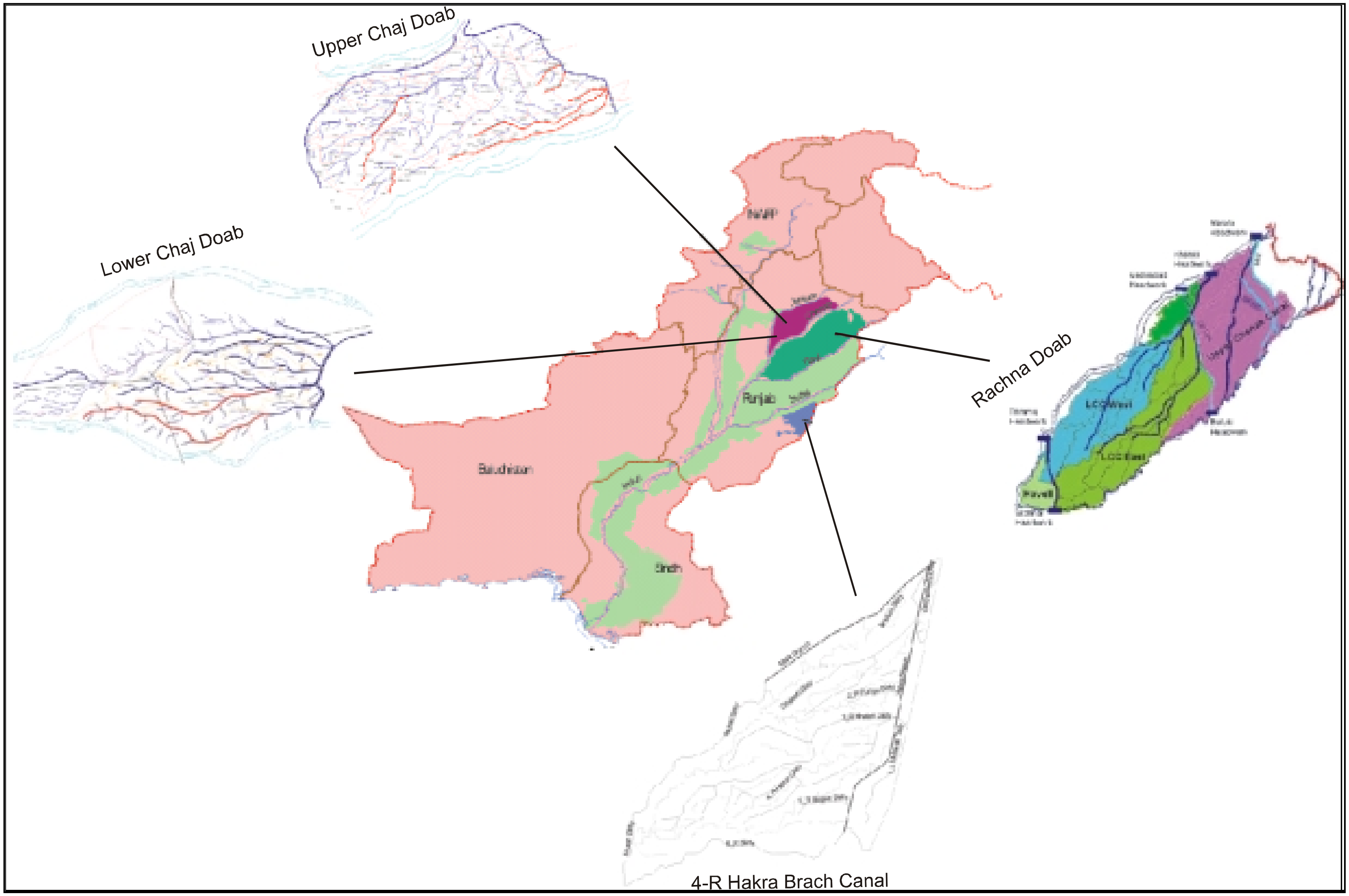
a) The study used both primary and secondary data and information for qualitative and quantitative analyses. Primary filed-level data and information were collected through participatory assessments and detailed household-level questionnaire surveys. A multistage stratified random sampling design was used to select the sample households for surveys in the study areas. At the first stage, the irrigated areas were divided into 5 irrigation systems: UJC system; Gujarat system; LJC system; LCC system; and Hakra system. These systems are irrigated through the Upper Jehlum Canal (UJC), Guajrat system, Lower Jehlum Canal (LJC), Lower Chenab Canal (LCC) East and Hakra 4-R, respectively. At the second stage, distributaries were selected on the basis of the agro-ecological characteristics considering differences in cropping patterns, nature of water supplies (perennial/non-perennial) and location of the watercourses across head, middle and tail reaches of distributaries. Based on these criteria, the entire study area was divided into seven cropping zones and the following ten distributaries were selected at stage 3 of sampling:

1) 9-R and 10-R characterized by Rice-Wheat crop rotation with perennial irrigation system located in the Gujrat District.
2) 13-R and 14-R characterized by Rice-Wheat crop rotation with non-perennial irrigation system located in Gujrat District.
3) Phalia characterized by Mixed-Wheat crop rotation with non-perennial irrigation system located in the Mandi Bahaudin District.
4) Kakowal characterized by Mixed-Wheat rotation with perennial irrigation system located in the Mandi Bahauddin District.
5) Lalian and Khadir characterized by Mixed-Wheat rotation with perennial irrigation system located in the Sargodha District.
6) Khikhi characterized by Mixed-Wheat rotation with perennial irrigation system located in the Toba Tek Singh/Jhang Districts.
7) Hakra-4R characterized by Cotton-Wheat rotation with perennial irrigation system located in the Bahawalnagar District.

The Upper Jehlum Canal (UJC) subsystem was divided into six distributaries with two distributaries (9-R and 10-R) having rice-wheat as the dominant cropping pattern with perennial irrigation supplies, and 13-R and 14-R having rice-wheat pattern with non-perennial supplies. Sugarcane, rice and wheat are the main crops grown in command areas of Kakowal and Phalia distributaries. Irrigation supplies in these distributaries are perennial in nature. Lalian, Khadir and Khikhi have a mixed-wheat cropping pattern where water supplies are perennial. The Hakra 4R has a cotton-wheat cropping pattern with perennial water supplies. While each distributary was fairly homogenous within its boundaries, in terms of the abovementioned characteristics, however, there could be intra-distributary differences in access to water (head, middle and tail watercourses) due to locational differences in the availability of water. These intra-distributary variations were captured through sampling across head, middle and tail within a distributary. At the final stage five households from each of the selected watercourses were selected through systematic random sampling from a complete sampling frame for each watercourse (i.e., list of all households on the watercourse). Landless households were drawn from the voters' list through systematic random sampling based on their proportion in the total number of households on each selected watercourse. An equal allocation method was adopted for selecting distributaries and watercourses across head, middle and tail reaches of the selected distributaries and for the sample size of households across each of the selected watercourses.

A total sample of 1,224 households was selected for field-level data and information collection through a well-designed pre-tested questionnaire. In the case of the first 6 distributaries in Gujrat and Mandi Bahauddin altogether 540 households were selected along 36 watercourses located on head, middle and tail areas. In each of the first 6 distributaries in irrigated areas, about 90 households were selected from each selected distributary with an equal number of 30 households from head, middle and tail reaches of a distributary. In the case of the last four distributaries (i.e., Lalian, Khadir, Khikhi and Hakra 4-R) about 171 households were selected from each distributary, with an equal number of households drawn from three watercourses at head, middle and tail reaches of distributaries. For poverty assessments, the study used two poverty lines for rural Pakistan: Rs 730/capiita/month and Rs 530/capita/month.

Figure P–1. Location of Chaj Doab, Rechna Doab and Hakra area in Punjab, Pakistan



**Summary of Main Findings and Conclusions**

The size of irrigation systems studied varies from 2,870 hectares to 47,430 ha. Except Hakra-4R, all systems are being managed by public-sector agencies (ID). All the systems are characterized as water-short systems, and conjunctive use of surface water and groundwater is common. Wheat, rice, cotton and sugarcane are major crops, with variations in cropping patterns across systems. Average landholding size per household in the selected systems varies from 2.49 to 6.54 ha, with the average land size increasing towards the lower part of the Indus basin. Inequity in land distribution is very high, with 75 percent of sample households (small farmers) owning around 40 percent of land, and 25 percent (medium and large farmers) owning 60 percent of land. Estimated Gini coefficient for landholdings across selected systems ranges from 0.31 to 0.56, with an average value of 0.49. In general, inequity in land distribution is much higher in systems located in the lower part of the basin.

In all the systems studied, irrigation water is allocated to farm households based on size of landholdings, that is, land and water rights tend to be coupled. Under inequitable land distribution, water distribution when measured in terms of total amount allocated per farm household also becomes inequitable, and vice versa. In addition, there is a significant inequity in the distribution of water across head, middle and tail reaches of systems. The estimated head-tail equity ratio ranged from about 1 indicating a highly equitable distribution (in the transferred Hakra-4R system) to 2.5 indicating high inequity in other systems. Table P–2 shows a typical situation of head-tail inequity in water distribution across reaches of the systems.

Table P–2. Upstream-downstream inequity in water, crop productivity and intensity of poverty (Lalian distributary, Punjab, Pakistan).

| Item/location | Head | Middle | Tail |
|---|---|---|---|
| Access to canal water ($m^3$/ha) | 1,500 | 2,745 | 345 |
| Access to total water ($m^3$/ha) | 3,345 | 4,049 | 2,491 |
| Productivity (wheat - kg/ha) | 4,946 | 3,917 | 3,188 |
| Poverty gap (%) | 41 | 39 | 44 |

*Source*: Based on primary data 2001-2002.

Cropping intensity in the systems varies from 124 percent to 183 percent. In general, copping intensity is inversely related to size of landholdings, with cropping intensity higher on smaller-size holdings. System-level efficiency of water use varies from as low as 28 percent to 71 percent. Gross value of crop productivity per hectare is low and varies significantly from US$230 to US$500. Net productivity benefit of irrigation (defined as net value of output from irrigated crop production minus net value of output from rain-fed crop production) varies significantly from US$23 to US$206 across systems. In general, productivity and benefits of irrigation are low in systems where land and water distribution is inequitable. This is further supported by a recent study by the Word Bank (2002), which indicates that inequity in land distribution is one of the important causes of low agricultural productivity in Pakistan. A detailed productivity analysis shows that inequity in canal water distribution, poor quality of groundwater (especially at tail-end areas where canal water availability is less), and farm-level practices such as sowing of older varieties, and delay in timing of sowing and application of production inputs, as the key factors responsible for low productivity levels. Overall, share of crop income in total household income varies from 14 percent to 39 percent across the systems.

Income poverty incidence varies from 40 percent to 77 percent across systems, with an average poverty of 59 percent. Poverty incidence is higher in those systems where land distribution is highly inequitable, productivity is low, and overall benefits of irrigation are low. Poverty varies across systems and across locations within systems, and there are some spatial trends in poverty within and across systems. In general, poverty increases in systems towards the lower part of the basin. Within systems, poverty incidence is relatively low at middle reaches, where land quality is generally better, access to water is also better and crop productivity is relatively higher, than at head and tail reaches. The depth and severity of poverty are also lower at middle reaches, and these are higher at tail reaches.

Table P–3. Estimates of poverty across reaches of irrigation systems, Indus Basin, Pakistan.

| | Headcount | | | Poverty gap | | | Squared poverty gap | | |
|---|---|---|---|---|---|---|---|---|---|
| Distributary | Head | Middle | Tail | Head | Middle | Tail | Head | Middle | Tail |
| 9-R Khoja | 0.48 | 0.38 | 0.40 | 0.31 | 0.27 | 0.26 | 0.13 | 0.09 | 0.09 |
| 10-R Dhup Sari | 0.44 | 0.50 | 0.27 | 0.27 | 0.36 | 0.26 | 0.11 | 0.15 | 0.09 |
| 13-R Saroki | 0.40 | 0.57 | 0.29 | 0.26 | 0.24 | 0.34 | 0.11 | 0.07 | 0.13 |
| 14-R Maggowal | 0.60 | 0.37 | 0.57 | 0.21 | 0.32 | 0.29 | 0.10 | 0.12 | 0.13 |
| Phalia | 0.63 | 0.46 | 0.39 | 0.29 | 0.26 | 0.30 | 0.11 | 0.11 | 0.11 |
| Kakowal | 0.37 | 0.59 | 0.35 | 0.29 | 0.29 | 0.35 | 0.11 | 0.12 | 0.17 |
| Lalian | 0.69 | 0.51 | 0.69 | 0.46 | 0.43 | 0.48 | 0.26 | 0.21 | 0.27 |
| Khadir | 0.77 | 0.70 | 0.86 | 0.51 | 0.45 | 0.55 | 0.29 | 0.23 | 0.33 |
| Khikhi | 0.81 | 0.53 | 0.74 | 0.45 | 0.47 | 0.47 | 0.24 | 0.25 | 0.26 |
| Hakra 4-R | 0.68 | 0.68 | 0.75 | 0.51 | 0.46 | 0.49 | 0.29 | 0.26 | 0.28 |
| Table Total | 0.64 | 0.55 | 0.59 | 0.41 | 0.39 | 0.44 | 0.21 | 0.19 | 0.24 |

*Source:* Primary data 2002.

Poverty in the selected systems is the outcome of a range of factors. Family size and dependency ratio are significant positive determinants of poverty. Crop productivity, access to canal water and good-quality groundwater, share of non-crop income and land distribution structure are significant negative determinants of poverty in irrigation systems. In other words, poverty is high among households with larger family size, larger number of dependents, with no land for cultivation or with only a small size of the holdings (generally less than 2 ha), and that are located in areas with least access to good-quality canal water or groundwater, and lower agricultural productivity. Poverty incidence and severity are significantly high among landless households, whose members work as unskilled laborers in agricultural and nonagricultural sectors. These households with significantly less incomes and expenditures (around one-third of non-poor households) and with little assets, face greater deprivation in terms of access to electricity, toilets and room space (on average more than 3 persons share one room in poor households).

The study findings suggest that, given large inequities in the distribution of land and water, large landholders are the main beneficiaries of irrigation water (and other public-sector programs). While poor small and marginal farmers do benefit when they have access to water, they are often constrained to optimize benefits from the available water due to lack of access to other necessary inputs and support measures.

Further, there are locational differences in productivity and poverty. Analysis of inter-reach differences in productivity and poverty within systems indicate that these differences are more pronounced in larger-size systems, where inter-reach inequities in canal water distribution and resulting differences in productivity are high. Also, variations in groundwater quality contribute to such differences. The poverty situation tends to worsen in reaches/locations where surface water availability is low, groundwater quality is poor, agricultural productivity is low and opportunities in the non-farm sector are limited. This situation is quite common in tail ends of large-scale systems. Overall, the study finds that poverty is lower at the middle reaches of the systems where productivity is relatively higher, and poverty is higher at tail reaches. Contrary to common perceptions, the results suggest that poverty is not necessarily lower in locations within canal systems closer to the source of water (i.e., head reaches). Given the socioeconomic characteristics of the poor and locational differences in poverty, there are, to some extent, opportunities for targeting interventions for poverty reduction.

Performance of irrigation systems was assessed using a range of indicators including productivity (irrigation and cropping intensity, output per unit of land, labor and water), equity (head-tail equities in output and water distribution), water supply (water delivery capacity, water delivery performance, and overall system efficiency), sustainability indicators (related infrastructure, economic and environmental aspects) and institutional- and management-related indicators. The following major conclusions emerge from the analysis:

a) There are substantial differences in performance of various systems in terms of the above indicators.
b) The performance of most systems is much below the realizable potential, and there is a significant scope for improving performance of systems through institutional and technological interventions.
c) There is a significant relationship between system performance and poverty, i.e., improved system performance in terms of improved water use efficiency and crop productivity would significantly reduce poverty.

A detailed analysis of agricultural performance of the systems indicates that major causes of low productivity in most systems include: inadequacy of irrigation water, lack of proper land leveling, farmers' lack of access to good quality basic inputs such as seeds, fertilizers and chemicals when necessary, low awareness of and lack of access to productivity-enhancing technologies and new methods of cultivation, lack of access to much-needed information (new techniques, necessary crop-protection measures, prices, markets), lack of access to finance (credit), and other socioeconomic factors such as size of farms, tenancy status and lack of credit to purchase farm inputs. The performance of the public sector in the provision of these key inputs or services has been disappointing, where access to the services has been limited mostly to large farmers and the non-poor. Services by the public sector have been provided through sectoral approaches, which entailed higher transaction costs, not only in the provision of these services but also in accessing the services by farmers. The results suggest that there is a considerable scope to improve productivity by removing these constraints through improved access to inputs, technologies, information and other related services. The study suggests that productivity can be increased by: a) improving agronomic/farm management practices—i) promoting the use of improved/newer varieties of seeds, and ii) providing/improving extension services to farmers for dissemination of up-to-date knowledge on appropriate sowing dates, and quantities and timing of application of inputs, particularly irrigation water; b) improving water-management practices at the farm as well as at the canal level through—i) improving timing of water delivery; ii) increasing the overall canal water supplies at the farm level; and iii) considering the inter- and intra-system locational variations (and inequities) in canal water supplies and quality of groundwater. The other option to increase farm-level water supplies for increased productivity and profitability of crop production is to reallocate canal water within and across distributaries and encourage the use of groundwater (to sustainable levels) in locations where it is of relatively good quality.

Crops diversification is found to enhance benefits of access to irrigation with positive influence on farm income. The study finds that crop and income diversification reduces incidence and severity of poverty. The results suggest that small-scale cultivation and resource conservation technologies, such as bed and furrow method, zero tillage technology, and precision land leveling, benefit farmers by helping save water estimated at 20-30 percent, and increase crop yields by 15-20 percent, all resulting in reducing cost of production and increased returns to farming.

Poor service delivery in irrigation is the fundamental cause of the poor performance of irrigation. Underlying factors leading to poor service delivery and overall poor performance include: a) lack of appropriate and effective institutional arrangements and/or their effective implementation (including appropriate policies, laws, regulations and management organizations), including clarity in rights and responsibilities, appropriate incentive structures and effective accountability mechanisms, and b) inadequate funding available and under-spending in the sector—an outcome of low cost recovery resulting from low level of irrigation charge, inappropriate charging structures and poor collection rates. These factors are interrelated and reinforce the impact of each other. Inadequate funding is the root cause of the other factors. The study suggests that poor service delivery and low irrigation charges create a vicious circle of poor irrigation performance. These factors reduce the poors's access to water and result in reduced antipoverty impacts of irrigation.

The level and structure of irrigation charges are determined by the state/provincial governments. Irrigation charges at the farm level are levied based on area cultivated/cropped, crop type, crop condition, and crop season (rabi/ kharif). In each season, irrigation charge assessment at the field level is undertaken by irrigation/revenue department officials. Even in the transferred system (Hakra-4 in Pakistani Punjab) irrigation charges are determined by public authorities while assessment is either jointly undertaken by government officials and WUAs or in some cases by WUAs (as in Hakra-4 R). Within a province, water charges are uniform across canal commands, irrespective of the amount of water delivered to a canal command. For example, in Lalian and Khadir systems, the average amount of canal water applied per hectare for wheat during the rabi season is 1458 $m^3$, and 465$m^3$, respectively (with significant head to tail variations); however, crop water charge is uniform in both systems. Groundwater contributes 55 percent and 89 percent, respectively, of total water applied per hectare, in the two systems. Variations in canal water allocations are not clearly reflected in the charging structure. At present, water charges are remitted to the government and there is no direct link between funds collected and funds spent on O&M. The level of irrigation charges vary from Rs 274/ha/year to Rs 635/ha/year (or US$4.6/ha to US$10.6/ha), which constitutes 1.7 to 3.9 percent of gross value of product per hectare; however, overall collection rate is fairly high at 80-99 percent.

As mentioned earlier, irrigation water allocation/distribution in Pakistani systems is based on land size, and irrigation charges are levied based on cropping intensity. Under the warabandi system, all farmers in a particular location are entitled for equal allocation of water per hectare of land, regardless of the land size. As shown in table P–4, average cropping intensity varies significantly across farm-size categories, with the highest cropping intensity of 181 percent on the smallest farm-size category and the lowest cropping intensity of 115 percent on largest farm-size category. There are only marginal differences in average cropping intensities across the poor and non-poor farmer groups in aggregate terms. However, disaggregated analysis shows that average cropping intensities for the poor small farmers are relatively less than for the non-poor small farmers.

Table P–4. Cropping intensity, water charges for canal water and groundwater, and GVP by landholding size and for poor and non-poor farmers.

| Land size category | Cropping intensity (%) | Average cost of canal water irrigation/ ha/year (charge/ abiana) (Rs ) | Average cost of groundwater irrigation/ha/ year (Rs ) | Total cost of irrigation /ha/ year (Rs ) | GVP/ha/year (Rs ) | Annual canal water cost as % of GVP | Annual total water cost as % of GVP | Ratio of groundwater cost to canal water cost |
|---|---|---|---|---|---|---|---|---|
| < 1 ha | 181 | 440 | 4555 | 4995 | 19262 | 3.32 | 30.1 | 10.35 |
| 1.1 to<3 ha | 156 | 439 | 4038 | 4477 | 21552 | 2.63 | 22.0 | 9.21 |
| 3.1 to<5 ha | 148 | 432 | 3549 | 3980 | 22156 | 2.41 | 17.9 | 8.22 |
| 5.1to<10 ha | 133 | 385 | 3209 | 3594 | 22198 | 2.25 | 16.5 | 8.34 |
| 10 ha and above | 115 | 367 | 2779 | 3146 | 25013 | 2.18 | 15.3 | 7.58 |
| All | 148 | 420 | 3707 | 4127 | 21909 | 2.53 | 20.2 | 8.83 |
| Poor | 145 | 404 | 3748 | 4152 | 19802 | 2.63 | 22.1 | 9.28 |
| Non-poor | 152 | 439 | 3657 | 4096 | 24485 | 2.41 | 17.8 | 8.33 |

*Source*: Based on field-level primary data (2001-2002) collected from a sample of 1,224 households in 10 distributaries in Punjab, Pakistan.

*Notes:*
1. Farm cropping intensity is calculated as: (cropped area of $farm_j$ /total cultivated area of $farm_j$).
2. Annual canal water charge per hectare is calculated as: sum (crop area of $crop_i$ on $farm_j$*charge for $crop_i$ on $farm_j$)/total cropped area of $farm_j$.
3. GVP is gross value of product per hectare calculated as: sum (crop area of $crop_i$ on $farm_j$*yield of $crop_i$ on $farm_j$ *price of $crop_i$ on $farm_j$)/total cropped area of $farm_j$.
4. Poor are defined as those whose income is below the national poverty line of Rs 730/capita/ month.

The average land size of the poor and the non-poor is 2 hectares and 5 hectares, respectively. In general, there is a significant inverse relationship between poverty and land size, i.e., most of the poor are those who own and operate small landholdings.

The average annual irrigation charge per hectare (area weighted) is Rs 420. Average per hectare irrigation charge is inversely related to land-size categories: landholders owning land from 1 to 5 hectares paying significantly more than the overall average, and those with greater than 10 hectares paying less than the overall average. This is basically due to differences in cropping intensities, which are higher on smaller-size farms due to greater use of labor and groundwater. As shown in column 4 of table P–4, the average groundwater cost per hectare is inversely related to farm-size categories, smaller-size farms using more groundwater and incurring higher costs and vice versa. Since under the present charging systems, crop area that is partially irrigated with canal water and partially with groundwater is fully liable for canal water charges, small farmers are penalized for making relatively greater use of groundwater. On average, poor farmers incur Rs 56 more in total per hectare cost of irrigation than the non-poor, due to greater use of groundwater and resulting higher overall cost. Overall, cropping-intensity-based irrigation charging is pro-large landholders, anti-small farmers and the poor who make greater use of groundwater to increase their cropping intensities.

Overall level of canal water charges remains low (this is despite recent increases in the level of charges), constituting only 2.5 percent of GVP/ha. Due to less access to canal water, poor small farmers incur significantly higher cost/ha due to greater use of groundwater, which is around 9 times more expensive than the canal water. Average groundwater cost/ha constitutes over 20 percent of GVP/ha (compared to only 2.5% for canal water), and groundwater cost as a proportion of GVP decreases with increase in size of landholdings. The analysis suggests that the major beneficiaries of the present charging system, both of the level and the structure of charging (and of implicit subsidies to the irrigation sector) are large landholders and the non-poor farmers.

The study analyzed three policy options:

Scenario – 1: Present policy: No change in the structure and level of irrigation charges; charges are based on cropped areas and cropping intensities.

Scenario – 2: Flat rate policy: Flat rate per unit of irrigated land based on land size, independent of crop type and cropping intensities; present average irrigation charge applied uniformly across all farm size categories.

Scenario – 3: Differential rate policy: Differential rate per unit of irrigated land based on land size, applied differentially across various farm-size categories–progressive rate structure (similar to increasing block rate charging). Lower irrigation charge for the first two ha, applied uniformly to all land-size categories, and charge increases progressively with increase in size of holdings above 2 ha, by Rs 50/ha for each successive category of land size, as shown in the following equations.

At the provincial level, under the present charging policy, small farmers in Punjab pay more than large farmers in proportion to the share of each group in total landholdings. That is, small farmers contribute more to total revenues in proportion to their share in total land. The present policy clearly disfavors the poor marginal and small farmers. At the provincial level, option – 2 (flat rate charge at present level of average water rate) would result in annual gains for small farmers through reduced costs by Rs 74.45 million, cost to larger farmers would increase by Rs 326.77 million, and total revenues would increase by 5.3 percent. Policy option – 2 is better than policy option – 1 in terms of equity and revenues. Under policy option – 3, smaller farmers, as a result of reduced costs, would gain annually by Rs 346.88 million, larger farmers would contribute more towards costs by Rs 529.76 million, and overall revenue would increase significantly by 21.8 percent. With policy option – 3, Rs 876 million would be redistributed with a significant part in favor of poor small landholders in Punjab.

For Pakistan as a whole, option – 2 (flat rate charge at the present average rate) would result in annual gains for small farmers through reduced costs by Rs 130.06 million, cost to larger farmers would increase by Rs 605.97 million, and annual total revenues would increase by 5.6 percent. Under option – 3, smaller farmers, as a result of reduced costs, would gain by Rs 519.65 million, larger farmers would contribute more towards costs by Rs 842.45 million, and overall revenue would increase significantly by 22.7 percent. With policy option – 3, over Rs 1,362 million would be redistributed with a significant part in favor of poor small landholders in Pakistan. Option – 3 is better than both options – 1 & 2 from revenue and equity perspectives. Option – 2 is relatively equitable, option – 3 is pro-poor, as per hectare irrigation charge to the poor would be less than that to the non-poor, and would be significantly less than that for options – 1 & 2.

The study concludes that the irrigation charging policy that is based on cropped areas and cropping intensities favors larger landholders, and disfavors small and poor landholders. Policy changes towards *flat rate*[22] *per unit of land based on land size*, independent of crop area, crop

---

[22]On 10 June 2003, the Government of Punjab took a historic decision to change canal water charging policy from crop area-cum-crop-type-based charging to crop-area-based flat rate charging. Under the crop area-cum-crop-type-based system, water charges were levied based on area cropped and differentiated by crop type, crop condition and crop season. Charges were generally higher for high water-consuming crops such as rice, and low for less water-consuming crops such as wheat (for example, per-hectare-crop-based water charges prior to June 10 were Rs 37 for fodder, Rs 148 for wheat, Rs 222 for cotton, Rs 297 for rice, Rs 432 for sugarcane). Under the new flat rate system, per hectare water charges are to be fixed for rabi and for kharif seasons regardless of the type of crops grown in each season (new rates per hectare are Rs 124 for rabi and Rs 210 for kharif crops, regardless of the type of crops grown). Several factors have led to this change. These include: a) the crop-based charging system was considered obsolete and not in line with changing water and irrigated agriculture situation; b) it was thought to be often manipulated by the influential farmers and revenue officials (such as misreporting and mis-recording crop types and crop areas, e.g., charging for fodder rates when high water rate crops such as rice or sugarcane were cultivated); c) as the water charge assessment was based on the discretion of the revenue officials, it is generally perceived that it has led to creating an environment for rent-seeking behavior; d) crop-based charges were considered advantageous to large farmers and disadvantageous to small farmers who constitute the majority in the farming community; and e) the old system has led to increased pressure on public funds resulting from the widening gap between irrigation expenditures and revenue collection (e.g., in recent years, the total revenue collected through water charges in the Punjab Province accounted for 31.4 percent (or Rs 1.6 billion) of the total expenditures (of Rs 5.1 billion). Also, the estimates suggest that the government has been spending three rupees for every one rupee of water charge collected. Reaction to this policy change has been mixed. While there are many supporters of this change who see this as a welcome development, some continue to resist and criticize it.

type and cropping intensities, applied uniformly across all farm-size categories or differential rate based on land size applied differentially to various land-size categories would result in redistribution of a significant amount of rural incomes, largely in favor of the small and poor landholders. These policy changes could be implemented with existing institutional arrangements in place, and as such do not involve any major implementation costs. Major benefits from such a policy change would include: a) more funds available for O&M of irrigation systems, with resulting improvements in performance of the systems leading to increased efficiency in water supply and productivity; b) significant benefits in terms of reduced costs to small and poor landholders; and more importantly, it would be a step forward to reversing existing inequities in water charges. What is needed is a clear understanding of the problem and strong political will to a policy change that improves irrigation management in a pro-poor mode.

As mentioned earlier, IMT was initiated at the Hakra-4R distributary, which was the first and the largest pilot project implemented in Pakistan. Under the newly formulated Punjab Irrigation and Drainage Act of 1997, Hakra 4-R was handed over to farmers in May 2000, and since then an FO has been managing the distributary (secondary level) and WUAs managing the watercourses (tertiary level). The system is being managed through participation of farmer members and their elected representatives. Our performance assessment of the system indicates that after transfer irrigation charges have been increased in the system, service delivery has improved, irrigation infrastructure condition and its management have also improved, the overall performance of the systems (in terms of equity in water distribution, access to water by tail enders, cropped areas and cropped productivity) has also improved. As shown in table P–5, after the transfer of management to the FO and improvement in service delivery, irrigation charges were increased, collection rate improved and total revenue collection increased by about Rs 1 million. This resulted in more funds available for O&M of the system. Infrastructure of the distributary was improved, including adjustments of outlets, desilting, strengthening of banks and other repair work. Along with infrastructural management, irrigation water management/distribution was also improved. These

---

There are three key issues in relation to this policy change. First, in the newly introduced flat rate system, the charge is based on the farm *area cropped* during rabi and kharif seasons (i.e., flat rate per hectare of area cropped in each season) and not based on farm *area owned* or farm area having water entitlement or area receiving water. Under warabandi type of systems, water allocation is made based on the size of farm landholdings. In aggregate terms, large farmers receive and use more canal water than small farmers. On a per hectare basis, if we assume that small and large farmers receive a similar amount of water, small farmers who generally have higher cropping intensity will end up paying more per hectare water charge than large farmers. As in the past, under the new policy, area irrigated partially from surface water and partially from groundwater would be fully liable for canal water charges. Those who make more use of groundwater and other inputs to increase their cropping intensity would have to pay more in per hectare water charges. It is important to note that it is the farm size that forms the basis of water allocation, regardless of the proportion of farm area cropped. Therefore, it makes sense to levy a flat rate charge based on farm size or farm area having water entitlement. The new crop-area-based flat rate policy, though does not account for intra-seasonal crop differences, but it accounts for inter-season crop differences and, like in the old system, water charges are levied based on area cropped and cropping intensity during a season. So, while the new system would help in addressing the crop type-misreporting issue, it would not resolve the problem of crop area misreporting. The flat rate per unit of land, based on land size, and independent of crop type and cropping intensities is a better option to address both of these issues.

factors led to increasing water-delivery performance and overall system efficiency as shown in table P–5. Increased overall water availability and its improved access have resulted in increased crop area by around 6 percent from 25,614 hectares to 27,115 ha.

More importantly, distribution of water improved significantly with head-tail equity ratio of around 1. Among the distributaries studied, equity performance of Hakra - 4R was the highest (head-tail equity ratio for other distributaries studied in Punjab ranged from 1.23 to 2.50, indicating significant inequity in water distribution). With improved service delivery, availability, reliability and access to water at the tail ends have improved significantly. Given that there is more incidence of poverty at tail ends of Hakra-4R, as mentioned earlier, the poor farmers have benefited from this improvement. During farm-level surveys, 43 percent of poor small farmers at the tail ends indicated that they had benefited from the improved service delivery and resulting improved system performance. Overall, 63 percent of farmers showed satisfaction in terms of receiving their due share of water. Other benefits included reduction in water theft (as indicated by 81% of the respondents), reduction in litigation cases related to irrigation water and rent seeking by irrigation officials, improved assessment of irrigation charges, and increased information-sharing among farmers. On the other hand, there have been concerns regarding control by larger landholders and influential people who have promoted nepotism.

