Irrigation (Group Nile)

Water, Irrigation and Food Supply - a Keynote Address

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The challenge

The present 6 billion world population is projected to increase to 9 billion over the next 50 years with an estimated 95% of the growth taking place in developing countries. The associated increase in food requirements coupled with increasing constraints on available water and land resources presents a tremendous challenge for present generations working to overcome poverty in less-developed countries without compromising living conditions for future generations. The increasing demand for food will occur at the same time as a large part of the world population suffers from food shortages and heavy malnutrition. Much of the required increase in food production over the next 30 years will be in developing countries.

Land and water resources play a major role in increasing food production. But land and water resources are limited. Land degradation in the developing countries is increasing rapidly. A large part of rainfed agriculture is already extremely vulnerable to drought, soil loss, declining soil fertility, and disruption of water resources. Many of the agrosystems are ecologically fragile and require soil and water conservation measures and techniques to prevent degradation and maintain yield potentials. Land resources in irrigated and potentially irrigated areas also suffer from mismanagement, flood hazards and salinization.

Water is abundant globally but scare locally. Of the earth's 1,360 million cubic kilometres of water, 97 percent is in the oceans. Three quarters of the freshwater is in glaciers and icebergs, another fifth is groundwater, and less than 1 percent is in lakes and rivers. Almost two-thirds of the renewable freshwater provided by annual rainfall over land evaporates. Much of the rainfall transformed into runoff is lost to floods. Given current global water use of 4,000 cubic kilometres, the remaining 14,000 cubic kilometres of effective runoff would be adequate to meet demand for the foreseeable future if supplies were distributed equally across the world's population. But freshwater is distributed extremely unevenly across countries, across regions within countries, and across seasons.

Fortunately, there is a potential for expanding food production. Actual cereal yields in the developed countries is now over 4 t/ha, while in developing countries it is only 2.3 t/ha. Irrigated land accounts for 18% of the cultivated land, but produces 33% of the world's food supplies. It is expected by Pereira et al. (1996) that appropriate intensification and expansion of irrigated areas may account for more than 50% of food requirements by the year 2025. Thus, to meet the expanding food demand there is a need for increasing the average yields and a need for irrigated agriculture.

Water resources play a major role in expanding irrigated agriculture and associated food production. Existing technologies and management techniques for improved water utilisation in agriculture will play an important role in meeting the enormous challenge of population growth and increased food demand. Because of this challenge research efforts have to be increased. There is especially a need to redirect research to fully meet the requirements of sustainable land and water resources utilisation in agriculture. This research and associated information transfer should lead to technologies that would conserve the natural resources, land, and water in particular, and be environmentally nondegrading, technically appropriate, economically viable, and socially acceptable.

Water

The water crisis, which some arid and semi-arid countries are facing already for some time and which more and more other countries will start to face as we enter the 21st century, can be according to Biwas (1991) considered to be the direct result of four important but interrelated phenomena.

First, the amount of fresh water available to any country on a long-term basis is limited. Since nearly all the easily available sources of water have more or less been developed or are in the process of development, the unit costs of future projects can only be higher.

Second, world population is increasing steadily, in some parts of the world even dramatically. Consequently, water requirements for domestic, agricultural and industrial purposes and hydroelectric generation will increase as well. There is of course no one-to-one relationship between population and water requirements, but that the water requirements will increase that is for sure. In this connection we have to consider that past experiences indicate that as the standard of living increases, so do per capita water requirements. Hence, if the present poverty alleviation programmes succeed, both water requirements will increase further and the water management process must become significantly more sophisticated. These two facts have often not been considered by policy makers and planners, both nationally and internationally.

Third, as human activities increase, more and more waste products are contaminating available sources of water. These contaminants are seriously affecting the quality of water, especially for domestic use. They also restrict the amount of fresh water available.

The fourth major factor is the increasing delays that are likely to be witnessed in the coming decades to implement new water projects. Higher project costs and lack of investment funds will be two major reasons for this delay. Equally, social and environmental reasons will significantly delay project initiation time, certainly much more than what have been witnessed in the earlier decades.

