Water Scarcity and Poverty

A Global Perspective on

Water Scarcity and Poverty

Achievements and Challenges for Water Resource Management

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The International Irrigation Management Institute, one of sixteen centers supported by the Consultative Group on International Agricultural Research (CGIAR) was incorporated by an Act of Parliament in Sri Lanka. The Act is currently under amendment to read as International Water Management Institute (IWMI).

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The Picture in Brief

- Irrigation has played a major role historically in poverty alleviation by providing food security, protection against famine, and expanded opportunities for employment both on and off the farm. Development of irrigated agriculture has been a major engine for economic growth and poverty reduction.

- One of the most recent examples of success in poverty alleviation has been in eastern India and Bangladesh. Here the spread of low-cost tube-well irrigation has stimulated growth in agricultural production and contributed to the reduction of the number of people below the poverty line.

- The growing scarcity and competition for water, however, stands as a major threat to future advances in poverty alleviation. Food production is likely to be adversely affected particularly in the semiarid regions, which include two of Asia's major breadbaskets, the Punjab and the North China Plain. An increasing number of the rural poor are coming to see entitlement and access to water for food production and for domestic purposes as a more critical problem than access to primary health care and education.

- The development of tube-well irrigation has contributed significantly to the increase in food production and reduction in poverty. However, in many of the more arid regions the overexploitation of groundwater poses a major threat to environment, health, and food security—a threat to the welfare of the poor far more serious than that posed by the widely criticized construction of large dams.

- Poverty persists in many of the rain-fed and upland areas, the so-called *marginal areas* most of which can be described as *water scarce*. Much of sub-Saharan Africa, with its lack of developed water resources, fits this category. Despite the apparently wide range of potentially useful technologies, efforts to increase productivity and alleviate poverty have thus far met with limited success.

Some Challenges

- In an environment of growing scarcity and competition for water, a comprehensive strategy is needed to improve the productivity of water in both irrigated and rain-fed agriculture, and to ensure access to water by poor men and women.

- As water is withdrawn from agriculture, in the management of irrigation systems, more attention must be given to water needs for multiple uses not only for agriculture, but for other domestic uses, and for environmental needs.

- Policies and institutions must be developed and cost-effective management practices adopted to halt the environmental degradation caused by overexploitation of groundwater resources.

- A basin approach to management and allocation of groundwater and surface water will require new institutional arrangements to assure both efficiency and equity in the use of basin water resources and to protect the interests of the poor.

- Special attention must be given to implementing policies and developing technologies suitable for adoption by resource-poor farmers in water-scarce or marginal upland and rain-fed areas, particularly those in sub-Saharan Africa, as well as those in well-watered areas such as eastern India.

The Issue

Poverty eradication through sustainable development can be regarded today as perhaps the central goal of the Consultative Group on International Agricultural Research (CGIAR), of most agricultural research and development institutions in the developing world, and of the national governments that support their research. *Irrigation* has played a central role in poverty reduction in the past. But the growing scarcity and competition for water and the overexploitation of groundwater resources are putting the poor in irrigated areas at great risk. In addressing the poverty problem, we must consider the impact of reduced water availability for irrigation not only on crop production, but also on the wide range of other uses that are a part of the livelihood of rural agricultural communities. Meanwhile, poverty persists in many of the rain-fed and upland areas, the so-called *marginal* or traditionally *water-scarce areas.* In these areas, the inability to effectively mobilize water resources has prevented farmers from using modern yield-increasing inputs and raising incomes.

There are two regions of the world that stand out in terms of the scope and magnitude of rural poverty—South Asia and sub-Saharan Africa. They could not be more contrasting in terms of water resources and irrigation development and hence the challenge posed to International Water Management Institute (IWMI) scientists and others for poverty alleviation. In South Asia, close to 50 percent of the cereal grain area is irrigated. Two-thirds of cereal grain production and most of the marketed surplus comes from the irrigated areas. On the contrary, in sub-Saharan Africa, the contribution of irrigation to cereal grain production is about 5 percent.