Table P–5. Impacts of improved service delivery in Hakra-4R, Punjab, Pakistan.

| Indicator | 1998 (before transfer) | 2002 (after transfer) |
|---|---|---|
| Water charge (Rs /ha) | 175 | 199 |
| Total revenue collection (Million Rs ) | 4.49 | 5.40 |
| Water delivery performance* | 0.91 | 1.04 |
| Overall system efficiency** | 0.47 | 0.52 |
| Cropped area (ha) | 25,614 | 27,115 |
| Head-tail equity | Na | 1.09 |
| Farmers response | | |
| - increased benefits at the head (%) | | 40 |
| - increased benefits at the middle (%) | | 38 |
| - increased benefits at the tail ends (%) | | 43 |
| - overall satisfaction (%) | | 41 |

* Water delivery performance is defined as the ratio of actual to target volume of water delivered.

** Overall system efficiency is defined as the ratio of annual crop water requirement and total inflow into the canal system (with 40% losses).

Overall, the experience in Hakra 4-R suggests that IMT has created an environment conducive to improved management of irrigation. However, there are certain issues such as continuing conflict between FO and the ID, and potential conflicts among communities along the systems that need to be addressed. Whether the Hakra-4 model can be replicated at a broader level is still a big question. In the PPAs, communities were consulted on this issue, and the response was mixed. The communities strongly suggested that, since there is significant inequity in land distribution and that the society is divided into classes and castes, strict government regulation and laws along with their effective implementation, will be crucial to successfully implement the current reforms at the broader level.

**Conclusions and Recommendations**

In sum, the study demonstrates that irrigation is a significant determinant of poverty alleviation, and the antipoverty impacts of irrigation, depends, in addition to other factors, on the performance of irrigation systems—which is influenced by the availability of funding and spending mechanisms, and the effectiveness of institutional arrangements and incentive structures in place. In order to realize the enhanced antipoverty impacts of irrigation, there is an urgent need to improve performance of the systems. The study suggests that: a) the availability of funding for the sector needs to be increased through increase in irrigation service charges to the level that fully covers the cost of irrigation service, with a gradual move towards market-based charging for irrigation; b) irrigation management institutions need to make more decentralized and financially autonomous—in terms of setting irrigation charges, charge assessment, collection and spending—to create incentives and strengthen financial linkages between irrigation managers, service providers and the users; c) poverty concerns need to be specifically recognized in irrigation charging, and overall management policies, and the poor should have an equal voice in irrigation management organizations. Where necessary, irrigation charging structure may be made pro-poor through effective implementation of discriminatory/ differential charging in favor of the poor; d) irrigation charges should be linked to service delivery; e) irrigation service providers should be required to meet certain standards in relation to irrigation system performance in terms of maintenance of irrigation infrastructure, water conveyance and use efficiency, productivity, equity and sustainability of the systems; f) the public-sector agencies should play roles as regulator (providing regulator backup, and enforcement of rules and regulations), enabler and facilitator for effective implementation of performance improvement measures. Based on the study findings and deliberations in the national-level workshops, the following interventions are recommended for addressing the poverty problem in agriculture.

***Creating Assets for the Poor.*** Poverty is a complex and multidimensional phenomenon, which needs interventions on many fronts including the creation of physical assets, social and economic assets, safety nets for the poor and pro-poor governance. There is a need to create conditions in which the poor are either given or enabled to acquire the assets while creating an environment for them to get returns from these assets. Distribution of the remaining public lands to the landless rural households should be a first step in this direction (e.g., in Pakistan about 0.29 million ha of land resumed from large landowners by the government and 0.89 million hectares of state lands (though largely undeveloped) are still available for distribution. Second, the government can initiate incentives and market-based land reforms, even if it means buying lands from large landholders for distribution to the poor landless and marginal farmers including poor women farmers, with emphasis on providing basic holding size that is economically viable and generate livelihoods sufficient enough to support the family. Such land reform initiatives, unlike the past ceiling-based administrative reforms, which were largely ineffective, would be important for creating land assets for the poor (particularly landless who constitute the bulk of the poor in rural Pakistan), in order to create a significant dent in rural poverty. Land distribution to the poor would also lead to improved distribution of benefits from water-sector investments.

***Improving Performance and Service Delivery in Irrigation Systems.*** The study indicates that poverty is linked to irrigation performance and that there is a significant potential to improve irrigation system performance for poverty alleviation. Interventions are needed in two specific areas.

*Upscaling and replicating institutional reforms.* The study indicates the institutional reforms such as IMT that benefits the poor through improvements in water distribution and crop productivity. The IMT model of Hakra-4R should to be replicated in other canal commands. However, strong regulatory backup and monitoring would be important to ensure that the poor receive the expected benefits, and that the poor small farmers and those at the tail ends are represented in the management of WUAs and FOs. Management organizations, while working as utility companies/on commercial principles, should be required to meet certain standards and targets in terms of performance improvements and benefits to the poor. Handing over of the systems should be accompanied with simultaneous improvements in irrigation infrastructure and increase in irrigation-service charges.

***Making Irrigation Systems Financially Self-Sufficient.*** The irrigation-sector financing should be based on full O&M cost recovery. The study indicates that the present charging policy is disadvantageous to the poor both directly and indirectly. The level and structure of irrigation charges need to be corrected and charges should be related to service delivery. The differential charging strategy (as suggested above) may be adopted to benefit the poorest of the poor.

***Integrating Management of Surface Water and Groundwater.*** There are significant locational differences in canal commands in terms of farmers' access to canal water and quality of groundwater. The two resources need to be managed jointly for increasing productivity, especially in poor locations and for the poor farmers. The study results imply that conjunctive management of surface water and groundwater is both productivity-enhancing and pro-poor.

***Improving the Access of the Poor to Inputs and Services for Increasing Agricultural Productivity.*** A significant gap between actual and potential productivity levels prevails, which calls for enhancing land and water productivity. Key to enhancing productivity and returns to farming is to improve access to production inputs (water and other inputs), and delivery of services and output marketing. This could be achieved by creating effective institutional arrangements that entail low cost to service providers and to farmers in accessing the services by involving the private sector in the delivery of services. Delivery and access cost is likely to be reduced significantly by providing the major inputs and services in an integrated manner through the involvement of the private sector with the public sector playing an important role as enabler, facilitator and regulator, as explained in part 1 of this report. However, more action research is needed on this intervention.

***Enhancing Benefits of Irrigation to the Poor.*** The farm practices such as crop diversification, and the use of resource-conserving technologies are found to have significant impacts on farm incomes and poverty. The strategies to change cropping patterns should be based on crop diversification towards high-value crops (including nonconventional crops) and resource conservation practices. Effective dissemination of existing resource-conserving technologies and development of new technologies should be promoted to enhancing the benefits of available irrigation water resources.

***Targeting New Investments to the Poor.*** In many areas, investments are needed for further development, improvement and rehabilitation of surface-water supply systems. The new investments should be targeted to the poor, geographically and socio-economically.

## Literature Cited


Asian Development Bank. 2002. *Poverty in Pakistan: Issues, causes and institutional responses.* Islamabad: ADB, Pakistan Resident Mission.

Adams, J. J.; He, R.H. 1995. *Sources of income inequality and poverty in rural Pakistan.* http://www.ifpri.cgiar.org/pubs/obstract/abstr/oz/htm

Gill, Mushtaq Ahmad. 1996. Participatory irrigation management: Pakistan's experience. Paper presented at the International Seminar on Participatory Irrigation Management held in Turkey, April 10-17.

Government of Pakistan. 2001. *Agricultural Statistics of Pakistan 2001*. Islamabad, Pakistan: Economic Adviser's Wing, Ministry of Food Agriculture and Livestock.

Waqar, Jehangir A.; Muhammad, Ashfaq; Hussain, Intizar; Muhammad, Mudasser. 2004. *Country Final Report – Pakistan: Pro-poor Intervention Strategies in Irrigated Agriculture in Asia* - *Poverty in irrigated Agriculture in Pakistan – Issues and Options.* Colombo, Sri Lanka: International Water Management Institute.

WAPDA (Water and Power Development Authority). 1997. *Ninth five-year plan 1998–2003*. Lahore: Water Resource Development.

World Bank. 2002. Pakistan poverty assessment, poverty in Pakistan: Vulnerabilities, social gaps and rural dynamics.

# Poverty in Irrigated Agriculture in Bangladesh: Issues, Options and Pro-poor Intervention Strategies

## Historical and Contextual Frame

Bangladesh has achieved significant improvements in social and economic indicators over the past decades. The annual growth rate of GDP during 1991-1997 was 3.2 percent, and the GDP further expanded at the rate of 5.5 percent during 1996-1999 despite huge damages brought by recurring floods in 1998/99. Real gross GDP increased by 64 percent during 1991-2000 as major sectors like agriculture, services and industry have shown a growth by 41 percent, 58 percent and 103 percent, respectively. The per capita income growth rate of 3.7 percent per annum during 1996-99 is a respectable performance, although the level of per capita income (of about US$ 350) continues to be among the poorest countries in the region. A large population of over 128 million growing at a relatively high rate of 1.8 percent per year, a rapidly growing labor force, a limited resource base and continuing high inequities in the distribution of available resources and opportunities, the inefficiency of state-owned enterprises and overall governance-related concerns, frequent natural disasters, such as cyclones and floods are among the major impediments to growth in Bangladesh.

The economy of Bangladesh is primarily dependent on agriculture. The country has 9.03 million ha of net cultivated area, of which 4.0 million ha are currently irrigated. Of the net cultivable area, 37 percent is single-cropped, 50 percent double-cropped and 13 percent triple-cropped. Rice and jute are the primary crops; wheat is assuming greater importance; and tea is grown in hilly regions of the northeast. Rice cultivation continues to be the single most important activity in the agricultural economy, with *aus, aman*, and *boro* being the major rice varieties grown in three cropping seasons: *kharif I* (pre-monsoon), *kharif II* (monsoon), *rabi* (winter or dry). Over the past two decades, area cultivated to dry season HYV *boro* rice has been increasing —a trend that is likely to continue. Nearly 75 percent of the population is directly or indirectly dependent on agriculture and is engaged in a wide range of agricultural activities, and the sector contributes to around 25 of the national GDP. Among crop, forest, fisheries and livestock sub sectors, the crop sub sector contributes 71 percent, forest 10 percent, fisheries 10 percent and livestock 9 percent to agricultural GDP. The sector generates 63.2 percent of total national employment and agricultural exports of primary products contribute 10.4 percent of total export earnings.

The production performance of the agriculture sector in Bangladesh, particularly the crop sector, has considerable bearing upon the rate and structure of poverty and malnutrition, the trade balance and the budgetary position of the government, and consequently upon the rate of growth of the Bangladesh economy as a whole. Since the 1970s, agriculture in Bangladesh has experienced a modest growth and a slow transition: with wide fluctuations, agricultural growth averaged around 2.5 percent per year. A significant acceleration of agricultural growth, however, took place during the second half of the 1990s, primarily led by the growth in production of food grains, particularly rice. Agriculture's share in GDP declined to 25 percent in 1999-2000 compared with 30 percent in 1989/90. Agricultural growth accelerated in the late 1990s with the annual growth exceeding 5 percent in 1997-2000 compared with 2 percent during 1991-1996.

While all sub sectors experienced higher growth, growth in crop and horticulture was rapid at 4.2 percent per year, which was higher compared to any period in the past.

Bangladesh has made significant progress in cereal production since the 1970s. The production of rice and wheat increased from around 10 million tons in the early 1970s to nearly 25 million tons by the late 1990s. The production of rice and wheat increased from around 10 million tons in the early 1970s to nearly 25 million tons by the late 1990s. The increased domestic production has contributed to improving national food self-sufficiency and food security with positive impacts in reducing absolute poverty. Between 1991-92 and 2000, the incidence of poverty has decreased from 58.8 percent to 49.8 percent. However, actual numbers of the poor remain the same at 63 million due to a high population growth. The incidence of extreme poverty has also decreased from 42.7 percent to 33.7 percent in 2000 and the number has also decreased from 45.2 million to 42.5 million. Overall, as estimated in 2000, poverty is high (at 53%) and deeper in rural areas than in urban areas (at 36.6%). Bangladesh's performance in reducing human poverty (or the non-income dimensions of poverty) was even better. Measured by the Human Poverty Index (which focuses on deprivations in longevity, knowledge and economic provisioning), the incidence of human poverty in the country declined from 61.3 percent in 1981-83 to 40.1 percent in 1995-97. It is also noteworthy that progress in reducing human poverty was faster in the 1990s than in the previous decade.

Unlike Pakistan, progress in poverty reduction in Bangladesh was faster during the 1990s compared with the 1980s. The faster pace of poverty reduction in the 1990s is attributable to the accelerated growth in consumption expenditure (income). The comparative progress was uneven between rural and urban areas. The pace of rural poverty reduction was slow in the 1980s, but became faster in the 1990s. The reverse is true for the urban areas. During the period between 1991/92 and 2000, the level of consumption expenditure inequality increased from 30.7 to 36.8 percent in urban areas, and from 24.3 to 27.1 percent in rural areas.

In addition to sectoral variation, considerable regional variation in poverty is noticeable. Dhaka and Khulna (including the study area of the G-K project) divisions have lower incidence of poverty than Rajshahi (including the study area of Pabna Irrigation and Rural Development Project). Progress in poverty reduction over the 1990s has been unequal across regions, with rapid progress in the Dhaka division and very little change in the Chittagong (including Sylhet) division. Also, there is considerable district-level variation in poverty, as suggested by the district-level agricultural wage data as well as various indicators of social deprivations such as illiteracy and child mortality. The level of poverty is typically higher for the landless, especially those who work as agricultural wage laborers, and for those who are engaged in marginal occupations and skills. The incidence of extreme poverty is generally higher among female-headed households. Poverty and social deprivations tend to be higher in case of the hill people of the Chittagong Hill Tracts (CHT) and for the tribal population residing in other parts of the country.

Studies on poverty conclude that the major causes of poverty in Bangladesh are: low growth and unequal distribution of growth benefits; inadequate access to employment, basic services and resources by the poor; inequitable distribution of assets and resources, technology and socioeconomic opportunities; low productivity and wages; underdeveloped infrastructure and other structural processes. The persistence of poverty, moreover, reflects the poor's varying state of vulnerability coupled with deprivation. The poor differ in economic, social, geographic, physical and other characteristics so that reliance on increasing income alone is not likely to lead to sustained poverty reduction in the country. Poverty in Bangladesh has many dimensions and requires a multi-strategy solution. Development priorities in Bangladesh should focus on efficient and pro-poor growth policies and provision of basic services to the poor.

In Bangladesh, of the 9.03 million hectares of total cultivable area, 84 percent of land (or 7.58 million hectares) is suitable for irrigation. In 1999/02, a total area of about 4 million hectares is estimated to be under irrigation (or 53% of land suitable for irrigation), of which surface water irrigation covers around 27 percent and groundwater covers 73 percent. There is significant potential for expansion of irrigation through exploitation of surface water and groundwater resources. Over the past years, expansion in groundwater irrigation has been much faster than surface water irrigation. Presently, over 80 percent of the irrigated land is cultivated with rice, with only a small area grown to high-value crops.

Land is a major limiting resource in the country. With continuing increase in population and expansion in non-farm activities, estimates suggest that about 220 ha of land are going out of agriculture every day. The distribution of limited land is highly inequitable. As per official statistics from the Ministry of Finance, in 1995-96, estimates in 1996 indicate that 0.19 percent of (17.83 million households) have no homestead land, 28.06 percent have homestead but no cultivated land, 29.12 percent have homestead land and cultivated land up to 0.2 hectare per household, 13.99 percent have homestead land and cultivated land between 0.21 and 0.4, and 27.91 percent have homestead land and cultivated land above 0.4 hectare (Toufique and Turton 2002). These values indicate that around 29 percent of households are absolutely landless (first three categories above) and over 29 percent having only marginal-size holdings of up to 0.2 hectare. Among landowners about 19 percent of farmers own 59 percent of operated land and the remaining 81 percent (small and marginal farmers) share 41 percent of the land. In Bangladesh, land reforms have been adopted several times over the past decade. The administrative land reforms attempted in 1950 and 1972 (with the upper ceiling of 33.3 acres) and 1984 (with the upper ceiling of 25 acres) largely failed. There are about 0.283 million hectares of public lands available for distribution.

Agriculture continues to be the dominant user of water. In the country, major, medium and large-scale surface irrigation projects include: G-K Project, Chandpur Irrigation Project (CIP), Karnaphully Irrigation Project (KIP), Muhuri Irrigation Project, and Pabna Irrigation and Rural Development Project (PIRDP). These state-managed projects irrigate about 0.20 million ha of land. The surface irrigation coverage has been continuously declining, mainly due to water shortages as a result of upstream (in India) diversion of water of transboundary rivers. Its adverse effect is more pronounced in the tail-end reach of the irrigation canals and also perhaps on the small and marginal farmers. The Ganges, the Brahmaputra and the Meghna river systems are the prime hydrologic sources for Bangladesh. In fact, the Ganges, the Brahmaputra and the Meghna river systems constitute the second largest hydrologic region in the world. The total drainage area of the region is about 1.72 million sq. km stretching across five countries including Bangladesh at the tail end to carry the entire load into the Bay of Bengal. Bangladesh shares all three river systems. The average annual water flow from these river systems in the region is estimated to be around 1,060 billion cubic meters, of which nearly half is discharged by the Brahmaputra. The rainy season of Bangladesh generally lasts from June to October. Over 80 percent of the annual rainfall occurs between June and October. The annual rainfall ranges from about 1,200 mm in the western part to over 5,000 mm in the extreme northeast, countrywide average being about 2,300 mm.

Estimates suggest that the cross-border flows into the country amount to around 1,010 billion cubic meters (BCM), and an additional volume of 340 BCM is generated from local rainfall. Of this total quantum of available water (1,350 BCM), about 190 BCM of water is lost through evaporation and evapotranspiration, while the balance 1,160 BCM is available for use or flows into the Bay of Bengal. Eighty percent of this huge flow of water is concentrated in the five-month monsoonal period from June to October.

***Irrigation Sector Reforms***

Over time, the Government of Bangladesh established a number of organizations at various levels including macro, intermediate, district and local level (Upazila/Union levels) for carrying out planning and implementation of water resources for small-, medium- and large-scale systems at these levels—mainly under three ministries: ministry of water resources, ministry of agriculture and ministry of local government & rural development. Lack of coordination and linkages across these organizations, overlapping in their functions and inefficiencies are some of the well-known problems of most public-sector organizations (details of various organizations and their functions are provided in the country project report for Bangladesh).

Much of the past efforts in institutional development in the water sector has been limited to establishing, reestablishing and reconstituting organizational arrangements at the national level with only little attention to organizational development at the lower levels. At present, the National Water Resources Council is the apex body for the water sector. Macro-level water resources planning and management are undertaken by the Water Resources Planning Organization (WARPRO), an agency under the Minister of Water Resources (whose mandate was gazetted in December 1991). Water-sector policies, plans and projects are implemented by the Bangladesh Water Development Board (BWDB). BWDB was reconstituted in July 2000 under a new Act that repositions the organization and aligns its responsibilities to those set out in the National Water Policy; it is an autonomous body and is responsible for O&M of all large and medium-scale surface irrigation systems in the country. WARPRO is a macro-level planning organization and BWDB is a national-level organization responsible for local-level implementation. In 1992, BWDB initiated the systems rehabilitation project (SRP) for rehabilitation of some 80 BWDB partially dysfunctional projects. However, the project was largely unsuccessful. After a review, in 1984, the World Bank emphasized the adoption of the participatory approach in irrigation management through the formation of water user organizations (WUOs)—which led to the initiation of irrigation reforms at the local level.

In 1995-96, a three-tier management structure was introduced: water management groups (WMGs) at the lowest level/tertiary/outlets, consisting of nine members—one-third each from large, medium and small farmers' water management associations (WMAs) consisting of 10-15 WMGs at the middle/secondary level of systems, and water management federations (WMFs) at the apex level of a system (the proposed structure consists of a one- to two-tier structure for systems of sizes up to 1,000 ha (WMG at the lowest level for each smallest hydrological unit or social unit [*para*/village], and WMA at the apex level of the project/sub-project/scheme), a two- to three-tier structure for systems of sizes between 1,000 and 5,000 ha and a three-tier structure above 5,000 hectare-size systems). These were expected be working in close cooperation with BWDB. On paper, the scale of WMG formation grew rapidly, particularly during 1995-96. Targets for the spread of WMG formation were set, the tiers above the WMGs identified (with a hierarchy of committees for each subproject of Water Management Committees), and Water Management Associations (WMAs), a Project Council (PC) and group formation were rapidly expanded. However, the whole process became target-oriented and the effectiveness and functionality of groups after formation were lost. Field-level surveys indicate that the WMG/O formation process has had little success in initiating a community-based management of the O&M of the water-control structures. A robust process through which meaningful participation could be achieved has not yet emerged. Overall, however, progress in the formation and development of these water user groups has been very slow, and in many areas these groups are yet to be formed. Partly, this is attributed to flaws and weaknesses in the guidelines for people's participation (GPP) initially developed in 1992 which, after a long review, were revised and further developed in early 2000. Overall, while people's participation in irrigation water management has come to light, the irrigation sector continues to be managed at all levels by the public-sector agencies.

A unique pro-poor intervention in irrigation management has been the establishment of labor-contracting societies (LCS), the embankment maintenance group (EMG), and channel maintenance group (CMG) established in early 1980. The LCS, known as the Landless Contracting Society aims at providing employment and income-generating opportunities to the rural people, both men and women, and ensuring fair wages and achieving high quality of construction work. At least 25 percent of the earthwork of any public water project/ subproject/scheme is supposed to be reserved for the LCS. Preventive maintenance of embankments is an integrated component of O&M and aims at maintaining their crests and slopes in optimal physical condition. Preventive maintenance is executed through the EMG throughout the year. The CMG also follows similar guidelines as in the EMG. A certain portion of main and secondary canals would be maintained by a women's group facilitated through an affiliated agency. This affiliated agency is in charge of the recruitment of female laborers willing and capable of engaging themselves in an EMG/CMG for a period not shorter than 6 months. Priority would be given to Female Headed Households (FHH). The CMG are in place in the Pabna system and the EMG are operating in the G-K system. In both systems, the majority members of both EMG and CMG are vulnerable women. In addition to earning from wage labor, women are using the slopes of the canals and the embankments to harvest vegetables thereby adding an extra income.

The Government of Bangladesh developed the first ever National Water Policy (NWP) in early 1999. The overall goal of the new policy was specified as "to ensure progress towards fulfilling national goals of economic development, poverty alleviation, food security, public health and safety, a decent standard of living for the people and protection of the natural environment." The policy emphasizes river basin and integrated water resources management; equity in water rights and allocations, public-private sector partnerships and participatory approaches in water management, and water pricing and cost recovery, incentives and regulation in water management. The objectives of the policy are to: a) address issues related to the harnessing and development of all forms of water and groundwater and management of these resources in an efficient and equitable manner;  b) ensure the availability of water to all elements of society including the poor and the underprivileged, and to take into account the particular needs of women and children; c) accelerate the development of sustainable public and private water-delivery systems with appropriate legal and financial measures and incentives, including delineation of water rights and water pricing; d) bring institutional changes that will help decentralize the management of water resources and enhance the role of women in water management; e) develop a legal and regulatory environment that will help the process of decentralization, and sound environmental management, and will improve the investment climate for the private sector in water development and management; and f) develop a state of knowledge and capability that will enable the country to design future water-resources management plans by itself with economic efficiency, gender equity, social justice and environmental awareness to facilitate achievement of the water management objectives through broad public participation. A detailed water-management plan has been prepared within the framework of the NWP, which is awaiting government approval. While NWP has important pro-poor dimensions, the success in its implementation and effectiveness remains to be seen.

## Study Settings, Data and Methods

For the purpose of this study, two of the major irrigation systems, namely, Ganges-Kobadak (G-K) irrigation system, and Pabna system, commonly known as the Pabna Irrigation and Rural Development Project (PIRDP), were developed/rehabilitated with assistance from the ADB. A brief description of the key characteristics of these systems and of the selected sites in these systems is presented below. Figure B–1 is the map of Bangladesh showing G-K and Pabna projects.

### *Ganges-Kobadak (G-K) Irrigation Project*

The Ganges-Kobadak Irrigation Project, Phase-I and Phase-II, is located in the southwestern part of Bangladesh in four districts: Kushtia, Chuadanga, Jhenaidah and Magura districts. It is situated between latitudes $23^{o}$ 27’and $24^{o}$ 03’ and longitudes $88^{o}$ 47’ and $89^{o}$ 30’, and covers an area of 197,500 ha with a population of 2 million. The present irrigated area is estimated at 142,000 ha. The project area lies within the floodplain of the Ganges river. Prior to the implementation of the project, the lowland was used to be flooded by the Ganges. Now it is flood-free due to the embankment on the northwest corner and on the right bank of the Gorai river. The land elevation near Bheramara is about 12 m (above mean sea level, MSL) and this slopes down to about 5.5 m near Magura. Two other main rivers namely Kaliganga and Dakua runs north to south near the center of the area. The Kumar river bifurcates the project area and the river Nabaganga is the southern peripheral river. The G-K project area lies within the driest part of Bangladesh where annual rainfall ranges from 1,000 mm to 1,500 mm. The project was conceived in the mid-1950s to supplement rainfall for paddy production and to protect crops from flood damages.

Figure B–1. Map of Bangladesh showing G-K and Pabna projects.


The G-K system derives its water from the Ganges river. The Project includes two major pumping plants, flood and drainage facilities and an irrigation distribution network comprising the main, secondary and tertiary canals. Irrigation water is pumped from the Ganges river by a main pumping plant having three pumps of 35.8 cumec capacities and also by a subsidiary pumping plant having 12 pumps of 3.54 cumec capacity each. The main canals are about 193 km, secondary canals about 467 km and tertiary canals about 995 km in length.

The operation of the pumps, under Phase-1 of the project, which comprised 42,000 ha started functioning from 1962. In 1975, diversion of Ganges water through Farakka was commissioned. The maximum discharge of the Ganges river before the commissioning was 73,000 $m^3$/sec and the minimum discharge was 1,190$m^3$/sec during April and May. After 1975, the maximum and minimum recorded discharges were 68,000 $m^3$/sec and 660 $m^3$/sec, respectively. The lowest water level before 1975 was 6.3 m and after 1975, the minimum water level was recorded at 5.00 m. These shortfalls gave rise to Phase-2 of the project consisting of about 83,000 hectares. It was completed during 1969-1983. Between 1985 and 1994, the project was under rehabilitation to address the operational deficiencies in covering the command area.

A typical monsoonal climate prevails in the project area. The average annual rainfall is about 1,500 mm, about 70 percent of which occurs during mid-June through mid-October. The period from November to March is significantly dry. Maximum temperatures vary from about 28 $^oC$ to 36 $^oC$ with the highest temperature experienced from March to June. There is a significant diurnal fluctuation with the minimum temperature ranging from about 10 $^oC$ to 23 $^oC$. Relative humidity is high throughout the year with an average of more than 70 percent. Potential evapotranspiration ranges from about 2.55 mm/day in December to about 5.5 mm/day during the premonsoonal month in May.

Rice is the dominant crop cultivated over about 70 percent of the total cropped area. Pulses and oil seeds, tobacco, jute, sugarcane, onion and wheat are also grown in the project area. In irrigated areas, mostly HYVs of paddy are grown. At present, about 93,000 hectares are benefited from the supplemental irrigation during kharif-II season (mid-July to mid-November) against a targeted area of 125,000 hectares while about 25,000 hectares are irrigated during the kharif-I season (March to June) due to scarcity of water at the source (Ganges river). Average paddy yields range from 3.2 t/ha to 4.0 t/ha for transplanted HYV and are about 2.5 t/ha for transplanted local varieties.

About 70 percent of about 2 million people depend on agriculture in the area. There are about 120,000 households with 5-6 persons per family. The average farm size is about 0.90 ha (which decreased from an average farm size of 2 ha in the 1960s). Crop yields in the area are three to four times that in the 1960s, and the project has made significant contribution to improving the socioeconomic conditions of the people in the area.

The G-K Irrigation Project derives its water from the Ganges river. The project includes two major pumping plants, flood and drainage facilities and an irrigation distribution network comprising main, secondary and tertiary canals. Irrigation water is pumped from the Ganges river by a main pumping plant having 3 pumps of 35.8 cumec capacities and also by a subsidiary pumping plant having 12 pumps of 3.54 cumec capacity each. The project’s main canals, secondary canals and tertiary canals are about 193, 467 and 995 kilometers in length. Water from the river is pumped into the main canals, and is distributed through a network of secondary and tertiary canals. The command area of a tertiary canal is called a tertiary unit and receives water from a tertiary offtake. A tertiary unit is subdivided into quaternary units called *chaks*, which vary in size from 25 to 40 ha. Chaks receive water from the tertiary canals through the outlets.

***Pabna Irrigation and Rural Development Project (PIRDP)***

The Pabna Irrigation and Rural Development Project (PIRDP) is located in the west-central part of the country. The project was planned in the late 1960s and was originally planned to provide flood control and drainage (FCD) facilities to 186,000 ha and irrigation to 145,300 ha. The project area extends to Pabna, Serajganj and Natore districts of the Rajshahi division, and Phase-1 of the project was completed in 1992. The project area is situated between latitudes $23^0$ 57' to $24^0$ 08' 30" and longitudes $890^0$ 25' to $89^0$ 40' and covers an area of 186,000 hectares with a population of 2.3 million. Currently, the irrigated area is 145,300 ha.

Phase – I of the Pabna project, the selected site for this study, is located in three upazilas: Santhia, Bera and Sujanagar, in the Pabna district near the confluence of the Ganges and Brahmaputra rivers. The Pabna Irrigation System covers a gross area of 27,472 ha of which the cultivable area is 21,976 ha and the irrigable area is 18,680 ha, located in Bera, Santhia and, to a small extent, in Sujanagar upazila of the Pabna district.

The project area lies within the floodplain of the Brahmaputra and Hurasagar rivers. The two pump stations Bera and the Kaitula are respectively located on the Hurasagar and Brahmaputra rivers. The Brahmaputra river originating from the Tibet (China) on the northern side of the Himalayas flows towards the east and then to the south to cross the Himalayas; thereafter it moves towards the west over the Assam valleys in India and then moves south to enter Bangladesh at Noonkhawa in the Lalmonirhat district.

Prior to the implementation of the project, most of the project area used to be flooded by flood flows of the Brahmaputra and Hurasagar rivers. Now the project area is almost flood-free due to the embankment on the southeast side on the bank of the Brahmaputra river and on the north and the west on the bank of the Hurasagar and Baral rivers. The implementation of the first phase of the project was started in 1970-1971. But due to shortage of funds there was no progress in the execution of the project. In 1977, the Asian Development Bank and IFAD came forward for funding the project for the irrigation and drainage component, and with some changes in the original plan. Phase one was completed in 1992. At present, the command area development of the project is in progress under a separate loan agreement from the ADB.

A typical monsoonal climate prevails in the project area. The average annual rainfall is about 1,470 mm, about 77 percent of which occurs from mid-June through mid-October. The period from November to March is significantly dry. The maximum temperatures vary from about 33.4$^o$C to 36.3$^o$C with the highest temperature experienced during the period March to June. There is a significant diurnal fluctuation with minimum temperatures ranging from about 11.5 $^o$C to 26.2 $^o$C. The potential evapotranspiration ranges from about 2.63 mm/day in December to about 5.85 mm/day during the pre-monsoonal month in May.

The Ichamati river serves as the main irrigation canal of PIRDP with a total length of 42.50 kilometers. There are some 19 secondary canals, 65 tertiary canals and 524 farm turnouts, approximately one for each 40-hectare block. Paddy is the dominant crop occupying about 64 percent of the total cropped area. Pulses, potato, vegetables and oil seeds, jute, sugarcane, onion and wheat are also grown in the area. At present, about 10,182 hectares are benefited from irrigation during the boro season (November to May) against the targeted area of 10,382 ha while about 26,015 ha are irrigated during the kharif-I season (March to June).

The population of the project area is estimated at 233,000 of which 176,000 live in the command area. Over 30 percent of the land is owned by large farmers, 45 percent by medium farmers and 24 percent by small farmers. The average landholding is about 0.70 ha (which decreased from an average holding size of 2 ha in the 1960s). Crop yields in the area have increased three to 4 times that in the 1960s. The average annual income of small, medium and large farmers is estimated at Tk 29,000,[23] Tk 50,400 and Tk 80,200, respectively.