There is no doubt according to Biwas (1991) that water requirements of developing countries will continue to increase significantly during the next several decades. However, the traditional response of increasing water availability to meet higher and higher water demands will no longer be adequate in the future for two important reasons:

- Many countries simply do not have any major additional sources of water to develop economically.
- Even those countries that may have additional sources of water, time periods required to implement those projects are likely to be much longer than expected at present.

Seckler et al. (1999) pointed out in a more recent publication that after thousands of years of human development in which water has been a plentiful resource in most areas, amounting virtually to a free good, the situation is at the beginning of the twenty-first century changing abruptly to the point where, particularly in the more arid regions of the world, water scarcity has become the single greatest threat to food security, human health and natural ecosystems.

Talking about water scarcity raises the question: When does water scarcity becomes a problem? Water analysts use the following rule of the thumb: countries with freshwater resources of 1,000 to 1,600 cubic meters per capita per year face water stress, with major problems occurring in drought years. Countries are considered water scarce when annual internal renewable water resources are less than 1,000 cubic meters per capita per year. Below this threshold, water availability is considered a severe constraint on socio-economic development and environmental quality. Currently, some 30 countries are considered water stressed, of which 20 are absolutely water scarce. By 2020, the number of water scarce countries will likely approach 35. Equally worrisome, virtually all developing countries, even those with adequate water in the aggregate, suffer from debilitating seasonal and regional shortages that urgently need to be addressed.

Analysing water scarcity in the next century Rosegrant (1995) identified the following challenges for the future:

Low water use efficiency. The foremost challenge related to water scarcity in developing countries is the need to increase generally inefficient water use in agriculture, urban areas, and industry. Irrigated area accounts for over two-thirds of world rice and wheat production, so growth in irrigated output per unit of land and water is essential. Improved efficiency in agricultural water use is required both to maintain productivity growth and to allow reallocation of water from agriculture to urban and industrial uses.

Expensive new water. New sources of water are increasingly expensive to exploit. Water to meet growing household and industrial demand may thus need to come increasingly from water savings from irrigated agriculture, which generally accounts for 80 percent of water diverted for use in developing countries. To truly contribute to reducing water scarcity, improved efficiency in urban and industrial use.

Resource degradation. The quality of land and water must be sustained in the face of mounting pressure to degrade these resources through waterlogging, salinization, groundwater mining, and water pollution.

Water and health. Pollution of water from industrial effluents, poorly treated sewage, and runoff of agricultural chemicals is a growing problem. Unsafe water, combined with poor household and community sanitary conditions, is a major contributor to disease and malnutrition, particularly among children. One billion people are without clean drinking water, and 1.7 billion have inadequate sanitation facilities. As many as

1 billion episodes of diarrhoea occur annually in developing countries. The World Bank has estimated that access to safe water and adequate sanitation could result in 2 million fewer deaths from diarrhoea among young children.

Massive subsidies and distorted incentives. Most of the world does not treat water as a scarce resource that it is. Both urban and rural water users receive massive subsidies on water use; irrigation water is essentially unpriced; in urban areas the price of water does not cover the cost of delivery; capital investment decisions in all sectors are divorced from management of the resource. In most countries, water subsidies go disproportionately to the better-off: irrigated farmers and urban water users connected to the public system. The inequity is exacerbated because subsidies are often financed from regressive taxes.

Irrigation and food supply

One measure of the importance of irrigation as a factor in agricultural development is the share of food and agricultural output that is produced off irrigated Land (Yudelman, 1994). The Technical Advisory Committee (TAC) of the Consultative Group on International Agricultural Research (CGIAR) has estimated that between 1987 and 1989, the annual value of all crop production in the developing countries was around US$364 billion. US$104 billion worth of crops, that are 28.5% of the value of all production, was produced on irrigated land. More than 30% of all food production was grown under irrigation. Perhaps, irrigation's largest contribution to both consumers and producers is that an estimated 46.5% of all grain and 57% of the total value of the most widely grown basic staples (rice and wheat) were produced under irrigation.