In this paper, we discuss the implications for poverty alleviation of growing water scarcity with particular reference to South Asia and sub-Saharan Africa. First, we briefly summarize the impact of irrigation development on poverty alleviation in South Asia in the recent past. Emphasis is placed on the role that advances in irrigation technologies and private development of groundwater resources have played in providing the poor access to water. Then, in an environment of growing water scarcity, we examine the challenges that lie ahead for the development of water resources leading to sustained poverty alleviation.

Irrigation and Poverty Alleviation—Past Achievements

Between the 1960s and the 1990s, real food grain prices fell by approximately 50 percent. This decline was principally but not entirely due to the impact of the so-called *green revolution* in the developing countries. The subsidization of food grain production by the developed economies also contributed to the decline. Determining the precise share of the gains in cereal grain production attributable to new seeds, fertilizer, and irrigation is an almost impossible task. However, there is little doubt that without the advances in irrigation technologies and extraordinary investments in irrigation expansion by both the public and private sectors, the impact of the green revolution would have been greatly reduced.

The benefits of lower food grain prices to the poor are obvious. Sixty percent of the money spent on food by the people below the poverty line in Asia is apportioned for cereals (which provide as much as 70 percent of their total nutrients).

A second major impact of irrigation is in the employment generated both on and off the farm, providing entitlement or purchasing power for the poor. For landless laborers, increased cropping intensity has the greatest impact on employment. Irrigation means more work in more days of the year. The employment impact is felt not only in irrigated areas but also in rain-fed areas. Sometimes, landless workers in rain-fed villages migrate long distances to take advantage of employment opportunities in the irrigated areas. There is also a multiplier effect, with higher incomes in agriculture creating employment opportunities off the farm.

Between the mid-1970s and 1990, the number of people below the poverty line in India fell from over 50 percent to approximately 35 percent (Datt 1998) while in Bangladesh it fell significantly (Palmer-Jones 1992). However, the absolute number of people below the poverty line increased slightly. An important contributor to poverty alleviation was the growth in public-sector-funded canal irrigation and in largely private-sector-funded tube-well irrigation (Shah 1993). Technological advances in storage dam construction and in tube wells and lift pumps enhanced this expansion and allowed a larger portion of the crops to be grown during the drier periods of the year thus avoiding crop losses due to flooding and typhoons. In addition, the dry season environment of high solar energy and low pest infestation gives the highest crop yield response to fertilizer application.

Tube-well technologies in particular were instrumental in poverty reduction in eastern India and Bangladesh, where agricultural development was long seen as an intractable problem. The initial emphasis in the 1960s and1970s was on publicly financed deep tube wells with command areas of around 20 hectares. These systems

performed poorly and management committees tended to be dominated by the richer and influential farmers (Boyce 1987). The gradual expansion of private tube wells, often within the deep tube-well command areas, also favored the elite who had access to the required capital (Shah 2000). However, three important developments have allowed small farmers and poorer farm households to gain access to irrigation water: (i) the development of water markets, (ii) the introduction of cheaper and smaller Chinese engines, and (iii) the widespread adoption of treadle pumps (Palmer-Jones 1992, Shah et al. 2000 and Shah 2000). For those that purchase water, there is strong pressure to economize on groundwater use, whereas tube-well owners feel no such pressure. The manually operated treadle pump, which requires an investment of less than Rs700 (US$18), is particularly well suited to farmers with less than an acre of land. To facilitate the spread of these technologies among the small farmers, credit schemes were developed by the Grameen Bank and other NGOs with particular emphasis being given to the role of women in obtaining loans and managing the pumps (van Koppen and Mahmud 1996).