## Sample Selection

The study is based on both primary and secondary data and information, collected through a variety of methods including: participatory rural appraisals (PRAs), key stakeholder interviews/consultations, household surveys, primary measurements, for example, water productivity measurement, and from secondary sources, including government publications, research studies, and project reports and documents. As in other participating countries for this study, a consistent procedure was adopted for household-level data collection.

A total sample of 900 households was selected from three territories in each of the two selected irrigation systems, including a sample of households from the adjoining rain-fed areas through a multistage stratified sampling. The broad distribution of households in the command area of each of the six territories is as follows: landowning households in the secondary system: 106-108, landless households in the secondary system: 21-22, landowning households in the rain-fed areas: 21-22, with a total sample of 150 households from each tertiary.

At the first stage, three secondary canals were selected according to the location of the canals at head, middle and tail of the system. Three tertiary canals for each selected secondary canal were selected according to the three stratified locations—head, middle and tail—of the territories of each secondary. The selected households were located in 41 and 29 villages, in G-K and Pabna, respectively. A comprehensive household survey questionnaire was used to collect field data on irrigation, productivity, poverty and other related aspects. National income poverty line of Tk 10,200 per person per annum was used to estimate poverty in the selected systems.

## Summary of Main Findings and Conclusions

Availability of land for agriculture in the systems is declining sharply as a result of increasing population and nonagricultural use of land, and the proportions of small and marginal farmers have been increasing over time. Land distribution in both systems is fairly inequitable, and this is more so in the G-K than in Pabna. In G-K, 4 percent (large landholders) of landowning households own 43 percent of the total land and 16 percent of all households are landless; in the PIRDP, 10 percent (large landholders) of landowning households own 25 percent of the land, and

---

[23]US$1.00 = TK59.54.

14 percent of households are landless (note: on the basis of landholdings, households are classified as: landless—those owning land below 0.20 hectare each; marginal—owning 0.21 to 0.50 hectare each; small—owning 0.51 to 1 hectare each; medium—1.01 to 3 ha each; and large—3.01 ha and above).

Irrigation in the two project areas has improved the cropping patterns in terms of expansion of HYVs. In G-K, HYV aman area has increased by 55 percent and HYV aus by 44 percent. In PIRDP, the increase is exclusively in HYV boro but, proportionally more than in G-K. Substantial growth in the adoption of HYVs has led to higher farm income (Tk 29,000 to Tk 46,000/ha in G-K and Tk 28,000 to Tk 29,000 in PIRDP). There has also been a significant increase in crop production, employment and net returns to farming in all parts of irrigation systems—head, middle and tail compared to rain-fed areas. In the irrigated areas, higher cropping intensity and greater adoption of modern technologies, resulting in improvement of land productivity, have contributed to higher farm incomes. Production and net returns to crop production in the irrigated areas have increased by 2 to 4 times over those in the rain-fed areas. Increased employment consequent upon modern rice cultivation has also been an important source of income for the land-poor and landless. In both projects, landless have benefited from increased opportunities for employment in the irrigated areas, and net increase in employment due to irrigation is estimated at 80 to 116 labor days/ha/annum. These opportunities have contributed to improving livelihood conditions for small and marginal farmers and landless in the irrigated areas and surrounding rain-fed areas.

Access to irrigation has contributed to increased household incomes for all categories of households, small, medium, and large farmers as well as the landless in all locations (head, middle and tail) of all selected secondary canals in both systems through the following improvements: net increase in per hectare production of cereal food crop estimated at 2.5 to 3 tons; net increase in per hectare employment in irrigated agriculture estimated at 80 to 116 labor days per annum; net increase in per hectare financial returns from cereal production estimated at Tk 15,000 and Tk 23,000 in G-K and between Tk 18,000 and Tk 22,000 in PIRDP; and net increase in per hectare economic returns estimated at Tk 13,000 to Tk 16,000 in both G-K and PIRDP. These figures also imply that overall production, employment and net returns to farming in the irrigated areas are much larger compared to those in rain-fed areas.

The above factors have contributed to improving poverty situation in irrigation systems, where incidence and severity of poverty are estimated to be much less compared to adjoining rain-fed areas. In the G-K system, 58 percent of sample households are estimated to be under income poverty compared to 77 percent in the nearby rain-fed area. In the PIRDP, 35 percent of sample households are estimated to be under income poverty compared to 51 percent in the nearby rain-fed area. In both the systems, poor households have little or no land, low agricultural productivity, large family size and higher family dependency and low level of education.

In general, command areas at head, middle and tail reaches of the canals receiving less irrigation water per hectare have lower productivity. Farmers at tail reaches often do not get adequate water for irrigation and, therefore, productivity is low. In general, the households at head and medium reaches have benefited more than those at tail reaches, although there are exceptions. Where performance at tail ends is better (as in some areas in PIRDP), it is due to availability and access to groundwater to supplement the inadequate surface irrigation.

In the rain-fed areas, modern rice cultivation is restricted to boro and T. aus seasons. Although sometimes, modern rice is cultivated during T. aman season the yields often remain low. Therefore, lack of opportunities for using modern technologies such as HYV cultivars and production inputs has been an important cause of poor productivity and persisting poverty in rain-fed areas.

While larger landowners have benefited more from irrigation in aggregate terms (i.e., per holding), it is found that smaller landowners have derived greater benefits per unit of land (compared to large farmers) by efficiently using the available water on the limited account of land they cultivate. Although the share in land of these groups is very small (i.e., 55% of farming households (small and marginal farmers) own only 21 percent of land in G-K and 64 percent own only 37 percent of land in PIRDP), the proportion of area under modern rice varieties is higher for small and marginal farmers and their yields are also higher compared to the larger landholders. Intensity of irrigation and the proportion of coverage of HYV rice in the irrigated areas are higher for the small farmers. Other available empirical studies also corroborate this finding (Mandal 1980). Thus, the benefits of irrigation per unit of land in both G-K and PIRDP are higher for the relatively small and marginal farmers. This indeed is a pro-poor outcome. However, given their small or marginal holdings, the total direct benefit they derive is small compared to larger landowning groups. Also, the increased labor requirement under irrigated conditions has benefited the small and marginal farmers and landless, who gain employment as wage laborers as mentioned above. These opportunities for earning incomes have helped many land-poor to retain their land and save themselves from joining the ranks of the landless in the two project areas. Through appropriate interventions, such as participatory management, some enhancement of benefits receivable by the small and marginal farmers is possible. However, for substantial improvements in the benefits accruable to the land-poor and landless, and for any significant dent in rural poverty, appropriate land distribution through reforms is necessary, which, of course, is an involved and difficult objective to achieve under the prevailing sociopolitical dynamics but one that should be given serious consideration. As for Pakistan, incentives and a market-based land redistribution option need to be explored.

Irrigation performance of the canals under study, in terms of irrigation coverage, crop productivity and water use, vary substantially in both the systems, with the head territories performing relatively better. Improved performance is also exhibited by the middle territories, but a mixed picture emerges from the tail territories. The differential levels of performance among the territories are due to a number of factors including management factors. Our analysis and detailed review of literature related to performance in G-K, Pabna and other surface irrigation systems in Bangladesh suggest that the main problems influencing the performance of irrigation systems (especially those under study) are inadequate power supply for river water pumping; inadequate number of tertiary channels; high operational and seepage losses from the canal system; poor O&M; lack of adequate extension services; non-availability and less access to farmers of micro-credit, inadequate and poor quality farm input supply; and continuing bureaucratic top-down approach to irrigation management and lack of community participation in the design and implementation of irrigation projects.

The study results suggest that the G-K and PIRDP irrigation systems have not performed satisfactorily and, as a result, their full potential has not been realized. The performance when assessed in terms of area coverage, irrigation intensity, output per unit of water, output per unit of labor, and head-tail inequities indicate that both G-K and PIRDP irrigation systems have been performing much below their actual realizable potentials. The adoption of HYV rice varieties varies between 44 percent and 55 percent. Paddy continues to be a major crop cultivated in both the systems, and crop diversification to high-value crops has not been promoted to any significant extent. Irrigation intensity is found to be low and varying widely across seasons and reaches of the systems. In the G-K, irrigation intensity is estimated at 60 percent in kharif-I and between 45 and 98 percent in kharif - II season. In PIRDP, irrigation intensity varied significantly, with the highest at 206 percent. The crop yields are rather low, ranging from 2.47 to 5.04 tons of T-aman per hectare in G-K. In PIRDP, HYV boro paddy yield varies from 3.99 to 5.99 tons per hectare. Adoption of modern technologies is also low in both the systems. The output per unit of diverted irrigation water ranges from the lowest of 0.12 $kg/m^3$ to the highest of 0.48 $kg/m^3$ in the G-K system. In PIRDP, it ranges from 0.006 $kg/m^3$ to 0.163 $kg/m^3$. In general, the performance of tail-end reaches of the systems is poor because of inequities in irrigation water distribution and poor management practices, which have resulted in reduced total productivity in both the irrigation projects, affecting the incomes of the small and landless households. In sum, major causes of low productivity and returns from crop production in the two systems include: a) low adoption of HYV rice varieties, b) poor irrigation intensity, c) lack of technology transfer, d) weak or no participation of users including the poor farmers in water management, e) ineffectiveness of WMGs/ WMAs in most areas, f) non-availability of adequate credit, and production inputs; and g) lack of crop diversification.

Both project areas are almost flood-free due to the construction of embankments. The soil quality in these areas does not pose any major constraint on productivity and the agro-climatic conditions are suitable for year-round crop production. There is ample scope for expanding irrigated areas and increasing irrigation intensities in both projects. In both projects, there are considerable opportunities for increasing crop productivity through: a) expanding irrigation coverage in both rabi and kharif seasons by improving system conveyance efficiencies, b) increasing HYV rice cultivation from the present level of 55 percent to 80 percent, c) application of precision irrigation technologies through organized extension system for the irrigated agriculture and by providing on-farm water management training to the water user groups and associations, and d) increasing cropping intensity through multiple cropping and crop diversification, both the project areas are suitable for intensive practices, and intercropping patterns with pulses and oilseeds. Many high-value winter vegetables including potato are now cultivated in some areas and there is considerable potential for expanding cultivation of these crops, during rabi and pre-kharif seasons, with partial irrigation practices.

The irrigation-sector reforms initiated in the mid-1990s emphasized on increasing users' participation in the irrigation management, including infrastructural maintenance and water allocation. A three-tier structure was introduced: water management groups (WMGs); at the lowest level/tertiary/outlets, a WMG consists of nine members—one-third each from large, medium and small farmers' water management associations (WMAs) consisting of 10-15 WMGs at the middle/secondary level of systems; and water management federations (WMFs) at the apex level of a system. These groups were expected be working in close cooperation with BWDB. However, the progress in the formation and development of these water user groups has been very slow, and in many areas these groups are yet to be formed. The slow progress is the outcome of a quick-fix approach adopted without following an effective process and an appropriate framework. In the Pabna irrigation system, for example, there are 365 WMGs of which only two have been registered with the government. Where these groups have been formed, outcomes in relation to their effective functioning and performance impacts are mixed. In G-K, formation of WMGs and WMAs has led to improving maintenance of irrigation infrastructure and water distribution in some areas. Most of the WMG members interviewed were of the opinion that the existing WMG committees were not effective and that new committees needed to be properly constituted for effective contribution to efficient O&M of the irrigation systems. So far, even the groups that have been established have not been involved in the assessment or collection of irrigation charges or in spending of revenues; these functions are still being performed by BWDB.

The overall conclusion is that the existing water management groups and associations (WMGs and WMAs) are not yet fully active and functional in all areas, even in the long standing G-K project, and the systems continue to be managed by the public-sector agencies. User groups, where established, are still at the early stages of operation or at the formation stage in different parts of the systems. Steps are needed to be taken to make these organizations more effective and functional. Detailed guidelines for participatory irrigation management have been developed, but they have not been effectively implemented. In participatory assessments and village-level group discussions, it was brought out that the user groups are capable of, and willing to, take responsibility for managing the systems provided they are handed over systems in good running condition, given legal support by law enforcement agencies, provided technical support and training by the agencies, and conferred with authority to assess and collect irrigation service charges. Also, it came out clearly during the group discussions that the prevailing inequities in land distribution may lead to a situation where the reforms may end up empowering the already powerful groups and reinforce the dominance of local influential people and large landholders in user groups.

As mentioned earlier, the BWDB is the only agency responsible for distribution of irrigation water at the primary canal level. Irrigation charges are assessed and collected by BWDB. Assessment of water charge is made on the basis of the area irrigated irrespective of the size of the farm. The average level of irrigation charge is fixed at around Tk 500 per acre in G-K and Tk 540 in PIRDP, and the charge differs by crops depending on the water requirements of a crop. However, the charge for a crop is uniform throughout the project area, and it does not differentiate between the land topography or soil quality, basically for the sake of easy administration by the agency. Collection of the irrigation charges is poor in both the systems. In G-K as a whole, annual rate of collection in the 1990s ranged from 5 percent to 15 percent of the targeted sum; moreover, the collection rate has fallen over time. In PIRDP, collection rate was only 9 percent in 2000-01.

A unique pro-poor intervention in the medium- and large-scale irrigation systems has been the establishment of LCSs, EMGs and CMGs. LCS, known as Landless Contracting Society aims at providing employment and income-generating opportunities to the rural people, both men and women, ensuring fair wages for their labor and achieving improvements in the quality of construction work. At least 25 percent of the earthwork of any public water project/subproject/scheme is supposed to be reserved for the LCS. The work would be offered to WMOs, which would carry out the actual work through the LCS. An agreement is usually signed between the implementing agency and the WMO and another agreement would be signed between the WMO and the LCS. The landless male and female groups of the Bangladesh rural development board and such groups formed by the NGOs would be included as LCS members. At least, 30 percent LCS groups or 30 percent LCS members are required to be women. LCS is supposed to be used in the earthwork and construction process. Due to the heavy nature of work, however, these initiatives were not considered suitable for women. No LCS existed in both the systems. Preventive maintenance of embankments is an integrated component of O&M and aims at maintaining their crests and slopes in optimal physical condition. Preventive maintenance is executed through EMG throughout the year. CMG also follows guidelines similar to those of the EMG. A certain portion of main and secondary canals would be maintained by a women's group facilitated through an affiliated agency. The affiliated agency is in charge of the recruitment of female laborers willing and capable of engaging themselves in an EMG/CMG for a period not less than 6 months. Priority would be given to Female Headed Households (FHH). CMGs are in place in the Pabna system and EMGs are operating in the G-K system. In both systems, majority members of both EMG and CMG are vulnerable women. In addition to earning from wage labor, women use the slopes of the canals and the embankments to harvest vegetables and thereby earn extra incomes.

## Conclusions and Recommendations

Based on the analysis, the study recommends the following interventions and actions:

a) Entire potential command areas of both the systems be brought under irrigation through further investments, with emphasis on *targeting new investments* to the poor communities.

b) Promote equitable distribution of water to all reaches of the canal—head, middle and tail—and to all socioeconomic groups including small and marginal farmers through effective implementation of the proposed *reform model* that emphasizes participatory approaches including representation of the poor and those at the disadvantaged locations.

c) The study suggests that public-sector agencies alone have not been making a significant impact towards improving agricultural performance. Beneficiaries should, therefore, be involved in the management of the irrigation systems through *participatory irrigation management (PIM*) or irrigation management transfer (IMT) activities, e.g., effective formation and functioning of WMGs and WMAs. WMGs and WMAs should be effectively involved in O&M activities. Importantly, transparency in BWDB functions is needed, which can be ensured through mandatory regular consultation with the farmers and their organizations viz. WMGs and WMAs.

d) Over time, surface water in the country has become increasingly scarce and, hence, its optimum use needs to be ensured. To that end, water losses from the canals should be reduced through proper maintenance of water infrastructures through user involvement, and *canal lining in selected areas* through further targeted investments.

e) Discourage monotonic cultivation of rice in the systems and *promote crop and enterprise diversification* towards high-value crops and other farm enterprises according to the agronomic and agro-ecological settings, not only through effective implementation of the new water sector policy and plan but also by linking it to the new agricultural policy formulated in 1999.

f) For improved agricultural yield per unit of land, labor and irrigation water used, proper application of irrigation-seed-fertilizer technology is needed *through building effective partnerships* between BWDB and other government agencies on the one hand and WMGs/WMAs on the other.

g) It is suggested that *an integrated approach in service delivery*, which conceives irrigation as one critical production input to be combined with provisions of credit, agricultural inputs, marketing services and information in an integrated framework, be adopted to address the poverty issue along with that of increased production.

h) The existing water-management groups and associations (WMGs and WMAs) are not yet fully active in all areas, even in the long standing G-K project. They are still at early stages of operation or in the formation in different parts of PIRDP. Steps need to be taken to make these organizations more effective. In the first stage, all tertiary canals and below should be handed over to the WMGs for management. Importantly, the proposed *three-tier reform structure should be implemented comprehensively* rather than through a piecemeal approach.

i) In both the systems (as in other systems) irrigation charge collection rate is poor, and the amount collected does not cover even a small part of the O&M cost, and spending on system maintenance is lower than that required. *Assessment and collection of irrigation charges and revenue spending functions should be handed over* to the water user organizations.

j) The National Water Policy has not specifically addressed the issue of irrigation rights and obligations; and no regulation exists for dealing with defaults on irrigation charges. It is necessary to *establish equitable irrigation rights* and obligations at the policy and operational levels and involve WMGs and WMAs at the field level in the process of ensuring that the codified irrigation rights and obligations are properly observed by all concerned to ensure equity in water distribution and efficiency in water use.

k) Towards enhancing the benefits receivable by the land-poor and landless, *provisions need to be made in the IMT agreements to provide employment to the marginal farmers and the landless in infrastructural maintenance and water distribution activities similar to* *those as in the case of LCS, CMG and EMG groups.* This should be one of the important pro-poor dimensions of the reforms in irrigation.

l) ***Promote opportunities for the land-poor and landless in rural nonagricultural activities*** for which scope would expand as agricultural income increases as a result of improved irrigation management and agricultural practices. Through appropriate advisory arrangements and ensuring availability of credit, technologies and other needed services, they may be encouraged and facilitated to start tiny/small enterprises in agro-support (e.g., fertilizer, pesticide, farm implements) and agro-processing (as vegetable, fruit processing) activities.

m) From a long-term perspective, greater emphasis should be on creating permanent assets for the poor. In this regard, the study suggests that *land redistribution*, through effective land reforms (administrative or incentive and market based), to the marginal farmers and the landless should be considered one of the important options. Land redistribution, in addition to promoting pro-poor institutions, technologies and opportunities, would not only lead to increased productivity but also to greater equity in the distribution of new investments in the irrigation sector—all with positive outcomes for poverty alleviation.

# Literature Cited

Ahmed, Q.K.; Karim, Zahurul; Haq, A. Khandaker; Quasem, Abul; Rahman, Khalilur; Chakravorty, Nityananda; Ali, Noajesh; Akhter, Rowshan; Hasan, Z. Mohammad; Zubair,H.Mohammad; Younus, A. F.; Hossain, Afzal; Karim, M.A.; Siddiqui, S.M.; Hussain; Khoshbu; Newaz, A.; Hussain, Intizar. 2004. *Country Final – Bangladesh: Pro-poor Intervention Strategies in Irrigated Agriculture in Asia- Poverty in irrigated Agriculture in Bangladesh — Issues and Options.* Colombo, Sri Lanka: International Water Management Institute.

Hossain, M.; et al, 1994. Production environment, modern variety adoption and income distribution in Bangladesh. In *Modern rice technology and income distribution in Asia*, ed. Cristine C. David & Keijiro Otsuka Lynne Remner. Boulder & London.

Mandal, M. A.S. 1980. Firm size, Tenancy and Productivity in an Area of Bangladesh. *Bangladesh Journal of Agricultural Economics* 3 (2).

Toufique, Kazi Ali; Turtin, Cate. 2002. *Hands not land: How livelihoods are changing in rural Bangladesh.* Dhaka: Bangladesh Institute of Development Studies, and London: Department for International Development (DFID).

# Poverty in Irrigated Agriculture in China: Issues, Options and Pro-poor Intervention Strategies

## Historical and Contextual Frame

The Chinese economy has been undergoing a systematic change and transformation since the economy-wide reforms were initiated late 1978 with the objective to move from centrally planned to a more market-oriented economy. The authorities switched to what is called a "household responsibility system" in agriculture in place of the old collectivization, increased the authority of local officials and plant managers in industry, permitted a wide variety of small-scale enterprise in services and light manufacturing, and opened the economy to increased foreign trade and investment. The result has been a quadrupling of GDP since 1978. The agriculture sector, which showed an impressive performance, was at the forefront of reforms. The annual rate of agricultural growth averaged 7.4 percent and total factor productivity growth was 6.6 percent during the 1978-85 period. In the 1985-95 period, the annual growth rate declined to 5.8 percent. However, growth in high-value products and foods such as livestock, fisheries, vegetables and melons grew at 9 percent per year or more after 1985. With an accelerated growth rate in agriculture, the sector's share in the workforce dropped from 71 percent to about 50 percent in 20 years (it took the U.S. 50 years and Japan 60 years to achieve the same rate of decline). Agricultural reforms consisted of increasing procurement prices for grains, allowing farmers to sell above quota production at market prices, lowering grain quotas, increasing grain imports, and expanding private inter-provincial trade. But the most important feature of the reforms has been the household responsibility system, in which collective land was assigned to households on log lease contracts and local governments took the strong initiative of transferring production decisions and profits from communes to households. Agricultural reforms became the cornerstone of the reforms in the entire economy providing the basis for reform of the industrial sector. Increased investments in both agricultural and nonagricultural sectors and resulting impressive growth rates have led to great advances in improving people's lives in China.

The effective land revolution through successful land reforms formed the basis for laying a solid foundation for development of the rural economy in the country. A radical farmland revolution was carried out in the early 1950s by expropriating land from landlords and distributing it to landless peasants fulfilling the dream the Chinese farmers had for thousands of years. In the mid 1950s, China carried out its second land reform, where individual farmers were compelled to join collectives, leading to the development of People's Communes. In 1978, as a part of the larger economic reform, China carried out a third land reform introducing a household responsibility system through family-based contracts distributing collective lands to individual households equitably based on family size. Land distribution led to increased productivity and overall improved agricultural performance. However, the equity principle followed in sharing of land based on its quantity, quality and location, led not only to very small-size holdings but to the fragmentation of plots allocated to a family. A survey conducted by the Chinese Ministry of Agriculture in 1986 indicated that among 7,983 sample villages in 29 provinces the average cultivated area per household was 0.446 hectare fragmented into 5.85 plots, each plot, on average, being 0.08 hectare (Chen and Davis 1998). Led by (over) equity in land distribution, fragmentation of family land plots is now one of the major issues in the land economy of China, despite the fact that land reforms contributed to improving lives of the rural masses.

As a result of the above initiatives, China has made great progress in poverty reduction since the late 1970s when the rural economic reform was initiated (LGPR et al. 2000). From 1978 to 2000, more than 200 million people in rural areas have escaped from poverty. Based on the government's poverty line, the incidence of poverty declined from 30.7 to 3.4 percent.[12] China's poverty reduction has been attributed to the adoption of a broad program of rural economic reforms (Zhang *et al*. 2002) that have been associated with dramatic rural economic growth.

Per capita rural income in China was very low prior to the reforms. In 1978, average income per rural resident was only 220 yuan per year, or about US$150 (figure C-1). During the 29 years from 1949 to 1978, per capita income increased by only 95 percent, or 2.3 percent per annum (Fan et al. 2001). China was one of the poorest countries in the world. However, since the rural reform in 1978, per capita income increased to 552 yuan in 1984, a growth rate of 15 percent per year (figure C-1). During the second stage of reforms (1985-89), rural income continued to increase, but at the much-slower pace of 3 percent per annum. This was due mainly to the stagnation of agricultural production after the reforms.

Evidence shows that poverty reduction is greatly related to rural income growth and agricultural development, especially in the 1980s. In 1978, China's poor population was as high as 260 million. However, in 1984, poor population was reduced to 89 million and poverty reduction was exceptionally rapid in this period. The incidence of rural poverty (poor as a proportion of rural population) decreased from 30.7 percent in 1978 to 15.1 percent in 1984. This was also the quick growth period of rural income and agricultural production in China. Because of the equitable distribution of land to families, income inequality measures such as the Gini coefficient, increased only slightly from 0.21 in 1978 to 0.26 in 1984 (Fan et al. 2001).

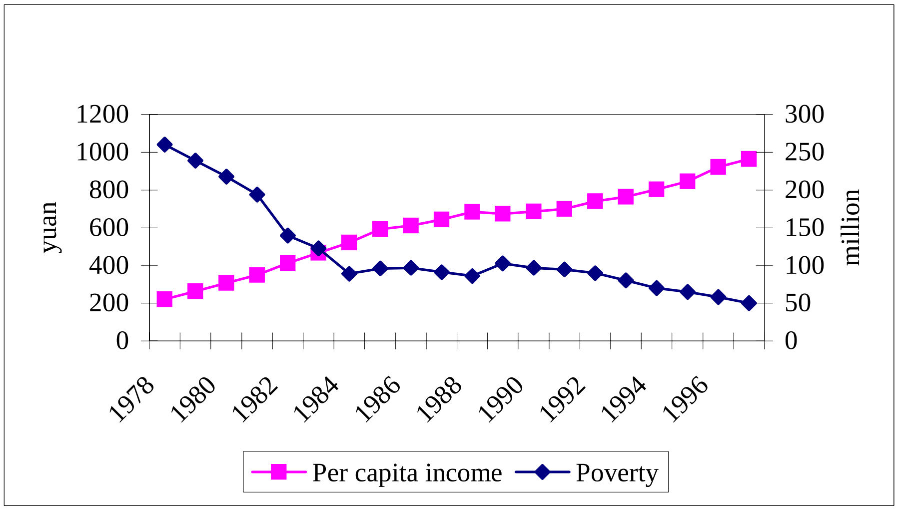
The effects of fast agricultural growth on rural poverty were largely exhausted by the end of 1984 (Fan et al. 2001). Over the period of 1985-1989, rural income distribution became less egalitarian, and the Gini index rose from 0.264 to 0.301. The ratio of per capita rural income in coastal regions to that in other areas also increased, from 1.21 to 1.51. The changes in income distribution probably resulted from the changed nature of income gains and the growing differential in rural non-farm opportunities among regions (Rozelle 1994). As a result, the number of poor increased from 89 million in 1984 to 103 million in 1989, a net increase of 14 million in 5 years (figure C-1).

It was only in 1990 that rural poverty began to decline once again. The number of poor dropped by 9 percent per annum, from 103 million in 1989 to 50 million in 1997 (figure C-1). Moreover, the rate of rural poverty reduction was faster than that of income growth (5% per annum) during the period, indicating that factors other than income growth were at play (Fan et al. 2001).

---

[12]However, based on the World Bank poverty line ($1/day), China still had 124 million rural poor populations in 1997 though the poverty decline trend is also very obvious (Table 1.1).

Figure C-1. Trends in average income and poverty in China.



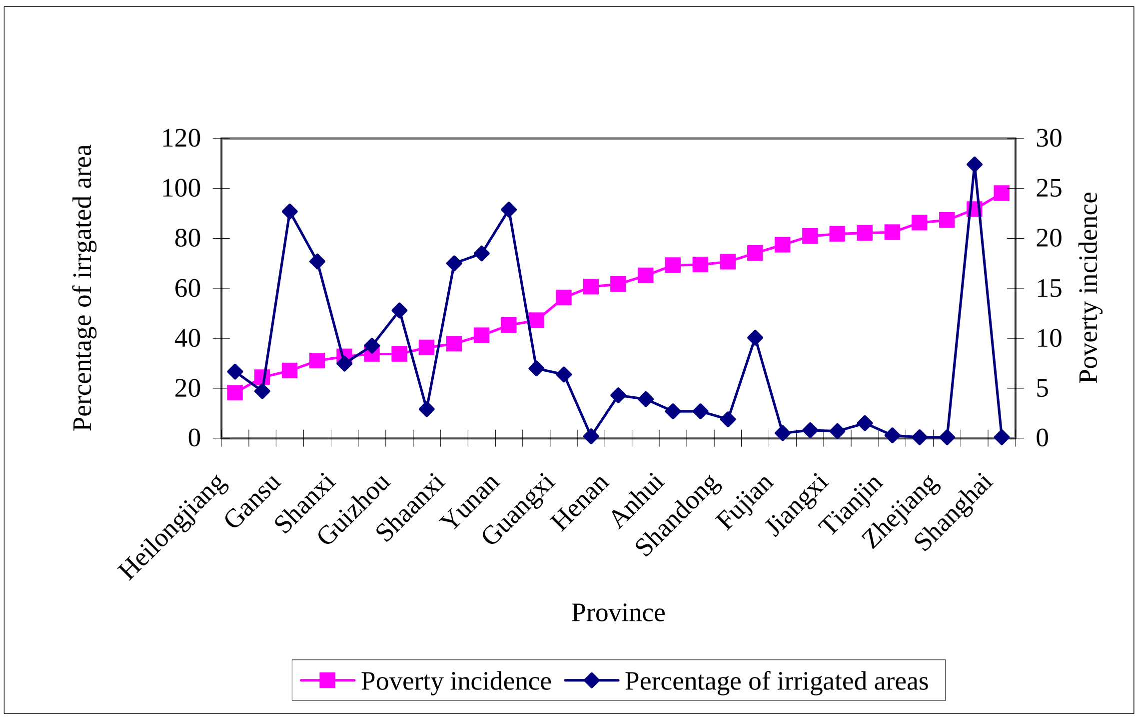

In the 1980s, aside from those in counties under special military administration, most of China's poor lived among more than 200 million residents who resided in officially designated poor counties (Piazza and Liang 1997). These poor counties were distributed across 23 of China's 27 provinces, but 78 percent of them were concentrated to the west of a north-south line that runs through the central mountainous parts of the country from Heilongjiang, Gansu, and Inner Mongolia in the north to Guangxi and Yunnan in the south. The remaining "poor" counties, generally better-off among all poor counties, were located in less-contiguous islands of poverty in the hills of eastern and southeastern China.

Poor counties in the first wave of officially designated counties were normally characterized as being poorly endowed by geographic location (remote and mountainous) and at a disadvantage in terms of agricultural resources, such as soil, rainfall and climate (Tong et al. 1994). Many of these areas suffer from severe ecological damage, such as deforestation and erosion (Li 1994). Poor counties also tend to have more variable yields (Weersink and Rozelle 1997). Partly as a result of these poor natural conditions, and partly as a result of poverty itself, farmers in poor areas suffer from below-average irrigation facilities, fertilizer use, and general infrastructure (Tong et al. 1994). Poor counties in the 1980s were still highly subsistent in their grain needs, and in net terms, often needed to procure grain to meet household demand (Piazza and Liang 1997). Participation in the non-farm labor markets in the 1980s lagged far behind the national average (Rozelle et al. 1999).

Irrigation, the most important form of investment in the agriculture sector in both rich and poor areas of the rural economy, is also believed to have played important roles in increasing agricultural productivity and reduction of the poverty. In 2000, China invested 35 billion yuan in irrigation, which is 10 times more than what it spent on agricultural research (3.4 billion yuan). Investment in water control, more generally, also dominates all other forms of investment. For example, spending 83 billion yuan in 2000 on water control (Ministry of Water Resources 2001) far exceeded the annual budget of 22.4 billion yuan that was targeted specifically at poverty reduction (National Statistical Bureau of China 2001).

Provincial-level data on percentage of irrigated areas over total land areas and poverty incidence in 1996 show the relationship between irrigation and poverty. Figure C-2 shows the negative relationship between share of irrigation area and poverty incidence. Generally, except for the Xinjiang province (a full irrigation area), if provinces have a high share of irrigated areas and poverty incidence in these provinces is also relatively low, it implies the importance of irrigation in poverty reduction.

Figure C-2. Relationship between irrigated area and poverty incidence in China.




However, low and declining marginal returns to irrigation investment at the aggregate level are not unexpected since China has exploited nearly all of the opportunities to irrigate cultivated areas that are relatively easy to do. The proportion of cultivated area under irrigation increased from 18 percent in 1952 to more than 50 percent by the late 1990s (National Statistical Bureau of China 2001). Given this high level of irrigation, the increasing costs of bringing additional land under irrigation, and the severe financial constraints of government budgets, the potential contribution of expanding irrigation area to agricultural productivity and poverty reduction may be fairly limited.