On a regional basis, it is estimated according to Yudelman (1994) that around 60% of the value of crop production in Asia is grown on irrigated land. This includes about 80% of Pakistan's food, 70% of China's food and over 50% of the food of India and Indonesia. In the Middle East and North Africa, more than one third of the region's crop production by value is irrigated, including all food grown in Egypt and more than half of that grown in Iraq and Iran. A relatively small proportion of agricultural production in Latin America, around 10%, is grown under irrigation, but half of the crops grown for export in Chile and Peru are irrigated. Madagascar produces more than 20% of it's agricultural output and food on irrigated land. Sub-Saharan Africa has the smallest regional area under irrigation, and produces an estimated 9% of it's total food production of irrigated land (Yudelman, 1994).

The irrigated sector performs an essential task in meeting the basic food needs of billions of people in the world, especially in Asia. It has provided according to Yudelman (1994) more than half of the two most important basic staples and close to a third of all food crops. In the future, the irrigated sector will have to provide an even larger proportion of the total food output.

For most of modern history the world's irrigated area grew faster than the population. Since 1980 the irrigated area per person has declined and since the mid-1980s cereal grain production per capita has also declined.

The debate regarding the world's capacity to feed a growing population, brought to the fore in the writings of Malthus two centuries ago, continues unabated. But the growing scarcity and competition for water adds an important element to this debate over food security. The eighteen percent of the world's cropland that is irrigated accounts for over a third of the food production. Fifty percent of the increase in food production over the past three decades has come from higher yields on an expanding irrigated land area.

Table 1. Estimates of values of food and agricultural crop production and percentages grown on irrigated land in developing countries 1988 - 89.

Crops	Value (US$ billion)		Percentage grown on irrigated land
	Total	Irrigated	
All crops	364.2	104.1	28.5
Food crops	310.8	96.1	30.9
All grains	148.3	69.1	46.5
Rice and wheat	117.1	67.1	57.1
Wheat	31.1	15.5	50.0
Rice	85.9	51.6	60.0

Source: Yudelman, 1994

Between the 1960s and the 1990s real food grain prices fell by approximately 50 percent. This decline was, according to Barker and v. Koppen (1999) due principally but not entirely to the impact of the so-called green revolution in the developing countries. The subsidisation 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 varieties, fertilisers, and irrigation is an almost impossible task. However, there is little doubt, according to Barker and v. Koppen (1999), 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 people in third world countries, especially 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.

While irrigated area grew at 2 percent per annum during most of the past three decades, the period of major construction of new irrigation systems has come to an end. Future growth in new cropland irrigated is projected at less than 1 percent per annum. In fact, with the losses in irrigated land due to salinity, urbanisation, and other factors, the net irrigated area in the world may already be declining. With potential crop yields still well above those now being obtained by farmers, water is now more binding than the agronomic constraint to increased crop production.

The development and expansion of tube well irrigation contributed significantly to the increase in food production during the last decades. However, in the arid and semiarid regions, the point has now been reached where overexploitation of groundwater poses a major threat to the environment, health and food security. Barker and v. Koppen (1999) consider this a threat to the welfare of the poor far more serious than that posed by the widely criticised construction of large dams.

Prerequisites for sustainable solutions

A large share of water to meet new demands must come by saving water from existing uses through comprehensive reform of water policy. Such reform will not be easy, because both long-standing practice and cultural and religious beliefs have treated water as a free good, and because entrenched interests benefit from existing arrangements.

The precise nature of water policy reform will vary from country to country, depending on underlying conditions such as level of economic development and institutional capability, relative water scarcity, and level of agricultural intensification. Additional research is required to design specific policies within any given country. According to Rosegrant (1995) key elements of comprehensive reform should include the following:

Secure water rights. Reform must provide secure water rights vested in individual water users or groups of water users. In some countries and regions, these rights should be tradable, which further increase the incentives for efficient water use. Such a reform can empower water users, provide investment incentives, improve water use efficiency, reduce incentives to degrade the environment, and increase flexibility in resource allocation.