While eastern India and Bangladesh have achieved a great deal of success in developing water resources to help attack poverty, many problems still remain. Particularly in India, major public policy initiatives have actually impeded groundwater development rather than expediting it (Shah 2000). Pump subsidy schemes need to be reformed. Efforts are also needed to promote a wider variety of diesel and manual pumps, to improve the fuel efficiency of pumps,and to experiment with innovative measures for fee collection for use of electricity. The potential for further development of groundwater in eastern India is great. Less than a quarter of the groundwater resource is in use at present.

Impact of Water Scarcity on the Poor

As we approach the next century, it is widely recognized that many countries (in contrast to eastern India and Bangladesh) are entering an era of severe water shortage. IWMI has undertaken a long-term program to improve the conceptual and empirical basis for the analysis of water in major river basins of the world (Seckler, Molden, and Barker 1998). The initial findings of this study project that in the first quarter of the next century 2.7 billion people or a third of the world's population will experience severe water scarcity. The bulk of this population will reside in the semiarid regions of Asia and in sub-Saharan Africa. Due to overexploitation of groundwater, food production will be adversely affected in the semiarid regions, which include two of Asia's major breadbaskets—the Punjab and the North China Plain. In northwestern India, the rise of tube-well irrigation crowded out manual water-lifting devices used by smallholders during the 1960s. In western and peninsular India, besides competitive lowering of groundwater tables, excessive pump irrigation has also resulted in fluoride contamination of groundwater, which has been the mainstay of the poor for their domestic water needs.

What are the implications of these findings for the poor? Water is both a commodity and a natural resource and a perceived human entitlement. When Nobel Laureate, Amartya Sen (1981) wrote about poverty and famines in Bengal, he spoke of "entitlements" in terms of purchasing power for food. The primary people affected by the famines were the landless rural poor. But in today's environment of growing water scarcity the problem is more pervasive. An increasing number of the poor—rural and urban consumers, rural producers, and rural laborers—are coming to view access or entitlement to water as a more critical problem than access to food, primary health care, and education.

The typical urban household uses water for drinking and sanitation. But rural areas use water for a wide range of purposes. Even in irrigated areas water is used not only for the main field crops but also for domestic use, home gardens, trees and other permanent vegetation, and livestock (Bakker et al. 1999). Other productive uses include fishing, harvesting of aquatic plants and animals, and a variety of other enterprises such as brick making. In addition, irrigation systems can have a positive or negative effect on the environment. Thus, the withdrawal of water affects the rural household, rural economy, and environment in a number of ways. Water scarcity is exemplified by situations such as: the need to carry heavy pots of water several kilometers every day to meet household needs; the destitution of farmers who lose their lands or of the landless who lose their jobs because of lack of irrigation water; the loss of wetlands or estuaries because of upstream water depletion; and increasing health problems due to water pollution and a rise in incidence of water-borne diseases.

Experts in the field agree that the quantity of water is even more important than the quality in terms of its impact on human health. However, water scarcity leads to declining water quality and pollution, which has an especially adverse impact on the poor. Many (perhaps most) of the poorest people in developing countries are forced to drink water that is unfit for human consumption.They suffer from a range of skin-related and other health problems.

As water is withdrawn from agriculture, in the management of irrigation systems, more attention must be given to water needs for domestic and health purposes, and to other consequences such as the impact on the environment. Unfortunately, in the case of water for agriculture, allocation cannot be accomplished solely through pricing mechanisms. Along with farmers other stakeholders, including the poor, should have a voice in how limited water supplies are to be allocated.

Emerging Groundwater Problem

As noted above, the development and expansion of tube-well irrigation contributed significantly to the increase in food production and reduction in poverty. However, in arid and semiarid regions, the point has now been reached where the overexploitation of groundwater poses a major threat to environment, health, and food security—a threat to the welfare of the poor far more serious than that posed by the widely criticized construction of large dams.

The regions of China, India, the Middle East, and north Africa, projected in an IWMI study to face *severe water shortage*, are the areas where overexploitation of groundwater has been most pervasive. These areas have had a "free ride" over the past 2–3 decades. Tube-well yields attributable to irrigation have typically been more than double the yields from canals and tanks. But the penalty for mismanagement of this common-pool resource is now coming due.