Furthermore, water shortages are threatening China's resource base and agricultural production. Despite ranking fifth in total water resources among the countries in the world, on a per capita basis, China has only 25 percent of the world average. Between 1949 and 1998, total water use increased by 430 percent. China's water utilization rates are already among the highest in the world, and there is little scope for tapping additional sources (Ministry of Water Resources 2002; Rosegrant and Cai 2002). Water demand in industry and urban sectors has risen so fast that the water available to the agriculture sector has declined.

It is not just the limited resource base and rising demand that have contributed to the water crisis in China but also the deterioration of the surface water irrigation system and the resulting inefficient water use. Constructed from the 1950s to the 1970s, surface water irrigation system has been the backbone of the effort to increase agricultural productivity. However, due to lagged investment (which has favored new projects rather than maintenance of old projects) and poor water management, surface water delivery infrastructure has been deteriorating and water cannot be used efficiently (Lohmar et al. 2002). Surface water delivery efficiency in China is only about 25 to 40 percent.

The Government of China has identified increasing water scarcity as one of the key problems that must be solved if the nation is to meet the objectives of its national development plan in the coming years (Zhang 2001). Shortages of water are harming efforts to alleviate poverty as well as becoming a major source of environmental problems (World Bank 1998; Zhang 2000). In many regions of the country, rapidly growing industry and an expanding and increasingly wealthy urban population regularly compete with the nation's farmers for limited water resources, threatening to curtail growth in food production.

In facing the emerging water crisis, leaders typically debate about which of several approaches should be used to address water-scarcity problems, although no option has proved very successful (Lohmar et al. 2002). Developing more water resources to increase water supply historically has been given the highest priority in resolving water shortages. Since the 1950s, China's government has invested more than US$127 billion for the construction of infrastructure to develop new water resources (Wang 2000). Recently, the State Council announced plans to allocate more than US$50 billion for the construction of a project to move water from the Yangtse river valley to northern China. Despite such ambitious goals, the high cost of developing new sources of water will result in the volume of water that can be added to north China's water equation becoming only marginal.

Leaders have also promoted water saving technologies and considered whether or not they should use a water pricing policy (Chen 2002; Rosegrant and Cai 2002). Unfortunately, most efforts to encourage the use of sophisticated water saving technologies, such as drip and sprinkler irrigation, have failed and, in the past several years, the Ministry of Water Resources has distanced itself from a water policy based on water-saving technology (Zai 2002). Moreover, political considerations will most likely keep leaders from moving too aggressively to raise prices, at least in the agriculture sector (Rosegrant and Cai 2002).

***Irrigation Sector Reforms***

With the failure and infeasibility of traditional methods, leaders in recent years have begun to consider water management reform as a key part of their strategy to combat China's water problems since they believe water in agriculture is being used inefficiently. Despite water shortages, users in all sectors of the economy, especially those in agriculture (the nation's largest consumer of water), still do not efficiently use the water that they are allocated. One study, for example, estimated that due to the poor management of the nation's canal network, only 50 percent of water from the primary canals is actually delivered to the field (Xu 2001). Farmers also do not efficiently use the water that reaches their fields, wasting between 20 and 30 percent of their water. Hence, only about 40 percent of the surface water allocated to production agriculture is actually used by farmers on their crops. Others have estimated even greater inefficiencies (Fang 2000). In response, it has been proposed that local leaders reform the institutions that manage water in China's communities (Nian 2001; Reidinger 2002).

Despite the consensus of the current leadership in China to push water management reform, there is considerable debate about its appropriateness. International evidence shows that water management and its institutional arrangements are important measures for dealing with water shortage problems (World Bank 1993; IIMI and FAO 1995). Since the 1980s, many developing countries have begun to transfer irrigation management responsibilities from the government to FOs or other private entities in order to mitigate the financial burden of water projects and to improve the efficiency of water use and supply (Vermillion 1997). Decentralized water resource management, if structured properly, can provide the incentives needed to stabilize and improve the efficiency of irrigation and water supply system. There are some cases internationally where these efforts have failed or even generated negative influences (Easter and Hearne 1993; Vermillion 1997; Groenfeldt and Svendsen 2000).

In fact, since the early 1980s and increasingly in the late 1990s, China's policymakers have promoted water management reforms, and like similar attempts outside China, the outcomes seem to be mixed although most evaluations are based only on anecdotes or case studies (Nian 2001; Huang 2001; China Irrigation Association 2002). Even in those areas in which management reforms have been well-designed, effective implementation of the reforms has been difficult (Ma 2001; Management Authority of Shaoshan Irrigation District 2002). Collective action, information problems and getting the incentives right are among the most important reasons that water management reform has failed. The design of water management reforms themselves also may create a number of negative externalities. Since the reforms provide financial incentives to the manager to more efficiently manage water, it is possible that the manager could take a number of actions that could negatively affect production, income and the poverty status of certain individuals. For example, managers could deliver less water than demanded by farmers or cut off water deliveries to slow or nonpaying poor households. Surprisingly, despite the high stakes of the reforms there is little or no empirically based work that has been conducted to understand and judge the effectiveness of water management reform. This study attempts to fill this gap.

Farmer participation in irrigation system management—or participatory irrigation management—has been developed as one of the key means for improving irrigation management. WUAs were first piloted in World Bank (WB) projects in 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 resource 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. 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. 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,[13] and the current drafting process for the new Water Law is seeking ways to further extend their introduction and operation.

## Study Settings, Data and Methods

The study used data from a number of sources, including primary and secondary sources. For assessment of impacts of irrigation on poverty, the study used primary data from almost nationally representative sample of 60 villages in 6 provinces (Hebei, Liaoning, Shaanxi, Zhejiang, Hubei, and Sichuan) of rural China (henceforth, the China National Rural Survey or CNRS). To reflect accurately varying income distributions within each province, one county from within each income group for the province, as measured by the gross value of industrial output was selected. The survey team randomly selected two villages within each county and used village rosters and our own counts to randomly choose 20 households, both those with their residency permits (*hukou*) in the village and those without. The survey included a total of 1,199 households.

For more detailed fieldwork and to meet other objectives of the study including assessment of irrigatiin systems performance and the implications of irrigation management reforms, four irrigation systems/districts in two provinces, Ningxia and Henan, along the Yellow river basin (YRB) were selected. Ningxia Province is located in the upper reaches of the YRB; Henan Province is in the lower reaches (Figure C-3). In addition, an attempt was made to increase the variation among sample regions within each province. To do so, one irrigation district in each province was chosen in the upper reaches of province's segment of the YRB. Another was chosen in the lower reaches. Specifically, the Weining Irrigation District (WID-N) and Qingtongxia Irrigation District (QID-N) in Ningxia Province.[14] were chosen. In Henan Province, the People's Victory Irrigation District (PID-H) and Liuyuankou Irrigation District (LID-H).[15]

---

[13] See the Ministry of Water Resources' July 28th 2000 Policy Circular to Provincial Water Resource Bureaus)

[14] The WID-N and the QID-N include gravity and lift irrigation regions, in order to compare with Henan's irrigation management (mainly gravity irrigation), we only selected the gravity irrigation regions to do case studies. In the gravity irrigation regions, there are scattered samples of lift irrigation.

[15] The selection of these two provinces is also due to the fact that 2 other major water projects locate in the

were chosen. Within each irrigation district, villages were randomly selected after all the villages in each district were classified by differences in the size and age of the village's irrigation systems and variations in infrastructure condition. In addition to fieldwork and interviews with key stakeholders, a survey of 231 households was undertaken using a comprehensive multi-topic questionnaire to collect detailed household-level data.

***Ningxia and Henan Provinces***

Given the poverty focus of the study, the two provinces selected for this study are both considered as less developed when compared to other provinces in China. Average per capita annual income in rural Ningxia was only 75 percent of the national average for rural China in 2000 (1,724 yuan versus 2,253 yuan).[16] The average income of rural residents in Henan is about 260 yuan, higher than that in Ningxia, but still 12 percent lower than the national average. The lower average income levels mean that both provinces also suffered form higher incidence of poverty. According to the most recently available secondary data on poverty (using the national poverty line from the State Statistical Bureau, 1996), the incidence of poverty in Ningxia (18.5 percent) and Henan (17.6 percent) was about three times the national average (6.3 percent). At the national level, this rate declined to 3.4 percent in 2000. Based on this national trend and the growth of rural income in Ningxia and Henan in the late 1990s, it is highly plausible that the incidence of poverty in these two provinces is about 10 percent.

Despite the fact that the Yellow river flows through both provinces, water use varies substantially between Ningxia and Henan Provinces. In 2000, average per hectare agricultural water use reached 24,525 $m^3$ in Ningxia, the upstream province, a level about 3.4 times of the national average. In contrast, Henan farmers used about 3,810 $m^3$, a level about six times less than that of Ningxia. Given such differences in water uses, it is clear that existing water rights and the current allocation system are clearly critical policy issues. Moreover, under the current water use regime, upstream regions—i.e., those in Ningxia-obviously have access to more water than the downstream ones. As a consequence, we would expect that alternative water allocation scheme could generate large welfare gains for the whole YRB. However, such a shift (that is, providing more water downstream and less upstream) would invariably entail significant changes in the local cropping system, land use pattern, water productivity, and farmer income in different reaches of the Basin. More fundamentally, such changes would also have implications for poverty—both positive and negative, depending on whether one were to have water allocations cut or raised. In addition, large differences in water access between the two study areas mean that there will likely be fundamental differences in how water is used by farmers and managed by the IDs and villages.

Moreover, because of the way that the location and other geographical characteristics of the study provinces differ, there are different levels of overall irrigation and use of water for agriculture

provinces: IWMI's rice water saving project in LID-H of Henan and ADB's Shapatou water project in WID-N of Ningxia. The selection of our irrigation districts in the above 2 projects areas helps and complements our project in many aspects.

[16] US$1.00=Yuan 8.3.

which could potentially affect pro-poor intervention strategies. In Ningxia, irrigated land accounts for 48 percent of the province's cultivated land, 7 percent less than the national average in 2000 (55 percent). A much higher proportion of Henan's cultivated area, however, is irrigated, above 66 percent. If one looks at the nature of irrigation in the two provinces, the higher proportion of irrigated areas in Henan is mainly due to the expansion of groundwater use. In Ningxia, surface water contributed 94% of the total agricultural water use in 2000; in Henan, one of China's most diversified areas in terms of conjunctive water use, farmers use both surface water and groundwater.

***Characteristics of the Selected Irrigation Districts***

The four sample IDs, two in Ningxia and two in Henan, have a number of similarities and also several fundamental differences. Each of the sample IDs belongs to a class of "large-scale" irrigation districts. The effectively irrigated area, or command area, of the IDs range from 31,000 ha (LID-H in Henan) to 304,000 ha (QID-N in Ningxia). The two irrigation districts in Henan have been in operation for 40 to 50 years. In contrast, the Ningxia IDs have a much longer history. In fact, several of the canals and their command area have been in operation for more than 2000 years, although during the past 50 years, enormous investments have been sunk into both fundamental renovations of the original system and expansion into adjacent areas.

Despite the importance of irrigation in China's agriculture, aging infrastructure, outdated water delivery technology and chronic funding shortages for canal maintenance have affected the irrigation facilities of the four IDs. All four are plagued by relatively poor physical conditions and low efficiency of water delivery. The water conveyance efficiency in each ID ranges from 40 to 50 percent. Consistent with the water endowments of their host provinces, as the IDs have developed, their water use patterns have evolved. The WID-N and QID-N IDs in Ningxia almost exclusively rely on surface water; the PID-H and LID-H IDs in Henan are best characterized as conjunctive systems, using both surface water and groundwater resources.

Since both IDs are located in the northern part of China, they have similar climatic characteristics that can be most basically classified as rain-short and seasonally variable. Annual rainfall ranges from about 200 mm in the two IDs in Ningxia to 630 mm in the two Henan IDs. Moreover, because of the dominance of weather patterns created by Siberia in the north and the Himalyas far to the south, almost 90 percent of the rainfall is concentrated in the summer months.

In such a dry, seasonally variable climate and being far from the nation's booming coastal areas, irrigation has played an important role in the economies of the area served by our study's four IDs. The shares of irrigated area inside the ID boundaries ranged from 82 to 93 percent in 2000. Without access to the transportation and other locational advantages of the provinces in the eastern part of the nation, agriculture is still an important sector in the local economies. Above the national average (16%, NSBC 2001), the share that agriculture contributes to GDP ranged from 27 to 46 percent in 2000.

Although there are unique features about each of the IDs, the cropping patterns of the farmers are mostly typical of China's northern and northwestern irrigated areas. Wheat is the dominant crop, a crop that is grown almost exclusively in the winter season (that is, planted in fall and harvested in late spring). In terms of cultivated area, maize is second, and is mostly a crop that is grown in rotation with wheat (typically being planted in early June—sometimes between the rows of the wheat that is almost ready to be harvested—and harvested in late September or October).

Some of the farmers in the study areas also produce a number of crops that are somewhat special in north China. For example, rice is an important crop in the upper reaches of the IDs in Ningxia (WID-N and QID-N) as well as in certain areas in one of the IDs in Henan (PID-H). Cotton, a crop that can only be grown with access to irrigation, can also be found being cultivated on land in some of our study IDs. Nongrain crops also vary among the irrigation districts.

The tremendous diversification of cropping systems that characterize all regions of China, including the selected IDs, makes it difficult to precisely assess the water productivity for the whole agriculture sector. Therefore, our analyses on water productivity concentrate on wheat, maize and rice. Based on our survey data, water productivity (i.e., unit of output per unit of water input) differs significantly by the major crop and between upstream and downstream areas along the YRB. For example, farmers produced somewhat more than 0.5 kilogram of wheat (in two of the IDs) and rice (in three of the IDs) per cubic meter of water. In contrast, maize farmers produced 1.29 to 2.97 kilograms. However, the productivity of water of wheat farmers varied sharply among IDs. Farmers in Ningxia produced less than 1 $kg/m^3$ of water, while those in Henan (LID-H) produced more than 1.5 $kg/m^3$. Such a large difference among crops and between regions is an indication of the potential opportunities to increase water productivity through water reallocation within and between IDs.

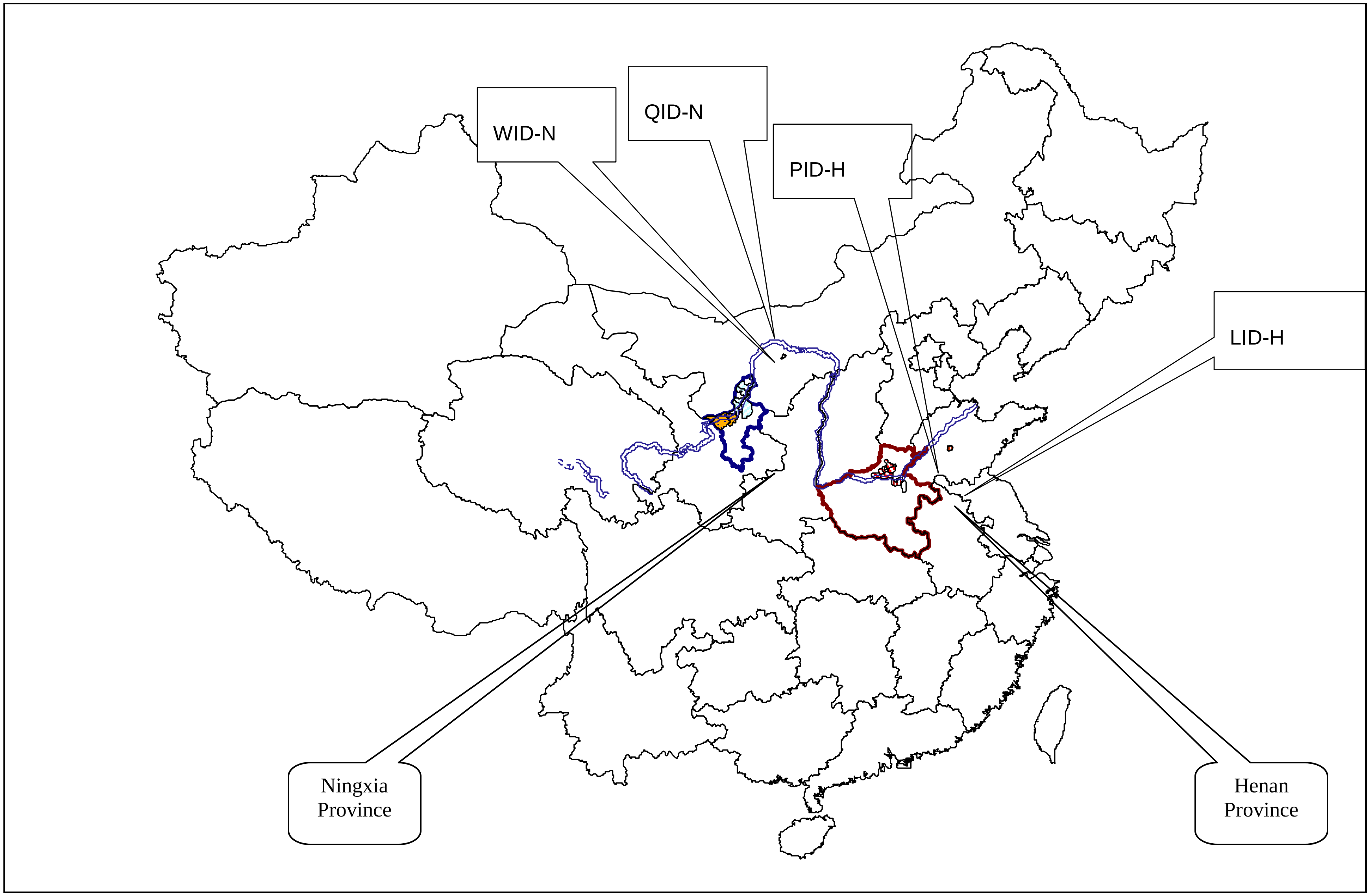
There are large differences in the O&M cost recovery rates among the four sample IDs. In WID-N and QID-N, both located in Ningxia Province, the average O&M cost recovery rate is 61 percent. Although far below 100 percent, the rates are even lower in Henan (25% in PID-H and 19% in LID-H). These large differences among IDs in the O&M cost recovery offer an opportunity to investigate how differences in O&M recovery affect the performance and management of irrigation systems in our study areas.

Water prices also differ across the IDs. Water officials in Ningxia charged less for water (0.012 $yuan/m^3$) in both sample IDs (WID-N and QID-N). Farmers in Henan, however, had to pay a higher price for their water (0.03 $yuan/m^3$ in LID-H and 0.04 in PID-H). These differences while large in percentage terms (the price of water in Henan is more than three times that in Ningxia), are consistent with the relative abundance of water (since Ningxia is in the upper reaches of the YRB and Henan is in the lower reaches). If the lower price of water is, in fact, a function of the lower cost of supplying water in Ningxia, it may also help explain why IDs in Ningxia have higher O&M cost-recovery rates.

During the field surveys, a great deal of heterogeneity in the way villages managed water both within and between the four sample IDs was observed. Villages in the two IDs in Ningxia and one in Henan (PID-H) use WUAs, contracting with individuals, and group and collective management to manage their water. Interestingly, the collective (village leadership) dominated water management in only one Henan ID (LID-H).

Two standards of poverty are used in this study. The first is China's official poverty standard that is published annually by the CNSB. The other is the international standard used by the World Bank (the so-called $1/day poverty line). In 2001, the official rural poverty line in China was 625 yuan/capita/year. In purchasing power parity terms this is about 71 cents per day. Hence, China's poverty line is 29 percent lower than that used by the World Bank (878 yuan/capita/year).

*Figure C-3. Location of the selected irrigation districts, China.*



## Summary of Main Findings and Conclusions

### *Impact of Irrigation on Poverty*

Compared to other countries in the world, the proportion of China's cultivated area that is irrigated is high. Data from six provinces show that 52 percent of cultivated land is irrigated. Of the area that is irrigated, farmers irrigate 61 percent with surface water and the rest with groundwater. Although this value is higher than the estimates published by CNSB (2001) in its annual yearbook (41%), both our estimates and those of the CNSB are higher than most of the other countries in the world (e.g., 33 % of India's cultivated area is irrigated; 4.8% of Brazil; and 12% of the US).

While most of China's cultivated area is irrigated, the proportion of area that is irrigated varies sharply by crop. For example, China's major food grains are mostly irrigated. Ninety-five percent of rice and 61 percent of wheat are irrigated, levels which in both cases are above the national average. In contrast, the majority of the area for most feed-grains and lower-valued staple crops is not irrigated. Despite the growing importance of maize in China's agricultural economy, only 45 percent of China's maize farmers irrigate their crop and even a lower proportion of coarse grains and tuber (white and sweet potatoes) farmers do the same. Although cash crops also vary among themselves, most farmers of the important cash crops in our sample irrigate their crops (e.g., 94% of cotton area and 69% of peanut area).

Analysis of differences between irrigated and non-irrigated yields shows that for almost all crops, yields of irrigated plots are higher than those of non-irrigated ones, though there are differences among crops. For example, wheat yields of irrigated plots are 70.9 percent higher than those of non-irrigated plots. Irrigated maize yields are 16.4 percent higher and irrigated cotton yields are nearly 200 percent higher.

The *annual output* of a particular plot of land also varies sharply due to the ability of irrigation to increase the intensity of cultivation. When two crops are planted in rotation with one another, the annual output per plot rises steeply when compared to the yields of a single season crop. For example, the annual yields of rice-rice (9,934 kg/ha), wheat-rice (9,266 kg/ha), and wheat-maize (8,263 kg/ha) rotations far exceed those of single season rice (6,195 kg/ha), single season wheat (1,931 kg/ha) and single season maize (2,876 kg/ha). And, although in some cases farmers can still produce two crops per year without irrigation, with the exception of rice, most single-season crops are not irrigated (more than 80%) while most of those that produce two or more crops (more than 60%) are irrigated.

Even larger differences appear when examining *differences between the revenues* (price times yields) earned by farmers on their irrigated and non-irrigated plots. Overall revenue from irrigated plots is 79 percent higher than that of non-irrigated plots. While it is difficult to precisely pinpoint the source of these changes, three factors account for the higher crop revenues of a plot when irrigation is introduced: higher yields (of same crop), increasing intensity (producing more than one crop per season), and shifts to higher-valued crops that are possible with irrigation.

The study results also provide evidence that, to the extent that new irrigation becomes available, it will raise incomes in poor areas. It is seen that by dividing villages by wealth level, farmers in rich and poor areas earn higher revenue from their irrigated crops. In rich areas, farmer revenue per hectare from irrigated plots is 89 percent higher than that from non-irrigated plots. In poor areas, revenue in poor areas rises even more in relative terms. Revenue from irrigated plots in poor areas exceeds those from non-irrigated ones by 93 percent.

While the data show that irrigation is effective in both rich and poor areas, differences in the nature of rich and poor economies suggest that irrigation may have the largest impact on rural welfare in poor areas. Cropping revenues in the poorest areas (93%) increase slightly more than those in richer areas (89%). Moreover, data show that cropping revenues make up the largest part of total income of those in poor areas but not those in rich areas. In rich areas only 10 percent of total income comes from cropping activities; in the poorest area, cropping activities contribute more than 40 percent. If we multiply the percentage increase of cropping revenue by proportion of cropping revenue in the total income, irrigation increases total income in rich areas only by 9 percent, while increasing it in poor areas by 38 percent. Since one characteristic of China's poverty is that the gap between the income of the poor and the poverty line is not overly wide (World Bank 2000), raising the income of the poor by more than one-third would almost certainly have the effect of pulling a vast majority of those in newly irrigated areas out of poverty. Most importantly, rigorous multivariate analyses support the hypothesis that irrigation raises yields for most crops and show that the descriptive results hold good up to multivariate analysis. For example, irrigation increases the yields of wheat by 17.7 percent, of maize by 29.4 percent, and of cotton by 28.4 percent.

Disaggregated analysis shows that in both rich and poor areas, irrigation has a significantly positive effect on cropping revenue, increasing by 132.8 percent in rich and 43.9 percent in poorer areas. While the higher marginal effects of irrigation on cropping revenue in the rich area may explain why more of the past investment in irrigation has gone into more favorable areas, it does not mean that the poor did not benefit. In fact, in terms of income effects, the poor may benefit more. The share of cropping revenue in total income is four times as high in poor areas (41%) as in rich areas (10%). Taking this into account, irrigation benefits farmers in the poorest area one-and-a-half times those in the rich area (18% in poor areas versus 13% in rich areas). The overall conclusion is that while the marginal impact of irrigation on revenue appears to be higher in richer areas, since the poor rely more on cropping revenues, the study suggests that farmers in poor areas increase their incomes relatively more than farmers in richer areas do.

***Poverty in Irrigation Districts***

Based on the national poverty line, the incidence of poverty in sample households is higher than that in the national average. About 7 percent of sample households earn per capita incomes fewer than 678 yuan annually. This level of poverty, while not too high relative to many countries, is about twice the national level (3.4% in 2000). However, these estimates are lower than the provincial averages of Henan and Ningxia provinces. According to CNSB (2001), poverty incidence in the rural areas of Ningxia and Henan is estimated to be around 10 percent in both provinces in 2001. This means that poverty inside irrigation districts is only a fraction of that in non-irrigated areas (since the average for non-irrigated areas is substantially higher than the provincial average). Applying the World Bank's poverty standard, the incidence of poverty rises to 14 percent. Interestingly, this estimate of the number of people who earn below one dollar per day is close to the 1997 poverty incidence reported by the World Bank (13.5%).

Although the IDs in the two sample provinces have similar rates of incidence of poverty when using the national poverty line, they differ substantially when using the World Bank poverty line. About 7 percent of households in Ningxia IDs and 8 percent of those in the Henan sample do not earn enough to be above the national poverty line. When moving to the World Bank poverty lines, however, the poverty incidences in Henan and Ningxia diverge. The proportion of households that fall below the one dollar per day line increases to 19 percent in Henan villages. Those in the Ningxia sample only rise marginally to 10 percent. Examining the average incomes in the sample counties in each province helps understand the result. Average incomes of the 6 selected counties in the 2 irrigation districts in Henan are lower than those in the other 5 counties in Ningxia. These differences between Ningxia and Henan Provinces are consistent with our expectation of the distribution of poverty along a river basin. Because of the superior access to water in the upstream localities, the incidence of poverty of the upstream areas is less than that in the downstream.

Poverty distribution along the IDs within provinces has not presented consistent patterns as that presented along the overall river basin. Applying the national poverty line reveals that poverty incidence of the upreach of ID (WID-N) in Ningxia Province is lower than that in the down reach of ID (QID-N); it is also supported by a larger poverty gap in the down reach ID; anyway, all these incidences seem to be consistent with the above analysis on the distribution of poverty along the overall river basin. However, examining the sample data in Henan Province generates the opposite result that there is more poverty in the upreach of ID than in the down reach and that poverty is deeper in the upper ID than in the lower ID.

When analyzing the poverty distribution along canals within IDs, evidence from sample data further indicates that farmers' poverty status is not strongly related to their location in the IDs. For example, poverty incidence in both IDs of Ningxia Province calculted by the national poverty line has almost no differences. Although there are obvious variations in poverty incidence between the upper and lower reachs of both IDs in Henan Province, the evidence from this Province does not provide a consistent story.

***Characteristics of the Poor***

While access to water and irrigated land accounts for some of the income differences of households a number of other factors appear to be correlated with income levels of sample households in the IDs. For example, *poorer household rely much more on agriculture than their better-off counterparts.* On average, the poor, who have an average income of only 373 yuan per year during the survey year, receive more than 80 percent of their income from the cropping sector and 7.3 percent of their income from raising livestock. In contrast, poor farm households receive only 12.4 percent of their income from the non-agriculture sector. For those in progressively higher income categories, however, the share of income generated from cropping declines. For the highest income group, households with average annual per capita income of 5877 yuan, more than half (53.8%) of their income comes from off-farm activities. Such findings are also consistent with various studies that show the importance of off-farm employment in farmer income growth and the poverty alleviation (Fan et al. 2001; World Bank 2001).

When examining the structure of incomes, it is worth noting that although the absolute income from agriculture for the non-poor is generally higher than that of the poor, the data clearly show that the poor generate a higher share of their income from agriculture. *In an economy in which the poor rely relatively more on agricultural earnings, if any action of the government (or whatever other entity) increases agricultural income, it means that it is more likely that there may be a higher proportional increase in the total income of the poor than that of the rich farmers.* Hence, if the government can implement policies that increase income in agriculture, including measures that increase agricultural incomes by increasing the amount of newly irrigated area and by raising the efficiency of the existing irrigated areas, the poor will benefit.

In addition to irrigation and the structure of rural incomes, some factors vary with income and appear to have a simultaneous effect on rural incomes, while others do not. *The size of farms in terms of cultivated land is very similar among the income groups and between the poor and the non-poor.* Likewise, there is little noticeable variation among income categories in cultivated land per capita. *Such an equitable distribution of land, which is perhaps the most important characteristic of China, even 20 years after its economic reforms, has been shown to play an equity increasing role in China's rural economy (Brandt et al. 2002)*. In contrast, family size falls and the number of laborers in a household rises (meaning the number of dependents in the household falls) as households move up the income ladder. Likewise, the average education of families rises with rising income.

***Benefits of Irrigation to the Poor***

In order to test the hypothesis of whether small and poor farmers receive fewer benefits from irrigation than large and non-poor farmers, sample households were classified into three farm-size categories. Each group contains an equal number of observations (or contains one-third of the sample households). In the two Ningxia IDs, WID-N and QID-N, the average per capita land sizes for small, moderate and large farms are 0.35, 0.67 and 1.22 ha. The farm sizes in Henan, both PID-H and LID-H, are even smaller. For example, the average size of a "large" farm is only 0.72 hectare, which, according to international standards would be considered as a small farm.

Data show that small and large farmers have relatively equal access to water, and there is not much difference in access to water for both Ningxia and Henan Provinces. In fact, in some cases, small farmers have higher per hectare water use than the large farmers. This result, while perhaps somewhat surprising is not consistent with findings elsewhere, such as in the South Asian countries. Further data show that small farmers have the highest income. In both IDs of Ningxia, for example, the average per capita annual income of households on small farms (2,978 yuan) is 11 percent higher than the average income of those on large farms (2,682 yuan). In the Henan IDs, the income gap between small and large farms is even larger (28%).

While this might be surprising to those unfamiliar with China, the positive relationship between farm size and poverty is common in China's rural economy. Every household in China has its own land contracted from their villages. The households with more constraints in land resources have induced farmers to explore alternative uses of their other family resources, such as labor in non-farming activities. Small farmers generally allocate a large portion of their family labor in off-farming activities and earn more than half of their income from non-agriculture sectors (53%), while large farms receive only 16 percent of their income from non-agriculture sectors, as these large farms allocate more of their family labor to agriculture. This is not to say that a small farm has a large income or lower incidence of poverty. The point here is that it is dangerous to use farm size as an indicator for poverty in China. This typical nature of farm size and poverty in irrigated areas in China implies that testing the benefit of irrigation to the poor and non-poor and to different size of farms should be separated, and estimating poverty based on farm size is irrelevant and could result in misleading conclusions. Indeed, as discussed earlier, one of the major principles in allocating water to agriculture is based on land. The average size of large farm is about 3 times the small farms; further, the average water use in large farms is also about 3 times that in small farms for the whole sample. However, a significant relationship between farm size and poverty has not been demonstrated from our multivariate analysis.

The study finds that the poorest farmers in both provinces have the greatest access to water when measured in terms of either per capita or per household use. This finding also holds good for all four irrigation districts. Although the differences among income groups using the per capita water use measures in Ningxia are less sharp, in Henan Province, the poorest farmers receive 1,348 $m^3$ water per person for use in their crop production. In contrast, the better-off farmers in Henan receive only 1,159 $m^3$ water per person. It could be that better-off households have less time or interest in spending their time lobbying ID officials and local-water managers to increase the flow of water to their villages. In contrast, members of the poorer households (who also have more land and rely more on farming), may find it worth their while to spend the energy in working with local water managers to find ways to provide them with more access. Alternatively, it could also be that leaders who are concerned about the welfare of the poor in their duties as water managers (in Henan) or contractees (in Ningxia) encourage the allocation of water to be directed towards the larger, poorer farmers.

It is interesting to find that if farmers do not have access to good irrigation, they tend to explore opportunities in marketing crop and working in the nonagricultural industry. Further analysis of data shows that, in most cases, farmers with poor access to water will allocate more labor in the nonagricultural work. Further, upper IDs deliver more water than lower IDs, implying that farmers in the upper IDs have better access to water than those in the lower IDs. In terms of reliability, the study finds that except for one quarter of farmers, all other farmers always have a reliable water supply in the sample areas. An examination of sample data demonstrates that water reliability has a positive relationship between crop yield and farmers' income. Most cases reveal that when farmers have no problem in accessing water in time, i.e., water reliability is near 100 percent, farmers' crops will generate higher yields.