User management of irrigation systems. In many developing countries, devolving irrigation infrastructure and management to water user associations will be beneficial. In the past, such steps often failed because they were not accompanied by secure access to water. Well-defined water rights provide the incentive for user groups to economise on water use, to bargain effectively with the water conveyance bureaucracy for timely and efficient service, and to undertake operations and management.

Reformed price incentives. Privatisation and deregulation of urban water services, together with reduced subsidies for urban water consumption, can also improve efficiency. When incremental water can be obtained at low cost owing to subsidies there is little incentive to improve either physical efficiency (such as through investment in pipes or metering) or economic efficiency. Secure water rights held by the urban companies and an active market have encouraged the construction and operation of improved treatment plants that sell water for agricultural or urban use. Removing subsidies on urban water use can have dramatic effects. Rosegrant (1995) assumes that the reforms described would free up substantial resources for both productive investment and targeted subsidies to the poor and groups who might be left out of the reform process.

Appropriate technology. Availability of appropriate technology will be essential as incentives are introduced for water conservation. Small-scale water harvesting techniques can have high payoffs in certain agro-climatic environments. As the value of water increases, sprinkler, computerised control systems, and drip irrigation using low-cost plastic pipes, all of which are common in developed countries, could have promising results for developing countries.

Environmental protection. Greater protection must be afforded to water and soil quality. The appropriate approach to environmental protection is likely to include both regulatory and market elements. Increased water prices or establishment of tradable water rights can cause farmers to take account of the costs their water use imposes on other farmers, reducing the pressure to degrade resources. Rosegrant (1995) illustrates this in a simple example. A farmer at the head of a canal who overuses water, thereby waterlogging other farmers' land through excess return flows, seepage, and percolation. If he could trade the excess water instead, he would conserve resources. Although any society can design effective environmental protection policies, how much environmental protection will be provided will be a matter of political choice and commitment.

International co-operation. Water policy reform must transcend national boundaries. In many regions, long-term solutions will require international co-operation between countries sharing scarce water resources. Intergovernmental activities to settle conflicts over shared water bodies of water have had mixed success. Co-operation between countries sharing the same water basin will become increasingly important as water becomes scarcer. Reconciliation is cheaper than armed conflict. Rosegrant (1995) sees a key to defusing potential international conflicts over water in a national water policy reform to ensure the most efficient use of available water supplies. Countries must therefore begin the painful process of reforming national water policies and treating water as a scarce resource.

A Vision of the Future

Through it's own research coupled with that of the International Food Policy Research Institute (IFPRI) has allowed the International Water Management Institute (IWMI) to arrive at a vision of the world water situation over the next 25 years. This is best characterised by summarising some of the major findings of this research:

IFPRI projects that demand for cereals will increase by 48% by 2025. Virtually all of this increase will be in developing countries, and most of it will be for feed grains to produce animal products - meat, milk, eggs, etc. The demand for vegetables and fruit, nearly all of which must be irrigated, will increase even more rapidly.

Population will grow about 38%, from the present level of 6.0 billion to 7.8 billion people in 2025. Again nearly all of the increase will be in developing countries. Per capita food supplies are expected to increase in most developing countries enough to satisfy reasonable nutritional requirements - with the major exceptions being in sub-Saharan Africa.

In order to achieve these food production levels, the irrigated area of the world will have to increase by about 34%, from about 250 million hectares in 1995 to 350 million hectares in 2025. This is true even with the most efficient and productive use of existing irrigation water that can be reasonably expected.

IWMI projects that better utilisation of existing water resources in irrigated agriculture could generate additional water supplies to irrigation, increasing by 17% over present levels. The only alternative to increasing productivity per unit of land and water would be massive and environmentally destructive conversion of forests and grasslands in agroclimatically favourable areas of Latin America and sub-Saharan Africa to rain fed agriculture.