The groundwater problem has two contradictory aspects. First, there is the rapid drawdown of freshwater aquifers mainly due to the worldwide explosion in the use of wells and pumps for irrigation and for domestic and industrial water supplies. Second, there is the opposite problem of rising water tables of saline and sodic water. Added to these two problems is the pollution of aquifers by toxic elements. Here again the poor often pay the price not only through loss of crop production or cropland but also through a shortage of water for the range of uses noted above and through increased health problems. The recent discovery of extensive arsenic poisoning of the aquifers in Bangladesh and fluoride contamination of well water in western India provides a prime example of the adverse effects of groundwater mismanagement in some of the poorest countries of the world.

While the problems of groundwater are clear, the solutions are not. The pricing and regulation of pumping of this common-pool resource are not feasible. Even if technical and management capacities are available, which country would be willing to pay the enormous cost of this policy in terms of reduced food production and domestic and industrial water supplies? The best way to recharge aquifers needs more careful analysis. Much of the seepage and surface runoff from canals recharges groundwater aquifers.

Seen in this light, Chambers (1988) suggests that a major and perhaps the main beneficial effect of new canal irrigation is to distribute water through the command allowing it to seep and so provide water for lift irrigation. Dhawan (1993) points out that according to his calculations half of the crop output originating from tube-well irrigated lands in the Punjab is from groundwater that is of canal origin. In short, much of South Asian irrigation must be analyzed and should be managed from a basin

perspective taking into account the complementary relationship between canal water and groundwater.

While there are technical solutions for reducing salinity, the financial costs of various options and the appropriate procedures for implementing management strategies at farm and system levels are not well understood. In short, given the truly alarming threat of fresh groundwater depletion in the world, it is astonishing how little attention, whether in research or action, is given to this problem.

Marginal Areas

Poverty persists in the irrigated areas but especially in many of the rain-fed and upland or the so-called *marginal areas.* In fact, most of the areas of persistent poverty are areas that can be described as *water-scarce.* Much of sub-Saharan Africa, with its lack of developed water resources, fits into this category.

There is a striking dissimilarity between the physical and socioeconomic environments in the irrigated lowlands of Asia and the rain-fed, water-scarce areas in sub-Saharan Africa and Asia. Strategies for water management that have been successful in reducing poverty in the former environment have proven to be largely inappropriate for the latter. There appears to be relatively few lessons from the South Asian experience with irrigation and poverty reduction that can be readily transferred to water-scarce rain-fed areas in sub-Saharan Africa and elsewhere. In fact, little progress has been made in raising agricultural productivity even in the water-scarce rain-fed areas of Asia. In these less favorable environments, the road to increased productivity may lie not only with the introduction of new technologies but also with the exploitation of traditional technologies (Agarwal and Narain 1997).

To date, efforts to mobilize water resources following conventional canal irrigation system designs have been largely unsuccessful. Carruthers and Clark (1981) cautioned that without careful pre-appraisal "the farmer's promised banquet may turn out to be simply an engineering picnic." And indeed many of the early irrigation projects in Africa all too frequently turned out to be "engineering picnics." Jones (1995) reports that 18 World Bank irrigation projects in sub-Saharan Africa cost US$31,238 per hectare, while 56 South Asian projects cost $1,746 per hectare. This explains why such a large portion of African projects received an "unsatisfactory" rating. Furthermore, many of these systems were in locations where either the physical or the socioeconomic environment, or both were ill-suited to irrigated agriculture.

Many scientists strongly believe that the rain-fed areas and natural wetlands offer the greatest potential for production gains in the immediate future. Scientists have shown that a number of water harvesting and supplemental irrigation technologies hold greater promise for increasing crop yields. But their adoption by farmers has been extremely limited, as the risk and costs seem to have outweighed the benefits (Oweis, Hachum, and Kijne 1999). In sub-Saharan Africa, part of the problem may lie in the much higher cost.