In order to understand the contribution of irrigation investment to increasing farmers' income and pulling farmers out of poverty status, irrigation investment also has been classified into three groups by the number of samples to do analysis. Grouping irrigation investment presents large variations across the samples. Villages in the lowest group invest less irrigation per hectare estimated at 384 yuan, while in the highest group, irrigation investment per hectare is as high as 8,074 yuan, more than 21 times that in the first group. The importance of irrigation on farmers' income, supported by our analysis in six provinces. has also been confirmed by samples in four IDs of Ningxia and Henan Provinces when the relationship between irrigation investment and farmers' income is examined. Sample data show that when irrigation investment per hectare increased from near 400 yuan to more than 8,000 yuan, farmers' total income will increase nearly 50 percent and also increase agricultrual income and cropping income by 12 percent and 9 percent, respectively.

Increasing irrigation investment seems to play roles in pulling more farmers out of poverty. Analysis of all sample data demonstrates that poverty occurs in villages having relatively low irrigation investment; in these villages, it is also harder to improve farmers' poverty condition. For example, in one ID in Henan Province, *when irrigation investment is as high as, or more than, 8,000 yuan per hectare, our field survey has not identified any poverty in these villages; however, when irrigation investment is less than 400 yuan per hectare, poverty incidence is as high as 19 percent and the poverty gap is also very high, nearly more than 100 percent.* Econometric results also show the significance of the irrigation investments for increasing farmers' income, where irrigation investment is positive and a statistically significant determinant of farm incomes. It implies that increasing irrigation investment in the IDs still has potential to increase farmer income.

IDs in the upstream of the river basin have been allocated more water than those in the downstream, and water use differences between IDs within a province are smaller than between provinces. For example, in one ID of Ningxia Province, WID-N, water use per capita is nearly four times that in one ID of Henan Province, LID-H, water use per hectare is more than 3 times. However, within Ningxia Province, water use per capita in WID-N is only higher by about 30 percent of that in QID-N, and water use per hectare is higher by nearly 80 percent. Evidence of water allocation along canals in the ID implies that it is easy to control water allocation within ID than that between IDs, especially IDs between provinces.

In order to improve water supply reliability, *more irrigation investment has generally been put in the lower than in the upper reaches.* For example, irrigation investment per hectare in WID-N is higher by 5 percent than that in QID-N. For example, irrigation investment in the lower reach of QID-N is higher by about 30 percent than that in the lower reach; regions in the lower reach of PID-H can get 70 percent of irrigation investment per hectare more than that in the upper reach.

Data analysis shows that differences in cropping intensity between provinces are higher than those within provinces or within IDs. For example, cropping intensity in the IDs of Ningxia Province are about 1.6, while in Henan Province, this number is more than 1.9, even near 2.0.

Farmers in the upper provinces generate a lower production value than those in the lower provinces, while it is not true within provinces or within IDs. Both gross and net production value in Ningxia Province are lower than those in Henan Province. For example, gross and net production values per hectare in WID-N are 10,937 yuan and 5,767 yuan, respectively, which are lower than those in PID-H: 11,969 yuan and 6,360 yuan, respectively. Therefore, farmers in Ningxia Province get less income from agricultural production than those in Henan Province.

Although the above analyses on agricultural production show some differences between head and tail regions, compared with other countries, especially South Asian countires, distribution of output exihibits relatively equal characteristics. Relatively equal output distribution is mainly due to equal land allocation.

Water is more productive in the down reaches of the river than in the upper reaches. We know that generally farmers in the upper reaches will be allocated more water than those in the lower reaches; however, differences of agricultural production between upstream and downstream are not much large; it is not hard to understand that water productivity in the downstream is higher than that in the upstream. For example, in the LID-H of Henan Province, every cubic meter of water can produce 2.1 kg of wheat, i.e., \$0.25; while in the WID-N of Ningxia Province, only 0.8 kg or \$0.09 can be produced by one cubic meter of water, less than 30 percent of that in PID-H. *Differences of water productivity along the river reach imply the possibility to reallocate water among regions to optimize water utilization.*

Water productivity also differs by crops, which implies the necessity to optimize the cropping structure. Most cases indicate that among the three major grain crops, rice water productivity is the lowest and the differences between wheat and maize seem not large, especially when comparing their water productivity by value. For example, in the IDs of Ningxia Province, per cubic meter of water can produce only 0.3 kg of rice, while water productivity for maize can be as high as 1.5 kg and wheat can reach 1 kg.

Econometric results show that water use in the upper IDs both within and across provinces along the YRB is higher than that in the lower, which are consistent with statistical description. Compared with the base ID (WID-N) in upper part of Ningxia Province, coefficients of all other IDs are negative and statistically significant at 1 percent. The water use differences between IDs across provinces are larger than those within provinces. For example, WID-N delivers more water: 8,500 cubic meters per hectare more than QID-N; however, the water use difference between WID-N and IDs in Henan Province is as high as 10,000 to 15,000 cubic meters per hectare. IDs in the upper reaches have been allocated more water than those in the lower reaches; the difference is more obvious across provinces. However, distribution of output exhibits relatively equal characteristics. As a result, water productivity in the lower IDs is obviously higher than that in the upper IDs.

***Water Allocation and Charging***

In China, ownership of water resources is with the state, and water rights are not coupled with land rights. In response to increasing water use conflicts among upstream and downstream IDs and other users, China has been trying various means to deal with the problems that have been created by its open-access water resources in the YRB. With increasing water shortages in the downstream regions of the YRB, in 1999, China initiated a new program called the Annual Allocation and Main River Water Quantity Control Program. With the experience and lessons learned in the past, the new program emphasizes the importance of enforcement and incentive policies to induce water authorities in the upstream regions to participate in the program and adhere to the national government's directives and their own agreements. Under the new program, water allocated to each province in the upstream regions will be reduced gradually. The allocation process uses both direct administrative intervention (cuts in water in the upstream regions) and market measures (by increasing water prices in upstream areas) which have been successful. For example, the Ningxia government doubled the price of water in agriculture from 0.006 yuan/$m^3$ to 0.012 yuan/$m^3$ in 2000. With the rise of price, the water authorities have regained some of their lost revenues.

In terms of the effect on the poor, the formulation of such agreements between upstream and downstream provinces may have important policy implications. In general, the reallocations that are occurring are from poorer ones (such as Ningxia and Gansu) to richer ones (such as Shandong). Most likely, the shift of water access away from the upstream provinces will have a negative effect on some producers in the ID and (as discussed above) could adversely affect the operation of the ID itself and have an effect on the future effectiveness of the ID. As such, to mitigate these negative effects, central government leaders who are concerned about the equity and poverty impacts of such policies can devise compensation methods.

Water allocation at the main or first-level canals and the second-level canals within a province's ID are controlled by one of the following government agencies—the provincial, prefectural or county's Water Management Bureau—depending on the size and reach of the ID. By regulation, the general principle for water allocation is to give first priority to that downstream, lift irrigation (vs. gravity irrigation), the canal's high offlets (versus the lower offlets), agriculture (versus forestry), more vulnerable groups, and large consolidated tracts of land (versus fragmented land).

The basic water allocation rule is to allocate water by comprehensively considering water volume, canal capacity, water quota and water delivery efficiency while abiding by the allocation principles. Among all these issues, the water quota is one of the important indices to guide the water allocation practices. The purpose of the water quota is to provide IDs with a way to allocate water and limit the overuse of an area's water resources.

Unlike the differences that occur in the execution of water allocation regulations among IDs, in some cases, water managers allocate water more evenly among upstream and downstream areas within IDs. At the tertiary canal level, local water managers are responsible for water allocation. *The study identified four kinds of water allocation approaches: equity, efficiency, payment capacity, and no rule allocations: a) equity allocation means that water resources are equally allocated to all water users along the canal. The implication of such a rule is that it allows the poor and other vulnerable groups to get access to water*. In practice, rules are often promulgated to provide water to those farmers at the end of the canals first, and those nearest last. *In our sample, we find that 13 percent of villages use this method of water allocation. b) In contrast, the efficiency criterion is adopted in other villages. According to this criterion, village water managers irrigate as the water flows into the canal. When the nearest fields are irrigated first, it is the physically most efficient way to allocate water. Interestingly, despite the emphasis of IDs on equity, a much greater number of villages (70%) claim they use the efficiency method of water allocation; and c) finally, some villages use other methods. According to the first come, first serve method, villages are supposed to provide water to those that ask for it first. We find no villages operating this way. However, there are a small number of villages that provide water on a first pay, first serve basis. This* *happens, according to our survey, in only 2 percent of the villages. In the rest of the villages, there are no established rules.*

***Irrigation Charging/Pricing***

Despite continuous increase in water prices over the past several decades, China's agricultural water is believed to be much under-priced. The level and structure of irrigation charges are determined by local water resources bureaus (county/township) under the guidelines provided by the provincial and central governments. Consequently, there is significant spatial variation in the level and structure of irrigation charges. In some systems, volumetric-based water charges are implemented at the main canal level (where water can be measured). At the farm level, irrigation charges are mostly based on area irrigated or, in some cases, based on time period to irrigate a field or, in a few cases, based on the number of members in a household.

In Ningxia Province, a three-part irrigation charging system is in practice: a) the first part is volumetric water price measured at outlets of the main or branch canals and is set at a level that is supposed to cover the variable costs associated with the supply of water (including staff salaries and O&M of main and branch canals)—and since 2000, this is set equal to 0.012 yuan/$m^3$; b) the second part consists of local water maintenance and management fee set at 6 yuan/mu (which cannot exceed 90 yuan/ha); and c) the third part is labor-discounted fee (used for irrigation districts maintenance work) set at 4 yuan. The amount collected on volumetric basis (first part) is deposited to the irrigation district’s government and is used for O&M of main canals and staff salaries. Of the amount collected through local maintenance and management fee (second part), 40 percent goes to the County Water Resources Bureau, and 60 percent to the Township Water Resources Bureau, and is used for facility maintenance and staff salaries at these levels. In Ningxia, fee collection procedures vary across villages: farmers to village collectives (or WUAs where they exist or contractors) to township governments and then to the irrigation district government. In some cases, WUAs and contractors collect fees from farmers and directly deposit them to irrigation districts.

On the other hand, irrigation charges in Henan Province are based on cropped area: paddy areas, 22 yuan/mu; dry and gravity irrigation areas, 2 yuan/mu; and lift irrigation areas, 7 yuan/mu. Irrigation charges are differentiated by location. Irrigation charges are generally higher in upper reaches of the systems (where share of rice area is higher) than in the lower reaches. Since the irrigation charge for rice is higher than that for dry crops, overall irrigation charges are higher in the upstream areas. In the studied systems in Ningxia and Henan, water charge collection rate is over 80 percent. *Collection rate is higher where private contractors and WUAs are operating at the local level, as they tend to cut deliveries in case of nonpayment of charges.* Irrigation charges appear to be related to cost of O&M, the overall cost of supplying water and relative water scarcity. Irrigation charges in Ningxia (located upstream of YRB, with more water supplies, and relatively less cost of supplying water) are lower than in Henan Province. Where water management reforms are being implemented through the formation of WUAs or by bringing private contractors/managers, the performance of systems is generally better. The overall irrigation charge system is fairly decentralized in the studied systems.

One of the major problems facing water management in Chinese villages is the difficulty of collecting water fees. Based on the field surveys, for most collectives, nearly 20 percent of water fees cannot be collected. The evidence shows that the private managers tend to adopt some strict measures to constrain farmers' water fee behaviors.

***Income and Poverty Implications of Irrigation Sector Reforms***

As mentioned earlier, irrigation management transfer and farmer participation in irrigation system management, or participatory irrigation management, constituted one of ten key components of the reform initiatives in China. There are varying degrees of success in implementation of reforms and their effectiveness. In the study area, three patterns of surface water management are identified: a) *Collective Management* – if the village leadership through the village committee directly takes responsibility for water allocation, canal O&M and fee collection, the village's irrigation system is said to be run by *collective management*, the system that essentially has allocated water in most of China's villages during the People's Republic period, b) *WUA Management* – a *WUA* is a farmer-based, participatory organization that is set up to manage the village's irrigation water. In WUAs, a member-elected board is supposed to be assigned the controlling rights over the village's water, and c) Contract-based management – c*ontracting* is a system in which the village leadership establishes a contract with an individual to manage the village's water.

Field data show that since the early 1990s and especially after 1995, reform has successively established WUAs and contracting in the place of collective management. The share of collective management declined from 91 percent in 1990 to 64 percent in 2001. Contracting has developed faster than WUAs. By 2001, 22 percent of villages managed their water under contracting and 14 percent through WUAs. Assuming the results from the sample reflect the more general trends across north China, the somewhat more rapid emergence of contracting may be due to the ease of setting the system up and the similarities of the reforms to the other reforms that have unfolded in rural China (Nyberg and Rozelle 1999).[17] *While there has been a shift from collective management to WUAs and contracting during the past 5 years, water management reform still varies across the four sample IDs.* WUAs and contracting have developed faster in Ningxia than in Henan. For example, in 1995, the collective ran 100 percent of the water management institutions in one of the Ningxia IDs. By 2001, however, the collectives managed water in only 27 percent of the sample villages. WUAs managed water in about 23 percent of the villages and contracting managed water in approximately 50 percent. In Ningxia's other sample ID, the share of villages under WUAs and contracting approached 49 percent, almost the same as those under collective management. In contrast, significantly less reform occurred in Henan. Only eight percent of the villages in one of the sample IDs and none in the other have moved to either contracting or WUAs. Based on our field survey, although some of the differences in water management among the IDs may be due to the characteristics of local villages and local water-management initiatives, the dramatic differences between Ningxia and Henan Provinces suggest that upper-level government policy may be playing an important role. In 2000, in order to promote water-management reform, Ningxia provincial water officials issued several documents

[17] During China's economic reforms, many government services have been contracted out to private individuals, including grain procurement, extension and health services.

that encouraged localities to proceed with water-management reforms. Regional water officials exerted considerable effort to promote water-management reform in a number of experimental areas. The sharp shift away from collective management is consistent with an interpretation that these measures were effective in pushing (or at least relaxing constraints to) reform.

The differences among the villages in Ningxia and variations in the way that different regions implemented the reforms (i.e., some moved to contracting while others shifted to WUAs) show that the reforms are far from universal. In fact, this is what would be expected in China, a nation that often allows local governments considerable room in making their own decisions on the exact form and timing of institutional changes. In contrast, neither the Henan provincial government nor any of the prefectural governments have issued directives mandating reforms.

While the shift in China's water management institutions demonstrate that the nation's communities are following policy directives that are being developed and issued from upper-level governments, when local leaders set up their organizational frameworks in their villages, practice often varies from theory. For example, in practice, at least in the early stages of the development of WUAs (the only stage of the organizations that we are observing since this type of management is so new), the organization of most WUAs varies sharply from theory. In most cases (70% of the WUAs), the governing board of the WUA was the village leadership itself. In a minority share of the cases (30% of the WUAs), village leaders appointed a chair or manager to carry out the day-to-day duties of the WUAs. In many of these WUAs that had village-appointed leaders, however, the manager actually had close ties with the village leadership, more than half being a leader in an earlier time period. In other words, in terms of the composition of the management team, most WUAs differ little from collective management.

An examination of the way the managers are compensated perhaps shows the greatest difference between theory and practice. To show this, one needs to understand the way farmers pay fees, managers are compensated for and how IDs are paid. In fact, water management reform has created a complicated system of fees, payments and charges that embody the primary incentives for the managers to save water. Water fees collected from farmers include two parts: *basic water fees associated with the fixed quantity of land in the village and volumetric water fees associated with the volume of water use.* Set by water bureau officials, the farmer is required to pay the basic water fee (which is based on his landholdings) and part of the basic water fee belongs to the water manager after it is collected. This part of the manager's compensation is paid to him as a *fixed payment* and provides little or no direct incentives to save water.[18]

Higher-level officials, however, can use the other part of the water fee to provide managers with more direct incentives. Prior to the farming year, ID officials determine (on the basis of historic use patterns and other criteria) a targeted amount of water that a village should use (called the *target quantity*). Based on a per cubic meter charge, the total value of the expected water use for the village is then divided by the village's total quantity of land and this volumetric water fee is added to the basic water fee to create the farmer's total water fee. Therefore, this form of

[18] Once the Manager collects the total fee from the farmer, he turns part of the basic fee to the village accountant who, in turn, sends it to the township, which is supposed to use the funds to maintain its canal infrastructure.

volumetric water fee provides the farmer with no incentives to save water since he pays a fixed fee for each hectare of land. The water manager in some communities, in contrast, does have an incentive. In implementing water management reform, ID officials agree that the water manager has only to pay the per cubic meter charge for the water that is actually used (*actual quantity*). If the actual quantity of water delivered to the village (at the request of the water manager) is less than the targeted quantity, the difference between the volumetric fee that is collected from the farmers and that which he pays for the water is his *excess profit*. The excess profit is an amount that is earned by the manager beyond the fixed payment.

Data show that there are sharp differences in the way that villages have implemented the incentives part of the reform packages, regardless of whether they are WUAs or contracting. For example, in 2001, on average, leaders in only 41 percent of villages offered WUA and contracting (or *non-collective*) managers with incentives that could be expected to induce managers to exert effort to save water in order to earn an excess profit. In the rest of the villages, although there was a nominal shift in the institution type (i.e., leaders claimed that they were implementing WUAs or contracting), in fact, from an incentives point of view, the WUA and contracting managers faced no incentives. In these villages, water managers are like village leaders in a collectively managed system in that they do not have a financial incentive to save water. The incentives offered to the managers also differ across IDs. Hence, to the extent that the incentives are the most important part of the reform, the differences across time and space mean that it would not be surprising if in some villages WUAs and contracting were more effective at saving water than in other villages.

The major difference between a non-collective and a collective is the incentives faced by managers. The critics of water management reforms often point out that one possible adverse consequence of using incentives to induce water reform is that managers may cut back on water deliveries to marginal users, who may also be those on the poorest land. The study analyzed the implications of three management patterns for the poor. *The study results show that if managers are provided with positive incentives to earn money by saving water, they will try to improve water management, and water delivered to farmers will be significantly reduced.* However, while water management with incentives will reduce water use, it will not have any negative impacts on farmers' output, farm income and poverty. Overall, the study proposes that the government should continue to support the water-management reforms based on incentives. However, different from the beginning stage, more emphasis should be put on the effective implementation of the reforms.

**Conclusions and Recommendations**

Key conclusions and recommendations of the study are summarized below:

a) Irrigation has a strong positive impact on crop yields and cropping revenues and farm incomes. While the marginal impact of irrigation on crop revenue is higher in richer areas, since the poor rely more on cropping revenue, the study findings suggest that farmers in poor areas increase their incomes relatively more than the farmers in richer areas.

b) Small and large farmers have relatively equal access to water. Equal water accessibility among farmers (or even in favor of the poor) is achieved not only through water-related institutions and water policies, but there are several policies that are working together to achieve this result (a finding that could have lessons for other developing countries). These policies include equal distribution of land, rapid expansion of off-farm employment, and the allocation and distribution of irrigation water based on the size of a farm's cultivated land.

c) About 7 percent of sample households in the selected IDs in Ningxia and Henan Provinces earn per capita incomes under 678 yuan annually and are classified as poor. This level of poverty, while not too high relative to many countries, is about twice the national level (3.4% in 2000). However, poverty in two IDs is lower than the averages of Henan and Ningxia provinces.

d) Command areas of specific canal reaches receiving less irrigation water per hectare do not necessarily have lower productivity and a higher incidence of poverty. IDs in the upper reaches are allocated more water than those in the lower reaches; however, the difference is more obvious across provinces than within provinces. However, output exhibits characteristics of relatively equal distribution.

e) Water productivity in the lower IDs is higher than that in the upper IDs. There are no spatial patterns in distribution of the poor in IDs.

f) In order to improve water-supply reliability, more irrigation investment has been generally put in the lower than in the upper reaches, resulting in improved productivity and returns to farming. Investments in irrigation play an important role in increasing farm incomes and reducing poverty. When irrigation investmenmt increased from nearly 400 yuan to more than 8,000 yuan, farmers' total income increased by about 50 percent, with significant impacts on poverty. The study suggests that periodic investments by the government in rehabilitation of infrastructure should be continued to stimulate and encourage investments in maintenance by water users.

g) Despite continuous increase in water prices over the past several decades, China's agricultural water is believed to be much under-priced. While the charge collection rate is fairly high, for most collectives, nearly 20 percent of water fees could not be collected. The evidence shows that private managers tend to adopt some strict measures in relation to water fee collection. Water charges need to be further increased to cover full O&M cost.

h) In the systems, where water management reforms are being implemented through the formation of WUAs or by bringing private contractors/managers, performance of systems is generally better.

i) Water-management reforms with strong incentives increase water use efficiency, reduces overall water use without any adverse impacts on farm incomes and poverty. The study indicates that there is significant scope for improving performance of irrigation systems under existing conditions with incentive-based effective and improved institutional arrangements. The study suggests that the government should continue to support the institutional reforms in irrigation management with greater emphasis on effective implementation of reforms.

j) Finally, the study suggests that the capacity of water managers should be developed through training programs for effective implementation of water-sector reforms.

# Literature Cited


Brandt, Loren; Huang, Jikun; Li, Guo; Rozelle, Scott. 2002. Land rights in China: Facts, fictions, and issues. *The China Journal* (2002)

Chen, L. 2002. Revolutionary measures: Water saving irrigation. Speech at the National Water Saving Workshop, April 16.

Fu, Chen; Davis, John.1998. Land reform in rural China since the mid-1980s. *Land Reform/ Reforma Agraria 1998/2.*

China Irrigation District Association. 2002. Participatory irrigation management: Management pattern reform of state-owned irrigation district. Paper presented at the Sixth International Forum of Participatory Irrigation Management, Held by the Ministry of Water Resources and the World Bank, Beijing, April 21-26, 2002.

Development, 22: 1325- Ma, ZR. 2001. *Deepening reform of farmer managed irrigation system, promoting sustainable development of irrigation district, participatory irrigation management: Innovation and development of irrigation system.* ed Lixin Nian, China Water Resources and Hydropower Publishing House. Beijing, China.

Easter, K.W.; Hearner, R.R. 1993. *Decentralizing water resource management: Economic incentives, accountability and assurance.* Policy Research Working Paper, 1219. World Bank.

Fan, Shenggen; Zhang, Linxiu; Zhang, Xiaobo. 2001. *Growth, inequality, and poverty in rural china: The role of public investments.* IFPRI Research Report, Final Draft. Conference Report #1.

Fang, Sh., 2000. Combined with allocating and controlling local water resources to save water. *Journal of Water Resources* 2000 (1).

Groenfeldt, David; Svendsen, M. 2000. *Case studies in participatory irrigation management.* World Institute.

Hebei Hydrological Bureau and Water Environmental Monitor Center. 1999. Heibei Water Resources Assessment.

Huang, W.B. 2001. *Reform irrigation management system, realizing economic independency of irrigation district, participatory irrigation management: innovation and development of irrigation system,* ed. Lixin Nian. Beijing, China: China Water Resources and Hydropower Publishing House.

IIMI (International Irrigation Management Institute); FAO (Food and Agriculture Organization of the United Nations). 1995. *Irrigation management transfer*. Rome: FAO, United Nations, Rome.

LGPR (Leading Group for Poverty Reduction); World Bank; United Nation of Development Program. 2000. *China: Overcoming rural poverty. International Conference on China's Poverty Reduction Strategy in Early 21st Century*. Beijing, May 2000.

Lohmar, Bryan; Wang, Jinxia; Rozelle, Scott; Dawe, David; Huang, Jikun. 2002. *Managing water for the poor, Proceeding of the Regional Workshop on Pro-poor Intervention Strategies in Irrigated Agricultural in Asia, Colombo, 9-10 August 2001. Bangladesh, China, India, Indonesia, Pakistan and Vietnam*, ed. Intizar Hussain and Eric Biltonen. Colombo, Sri Lanka: International Water Management Institute.

Management Authority of Shaoshan Irrigation District. 2002. Positively promoting reform based on practices of irrigation district, obtaining achievement of both management and efficiency. Paper presented at the Sixth International Forum of Participatory Irrigation Management, Held by the Ministry of Water Resources and World Bank, Beijing, April 21-26, 2002.

Ministry of Water Resources. 2002. Report on the water pricing research. Ministry of Water Resources. Duplicated.

National Agricultural Census Office. 1998. Cong Nongye Pucha Kan: Woguo Nongye He Nongcun Jingji. Zhongguo Tongli 2: 10-12, 16, reprinted in Renmin Daxue Fuyin Ziliao (F2): Nongye Jingli 4:27-30.

National Statistical Bureau of China. 2001, China Rural Poverty Monitoring Report 2001, Beijing, China

Nian, LX. 2001. *Participatory irrigation management: Innovation and development of irrigation system*. Beijing, China: China Water Resources and Hydropower Publishing House.

Nyberg, A.J.; Rozelle, S. 1999. *Accelerating China's rural transformation*. World Bank.

Piazza, Alan; Liang, Echo H. 1997. The state of poverty in China: Its causes and remedies. Paper presented at a conference on "*Unintended Social Consequences of Economic Reform in China,*" Fairbanks Center, Harvard University, May.

Reidinger, R. 2002. Participatory irrigation management: Self-financing independent irrigation and drainage district in China. Paper presented at the Sixth International Forum of Participatory Irrigation Management, Held by the Ministry of Water Resources and the World Bank, Beijing, April 21-26, 2002.

Rosegrant, M.; Cai, X. 2000. Rice and water: An examination from China to the world. Paper Presented in the First International Rice Congress, Held by International Rice Research Institute, Beijing, Sep. 16 to 20, 2002.

Zhong, Tong; Rozelle, Scott; Stone, Bruce; Dehua, Jiang; Jiyuan, Chen; Zhikang, Xu. 1994. China's experience with market reform for commercialization of agriculture in poor areas. In

*Agricultural commercialization, economic development, and nutrition,* ed. Joaquim von Braun and Eileen Kennedy, pp. 119-140. Baltimore, MD: John Hopkins Press.

Vermillion, D. L. 1997. *Impacts of irrigation management transfer: A review of the evidence.* Research Report Series, No. 11. Colombo, Sri Lanka: International Water Management Institute.

Wang, Jinxia. 2000. Innovation of property right, technical efficiency and groundwater irrigation management. Ph.D. diss. Chinese Academy of Agricultural Sciences.

Wang, Jinxia; Huang, Jikun; Xu, Zhigang; Rozell, Scott; Hussain, Intizar; Biltonen, Eric. 2004. *Country Final Report – China: Pro-poor Intervention Strategies in Irrigated Agriculture in Asia - Poverty in irrigated Agriculture in China – Issues and Options.* Colombo, Sri Lanka: International Water Management Institute.

Weersink, Alfons; Rozelle, Scott. 1997. Market reforms, market development, and agricultural production in China." *Agricultural Economics* 17 (2-3): 95-114.

World Bank. 1993. *Water resources management.* A World Bank Policy Paper, Washington D.C.

World Bank. 1998. *Rural China: Transition and development*. East Asia and Pacific Region, Washington D.C.: World Bank.

World Bank. 2001. *China: Overcoming rural poverty.* A World Bank Country Study, 22137, March 2001.

Xu, Z. F. 2001. Studying on increasing water use efficiency. *Journal of Water Resources* 2001 (8)

Zai, H. H. 2002. Speaking on the National Workshop of Water Saving Irrigation, Held by the Ministry of Water Resources, Beijing, Oct. 16-19, 2002.

Zhang, Y. 2000. Ten challenges faced with China water resources in the 21st century. *Journal of Water Resources* 2000 (1).

Zhang, Y. 2001. Carefully implement the fifth national conference, promoting the development of water resources into a new stage. *Journal of Water Resources* 2001 (1).

# Poverty in Irrigated Agriculture in Indonesia: Issues, Options and Pro-poor Intervention Strategies

## Historical and Contextual Frame

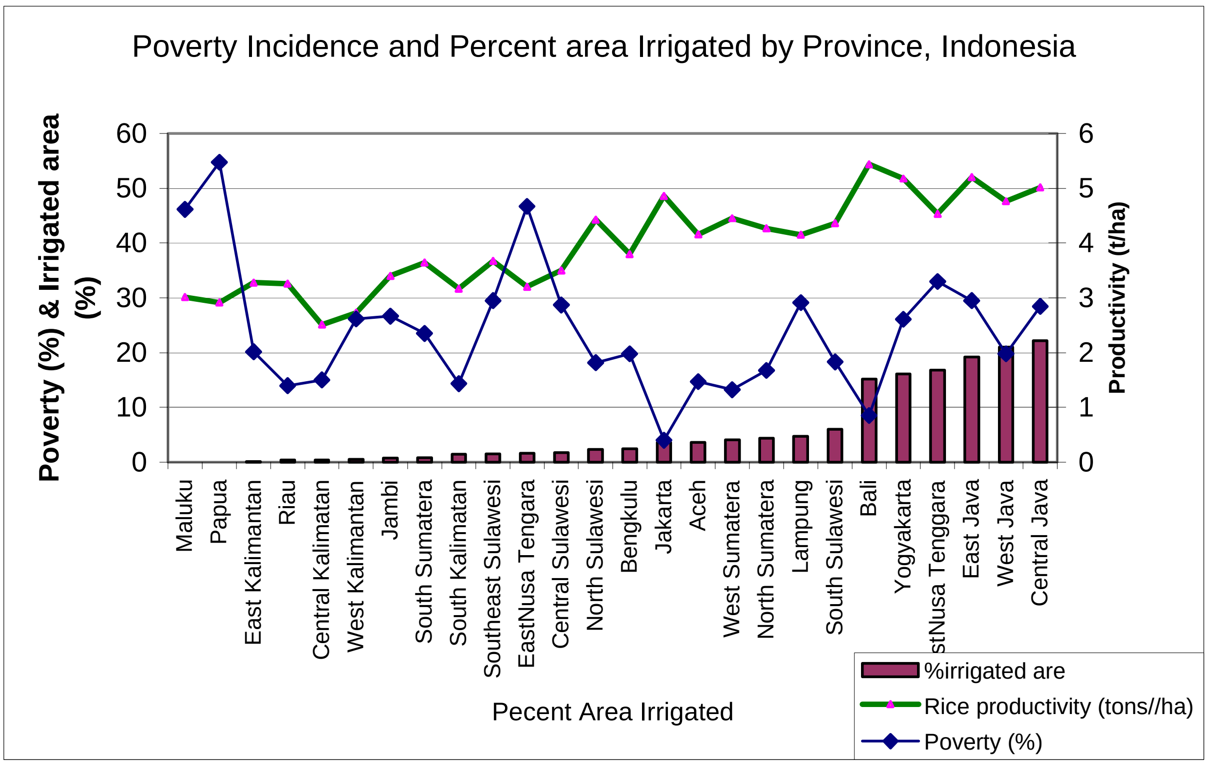
Indonesia made an impressive economic progress until 1996, when the financial crisis hit the South Asian region. From 1987 to 1996, Indonesian economy grew, on average, by over 6 percent per annum, and income per capita reached US$1,200. This, coupled with impressive reduction in population growth rate from 2.10 percent during 1960-70 to 1.35 percent in 1999-00, helped improve living conditions of the people in the country. The most powerful indicator of development success in the country was the degree of absolute and relative poverty reduction. During 1976-96, poverty reduced drastically from 40.8 percent (or 54.2 million poor) in 1976 to 11.4 percent (or 22.5 million poor) in 1996 (Maksum and Arif 2002). While poverty increased to around 24 percent during the post-crisis period, recent estimates by the Central Bureau of Statistics indicate that incidence of poverty decreased to 17 percent in 2002.

Indonesia's economic development has depended, in large part, on changes in the agricultural sector, particularly in the irrigated agriculture. The Government of Indonesia has developed around 4.5 million ha of technical irrigation in the country from the early 1970s to the 1990s. Water resources development and management have played an important role in agricultural and overall economic development, in terms of both production and public expenditures. By 1980, investment in irrigation accounted for more than half of the public expenditures, with publicly funded irrigation accounting for 85 percent of the irrigated area and 75 percent of the country's rice production (Pasandaran and Zuliasri 2001).