Even so, nearly one-third of the population of developing countries in 2025, some 2.7 billion people, will live in regions of severe or 'absolute' water scarcity. They will have to reduce the amount of water used in irrigation and transfer it to the domestic, industrial and environmental sectors. Many countries in the arid regions of the world will depend on increased imports to meet the food needs of their people. While there is sufficient production potential in exporting countries to provide this food, it is not at all clear how the importing countries - especially those in sub-Saharan Africa - will find the funds to pay for these food imports.

Groundwater reserves will be increasingly depleted in large areas of the world. In some instances this will threaten the food security of entire nations dependent on highly productive agriculture irrigated with pumps, such as India; it will certainly lead to major problems for food security and access to safe water for poor households in the affected regions.

The people most affected by growing water scarcity will continue to be the poor, especially rural poor, but also the urban poor; and among poor people, women and children will suffer most. If the world fails to invest in the research and development needed to find solutions, and in the application of these solutions, the health, livelihoods and incomes of millions of poor people will deteriorate.

Last, if irrigation and water resources generally are not managed much more effectively and efficiently, the additional water required by irrigation will double. It is now generally recognised that water is the major constraint on food production and one of the major constraints on health and environmental quality in a large number of developing countries. It is water, not land, that could provide the foundations of a Malthusian crises in these countries.

A vision of Egypt's water future ?

Egypt has only one main source of water, the Nile River. The availability of the reliable water supply from the Aswan High Dam is governed by the existing water-sharing agreement, under which 55.5 billion cubic meters are allocated to Egypt. Most of Egypt's water uses are within the agricultural sector, with 84% for agriculture, 8% for industry, 5% for municipalities, and 3% for navigation (Abu Zeid, 1994). Meanwhile, yearly about 4 billion cubic meters of agricultural drainage water is officially reused for irrigation. The groundwater aquifer underlying the Nile Valley and the Delta is entirely recharged from deep percolation from the Nile. The per capita share of fresh water resources is now 950 cubic meters per person per year; it is expected to drop to 350 cubic meters per person by the year 2025. With other words the distribution of Egypt 's share of the Nile's water to its population barely reaches the water poverty threshold and will fall well below this threshold in the years to come.

In a study to project the water supply and demand for 118 countries over the 1990 - 2025 period Seckler et al. (1999) came to the conclusion that Egypt is projected to be in a state of absolute water scarcity by 2025. Egypt belongs to the group of countries, within the 118, which do not have sufficient annual water resources to meet reasonable per capita water needs for their rapidly expanding populations. These countries will almost certainly have to reduce, according to Seckler et al. (1999) the amount of water used in irrigated agriculture and transfer it to the other sectors, importing more food instead. By importing food Egypt is virtually importing water in huge amounts. If one considers that the amount of 1,000 tons of water is needed for evapotranspiration to produce 1 ton of grain Egypt is already importing virtually up to 10 billion cubic meters of water annually. This amount will increase as Egypt's population increases and more food is needed in the years to come. This is because there is no extra water to increase food production within Egypt in quantities necessary to meet the growing demand by the population increase.

Looking at the water balance of Egypt it becomes clear that it is an illusion to believe that the Egyptian agricultural area can be expanded to the planed extent. Because of the scarcity of water there are also limitations in increasing agricultural production, as the increase in plant production is correlated with the plants consumptive use of water. Because of these limitations will have to open-up and develop alternative branches of the economy, instead of investing in the reclamation of marginal lands.

Of course Egypt still can hope, that rapid advances in technology, governance and the economy will help to solve the existing and upcoming problems of water scarcity and degradation. But they will not allow Egypt to assume that the water problems of the country will go away. The eminent historian Charles van Doran (1991) has said,, according to Serageldin (1999), that forecasting the future of knowledge is not just difficult, it is 'impossibly squared'.

But while we cannot see far into the future, on the water front we can see some distance ahead, and what we see gives more reasons for alarm the comfort. The challenges are daunting. We must think boldly, and act now (Serageldin, 1999).

Egypt has to act now. The necessary action will involve not only water sector and environmental professions, but also policy and decision makers, all the Egyptian people, that is the whole of the Egyptian society.

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