For example, a major difference between South Asia and sub-Saharan Africa is the cost of pumps and irrigation equipment. Because of the rapid and large-scale groundwater development, South Asia developed its own highly competitive pump industry that delivers low-cost pumps to small farmers for which, in Africa, farmers have to pay much more. This may also be an important reason why even smallholder

irrigation development in sub-Saharan Africa region has occurred only with massive government and donor support.

Developing a more intensive agricultural system will prove more costly in sub-Saharan Africa than in Asia for three reasons. First, as noted above, the equipment will be more expensive. Second, and related to the first, as IWMI's research in Burkina Faso and Niger emphasizes, there has been little time for the development of institutions such as credit, marketing, land and water rights that are essential to the sustainability of intensive agricultural systems (Abernethy et al. 2000). One cannot simply rely on the market to bring about the institutional changes needed. A strong role must be played by public policy and the state in facilitating the institutional changes and adoption of technologies that will increase agricultural productivity (Lele and Stone 1989; Binswanger and Pingali 1988). Finally, the ecological risks associated with intensification, particularly pests and diseases, might be more serious than those in Asia because intensive cropping has had no time to co-evolve with the natural biotic environment.

Challenge for Poverty Alleviation

With the onset of the population explosion following World War II, poverty in the developing world has been associated with hunger and food insecurity. The response has been to produce more food by increasing crop yields and expanding irrigation. Despite the advances in global food security, it has become increasingly clear that productivity alone could not win the *war against hunger.* Poverty alleviation has become associated less with food production *per se* and more with *livelihood* (Chambers 1988), with employment, and with Amartya Sen's *entitlements* to food (Sen 1981). Identifying a *poverty line* based on daily per capita income and measuring the reduction in the number of people below the *poverty line* have constituted the popular "yardstick" by which progress in poverty alleviation is measured. The growing scarcity of water relative to food in many parts of the world suggests that this may no longer be an appropriate yardstick. Access or entitlement to water is not simply a matter of having more money or purchasing power. *Water security* is an increasingly important element of any poverty eradication program.

Much is known already about policy and program design for *food security* and even about policy frameworks required for *environmental protection.* By contrast, little is known about the appropriate mixes of policies, institutions, and technologies that could help achieve *water security* for both men and women in water-stressed environments (Webb and Iskandarani 1998). Furthermore, because of multiple use of water, there are a large number of stakeholders among government agencies and the private sector who have a keen interest in water allocations. A basin approach to water management and allocation will be required to utilize water more efficiently (Seckler 1999) and to take into account off-site effects of more narrowly focused projects such as reforestation, which can have a negative impact on marginal upland farmers (Finlayson 1998; Starkloff 1998). As water becomes scarcer, the conflict over water allocations, rights and entitlements at farm, system, and basin levels is bound to increase. New water basin institutional arrangements will be required to assure both efficiency and equity in the use of basin water resources and to protect the interests of the poor.

Irrigation consumes about 70 percent of the world's available water. Subsidies for infrastructure have been reduced, the most accessible and cheapest water resources have been developed, and in an increasing number of basins all of the water has been committed. Demand for water for higher-valued uses—domestic, industry, and hydropower—is rising. The agricultural sector must produce more food with less water. Achieving this goal is thought by many to lie largely in improving the efficiency of canal irrigation systems. As suggested above, however, we believe that there must be more attention through research and action programs on the

management of groundwater and surface water in a basin context in irrigated areas and on assessing the potential of alternative low-cost micro irrigation technologies in raising crop production in water-scarce rain-fed areas.

There is an urgent need for new strategies to improve the productivity of water in both irrigated and rain-fed agriculture, and ensure access to water and technologies by the poor. As new policies, institutions, and technologies are devised and tested to achieve this goal, a major task of IWMI will be to design strategies to enhance *water security* for poor men and women, a critical step in *poverty eradication*.

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