Land and water resources in Indonesia are unevenly distributed throughout the country due to population density and resource endowment differences across islands. Of little over 200 million people in the country, 60 percent live in Java although it is a relatively small island with only about one-sixth of the total land area of two million square kilometers. About 60 percent of the total irrigated area is located in Java, with the island contributing around 60 percent to national rice production. In 1999, the highest area irrigated was in East Java (922,000 ha) followed by West Java (906, 700 ha) and Central Java (722, 200 ha). Productivity of paddy was highest in Bali (5.44 tons/ha), followed by East Java (5.19 tons/ha), Yogyakarta (5.18 tons/ha), Central Java (5.01 tons/ha), Jakarta (4.86 tons/ha) and West Java (4.86 tons/ha). Poverty was the highest in Papua (54.74% of the province's population), followed by East Nusa Tenggara (46.73%) and Maluku (46.14%). Analysis of provincial-level data suggests that, in general, provinces with higher proportion of area irrigated have much higher productivity and lower incidence of poverty (figure IS-1).

In Indonesia, irrigation was basically developed for increasing paddy production through expansion in irrigated areas, which constituted 69 percent of the total area cultivated in 1985. Between 1989 and 1993, average paddy area harvested is estimated at 12.27 million ha. Over 28 percent of the paddy area comes under technical irrigation systems, followed by around 22 percent under simple irrigation. Over one-fifth of the total paddy area is classified as rain-fed area. Technical irrigation grew rapidly during earlier decades. Semi-technical irrigation decreased during the 1970s, and remained more or less stable afterwards. Productivity levels vary across rain-fed areas and across different types of irrigation systems. Paddy yields, for example, are 2 tons higher in irrigated areas in Java than in rain-fed areas. Productivity differences are not only caused by per hectare yield differences but also due to differences in cropping intensity. Generally, cropping intensity of paddy in irrigated area is more than 150 percent, with the highest intensity in technical irrigation systems (of 181%). The average cropping intensity in other areas was 100 percent, with the highest intensity in rain-fed area of 111 percent per year. Cropping intensity has, thus, a strong relationship with the availability of water and its improved control and management. Overall, irrigation has made significant contribution to the total paddy production in the country, with incremental contribution of irrigation to productivity estimated at 16 percent, while that of HYVs and chemical fertilizer are estimated at 5 percent and 4 percent, respectively.

Figure IS-1. Poverty incidence (%) and area irrigated (%) in Indonesia.




Past agricultural and irrigation development efforts in the country have primarily focused on increasing rice production. Poverty alleviation, agricultural commercialization, crop diversification and farmer participation in management of irrigation were not taken into serious consideration in any irrigation development and management planning, design and implementation programs. Achievement of self-sufficiency in 1984 was the only success indicator of irrigation development in the country, while a significant proportion of farming population was still living under poverty. There is an apprehension that increased food production in the country may not have benefited the rural poorest in any significant way. Equity and sustainability objectives of agricultural and irrigation development were, therefore, poorly attained. In the aftermath of the Indonesian financial crisis (1997), rice-based agricultural development in the country was considered to have contributed to the adverse impacts of the crisis in rural areas.

In the future, Indonesia will enter an era of severe land and water shortages for crop production. While population continues to increase, growth rate of food production shows signs of stagnation (table IS–1). The fundamental reason for low production growth is the leveling-off of productivity factors: yields, cropping intensities and area irrigated. Yields have been stagnant for a decade, with average yield of paddy remaining at a level of 4.5 tons/ha. The slowdown in productivity improvement is due to near completion of the spread of modern varieties and intensified production programs, declining marginal productivity of fertilizers, less favorable price environment and reduction in irrigation investments. In addition, lack of innovation in production technology, continuing low level of crop diversification and declining size of average landholdings due to increase in population and continuous conversion of irrigated agricultural lands to nonagricultural uses are some of the major problems facing agriculture. In Central Java, for example, the average size of landholding declined from 0.39 hectare in 1994 to 0.35 hectare in 1998 (Pasandaran and Zuliasri 2001).

Table IS-1. Percentage change of harvested area, production and productivity of paddy (wetland + dryland), 1970-2000.

| Year | | Java | | | Outside Java | | | Indonesia | |
|---|---|---|---|---|---|---|---|---|---|
| | Harvested area | Production | Productivity | Harvested area | Production | Productivity | Harvested area | Production | Productivity |
| | | | | | | | | | |
| 1970-1975 | 1.58 | 3.42 | 1.81 | 1.33 | 3.96 | 2.60 | 1.47 | 3.63 | 2.13 |
| 1975-1980 | 0.53 | 6.06 | 5.50 | 1.93 | 5.45 | 3.45 | 1.17 | 5.83 | 4.60 |
| 1980-1985 | 2.10 | 5.63 | 3.45 | 1.71 | 5.68 | 3.91 | 1.92 | 5.65 | 3.66 |
| 1985-1990 | 0.44 | 2.33 | 1.88 | 2.02 | 3.98 | 1.93 | 1.18 | 2.97 | 1.76 |
| 1990-1995 | 0.22 | 0.71 | 0.49 | 3.23 | 3.70 | 0.46 | 1.72 | 1.94 | 0.22 |
| 1995-2000 | 0.96 | 0.70 | -0.26 | -0.34 | 0.67 | 1.01 | 0.29 | 0.69 | 0.27 |

*Source:* Pasandaran and Zuliasri 2001.

Poverty in Indonesia has decreased drastically from 54.2 million people or around 40 percent of the total population in 1976 to only 27.2 million people or 15.1 percent of the total population in 1990 (table IS–1). In 1996, the number of poor people in the country was reduced to 22.4 million. However, because of the economic crisis that overwhelmed Indonesia at the end of 1997, the incidence of poverty increased significantly in the country, with the number of the poor increasing to 49.50 million in 1998. However, the incidence of poverty decreased in the country with some improvements in the economic and political situation during the post-crisis period. The incidence of poverty has always been higher in rural areas compared to that in urban areas. Java being the most populated region, is home to the majority of the poor too (poverty in Java was estimated at 28.9 million in 1999). Table IS–2 shows the status of poverty in Indonesia in 1976–1999.

Table IS–2. Poverty in Indonesia, 1976–1999.

| Year | Poor population (million) | | |
|---|---|---|---|
| | Urban | Rural | Total |
| 1976 | 10.0 | 44.2 | 54.2 |
| 1978 | 8.3 | 38.9 | 47.2 |
| 1980 | 9.5 | 32.8 | 42.3 |
| 1981 | 9.3 | 31.3 | 40.6 |
| 1984 | 9.3 | 25.7 | 35.0 |
| 1987 | 9.7 | 20.3 | 30.0 |
| 1990 | 9.4 | 17.8 | 27.2 |
| 1993 | 8.7 | 17.2 | 25.9 |
| 1996 | 7.2 | 15.2 | 22.4 |
| 1998 | 17.6 | 31.9 | 49.5 |
| 1999 | 15.6 | 32.3 | 47.9 |

The small size of farm holdings is a major constraint in Indonesia. Data from Agricultural Census of 1993 indicate that the number of small farmers (with less than 0.5 ha) has been increasing over time. This phenomenon is more pronounced in outer Java than in Java. The number of small farmers in outer Java island increased from 2.2 million in 1983 to 2.8 million in 1993 (27.3%). Also, rapid industrialization in urban and peri-urban areas has resulted in a significant area of agricultural land converted to industrial uses. Overall, while marginal and small farmers (with holdings less than 0.5 ha) constituted 57 percent, they occupy only 26.8 percent of total agricultural land, whereas 43 percent own 73.2 percent of land. These figures indicate the degree of inequities in landownership.

Further, Indonesian official statistics indicate that, in 1993, about 9.05 million households (or 31.5% of rural households) were virtually landless, about 9.58 million farm households owned less than 0.5 hectare size holdings each (33.31% of rural households) and about 10.13 million households (or 35.22% of rural households) owned 0.5 hectare-size (or above) holdings. The proportion of landless and land poor is greater in Java than in outer Java island. In Java, of about 17.3 million agricultural households, 44 percent households own less than 0.5 hectare-size holdings each and 39 percent households work as agricultural laborers. Indonesia made some progress in redistributing lands through land reforms during 1960-65, but there have been almost no land reforms after 1965. Official statistics indicate that, during 1965-2000, the government redistributed 0.851 million ha (representing only 3% of all cropland in use in the country) benefiting 1.29 million families under all land reforms, with 0.339 million ha redistributed in Java (representing only 6% of all cropland in use in the region) benefiting 0.817 million households, as a result of reforms carried out so far (in 1961) in the country (Prosterman and Mitchell 2002).

Low paddy prices and higher cost of production continue to erode farm incomes, with poverty continuing to exist in irrigated agriculture. There are four major factors influencing poverty in irrigated agriculture in Indonesia: a) land size is very small (less than 0.5 hectare) and landlessness is increasing; b) access to production inputs and information about new production technologies are limited; c) marketing is an important issue, with lack of timely and reliable market information being important issues; and d) price and yield risk and uncertainty of incomes from the agriculture sector.

***Irrigation Sector Reforms***

During 1970-1984, the Government of Indonesia spent huge sums of money for construction and rehabilitation of irrigation systems in the country. Investments in irrigation were reduced with the achievement of rice self-sufficiency in 1984. Following this success in achieving rice self-sufficiency, the government began to face difficulties in covering the O&M budget of irrigation systems.

In 1987, the government set out a policy statement on the management of the irrigation system. This policy was launched to increase efficiency in O&M and recovery of O&M costs from the beneficiaries. The main components of the policy included: a) implementation of O&M irrigation system on a Need-Based Budget (NBB); b) introduction of the Irrigation Service Fee (ISF) program to farmers; c) Irrigation Management Turnover program (IMT, PIK); d) Efficient Operation and Maintenance (EOM); e) Programming and Monitoring System (PMS); f) Integrated Water Resource Management (IWRM); g) Project Benefit, Monitoring and Evaluation (PBME) and Cost Effective, Rehabilitation and Modernization of Irrigation Schemes.

ISF program was initiated and applied to large irrigation systems (with command areas of over 500 ha) to introduce a charge to water users, which would reflect the cost of providing the irrigation service in the course of implementation. The IMT (PIK) program was initiated for systems with a command area of less than 500 ha with the aim of ultimate turnover of all small-scale irrigation schemes to users. The program involved the transfer of responsibility from the government agency to WUAs. WUAs collected ISF and paid them to the district office of regional income. The ISF would return to the irrigation system in the form of an EOM budget. The EOM budget was developed, based on actual need for O&M and for overhead estimated in NBB. In general, the collection of ISF was not a success because farmers had doubts about the utilization of the ISF. In the district office of regional income, ISF was put together with other taxes to provide financial support for all development sectors and, hence, farmers could not distinguish the use of their ISF payment. The goal of the policy was to improve the management of the irrigation system; however, it was not implemented appropriately because: a) in the policy, assumption was made that conditions and legal institutions are uniform in all systems all over Indonesia; b) stakeholders failed to understand the benefits of the policy; and c) there was no freedom for executors to determine policy at their own management level. In other words, the policy was set up in a top-down manner so that it was difficult to interpret the policy at the field level. *Moreover, it was applied through a target-oriented project approach, which neglected the process to achieve the target.*

Experiments with the past policy led to changes in policy on water resources, especially in the irrigation sector. In 1999, the Government of Indonesia launched a reform in water resources sector including irrigation with the objectives to: a) improve the national institutional framework for water resource development and management; b) improve the organizational and financial framework for river basin management; c) improve regional water quality management regulatory institutions and their implementation; and d) improve national irrigation management policy, institutions and regulations. In correspondence with the reform, the Government of Indonesia then stated the presidential instruction no. 3/1999 on Irrigation Management Policy Reform (IMPR). The presidential instruction aimed at empowering the people for irrigation management to achieve the sustainability objective in the irrigation sector. Major components of the new irrigation policy include:

1. *Redefinition of the role and responsibility of irrigation management institutions.* In order to implement more effective and efficient irrigation activities, the government has to reformulate and redefine the duties and responsibilities of the irrigation management institutions at the national, provincial, district/municipality, and the farmer levels, with the WUAs as the most important decision makers within the irrigation system under WUAs' management.

2. *Empowerment of WUA.* In order to have an autonomous and self-reliant WUA, the government will encourage, facilitate and provide better opportunities to the farmers' community to establish economic and business units at the farm level, based on, and representing, the local needs in accommodating networking purposes with the outside community, managing production resources including water resources and irrigation systems, based on democracy and community socioeconomic self-reliance.

3. *Irrigation management transfer.* Under the principle of one system-one management, the government shall transfer the irrigation O&M, and its financial management of the overall system to WUAs on a gradual, selective and democratic basis.

4. *Availability of irrigation service fee.* Budgetary requirements for O&M, rehabilitation and irrigation system construction and other activities within the WUAs' operational area, will be the responsibility of the farmers through the payment of the irrigation fee (IPAIR) in all irrigation systems in Indonesia, whose collection, management and allocation are conducted by the concerned WUAs. Based on the fact that irrigation has a strategic role in agricultural development, particularly in supporting food production, the government is responsible for providing support in the development, financing and irrigation system management whenever needed by WUAs.

5. *Sustainability of the irrigation system.* Given that irrigation investment allocated by the government is very high (construction, O&M, rehabilitation and institutional development) the government is responsible for maintaining water resource sustainability and controlling the conversion of irrigated land to other uses through the issuance of macro-level policies and their consistent enforcement to maintain system sustainability. For the sustainability purposes, participation of the farmers must be invited in any development stage starting from the survey, investigation, design, construction, O&M and monitoring and evaluation stages. Stages in protecting and maintaining the sustainability of irrigation systems are designed to follow the following priorities: irrigation performance improvement, rehabilitation, and new construction whose implementation must be based on the local needs.

In 2001, the Government of Indonesia launched Government Regulation no. 77/2001 as an advancement of the Presidential Instruction of 1999, which aimed at regulating the implementation of the new policy. Various components of the new policy are interrelated, and the implementation of these components varies from one region to another. In general, the implementation of Government Regulation no. 77/2001 has not resolved some of the key issues, and this is due to the fact the regional implementing regulations have not yet been developed. Redefinition of the role and responsibility of the irrigation management institution has been initiated from provincial to district or lower level. In Klambu Kiri and Glapan systems (two of the four systems included in the study), along with regional autonomy, conflict among the province, district and WUAs has grown (with the province being responsible for primary canal management, and the district government for secondary-canal management).

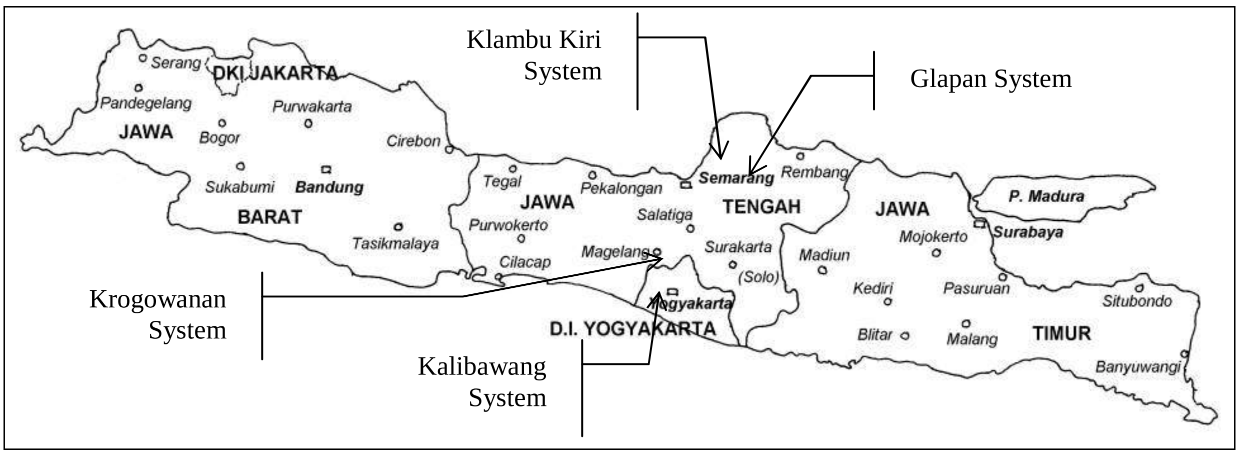
In principle, the new policy is people-centered and accommodates growth, equity and sustainability objectives of agricultural development. However, transition from centralized and rice-based development to a more decentralized, people-oriented and welfare-based development is constrained by a number of factors. Persisting characteristics of irrigation development are posing potential problems constraining system improvement in attaining new policy objectives during early stages of its implementation. Existing institutional structures, slow response from the existing bureaucracy and low farmer participation are some of the constraining factors. In addition, limited size of landholdings, unclear water rights, unsatisfactory infrastructural conditions in many cases, limited access to modern farming technologies and inadequacy of agricultural supporting systems, such as market environment, rural finance and extension services, are some of constraints faced during the transition period. The present performance of irrigation is far from satisfactory as far as distributive and welfare issues are concerned.

Under the reforms, implementation of IMT was initiated gradually in four provinces in Java, namely West Java, Central Java, Yogyakarta and East Java. During the first phase of IMT implementation in large and medium scale, a number of systems were transferred in 1999. In Yogyakarta, these included two of the six schemes (namely, Papa and Pengasih) in the Kalibawang system. In central Java, two systems namely, Krogowanan in the Magelang district and Beton in the Wonogiri district were transferred in 1999. In Phase-II, the other four systems in the Magelang district, i.e., Sidandang, Kajor Semendi, Pasekan and Sumberan were transferred in 2001, and the remaining four schemes in the Kalibawang system were transferred in 2002. In the transferred systems, the organizational structure consists of two or three tiers depending on the size of systems: WUA at the tertiary level, WUA federation (WUAF) at the secondary level, and a group of WUAFs at the system/primary level. In general, WUAs and WUAFs manage the respective levels of a system up to the secondary level, and public agencies manage the primary level of the systems. All assets in the systems still belong to the state and WUAs and WUAFs are responsible for management and O&M of the systems. In principle, these organizations should be autonomous, self-supporting and with authority to collect and manage revenues from the ISF, and should be established by, and for, water users/farmers democratically to provide them a forum. In the nontransferred systems, WUAs manage the tertiary level and the public sector agencies manage all other levels.

**Study Settings, Data and Methods**

Four irrigation systems, namely, Klambu Kiri, Glapan, Krogowanan and Kalibawang were selected to represent technical irrigation systems in Java (see figure IS–2 for the location of these systems). Administratively, the first three systems are located in the Central Java Province, and the last one is located in Yogyakarta Special Province. The Klambu Kiri and Glapan systems are located in the Demak district, Krogowanan in the Magelang district and Kalibawang in the Kulonprogo district. Central Java has an important role in producing food to the country since it has a relatively large area under irrigation, estimated at 1,002,306 hectares (30.84%). Although Yogyakarta is a small province in Java, irrigation management in this province is unique because it operates based on a reuse water system. In this system, drainage water from the irrigation system is then used in other downstream irrigation systems. Yogyakarta is also unique in the sense that it is a kingdom that is still governed by a Sultan as the emperor of the province. This has effects on the local government and socioculture of the people in the province. These two provinces have a relatively large number of people under poverty distributed in several districts. The systems selected for this study vary in terms of size, water supplies, water scarcity/abundance, condition of irrigation infrastructure, irrigation-management patterns, cropping patterns, crop productivity, level of crop diversification, land quality and size of landholdings.

Figure IS–2. Location of selected irrigation systems in Java and Yogyakarta.




Almost all irrigated areas in the Demak district are located in the Jratunseluna river basin. Jratunseluna consists of five main rivers namely Jragung, Tuntang, Serang, Lusi and Juana. In the upper part of the Serang river, the Kedung Ombo reservoir was developed in 1987. The Klambu weir is situated in the Serang river, where water is supplied from the Kedung Ombo reservoir. It was constructed at the same time as the development of the Kedung Ombo reservoir. Klambu has a command area of 48,715 hectares divided into two irrigation schemes, namely, Klambu Kiri (Klambu Left; 21,457 ha) and Klambu Kanan (Klambu Right; 27,258 ha). The Wulan river and Jajar river confine the command area of Klambu Kiri, which is selected as a sample scheme for this study.

The Glapan weir diverts water from the Tuntang river, which originates from the Rawa Pening lake. The weir is located in the Glapan village in the Grobogan district. The command area of the Glapan scheme is divided into Glapan Timur (East Glapan; 8,671 ha) and Glapan Barat (West Glapan; 10,113 ha). Krogowanan (832 ha) in the Magelang district is an interconnected irrigation system diverting water from several weirs and springs. It diverts water from the Pabelan river through three weirs, i.e., the Krogowanan, Banyusumurup and Surodadi weirs. Water from the Klesem river is diverted through Guwo, Kamal, Kendil Wesi, Karang Winong and Bangkong weirs while water from the Kunjang river is diverted from the Kunjang and Pace weirs. The Krogowanan system also receives water from four springs, i.e., the Udal, Mudal, Semaren and Gung springs.

Two major rivers dominate the hydrology of Yogyakarta Special Province, the Progo river to the west and Opak to the east. Most of the irrigated area in the Yogyakarta Special Province lies to the South of Mataram canal that transfers the flow eastward from the Progo river, via the northern suburb of Yogyakarta, eventually draining to the Opak river. The Kalibawang system is the largest irrigation system in the Kulonprogo regency. The system consists of five irrigation schemes namely Kalibawang, Penjalin, Papah, Pengasih and Pekik Jamal. The IMT program, under the new irrigation management policy, was implemented in Papah and Pengasih irrigation schemes in 1999 and later in Kalibawang and Pekik Jamal in 2002. Three out of five irrigation schemes in the Kalibawang system were selected as sample sites for his study, namely, Kalibawang, Pengasih and Pekik Jamal schemes to represent head, middle and tail reaches of the system, respectively. While the Mataram canal serves the left bank of the Progo river, the right bank is served by the Kalibawang canal. Along the Kalibawang primary canal, water is diverted into several tertiary blocks under the Kalibawang irrigation scheme (1,525 ha). At the end of the Kalibawang primary canal, water is diverted into two directions. To the left it supplies water to the Donomulyo secondary canal as well as the Papah river and to the right it supplies water to the Serang river. Furthermore, Penjalin (652 ha) and Papah (983 ha) irrigation schemes divert water from the Papah river while Pengasih (2,075 ha) and Pekik Jamal (739 ha) divert water from the Serang river.

Central Java and Yogyakarta, generally, have a tropical monsoonal climate. It is influenced primarily by the seasonal monsoons, namely, the Southeast (SE) and Northwest (NW) monsoons. The SE monsoon results in the dry season, normally from mid-May to October. The characteristics of this period are a less amount of rainfall, lower humidity and less cloudiness. The NW monsoon results in the rainy season, generally taking place from November to April. It is the period of frequent and heavy rainfall, high relative humidity and cloudiness. More than 80 percent of annual rainfall occurs in this period. The Yogyakarta, Borobudur and Semarang weather stations have recorded the mean annual rainfall as 2,330 mm, 2,147 mm, and 2,234 mm, respectively.

The average maximum temperatures recorded at the Yogyakarta weather station vary from 30.4 $^{o}$C in December to 32.5 $^{o}$C in September while the average minimum temperatures vary from 19.6 $^{o}$C in September to 24.2 $^{o}$C November. The mean monthly relative humidity varies from a minimum 69 percent in September to a maximum 87 percent in February. The mean monthly wind speed at the Yogyakarta weather station varies from 158 km/day in June to 223 km/day in December. The wind generally follows the monsoonal wind direction.

Because rainfall is an important source of water for agriculture, its distribution throughout the year is the main factor that affects cropping patterns. At the beginning of the rainy season, generally in October/November, farmers start the first planting season called the rainy season. During the rainy season, rice becomes the dominant crop because it can adapt to the excessive water in the rainy season. Following harvesting time of rainy season crops, the rainy season comes to an end. At the time when rainfall reduces in February or March, farmers start growing the second crop. This season is called dry season 1 (DS 1). In the area where irrigation supply is ensured to fulfill deficiency of crop water requirement when rainfall is inadequate, farmers generally grow rice, otherwise they grow other crops that need less water. Dry season 2 (DS 2) starts in June or July following DS 1. In this season, farmers generally grow *palawija* (upland crops), for example, maize, mungbean, or soybean that is more tolerable to dry conditions. Cultivation of vegetables is another crop choice when soil, temperature, elevation and other factors are suitable.

The discharge in Klambu Kiri varies widely from 1,000 lps to 17,000 lps. Likewise in the Glapan system discharge varies from 4,000 lps to 17,000 lps. In these two systems, peak discharge occurs in the beginning of the first planting season because of high water demand for land preparation. At the end of the first planting season, the discharge is lower. The lowest discharge occurs in the third planting season when upland crops become dominant and river discharge is also low. In the Kalibawang and Krogowanan systems, discharge varies from 5,000 lps to 7,000 lps and 1,000 lps to 2,000 lps, respectively. The fluctuation in discharge mainly follows rainfall patterns. The highest discharge of Kalibawang takes place in May or in the second planting season when irrigation requirement is high and water is available in the river. In Krogowanan, the highest discharge occurs in January or February at the peak of the rainy season. On the contrary, the lowest discharge of Kalibawang and Krogowanan occurs at the peak of the dry season in July and August.

***Characteristics of Selected Systems***

Table IS–3 outlines key characteristics of the selected systems. Systems vary in size from 813 hectares to 21,475 hectares. Krogowanan is the smallest system, where infrastructure is fairly well established, water supplies are abundant, head-tail inequities in water distribution are low, soils are of good quality, cropping patterns are well diversified and farmers practice multiple cropping with high-value crops; market infrastructure is also well established and employment opportunities in the non-farm sector (industry, mining) are also available. Kalibawang is a medium-size system, most of the canal infrastructure is lined and is in very good condition, water supplies are adequate, head-tail inequities are moderate and cropping patterns are well diversified in parts of the system. Klambu Kiri and Glapan are fairly large-size systems, infrastructural condition in several parts of the systems (especially at tail ends) is poor, both systems may be characterized as water-short systems, head-tail inequities in water distribution are fairly high, rice cultivation dominates the cropping patterns, with diversification practiced only in a few parts of the systems. In all systems, surface water supplies are major sources of water for irrigation. Groundwater is used only in the Pekik Jamal scheme of the Kalibawang system and at the tail parts of both the Pegasih scheme and the Glapan system.

Table IS–3. Characteristics of selected irrigation systems.

| | Klambu Kiri | Glapan | Kalibawang | Krogowanan |
|---|---|---|---|---|
| Size of system (ha) | 21,475 | 18,284 | 6,454 | 813 |
| Construction date | 1987 | 1930 | 1940 | 1976 |
| Rainfall (mm) | 2,092 | 2,458 | 2,291 | 2,065 |
| Temperature ($^{o}$C) | 27.9 | 27.9 | 27.3 | 26.2 |
| Water adequacy/shortage | Short | Short | Adequate | Abundant |
| Infrastructural condition | Good | Poor | Very good | Good |
| IMT experience | No | No | Yes | Yes |
| Average farm size (ha) | 0.77 | 0.73 | 0.25 | 0.35 |
| No. of crops grown | 6 | 3 | 11 | 15 |
| Rice yield (kg/ha) | 3,966 | 1,947 | 4,827 | 3,087 |

As mentioned above, rice is the dominant crop in the rainy season and DS I in all selected systems. Other crops planted during these seasons are onion and chili (Klambu Kiri), eggplant and watermelon (Glapan), tomato and cabbage (Krogowanan) and chili and onion (Kalibawang). In DS II, farmers grow several crops, i.e., *palawija* (maize, peanut, soybean, mungbean, and so on) and vegetables (chili, onion, tomato, cabbage and so on). In Klambu Kiri and Glapan, mungbean is the dominant crop during DS II while in Krogowanan and Kalibawang, *palawija* and vegetables dominate the copping patterns.

Cropping patterns in Kalibawang and Krogowanan systems are more complex than those in Klambu Kiri and Glapan systems. In Kalibawang and Krogowanan, *palawija* and vegetables are planted not only during DS II but also in the rainy season and DS I. In Klambu Kiri and Glapan, *palawija* and vegetables are planted only during DS II. In Kalibawang and Krogowanan, there has been a gradual shift from rice to non-rice crop cultivation.

**Sample Selection**

The study used both primary and secondary data and information, and qualitative and quantitative approaches to analyses. The primary data for the study were collected from the selected irrigation systems and from adjacent rain-fed areas through household surveys using a detailed survey questionnaire. The sample was drawn using a multistage stratified sampling method. In the first stage, each of the selected irrigation systems was purposively divided into head, middle and tail parts. In the second stage, one to three WUAs were selected in each part of the systems/schemes. In the third stage, households were randomly selected from the sampling frame. The total sample size for the survey consisted of 901 households from the four selected systems (300 from Klambu Kiri, 250 from Glapan, 250 from Kalibawang and 101 from Krogowanan) and 100 households from the rain-fed area. The selected households were interviewed with a structured questionnaire for gathering data and information on various aspects including demographics, landholdings and agriculture, irrigation, cost and returns of cultivation of various crops (both perennial and non-perennial), household assets, employment and earnings from the non-farm sector, credit, household total incomes and expenditures and other related aspects. The survey covered all cropping seasons during the 2000-2001 agricultural year. Poverty was measured using the income indicator, and poverty lines specified by Indonesia's Central Bureau of Statistics for each region/systems were used: Demak (Klamu Kiri) – Rp 76,785/person/month; Grobogan (Glapan) – Rp74,007/person/month; Magelang (Krogowanan) – Rp 79,358/person/month; and Kulonprogo (Kalibawang) – Rp 84,062/person/month.[19]

## Summary of Main Findings and Conclusions

Landholdings are generally small in all selected systems. The average size of landholdings varies from 0.21 hectare to 1.14 hectares across various parts of the systems. The size of landholdings is higher in Klambu Kiri (0.56 to 1.14 ha) and Glapan (0.62 to 1.09 ha) than in Krogowanan (0.28 to 0.40 ha) and Kalibawang (0.21 to 0.27 ha). In Klambu Kiri and Glapan, average landholding size is higher in the middle area than in the head and tail parts, while in the other two systems, average landholding size is higher at the tail reaches than at the head and middle reaches. A large majority of farm households own less that 0.5 hectare each, with only a very small proportion of households owning greater than 1 hectare each. Overall, land is extremely scarce and small landholdings are a major constraint in all the selected systems.

In Klambu Kiri and Glapan systems, water is generally inadequate in meeting crop water requirements in these systems, indicating that these are relatively water short systems. In the third planting season (dry season), available water is less than 20 percent of the requirements. Design capacity of these two systems is inadequate to supply water for peak consumptive demand. To make it worse, sedimentation in canals reduces their capacity. Head-tail (H-T) inequity in water distribution is high, as indicated by the H-T equity ratio. Inequity in water distribution is particularly high in the Glapan system, where some tertiary blocks at the tail reach receive little or no water. Major factors contributing to high H-T inequities are conveyance losses, sedimentation, water theft at head reaches, poor infrastructural condition, and unsatisfactory management practices. Overall, inequity in water distribution is higher in larger-size systems.

Water supplies are abundant in Krogowanan, and adequate in the Kalibawang system. However, water distribution is not equal especially during the third planting season. Farmers at the head reaches receive more water than those at the tail ends. Cropping intensity is fairly high in all the selected systems ranging from 253 in Klambu Kiri to around 300 in Kalibawang. Output per unit of diverted water is highest in the water-short Glapan system (0.88 to1.45 kg/m$^3$) and lowest in the water-adequate Kalibawang system (0.17 to 0.81 kg/m$^3$) during both rainy and dry seasons. Overall, there are significant differences in water productivity across the four systems.

There are also considerable differences in rice productivity across seasons and locations within irrigation systems. Overall, rice productivity is higher in the rainy season than in the dry seasons. For the rainy season, productivity varies from 3,078 kg/ha to 5,969 kg/ha, while in the dry season

[19] US$1.00=Rp8,671.

it varies from 1,582 kg/ha to 4,630 kg/ha. Rice productivity is highest in Kalibawang followed by Klambu Kiri, and lowest in the Krogowanan system. Generally, rice productivity is higher in the middle parts of all systems (except in Kalmbu Kiri where productivity is higher at the head reach) and lower at tail reaches.

Income from rice production forms a major part of the household food crop income; this is particularly so in large systems (such as Klambu Kiri and Glapan), contributing 52 to 92 percent of total income from food crop production. In the other two systems, income from non-rice food crops forms the major part of the total food crop income. Overall, income from food crops constitutes the major part of household farm income. The proportion of income from farm production varies from 36 to 79 percent, with the highest proportion in Klambu Kiri and the lowest in Krogowanan. The proportion of income from off-farm sources varies from 21 to 64 percent with the highest proportion at the Glapan head and the Krogowanan tail parts. On average, over 50 percent of income is received from off-farm sources. Household average income is higher at the middle reach of the systems, except in Glapan where higher income is estimated for tail reaches. The distribution of per capita income across locations within the irrigation systems follows similar trends.

Poverty incidence is much lower in irrigated areas than in rain-fed areas. The proportion of households living below the poverty line is estimated at 33 percent for irrigated areas compared to 59 percent for rain-fed areas. Depth of poverty as measured by poverty gap is also higher in rain-fed areas compared to irrigation systems. Further, there are differences in poverty across systems and across head, middle and tail locations within each system. Poverty incidence is relatively higher at the tail reaches of Klambu Kiri and Kalibawang and the head reaches of Glapan and Krogowanan. Overall, incidence of poverty is relatively less at the middle reaches of the systems where crop productivity is high. Household size, dependency ratio, gross value of product per hectare of non-perennial crops, gross income from perennial crops, size of landholdings, and location of households within systems are important determinants of poverty. The study results indicate that irrigation has a significant impact in reducing poverty, and the impacts vary across systems. Overall, the study suggests that improving crop productivity, access to land and water, and improving opportunities in the non-farm sector will have significant impacts in reducing poverty. Further, the results indicate that poverty is lower at middle reaches (where productivity is relatively higher). Poverty is relatively higher at the head and tail reaches. Contrary to common perceptions, the results suggest that poverty is not necessarily lower in locations closer to the source of water (i.e., head reaches). Also, locational differences are more pronounced in larger-size systems (such as Klambu Kiri and Glapan) where locational inequities in water distribution and differences in productivity levels are also high.

The study findings suggest that while there is scope to improve rice productivity in areas of low productivity, which currently receive less water through improved water distribution, there is a need to improve overall productivity of land and water through diversified cropping patterns with high-value crops. At the system level, results imply that system characteristics such as size of the system, infrastructural condition, water adequacy, locational distribution of water, cropping patterns and the level of crop diversification and market infrastructure matter in relation to impacts of irrigation on poverty. In larger systems, where landholdings are relatively larger, lack of diversification and inequity in water distribution are major problems; improving water distribution especially for downstream areas and increasing crop diversification would help enhance antipoverty impacts of irrigation. Overall, findings of the study imply that improving performance of irrigation systems by improving land and water productivity of crops, diversifying cropping patterns, improving infrastructure and water distribution across locations would help reduce poverty in presently low-productivity-high-poverty parts of the systems.

Under the reforms and new institutional arrangements, WUAs are considered important for water distribution at and below secondary level, and for O&M of irrigation infrastructure, and are to be required to achieve certain performance levels. The results in terms of functioning and effectiveness of new institutions (such as WUAs) in Kalibawang and Krogowanan are mixed (note that IMT has not yet been implemented in the Klambu Kiri and Glapan systems, and there is a joint management of the systems where WUA manages tertiary levels and the government manages the other levels of the systems). In the transferred systems, the establishment of WUAs and WUAFs has not been as socialized and as democratic as envisaged in the beginning. The village officials and influentials have been key players in the establishment process. While our analysis and data suggest that most member farmers are aware of the fact that the WUA is a registered body created to manage water and provide a forum for farmer members, the approach adopted was top-down. Field data indicate that meetings among members of the WUA are rarely held, mostly just once in a season, and the presence of members in the meeting, either at the block level, or WUA level is, in general, rare.

Our study suggests that a) there are clashes of interests among various departments dealing with irrigation (agricultural department, settlement department and regional department); b) irrigation management at the system level is still centralistic; and c) the mechanism of conferring authority to farmers as in law number 22/1999 is not fully effective. Instead, the authority is biased towards village officials (village heads and representatives). However, there is more autonomy of management in the transferred systems and the overall performance is relatively better. On the whole, it is still too early to judge whether the IMT implementation will or will not have impacts in terms of increasing farmers' prosperity.

The IMT has an effect on irrigation financing mechanisms. Prior to reforms, irrigation service fee (ISF) was collected by DIPENDA (Department of Regional Income) through the WUA to deposit it at the treasurer of the region. At that time, the O&M fund allocation used to be obtained through DIPDA (Regional Budget Proposal for a Project), which was proposed every budgeting year and recommended by DPRD (House of Representative at Regional Level). This mechanism was too slow and lacked transparency. Consequently, most farmers were reluctant to pay ISF. In line with the reform spirit, there was a change in irrigation financing procedures. In late 1998, the decision was taken that ISF be collected from, by, and for WUAs, with the aim to empower farmers so that they develop capacity for irrigation management and find the source of funding for covering O&M costs. Furthermore, irrigation financing is regulated in GR number 77/2001. Under the new arrangements, the government is responsible for financing the main irrigation network while farmers are responsible for providing funds for irrigation management of their authorized network. If the funds available to WUAs are insufficient, they can propose and request for funds from regional government/irrigation commission. The WUA source of irrigation financing includes routine ISF, development fee or occasional fee and material/labor, the government aid as well as other sources. In the transferred systems, the government provides what is called “stimulant donation,” especially in areas where WUAs have limited financial capacity. In the IMT agenda of the Kulonprogo regency, the regional government is to provide stimulant donation for O&M with a ratio of 1:4, that is, for every unit of ISF collected, the regional government should provide a 4-unit fund. In the Magelang regency, the ratio is 1:1. So far, the WUA has financed only minor O&M works (such as sediment dredging, garbage cleaning, grass cutting, leakage fixing, and other similar works). Rehabilitation of projects and heavy network upgrading are being handled by the regional government due to farmers’ lack of technical and financial capacity. In the Kalibawang system, farmers contribute to rehabilitation of any deterioration in the primary canal where the damage value is less than Rp 20 million. If the damage value is more than 20 million, farmers propose fund contributions from the government. The average routine O&M cost in the system is around Rp 112,000/ha/year.

The survey shows that farmers of the Kalibawang system incur the highest expenditure for irrigation (Rp 158,635 to Rp 177,678/ha/year). The WUA in this area has been running well so that its mechanism of social control is strongly influential, cost recovery has improved and overall performance of the system is better. Organizational activities, such as irrigation fee levying, are routinely carried out. Real irrigation expenditure covers irrigation service fees as much as Rp 15,000/ha/annum, WUA retribution value of 35,000 and incidental retribution value as much as Rp 60,000 and up to Rp 125,000. The average real irrigation expenditure in the Krogowanan system is the lowest in comparison with other systems due to abundant water supplies in the system throughout the year. As a result of abundant water supplies, head-end farmers feel reluctant to pay ISF. *Farmers in the middle part incur the highest amount of real irrigation expenditure as they also get the highest crop income.* ISF share to WUAF is Rp 10,000/ha/year. Development fee of WUA, so far, is temporarily collected to rehabilitate any deterioration in the irrigation network.

Interestingly, data show considerable differences in real irrigation expenditure between tail end and other reaches in the Klambu Kiri system. The tail farmers pay less irrigation fees compared to those in other parts because they generally receive less water. The household survey shows that in DS - II over 70 percent of tail farmers reported that about 0-24 percent of their field is irrigated while about 57 percent of tail farmers got no water at all. In Galapan, middle-area farmers incur the highest real irrigation expenditure compared to those at the middle and tail parts. In relation to implementation effectiveness of institutional reforms, the study findings suggest that:

a) In medium- and large-scale systems, IMT has been implemented at only a limited scale only recently. There are significant differences in the establishment, functioning and effectiveness of WUAs across systems and locations.

b) System performance, in terms of farmer participation, water distribution, infrastructural maintenance, ISF collection and cost recovery and water-related conflicts, is found to be generally better in transferred systems (Kalibawang and Krogowanan) than in nontransferred systems (Glapan and Kambu Kiri). Among the transferred systems, performance is relatively better in the water-adequate Kalibawang system than in the water-abundant Krogowanan system.

c) While the reforms and new institutions have led to increased farmer participation in irrigation management, most newly established WUAs still operate under power structures of village leaders and government officials.

d) While early indications are that IMT and/or PIM has generated positive results, there are certain issues that need to be resolved, such as improvement in water structures and capacity building of water uses. In systems where management transfer has not taken place, such as in Klambu Kiri and Glapan, unclear procedures as well as the absence of transparency and accountability in water allocation and distribution have generally led to tensions and conflicts among the users.

e) Irrigation charges are linked to water supplies and service delivery, particularly in the transferred systems. Charges/service fees differ by location and appear to be related to O&M cost, benefits of irrigation and farmers' capacity to pay. The charge is generally higher for middle locations of the systems where crop productivity is generally higher, and lower for the tail locations.

**Conclusions and Recommendations**

***Agricultural Diversification and Irrigation System Redesign***

The existing irrigation system and its management were designed to strongly support rice self-sufficiency only without being adjusted to accommodate the adoption of the non-rice crops. Relatively poor system performance of large irrigation systems, such as Glapan and Klambu Kiri, is due to poor diversification performance. Results of the study suggest that crop diversification results in improved farm incomes of the poor, with significant impact on poverty alleviation. In relation to implementation of the new irrigation policy, design suitability of the system is poor to support technological choices of the farmers in agricultural production. Consequently, choice for crop diversification is limited due to the irrigation system constraint. To accommodate agricultural diversification, water resource system redesign is important for poverty alleviation. Also, there is a need to develop and promote agricultural diversification approaches and technologies for realizing greater antipoverty impacts of irrigation.

***Implementation of Irrigation Management Policy Reform (IMPR)***

The formulation of irrigation management policy was a very remarkable achievement in laying the necessary foundation for the pro-people and pro-welfare development. Such a policy package, which was drafted by irrigation management specialists from several universities since 2001, has been getting public legitimacy through intensive public consultations for months before being proclaimed as an acceptably stronger policy measure. The new policy has a clear objective to improve farmers' welfare. The policy provides a legal basis for better irrigation management, which leads to performance improvement and farmers' welfare. At the grass-root level, the readiness of overall irrigation system in accommodating such paradigmatic changes needs several measures to smoothen the system in attaining its objectives.

It is not very surprising to find out that at the macro level, government consistency and political commitment to the implementation of IMPR are still in serious disarray. Although IMPR has been formally proclaimed as the new irrigation policy, interdepartmental coordination at the national level is poor. Without nullifying the fact that IMPR implementation at the ground has been facing various constraints, strong resistance of the Ministry of Resettlement and Regional Infrastructure against irrigation management transfer to the farmers and district irrigation financing (DPIK), vis-à-vis the Ministry of Home Affairs, the Ministry of Agriculture and the National Development Planning Agency, could be considered as a serious disarray and less than the needed political commitment, as far as IMPR is concerned.

***Institutional Strengthening of Organizations and Capacity Building***

There is a need to build capacity of government officials to facilitate them to formulate the necessary arrangements for implementation of new irrigation laws and policies. Capacity building of local government officials is important for understanding, interpreting and implementing the new policy in an effective manner. Farmers and WUAs, who used to manage only the tertiary level, have little or no capacity and knowledge for managing the secondary and primary level of systems. Actions in the following specific areas are urgently needed:

a) *O&M manual.* Before the implementation of irrigation management policy reform, water management procedure used in the systems was the centralized O&M system. After IMT implementation, O&M are conducted based on local conditions of each system, taking into account the capability of WUAs. Therefore, each system needs an O&M manual that should be developed in consultation with WUA members. This participatory O&M manual is expected to produce better performance than the previous nationally uniform O&M system.

b) *Asset management plan.* The condition of irrigation system network influences water delivery performance. The development of an asset management plan is needed for improved maintenance of irrigation infrastructure.

c) *Development of information system.* Data and information base related to water resources management remains weak. There is a need to strengthen this area for regular monitoring of system performance and O&M planning.

***Partnership Building and Strengthening Inter-Sectoral Linkages***

There is a need to promote local partnerships towards balanced participation of the state, private sector and civil society organizations (CSOs) including NGOs, universities and CBOs in supporting the pro-poor irrigation and agribusiness system development. Strengthening of inter-sectoral linkages and socioeconomic institutions including village unit cooperatives (KUDs), extension workers, rural banking, agricultural market and storage systems is key to enhancing productivity and benefits of investments in irrigation for poverty alleviation.

## Literature Cited

Arif S.; Maksum, Mochammad; Suparmi, Murtiningrum; Hartono, Slamet; Mawarni, Agnes; Rahardjo, Hussain; Hussain, Intizar. 2004. *Country Final Report – Indonesia: Pro-poor Intervention Strategies in Irrigated Agriculture in Asia - Poverty in irrigated Agriculture in Indonesia – Issues and Options.* Colombo, Sri Lanka: International Water Management Institute.

Maksum, Mochammad. 1997. On the critical triangle of agricultural development in developing countries. In *People based sustainable agricultural development for a global world*, ed. Maksum, Mochammad; Agus Setyarso and Dyah Ismoyowati. Center for Rural and Regional Development Studies, Gadjah Mada University. ISBN-979-95263-1-0.

Maksum, Mochammad. 2000. CSOs' role in enhanching human security in Asia: The case for Indonesia. Paper presented at the Third Intellectual Dialogue on Building Asia's Tomorrow: "Cross Sectoral Partnership in Enhancing Human Security". Organized by the Japan Center for International Exchange (JCIE) and the Institute of Southeast Asian Studies (ISEAS), in Bangkok, June 18-19, 2000.

Pasandaran, Effendi and Zuliasri Neulis, Development Perspectives of irrigated Agriculture in Indonesia 2001. In *Irrigation against rural poverty: An overview of issues and pro-poor intervention strategies in irrigated agriculture in Asia*. *Proceedings of National workshops on pro-poor intervention strategies in irrigated agriculture in Asia,* ed. Hussain, Intizar and Eric Biltonen. Colombo, Sri Lanka: International Water Management Institute.

Prosterman, Roy; Mitchell, Robert. 2002. Concept for land reform on Java. Paper prepared for the Land law initiative funded by the United States Agency for International Development (USAID), May 2002.

[Read MISSION REPORT on Indonesia of the FAO Special Program for Food Security (1998)].

# Poverty in Irrigated Agriculture in Vietnam: Issues, Options and Pro-poor Intervention Strategies

## Historical and Contextual Frame

Vietnam is primarily an agricultural country with roughly 80 percent of the population engaged in agricultural activities. Vietnam has a population of over 76 million of which 58 million live in rural areas (General Statistical Office 2001). The total area of Vietnam measures approximately 333,000 $km^2$ with 62 provinces in seven officially declared socioeconomic zones. Approximately 65 percent of people aged 13 and over are employed in agriculture and forestry-based activities (General Statistical Office 2001).

Vietnam has undergone tremendous changes during the last several decades. Faced with stagnation in agricultural production, severe food shortages, and increased economic difficulties, the Vietnamese Communist Party initiated renovation of the economy in 1981 with the introduction of a contract system in agricultural production, followed by a comprehensive reform program (*doi moi*) launched by Resolution No. 10 of the sixth party congress adopted in late 1986 with the aim of liberalizing and deregulating the economy, promoting the private sector and opening the economy to the outside world. Reform in the agriculture sector reforms was the principal component of *doi moi*, under which agricultural lands that used to be collectively managed by the agricultural cooperatives or cultivated by production teams were distributed to the individual farm households, shifting the basic production unit from the commune agricultural cooperatives to the farm households under the "household contract system" or "household responsibility system" (as in China). Farm households were now free to choose which crops to grow, and who to sell to, and they could keep the profits. The former socialist-type cooperatives, which were collective units of agricultural production, were dissolved and these became service cooperatives for the members.

The greatest achievement of reforms was the redistribution of lands to the landless with the introduction of complete contract systems in 1998 followed by the promulgation of law on land in 1993. Equity in land distribution is now a key feature of agricultural economy of Vietnam. Following *doi moi*, the economic renovation in Vietnam, in the agriculture sector, land was redistributed to farm households for private use. Equity was the guiding principle in land redistribution. Equal land redistribution, however, could not be done for a commune as a whole, although it was done within each traditional village and hamlet independently. Depending on local conditions, lands in villages and hamlets were divided into area units, which were homogenous in soil, irrigation and drainage conditions, and an equal acreage of these units was given to each person. The total acreage of all family members in an area unit made up a plot, which was located randomly. The equal land allocation was done to equalize the risk of drought and flood damage, equal duties and equal harvest for each household—good with bad and near with far. It enabled the communities to overcome poor irrigation and drainage by optimal water-management decisions. However, it brought about extreme scattering and fragmentation of land owned by households (where farm land is usually held in an average of seven plots, which are scattered across a wider area), thus requiring intensive labor input in cultivation and resulting in inefficiency in farm management. As per official statistics of Vietnam (1994 Census), 72 percent of households own holdings less than 0.5 hectare each (the breakdown is given as follows; landless – 1.1%; under 0.2 ha – 27%; between 0.2 and under 0.5 ha – 44%; between 0.5 and under 1 ha – 16.2%; between 1 and under 3 ha – 10.5%; between 3 and under 5 ha – 1% and between 5 and 10 ha – 0.2 ha and above 10 – 0%) (Soushun 2001). Like in China, small size and fragmentation of landholdings in Vietnam are now among the major problems in agricultural economy of the country.

Despite the emerging new difficulties and issues, the reforms have contributed greatly to socio-economic development in Vietnam. In response to these reforms the overall economy has grown at an average annual rate of 8.4 percent. Following reforms, agricultural productivity dramatically increased. For example, average rice yields increased from 2.78 t/ha in 1985 to 4.10 t/ha in 1999. Vietnam has transformed from being a net food importer to being the world's second largest rice exporter. These reforms have further aided in reducing the rate of food poverty from 25 percent in 1992 to 15 percent in 1998 (Poverty Working Group 1999). Other poverty measures indicate similar improvements in poverty reduction. Agricultural diversification has contributed significantly to poverty reduction.

However, poverty reduction was accompanied by a modest increase in inequality, largely due to the widening of rural-urban gaps. Gender inequality remains an issue, with gains made in some areas. The poor remain extremely vulnerable to a variety of shocks. Public safety nets and government poverty programs are small and weakly targeted. Poverty remains a key problem in Vietnam.

Rural poverty in Vietnam has clear regional characteristics with the highest poverty rates in the North Central Coast, Central Highlands and the Northern Uplands (table V–1). Within each region, however, the poverty rate varies from province to province and the poverty rate can be quite high (more than 40%) in some well-off regions, such as the Red river delta (Minot and Baulch 2001). Often, these variations can be linked to lack of access to different key resources, such as health, markets or education. Therefore, the Government of Vietnam pays special attention to the eradication of hunger and reduction of poverty, seeing them as constituting a noble social revolution and a key theme in its 2001–2010 socioeconomic development strategy.

Table V–1. Poverty incidence by regions in Vietnam (1993–1998).

| Regions | % poor of total population | | % poor of regional population | | Population of 1998 | |
|---|---|---|---|---|---|---|
| | 1993 | 1998 | 1993 | 1998 | Million | % |
| 1. Northern mountain | 21 | 28 | 79 | 59 | 13.5 | 18 |
| 2. Red river delta | 23 | 15 | 63 | 29 | 14.9 | 20 |
| 3. North of central part | 16 | 18 | 75 | 48 | 10.5 | 14 |
| 4. Central seacoast | 10 | 10 | 50 | 35 | 8.1 | 11 |
| 5. The Highland | 4 | 5 | 70 | 52 | 2.8 | 4 |
| 6. East of the South | 7 | 3 | 33 | 8 | 9.7 | 13 |
| 7. Mekong delta | 18 | 21 | 47 | 37 | 16.3 | 21 |
| National | 100.0 | 100.0 | 58 | 37 | 75.8 | 100 |

*Note:* Poverty level = Expenditure per capita in 1993 is VND1.2 million (US$83)/person/year. In 1998, it was VND1.8 million (US$128)/person/year.

*Source:* World Bank 1999.

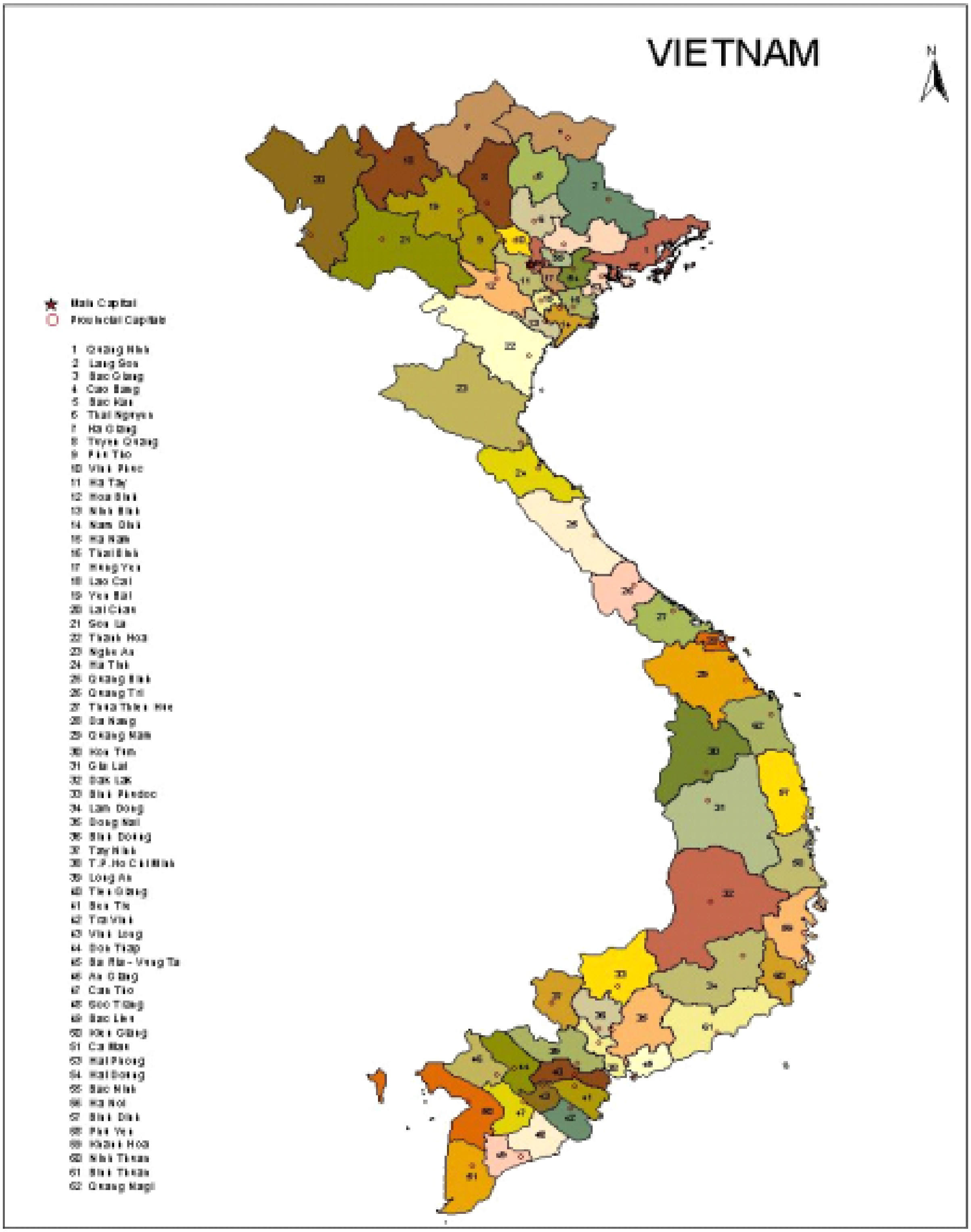
The poor are predominantly farmers (75% of the total poor) with low levels of educational attainment and limited access to information and functional skills. Agricultural activities remain the dominant source of income. Poor households have small landholdings and landlessness is becoming more widespread, especially in the Mekong delta. Households with many children or fewer laborers are disproportionately poor and are particularly vulnerable to high and variable health and education costs. Poor households are also socially and physically isolated. Poverty is widespread among ethnic minority groups and migrants to urban areas. Poor children are less able to attend school and are trapped in a cycle of inherited poverty and feel insecure.

With over 80–90 percent of the poor living in rural areas and involved in agricultural activities, land and water are two of the most important factors affecting production and farm incomes. Over the past years, a total of VND100,000 billion has been invested in the development of 8,265 irrigation systems with 743 reservoirs, 1,017 weirs, 4,712 irrigation and drainage gates, and nearly 2,000 pumping stations (JBIC 2001). There are 75 medium- and large-scale irrigation systems with a total designated area of 2.2 million hectares. The O&M of these schemes are directly managed by the 172 Irrigation Management Companies (IDMC) or the Department of Agricultural and Rural Development (DARD) of the Provincial People's Committee in each province. Also, there are numerous small irrigation systems constructed by the farmers and managed by the communes with assistance from the Service of Agriculture and Rural Development (SARD) of the District People's Committee in every administrative district. The O&M of all small-, medium- and large-scale irrigation systems are generally under the central policy guidance of the Ministry of Agriculture and Rural Development.

Vietnam has about 2.4 million hectares of irrigated land. The great bulk of the irrigated area (2.1 million ha or 88%) is devoted to rice, which is cultivated approximately 2.6 times per year. The Ministry of Agriculture and Food Industries (MAFI) gives a 1993 national paddy rice area of 4.08 million cultivated hectares and a total sown area of 6.46 million hectares, while the data of the

Ministry of Water Resources (MWR) indicated that 2 million cultivated hectares of rice-land were irrigated in 1993, with a total sown irrigated area of 5.41 million hectares. This suggests that just under half of the national rice-land is irrigated, but that 83.7 percent of the rice-sown area receives irrigation. This demonstrates that, in spite of the high levels of annual rainfall the country receives, irrigated production is the backbone of Vietnam's rice economy. Further, of the total area irrigated in 1994, pump and gravity irrigation each comprised about one-quarter of the total area. The other irrigated areas appeared to consist of land irrigated not by formal government systems, but by swing baskets, buckets, small private pumps and small gravity diversions. Studies indicate that cropping intensity in the irrigated land is 5.4 times higher than in rain-fed areas. Over the past 14 years, cropping intensity for irrigated crops has risen from 220 to 260 percent.

Figure V–1. Map showing regions and provinces in Vietnam



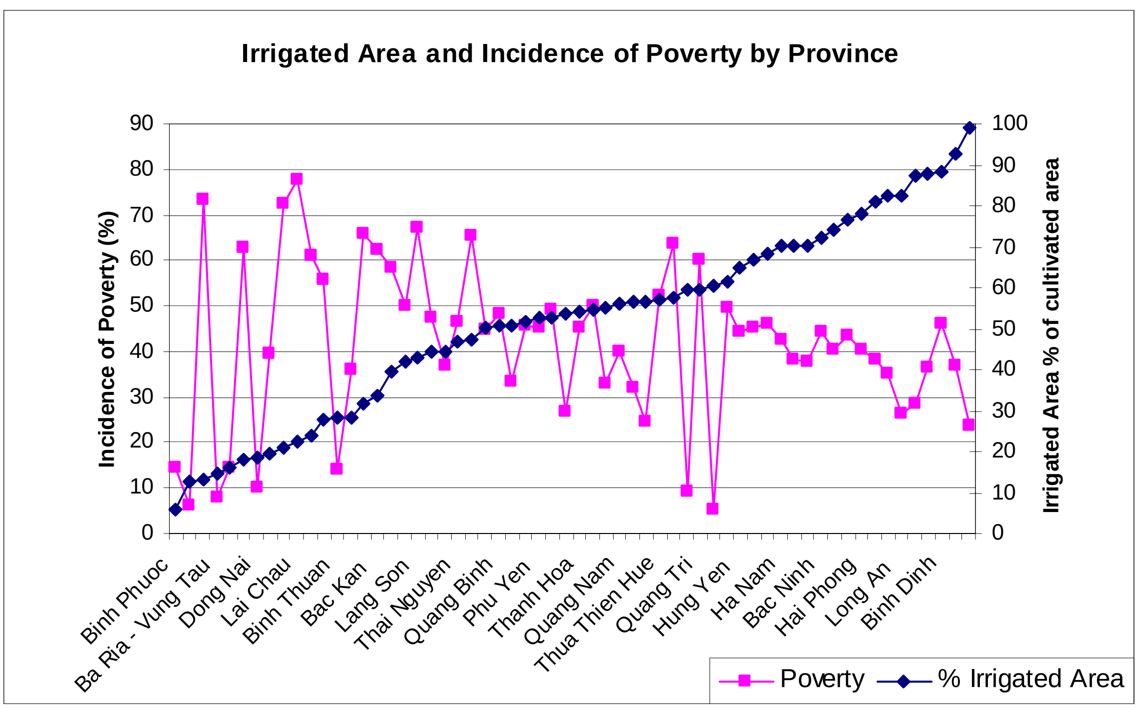

.

In Vietnam, gravity irrigation is widely distributed within the Mekong delta, North Central and Central coastal regions together accounting for about three-fifths of the total. Pump irrigation is concentrated in the two deltas accounting for almost two-thirds of the total. Some 59 percent of the pump irrigation capacity is electric, with the remainder relying on oil engines. Pumping is overwhelmingly electric in all regions, except in the Mekong, where oil engines dominate. This condition is likely the result of a lack of access to electricity for large areas of the rural Mekong delta.

Studies indicate that the distribution of existing water works is uneven among all regions and indeed may indicate some relation to poverty. The investment in waterworks in more developed regions, namely Red river delta, Mekong river delta, North Central and Southeast regions accounts for 60–80 percent of the country's total investment in water works. On the other hand, the area of irrigated land in the poorest communes only accounts for 15.5 percent of the total arable land area. Approximately, only 40 percent of the total number of the poorest communes have access to irrigation systems. Non-development of irrigation systems in poor areas is caused by underinvestment by the state, low level of production and unfamiliarity of the local population to irrigation-supported cultivation. Under these circumstances, the poorest communes are found to be short of appropriate irrigation systems (JBIC 2001).

Past studies indicate that irrigation can raise farm income by increasing the cultivable land area, enhancing crop choice and cropping intensity and providing the option of using HYVs, all contributing positively to poverty reduction. As shown in figure 2, poverty incidence is relatively lower in provinces with greater proportion of area under irrigation.

Figure V–2. Percent area irrigated and poverty incidence (%) across provinces in Vietnam



Studies on poverty-reducing impacts of irrigation suggest that if 5 percent more of the non-irrigated land was irrigated, household consumption would rise such that poverty would be lowered by 1.28 percent annually in Vietnam. This impact varies throughout the country. It is the largest in the Northern Uplands, which would experience an annual drop of 3.62 percent in poverty. Poverty reduction in rural areas of the Southeast would be the second highest at 2.73 percent per year. Although the impact on income is lower in the Southeast than in the other parts a small increase in income pushes more people over the poverty line. The lowest impact of irrigation on household consumption and poverty incidence would be in the Mekong delta. These projections indicate that the Northern Uplands have the largest impact on poverty reduction if it were to irrigate 10 percent of its non-irrigated land. If this investment was undertaken, 4.5 percent more people would be lifted out of poverty in this region.

Past emphasis on irrigation has been on technical and production issues. Irrigation development has concentrated on technical design, increases in irrigated area and production. Policy, institutional and poverty dimensions were often neglected. Thus, despite heavy investments in the irrigation sector, the current total irrigated land area of 3 million hectares is less than 70 percent of the designed capacity of the existing irrigation systems. Many irrigation schemes are in need of rehabilitation after only a few years of use. Yields, cropping intensities and crop diversification are constrained because of inadequate irrigation and drainage in the peripheral areas of irrigation systems. This is true even in areas with the heaviest investments in irrigation. Shortages of funds, incomplete construction works, damage to irrigation structures, and poor system O&M are common problems of irrigation systems in the country. There is high potential for increasing irrigation performance 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.

***Irrigation Sector Reforms***

In response to the above and other related issues, the government initiated institutional reforms in the water sector, including irrigation, since the mid-1990s. Focus in the reforms has been on four key areas: a) decentralization, b) privatization, c) financial autonomy, and d) farmer involvement in management. Decentralization has been initiated through devolving to the provinces major responsibility for water resource development, improvement and management, while at the same time consolidating, at the provincial level, power previously lodged with administrative districts. Provinces have been mandated to devolve water infrastructural construction and water resource management functions to corporate bodies to be spun off from provincial water resources services in order to improve management efficiency. Financial autonomy for privatized irrigation management, investigation and construction companies has also been mandated by the Center, in order to reduce the burden on central and provincial recurrent cost budgets, increase cost recovery from beneficiaries, provide incentives for improved institutional performance and more efficient resource allocation and management. In response to the national policy mandating privatization of various government departments and functions, most provinces have moved to establish separate companies under the DARD to a) design and investigate water resource projects, b) construct and repair civil works, and c) manage irrigation water.

There are numerous laws related to the management of irrigation and water resources. Chief among these is the 1998 Law on Water Resources. This law provides the foundation for irrigation management by giving state guidance on the management, protection, exploitation, and use of water resources. The law also prescribes for the prevention and combat against, and overcoming of, the harmful effects of water. The law gives the lead responsibility for these operations as related to irrigation to MARD. In 2003, the Ministry of Natural Resources and Environment was established, which will take over many of the water resources management responsibilities. While a revision of the law is being considered, the responsibility for the management of irrigation will remain within MARD.

The management of irrigation and drainage systems is divided into two levels. The system level is managed by state companies (IDMC). The farm level is managed by the Cooperatives. For the management of an entire irrigation and drainage system, the organizational structure is from the principal IDMC to the subsidiary IDMC, or enterprises, to the O&M field stations and finally to the agricultural Cooperatives. Most IDMCs consider their role to include a) providing irrigation water, b) collecting irrigation fees, and c) maintaining irrigation facilities. IDMCs are typically headed by a director who is assisted by a deputy. Under him are usually three or four departments for finance, administration, planning, and technical activities. In practice, the director reports IDMC's activities to the DARD or to the PPC through DARD.

IDMCs are expected to operate as businesses and to be financially self-reliant, that is, to recover their own operating costs through user fees and other subsidiary income. At the system level, the issue of cost recovery remains a sticking point with managers reluctant to raise water fees and users reluctant to pay higher fees. The situation remains that collected water fees do not fully cover costs. This is despite very high collection rates in the studied systems (95 to 99%). The water fee remains the main source of revenue for the IDMCs. *One pro-poor is that water fees are reduced in times of drought (which will seriously diminish yields and incomes). Costs for construction of main infrastructures are subsidized by the government while O&M costs are paid by farmers in the form of water fees.* Water fee is usually not sufficient for proper system maintenance causing deterioration of the irrigation system.

The "no-man's land" (secondary canals) is the weakest area in the system. With village-scale Cooperatives in the irrigation system, these areas become weaker. Support from the IDMC and Cooperative-led O&M in this land area would be an effective measure to involve water users and strengthen communication between the IDMC and Cooperatives. Moreover, many IMDCs cannot adopt this policy due to low water fees. If provincial authorities allowed the water fee to increase, this could enable the IDMC to give part of the water fee collected to the Cooperative conducting maintenance of secondary canal sections related to Cooperative water delivery. This is a measure for farmer involvement. The constraint is that the authorities are reluctant to increase water fees.

An Agricultural Cooperative consists of an executive board, board of editors and service teams. *Commonly, Cooperatives deal with farm extension, crop protection, land preparation, electricity and water management services.* On-farm water management is in charge of the water management team and local village communities. Farmers have to pay water fees to the IDMC, conforming to the water fee set by the government, and to the Cooperative, on the need, for on-farm water management. The portion of payment to the Cooperative and IDMC varies depending on the extent of services that the IDMC provides to the Cooperative and farmers and on the degree of farmer participation in irrigation management.

There is close communication between Cooperatives and the IDMC in planning and carrying out O&M activities. For irrigation, IDMC and Cooperatives sign an irrigation contract specifying crop areas to be irrigated and making provision for water-delivery schedules and quality standards.

On a system level, the water-delivery schedule is devised by the Cooperatives and the IDMC. Farmers have varying degrees of input into the water-delivery schedule. In Nam Duong, farmers have little say, while in Nam Thach Han, the relationship with the farmers appears to be much better. This results in the farmers having a greater say in the water-delivery schedule. Water distribution, in principle, is rotational among canal sections, especially for pump systems and those facing water-shortage problems. However, on the system level, it is rarely well operated. Upstream village farmers take water first to satisfy their need before water flows downstream. To cope with this situation many pumps were used in the downstream to supply return-flow water for downstream areas. *The on-farm water delivery, within each village community, is more equitably distributed.*

On irrigation financing, the studies indicate that the existing structure of water-use charges does not cover the full financing needs for system O&M of the IDMCs (Svendsen 1995). Fees collected represent only about 60 percent of the total charges. Although the financial shortfall is met partly from other sources, there remains significant and ongoing system deterioration. Although the state has been providing about VND100 million each year, mainly for pumping excess water from inundated fields (i.e., electricity bills), there is still a shortage of VND400–500 million (excluding capital for rehabilitation, upgrades and repairs due to natural disasters). The water tariffs have been set at a low rate. Several Cooperatives failed to collect water fees fully and some commune people's committees misappropriate the fees. Overdue debts are typically 5–20 percent because of fluctuations in rice prices in the market. The farmers also experienced great difficulty when they had large harvests because of consequent low prices. As a result, levels of fee collection were low. Therefore, water tariffs that depend on the market price of a commodity (usually rice or rice equivalent) do not reflect the value of irrigation water and its reliable delivery. It has been suggested that water fees should be levied based on system O&M costs. A survey of 800,000 farmers in 1,000 communes documented that only 13 percent think the water tariffs being applied are inappropriate because the service delivered is not worth the tariffs, 8 percent say these tariffs are too low and the rest think these water tariffs are affordable. In comparison with other costs for producing paddy, water fees equal 30–50 percent of fertilizer and/or compost costs (Tiep 1999).

## Study Settings, Data and Methods

Two irrigation systems, namely, Nam Duong (Gia Thuan) irrigation system, Bac Ninh Province, Red river delta region and Nam Thach Han irrigation system, Quang Tri Province, North central coast region were selected for this study. The selected systems had records of poor system performance, persistent pockets of poverty and targeted for past interventions; current and previous efforts from development agencies had also been focused there. Farms in these systems, in general, tend to have a large number of small plots scattered over a wide area. This is done to balance variations in land quality including susceptibility to natural hazards. This also makes it very difficult to classify farm households as being located at head, middle or tail.

***Characteristics of the Selected Irrigation Systems***

***Nam Duong irrigation system.*** The Nam Duong irrigation system is a subsystem of the Bac Hung Hai irrigation system *located in the Red river delta of North Vietnam*. The Nam Duong irrigation system is located along the south side of the Duong river, which links the Red river with the Thai Binh river. The design command area of the Nam Duong irrigation system is 16,500 hectares. The primary intake for the Nam Duong is the Nhu Quynh pumping station, which accounts for 12,000 hectares of the command area. While the Nam Duong is composed of three primary canals, only the north canal was chosen so as to facilitate the study. The north canal has two other major pumping stations located roughly at the middle (Mon Quang) and the tail (Kenh Vang).

The rainy season lasts from May to October with an average peak in August. The average annual rainfall is about 1,700 mm. The most common dry period is March and April, particularly in the middle and tail sections. Topographically, the Red river delta is essentially flat, with its average elevation ranging from 1 to 3 m above mean sea level.

In response to the threat of flooding posed by monsoonal rains and typhoons an extensive series of river and sea dykes has been built. The low-lying areas are quite susceptible to flooding and suffer frequent inundation resulting in low average crop yields. On the riverside of the dyke system, the land is farmed according to the flood season where cropping is either skipped or planted with water-resistant crops. No irrigation is available outside the dykes. These areas were considered rain-fed areas for the study.

The total population in the irrigated area is approximately 340,000 with 85,000 households. Of the total population, 88.5 percent are employed in agriculture. *The average farm size in the Nam Duong area is 0.28 hectare.* Cropping patterns are dominated by a rice monoculture. The average rice yield during the 1994 to 1998 period was about 4.0 tons/ha. Due to the heavy dependency on agriculture, the Gia Luong and Thuan Thanh districts inside the irrigated area are designated as agricultural specialization areas. As such, improving cropping intensities, yields and the application of modern technologies are key components of the current development plan.

***Nam Thach Han irrigation system.*** The Nam Thach Han irrigation system is located in Quang Tri Province in the Central coastal region. The water source for the Nam Thach Han irrigation system is the Thach Han river. The Nam Thach Han is primarily a gravity-fed irrigation system with the main intake being located at an earth-fill dam forming the Tram Lake. However, there are three main pumping stations under the control of the main management organization for getting water to the tail ends of two canals. The irrigated area is approximately 7,600 hectares, while the design area is approximately 13,310 hectares. About 2,000 hectares of the design area fall in the Hue Province, which is not irrigated due to lack of water.

The Nam Thach Han command area is vulnerable to extreme seasonal fluctuations in the climate. This area is subjected to a monsoonal climate and frequent typhoons. Flooding is a major problem in this area. However, during the dry season, drought becomes a major problem for agricultural activities. The rainy season is typically from September to December, while the dry season is from March to July. The average annual rainfall is about 2,600 mm and concentrated mainly in the rainy season. The land elevation ranges from 2.5 to 4 m above means sea level for most of the command area.

There are three areas served by the Nam Thach Han: Quang Tri town, Trieu Phong district and Hai Lang district. In 1999, the total population of this area was about 217,000. Over 80 percent of the population is engaged in farming as their principal occupation. Agriculture is dominated by a rice monoculture. The poverty rate in the Quang Tri Province is estimated to be about 66 percent according to the World Bank's poverty line and 24.4 percent according to the Vietnamese Government's poverty line. The main causes for loss of property and life are floods and droughts.

**Sample Selection**

In both the systems, data and information were collected through key stakeholder interviews/consultations, participatory rural appraisals and detailed household-level surveys. In the Nam Duong system, data were obtained from 4 communes, 13 villages and 480 households, of which 25 percent, 50 percent and 25 percent of households were selected randomly at the head, middle and tail reaches of canal systems. A similar procedure was adopted for data collection in the Nam Thach Han system from 9 communes, 10 villages and 480 households. Poverty is estimated using the income poverty line set by the Government of Vietnam for the rural area at VND100,000[20] per person per month.

**Summary of Main Findings and Conclusions**

In both irrigation systems studied, water resources are currently sufficient on an annual basis. However, due to extremely uneven evaporation, rainfall and flow distribution, these areas require storage (not necessary newly constructed storage). The topography and uneven water resources distribution are significant constraints to good irrigation and drainage and thus to poverty reduction. Better utilization of storage capacity inside the command area by water-control structures and effective management of water storage in internal rivers, serving as drainage courses would increase water storage for the dry season and increase command area and irrigation intensity of the irrigation system.

The results show high benefits from irrigation. Land productivity in irrigated areas is twice (VND14.6 – 21.2 million) as a high as in rain-fed areas (VND7.6 -11.2 million). In Nam Duong, the pattern is better irrigation and drainage quality at the head and lower quality at the tail end; and there is a high correlation between the quality of irrigation and drainage and the rate of productivity and poverty. There is, however, no pattern of higher irrigation benefit at the head and

[20] US$1.00=VND15, 921.

lower benefit at the tail end. In Nam Thach Han there is no pattern of head-tail irrigation and drainage quality. Irrigation positively influences farmer income and production. However, cropping patterns, decided by soil type, also have a high impact on farmer income and production. Overall, while poverty is strongly impacted by the availability of irrigation, it is also related with other factors as well. Quantitative analysis shows that land quality is the most significant factor after irrigation availability as a determinant of poverty. Other significant factors include education level, household head's gender, and number of nonagricultural sources of income.

The study results suggest that access to irrigation had the potential to significantly raise incomes. For a family of five, with an average-sized farm, this would amount to an increase in per capita income of VND332,600 (US$22) per person. This is equal to approximately 28 percent of the official Vietnamese poverty line and 19 percent of the World Bank's overall poverty line based on expenditures (World Bank 1999). Irrigation provides a significant contribution to the fight against poverty. This is also a strong indication for the necessity of maintaining the existing irrigation infrastructure.

Incidence of poverty varies across systems and locations within systems, from 10 percent to 22 percent. Poverty is lower in Nam Duong than in Nan Thach Han systems. A general hypothesis was that poverty would rise from head to tail within the system. However, while it appears that the hypothesized pattern holds true for the Nam Duong, an examination of poverty rates at the village level indicates highly variable and unpredictable patterns of poverty. As poverty in agriculture is caused by a number of different conditions, this is not unexpected. Along the canals, land quality and conditions vary widely and can offset the benefits of irrigation. Furthermore, in Vietnam, farmland is usually held in an average of seven plots, which are scattered across a wide area to even out the variability in land quality.

Table V–2. Poverty incidence at head, middle, and tail parts of the selected systems.

| Section | Poverty incidence in Nam Duong (%) | Poverty incidence in Nam Thach Han (%) |
|---|---|---|
| Overall | 12 | 18 |
| Head | 10 | 15 |
| Middle | 12 | 22 |
| Tail | 15 | 15 |

The spatial analysis has indicated that there is no clear spatial pattern of poverty that follows a simple head-to-tail rule. *Poverty is shown to be related to areas of poor irrigation performance and areas where irrigation infrastructure is poorly, or is not, developed.* Moreover, poverty is related to other factors than irrigation. Further, the study suggests that the location along the main canal can have a strong impact on poverty. This indicates that important factors, which inhibit the poor from rising out of poverty are based on location-specific conditions.

Overall, the results show that the poverty situation in the two irrigation systems is impacted by many factors in addition to irrigation. Two factors that are important are educational levels and economic diversification. Families with higher educational levels and more sources of nonagricultural income tended to be non-poor. Other significant factors involve household land resources relative to family size. In particular, families with a few laborers relative to family members tended to be much poorer. This also held for families that had relatively few land resources relative to the number of laborers. As the predominant cropping pattern is paddy and the potential for expanding cultivated land is severely limited, this points to the need to improve management of existing land. This can be facilitated by better-performing irrigation systems, particularly in providing a reliable source of water in the dry season. Other areas include increased diversification, especially to drought-resistant crops or crops that are less-water intensive.

An analysis of determinants of poverty indicates that the poor have less access than the non-poor to basic resources, such as education, land, capital, assets, irrigation and drainage. Moreover, the poor depend largely on income from agricultural activities. While land is limited, providing the poor with access to credit, education, better irrigation and drainage are opportunities for poverty reduction. The poor depend largely on agricultural income (62% in Nam Duong and 78% in Nam Thach Han). Income from cultivation makes up 70 percent. The non-poor rely on both agricultural and nonagricultural incomes with nearly equal shares.

The non-poor typically had more sources of income than the poor. The most important source of per capita income was the rainy-season crop production. The results show that nonagricultural sources of income played a significant part in the total income picture. However, it was the dry-season crop, which had a special relationship with income and negative deviations in income, indicating that ensuring a successful crop for the dry season can have a significant impact on alleviating poverty. This is especially true in regard to the vulnerability of low-income earners. This indicates a strong need to improve irrigation performance for all people, especially the poor. Also associated with poverty is the amount of land per person. Households with less land per person tend to be poorer. This effect is stronger in the Nam Thach Han than in the Nam Duong. Overall, for both systems, the general causes of poverty are households lacking access to inputs for production, such as labor, land, capital, advanced technologies, irrigation and drainage. This lack of access to inputs, including management knowledge, affects cropping patterns and lower productivity and higher poverty.

In relation to irrigation performance, the study shows that cropping intensity in Nam Thach Han is less than 200 percent, and this is because of unplanted area due to water shortage during the summer and inundation in winter spring. Cropping intensity of 209 percent in Nam Thach Han is due to the winter crop. Output per-unit of command area in Nam Thach Han of VND15 million is much less than in Nam Duong of VND20 million, due to more valuable crops such as vegetables. Water delivery in the Nam Duong is only 60 percent of that required by the irrigated area.

The Nam Thach Han irrigation system has an irrigation intensity of approximately 44 percent. Increased water storage upstream of the dam and inside the command area through enhanced water-storage practices could increase water availability during the summer season and increase the irrigation intensity of the Nam Thach Han system. In the Nam Thach Han irrigation system, cropping intensity is less than 200 percent due to unplanted areas. These areas are left fallow because of the high frequency of water shortages during summer and inundation during winter-spring. Water delivery in the Nam Thach Han irrigation system is twice higher than that required by the existing irrigated area.

In the Nam Thach Han, the output per unit of command area is VND15 million. Because of higher rates of percolation and evapotranspiration, output per unit of water consumed in Nam Thach Han is less than that in Nam Duong. For example, one cubic meter of water used in the Nam Duong irrigation system can produce as much as VND4, 800, while in the Nam Thach Han one cubic meter can produce only VND700.

In both systems, the head end has better yields than the tail end, but the difference is not very large, only 4 percent in Nam Thach Han and 16 percent in Nam Duong. The infrastructure in Nam Thach Han is better than that in Nam Duong. The number of on-farm irrigation staff in Nam Thach Han is almost twice higher than in Nam Duong. This is due to the nature of different on-farm management structures. Overall, it appears from the performance indicators that the Nam Duong irrigation system performs better than the Nam Thach Han irrigation system. The study findings suggest that irrigation systems performance has a significant impact on poverty, specifically in the dry season, and drought-prone crops have a significant relationship with poverty.

In relation to irrigation performance and poverty alleviation, the study suggest that there are many opportunities for improving system performance including: a) improving performance of irrigation and drainage services in areas where performance is poor; b) improving the quality of irrigation infrastructure, which is poor; c) increasing coverage of irrigation provision where it is lacking; d) addressing problems associated with poor land quality such as identifying more appropriate crops or activities and finding methods to improve land quality; e) increasing extension services to help farmers more effectively work within the given conditions of their land through crop diversification and enhanced management abilities; and f) improving irrigation performance in the dry season. This is especially true for addressing income vulnerability among the poor.

***Irrigation Service Charging***

As in other parts of Vietnam, the level and structure of water charges are determined by the provincial government. Water charges are based on crop type, cropping season (spring/summer), and crop output. Water charges are also differentiated by level of service, i.e., partial or full irrigation, with households receiving partial irrigation paying less charges. Water charges vary across systems. IDMC and cooperatives sign a water delivery-water fee contract. In the Nam Duang system, for example, water charge is set as follows: 209 kg of rice/ha for spring rice for full irrigation, 181 kg/ha for spring rice for partial irrigation, 195 kg of rice/ha for summer rice for full irrigation, 146 kg/ha for partial irrigation and 80-90 kg of rice/ha for the upland crop. In a way, water charges are partially linked to O&M and level of service. The success rate of fee collection is 85–95 percent. The annual income of the Nam Duong IDMC comes mainly from the collection of the water fee, which is approximately VND7 billion. The State Government subsidizes the IDMC with approximately VND 2 billion. Annual expenditures are VND11 billion. The Nam Duong IDMC is short of VND 2 billion every year, mainly indebted to the electricity company. Of the total expenditures, 60 percent is spent on staff salary and repairs and

40 percent on electricity. The highest output for the whole system was VND10, 848 million in 1996 and the lowest VND5,439 million in 1994.

Similar to the Nam Duong irrigation system, the main income source of Nam Thach Han comes from the water fee. The water fee is set by the Quang Tri Province People's Committee at 290 kg of rice equivalent per hectare per season for full irrigation and 90 kg for partial irrigation. The fee collection rate is 99 percent. The total annual income is approximately VND4.5 billion. The expenditure, where capital repair occupies 30 percent, minor repair 15–20 percent, administration and salary 30 percent, research and development 5 percent, fee collection 5 percent, and provincial fund for irrigation development 10 percent, is balanced to the income. In Quang Tri, a provincial fund for irrigation development, where the gravity irrigation system is required to submit some fund from its income, is established to support pump irrigation.

Cooperatives collect water charges, and administrative cost of fee collection is 5-6 percent. Overall, irrigation water charge level is fairly high (US$58 to US$61/ha), constituting 4.6 and 6.3 percent of gross value of product. Overall, O&M cost is also fairly high because of higher cost of pumping water. While collection rate is fairly high (85 to 99%), the amount collected depends on crop prices as charges are based on crop output. The amount collected through water charges is the main source of income for IDMCs; where the amount collected is not sufficient for O&M, the provincial government provides funds.

***Irrigation Management Institutions***

The IDMCs' current status highlights several strengths and weaknesses. These relate both to improving irrigation management in general and to making irrigation management more pro-poor. The strengths and weaknesses can be put into three broad categories of operations, finances, and farmer participation and pro-poor aspects.

The operational aspects are generally fairly strong as management of the whole irrigation system for bulk deliveries to the commune level facilitates more effective management by not taking responsibility for micro-management needs below the commune level. The planned delivery schedule is based on actual projected needs. The delivery schedule is flexible enough so that it can respond to changes in climate, such as extra rainfall. As the delivery schedule is based on cropping patterns, it can be modified as crop diversification is introduced.

Weaknesses with operations relate to their current legal status. The IDMC is a public company registered as a state-owned enterprise. The IDMC lacks authority to apply strict enforcement measures and lack autonomy to apply strict market measures. IDMC must rely on soft policy approaches to foster compliance. The delivery schedule is a general plan, but it is not binding or strictly enforced, especially the timeliness aspect. The IDMC has little control against illegal withdrawals and unauthorized structural modifications made by people illegally taking water.

Another aspect that can hinder operations is that the systems often lack water storage infrastructure which prevents the IDMC from responding adequately to changing demands. Often, the IDMC's responsibility does not extend to the cooperative, leaving a large portion of the secondary canal in a sort of "no-man's land" with the result that no one is in charge of O&M

in this area. A possible solution is for the IDMC to provide support and enlist the cooperative to better manage these sections. This is caused by insufficient resources, both human and financial.

In relation to the financial aspects, the main strength is high collection rates for irrigation fees (85-95%) in study areas. The weaknesses include the fact that the water fee is set by the Provincial Government and not by the IDMC. This creates a gap between the actual fee and the actual costs of providing irrigation services. Electricity costs are a substantial portion of annual expenses and payment is due in a time not consistent with the collection of irrigation fees (and harvesting). The IDMC relies on government subsidies to fully meet expenditure requirements. Currently, irrigation fees are insufficient to cover costs.

In regard to the farmer participation and pro-poor aspects, the main strength of the IDMC is that the water delivery schedule can be flexible depending on cropping patterns. Additionally, the delivery schedule often favors disadvantaged areas such as high-elevation or tail-end areas. In case of severe drought, the IDMC will waive irrigation fees to protect the livelihoods of the farmers affected.

The main weakness in relation to farmer participation and pro-poor aspects includes a lack of compliance with IDMC's management practices where good communication with on-farm water managers does not exist. Due to the bureaucratic and incentive structure, the IDMC may not have direct links to farmers, hindering effective management as the cooperative must protect their economic and political position. The delivery schedule is not responsive to changes in demand and is, often, not adequately fulfilled. Finally, the extension services are poorly implemented despite the widely recognized need for diversified crops and utilization of more modern technologies.

The cooperatives also have a number of strengths and weaknesses. These can be sorted into three broad categories of operations, finances and participatory and pro-poor aspects. The strengths of the cooperative regarding operations include the fact that when effective, the cooperative provides an institution that can maintain control, so that irrigation does not become an open-access resource at the local level. Legally, the cooperative has the power to make contracts with the IDMC. In some cases, such as in Nam Thach Han, the water fee is set during annual meetings between the Cooperative and IDMC, based on actual expenditures. In some areas, a self-monitoring process has been developed to verify actual water use and prevent wasteful or illegal water practices. Water-management responsibilities are often divided at the village level, which is a strong traditional rural community unit. Some places, such as Tri Qua, possess clear guidelines to resolve conflicts, such as what type of land gets priority in water delivery.

A weakness regarding the operations of the cooperatives includes the fact that cooperatives still tend to exist at the commune level even though they cannot provide services efficiently. Also, there are unclear regulations as to whether membership is voluntary and if a fee is required. Additionally, cooperatives' effectiveness is weakened where water supplies are unreliable or insufficient and there are limited off-farm income opportunities. These are, perhaps, the conditions where a strong cooperative is most needed. The fact that the cooperative is a secondary service provider of irrigation water allows it to not cooperate with the IDMC. Finally, there is poor information-sharing regarding system management needs and impacts from improved or degraded irrigation performance.

Regarding the financial situation of cooperatives, there are many weaknesses, which include irrigation fees that go into the cooperative's general funds and may not be put back into irrigation services. The current financial arrangements lack sustainability. In some areas, the cooperative has been separated from the commune, which has lowered salaries and diminished the cooperative's role. This also makes it more difficult to mobilize farmers in helping with maintenance.

The strength of the cooperatives regarding participation and pro-poor aspects includes the fact that the cooperative has a tradition of providing service to farmers at the local level. In Nam Thach Han, cooperatives are at the village level, which strengthens farmer involvement. The cooperative irrigation team communicates directly with the farmers. Finally, arrangements during times of drought allow the cooperative to take quick action in the interest of protecting farmers, but before official approval from the provincial DARD can be obtained.

The analysis clearly brings out the two primary problems with the irrigation management structure in Vietnam. The first problem is that the accountability structure is divided between administrative and irrigation-management institutions. Sub-institutions are accountable to the administrative unit they belong to and to the higher irrigation-management institution. The IDMC, however, is responsible for the entire system management and is accountable to the Provincial (or District) People's Committee. This can create serious ambiguities as to how the irrigation management is to be handled. This problem is exacerbated with commune-level agricultural cooperatives. The cooperatives must serve the interests of the commune and handle multiple services (with varying degrees of financial return). The financial arrangements are a further complication of this problem. Institutions lack the proper incentives to pass along fees accurately to higher institutions. Moreover, some individual institutions may not hold irrigation fees for the provision and maintenance of irrigation services. A well-entrenched system of government subsidies prolongs this situation.

The second major problem in irrigation management concerns the status of irrigation institutions. Irrigation institutions are owned by the state, but set up as for-profit enterprises. Policies and regulations require them to provide a public good regardless of financial return. Thus, they are restricted in their abilities to administer government tools and to administer private-sector tools. These institutions lack autonomy both financially and administratively. Irrigation-management institutions in Vietnam lack the incentives and the ability to improve their situation.

The institutional analysis identifies several areas of interventions including: a) resolution of recent restructuring including division and clarification of responsibilities; b) clarification and effective operation of River Basin Organizations; c) assessment of the impact of a full financially self-sufficient irrigation management system on the poor; d) improved farmer participation in management of the irrigation system (especially setting the water-delivery schedule), e) improved monitoring and enforcement mechanisms for agreed water deliveries; and f) development of an incentive system for mutual good performance between managers and users.

## Conclusions and Recommendations

The study identifies a number of areas for interventions and actions for improving irrigation system performance for poverty alleviation. These include the following.

### *Improving Coordination and Communication*

A typical organizational structure for managing an irrigation system consists of an IDMC for the system-level and Cooperatives for on-farm-level management. The IDMC typically consists of a Board of Directors with its several departments, mainly technical/water management, financial/administration to oversee system operation and field stations operating different sections of the system. Management of the system that is divided into many sections and layers requires effective coordination and good communication among the various sections and layers.

### *Improving Administrative and Incentive Environment*

Clearly written water delivery schedules and requests from the head, IDMC office, field stations, and Cooperatives, as well as better information shared among related parties, to determine a refined schedule for each water delivery constitute just a first essential step. It is important to have *timely information* on water availability and delivery status delivered to the head office; *strict monitoring and enforcement* of field stations and cooperatives on water delivery in secondary and tertiary canals are essential. Thus an *administrative environment for quick and timely action* during droughts is required to ensure implementation of the water-delivery schedule. The constraints associated are a lack of incentives for irrigation managers to improve water management. Providing an *effective incentive environment to irrigation managers* is an opportunity for better management.

### *Reforming Cooperatives*

There are ongoing efforts at reformulation of Cooperatives from the communal to a village base. Although in some areas communal Cooperatives still exist, their role is very formal. The actual body responsible for agricultural activities, especially water management, is the village. The *traditional village community is the most effective terminal unit in the multilevel/multilayer of the organizational structure for irrigation management.* The constraint is lack of detailed research on terminal units and pilot models to test the findings.

### *Developing Water-Control Structures*

In the central region, natural hazards are a major cause of poverty. Improving irrigation and drainage conditions, by implementation of water-control structures, would greatly improve farmers' welfare status and prevent the non-poor from reentering poverty. In Nam Thach Han, due to a major water-control infrastructure implemented during 2000–2001, drought and inundation damages have been reduced substantially. The water-control infrastructure helped prevent 13 percent of farmers from falling back under the poverty line during the 2002 drought.

*Improving Drainage Management*

Due to the hydrological regime and the topography characteristic, a large portion of water diverted into the irrigation system is just released to the Vinh Dinh river and wasted to the Eastern Sea. Though the Nam Thach Han irrigation system has brought about many irrigation benefits, an important part of the design command area has not yet benefited from the system. To further improve irrigation-system performance, improving the drainage management/capacity of the Vinh Dinh river (to drain flood water better and thus store irrigation water better) is highly recommended.

*Increasing Investments in Irrigation*

In rain-fed areas, there are potential opportunities for poverty reduction by providing irrigation. *Providing irrigation to rain-fed areas and improving irrigation and drainage quality*, of currently irrigated areas, would not only increase farmer incomes but also increase land-use intensity and provide conditions for crop diversification from rice to vegetables. This constraint, associated with better irrigation and drainage, would require significant investments.

The research results and workshop discussions highlight four main areas in moving forward to improve irrigation management in a pro-poor manner in Vietnam. These are:

- Strengthening the policy environment
- Innovating irrigation management
- Achieving financially/managerially self-sufficient irrigation institutions
- Developing action-/policy-oriented research

*Strengthening the legal/policy environment* concerns the development, implementation and enforcement of appropriate laws and regulations. Of particular note from the discussion is the need to make laws that are clear and consistent. However, policy must be flexible and dynamic to be suitable to conditions in different areas and at different times. There is a need for regulations that clearly deal with the issue of water charges. Also, there is a need for regulations that are specific in how punishments and enforcements should be carried out. This will require identification of responsible parties at different levels (grants of authority), means of funding or otherwise supporting efforts, and means of educating the users and managers.

*Innovating irrigation management* is primarily centered on two ideas: a) participatory-management process and b) sound financial practices. The workshop and study consistently brought up the need to include farmers strongly into the management process. This would help make management more transparent, responsive and accountable to the water users. This is also related to a need to make irrigation management more autonomous. Currently, management is hampered by “too many cooks.” Efforts are urgently needed to pursue this agenda, perhaps initially through pilot studies.

*Achieving financially/managerially self-sufficient irrigation institutions* relates to the above. Sound financial practices are related to water fees. There is a strong feeling in place that fees should be kept low in order to reduce the burden on poor farmers. Additionally, it is often felt that fees should be kept low due to poor-performing irrigation systems that do not offer reliable water supplies to farmers. Low fee-collection rates, in turn, result in a lack of capital to maintain, construct or repair irrigation infrastructure. There is also the related problem of low salaries for the irrigation managers. This condition results in a lack of incentives for staff to properly carry out their responsibilities. A process for implementing/creating a sound financial cycle needs to be developed, based on local needs and conditions as well as on the limitations of the central government.

*Action-/policy-oriented research* concerns what several workshop participants pointed out as "unrealistic" research, i.e., research that targets topics, which are not of issue to policymakers and/or yield results that are impractical in implementation. Researchers and policymakers should attempt to coordinate their efforts so that research is based on the practical needs of policymakers. Moreover, a sustained process of cooperation could help research results feed into the policymaking process. In this way, a system could be set up that increases cooperation between often disparate agencies and institutions, and refine the national-sector research agenda.

# Literature Cited


GSO (General Statistical Office). 1999. *Vietnam living standards survey 1997–1998.* Hanoi.

Minot; Baulch. 2001. *Localizing IDTs for poverty reduction in Vietnam: Eradicating poverty and hunger.* Hanoi, Vietnam: World Bank.

Poverty Working Group. 1999. *Vietnam attacking poverty.* Vietnam Development Report. Vietnam: World Bank.

Svendsen, M. 1995. Agricultural water control institutions in Vietnam: Functions, financing and sustainability. In *Water Resources Sector Review.* A joint report by World Bank, Asian Development Bank, FAO, UNDP and the NGO Water Resources Group in cooperation with the Institute of Water Resources Planning, Vietnam, 1996. Duplicated.

Soushun, Nakachi. 2001. Structure of land holdings in rural areas and the land law. In *Vietnamese agriculture under market-oriented economy,* ed. Kenji, Cho and Hironori Yagi. Hanoi, Vietnam: The Agricultural Publishing House.

Tiep, Nguyen Xuan. 1999. *Irrigation water tariffs, Proceedings of the Third National Workshop on Participatory Irrigation Management, Da Nang, 10th-15th May 1999.* ed. Riddell, Philip J. Vietnam: MARD-DANIDA.

Tiep. 2000. Ministry of Labor, Invalid and Social Affairs 2000. *Decision 1143/2000-QD LDTBXH* (in Vietnamese). Vietnam.

Tuan, Doan, Doan; Biltonen, Eric; Hussain, Intizar; Quy, N. Nguyen; Phong, The Dang; Hung, Ngoc Le; Hung, The, Dinh; Tiep, Xuan, Nguyen; Ban, Van, Pham; Dung, Danh, Nguyen; Chinh, Van Le; Dung, Anh, Tran; Vu, Manh, Nguyen. 2004. *Country Final Report – Vietnam: Pro-poor Intervention Strategies in Irrigated Agriculture in Asia - Poverty in irrigated Agriculture in Vietnam – Issues and Options.* Colombo, Sri Lanka: International Water Management Institute.