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Feeding the World

INTERNATIONAL IRRIGATION MANAGMENT INSTITUTE

Special Tenth Anniversary Issue

Irrigation Management Issues and Challenges 1984 1994

CALENDAR OF EVENTS

August/September

- August/September-Irrigation Management Training for Farmers, Saga, Tillakaina, Kourani Baria, Niger.
- 12 September—Workshop on Farmer Participation in Planning, Design and Rehabilitation of National Irrigation Rehabilitation Project (NIRP) Schemes: The State of the Art and Further Research Needs (IIMI/Irrigation Department), Colombo, Sri Lanka.

September/October

- 12 September-7 October—Water and Irrigation Management for Rice Production (Co-organizer: West Africa Rice Development Association), Niamey, Niger.
- 20–24 September—International Conference on Irrigation Management Transfer, Wuhan, China.
- September/October—Mid-Term Evaluation, National Workshop of the Irrigation Management Project, Niamey, Niger.
- 24–28 October—International Centers' Week of the CGIAR, Washington D.C., USA.

November/December

- 21 November—Workshop on Post Rehabilitation Operation and Maintenance (O&M) of Rehabilitated Schemes: a) Agency Perspective; b) Farmer Perspective (IIMI/Irrigation Department), Colombo, Sri Lanka.
- November—Internal Program Review, Colombo, Sri Lanka.
- 28 November–1 December—Board of Governors Meetings, Colombo, Sri Lanka.
- 1 December—IIMI's Tenth Anniversary Commemoration, Colombo, Sri Lanka.
- 13 December—IIMI's Tenth Anniversary Commemorative Lecture by Dr. Robert Chambers, Colombo, Sri Lanka.
- 12–16 December—Training on Research Methodology (IIMI/Irrigation Department), Galgamuwa, Sri Lanka.

CONTENTS

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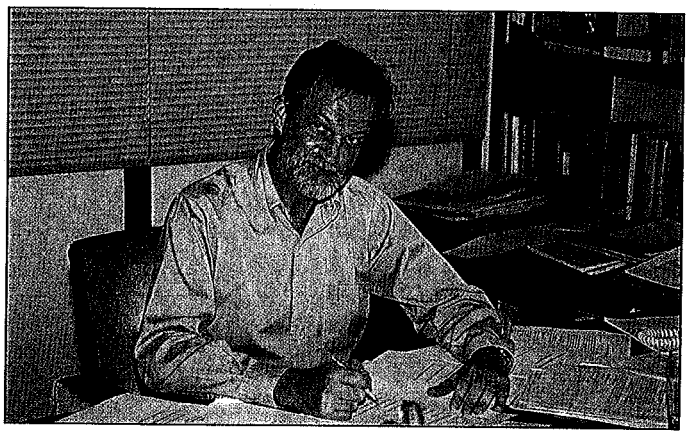
Director General's Message



A little over ten years ago—in June 1984—the first Director General of the International Irrigation Management Institute (IIMI) took up residence in Sri Lanka and launched the operations of the Institute. Now IIMI is simultaneously celebrating its first ten years of existence and preparing for its next decade of work at a time when concern about food security for the twenty-first century is growing throughout the world. IIMI is undoubtedly at a critical crossroads in its evolution, and has chosen to reflect in this special issue of the IIMI Review on several questions that relate to its past and may help direct its future.

The last ten years have seen dramatic changes in irrigation development and management. In the early 1980s, farmer participation was at best a topic for discussion at international conferences; today governments from Mexico to Indonesia are not only taking farmer participation seriously—but enacting legislation as fast as they can to turn over large numbers of irrigation systems from the public sector to farmer management. Careful assessment of performance, though not yet a day-to-day irrigation management practice, is given a much higher priority by irrigation practitioners than it was a decade ago. The irrigation community's awareness of environmental concerns has been greatly enhanced, especially in the wake of the 1992 meeting of the United Nations Conference on Environment and Development (UNCED), and the importance of such issues as salinity and waterlogging is no longer debated. Overall, the scope of international agricultural research has broadened to include environmental and natural resource issues. For example, the Consultative Group on International Agricultural Research (CGIAR) now includes not only IIMI but also several other centers which focus on natural resources management in relation to agricultural production.

In response to these changes, the Institute has initiated two major programs, on Performance Improvement and Assessment, and on Local Management of Irrigation, to help develop performance monitoring systems as an operational tool for managers and to support governmental efforts to turn over public irrigation systems to farmer management. Environmental matters are now formally recognized as a major crosscutting topic. And following IIMI's membership in the CGIAR system in 1991, the Institute has made deep changes in its strategy and organization, and shifted the focus of its mission from irrigation systems to irrigated agriculture.

As global change escalates, the next decade will undoubtedly see even more dramatic developments in the management of irrigated agriculture. Projected population increases coupled with increases in consumption resulting from rising incomes will combine to substantially increase the demand for food in developing countries. This increased demand will take place as the availability of water for agriculture decreases. Water will become an increasingly precious commodity competed for by multiple users; water conflicts, already begun, will grow in number and severity. The world will face a major dilemma: how to increase and sustain the productivity of irrigated agriculture while reducing the sector's water consumption. Producing more food with less water—and at lower financial and environmental costs—will be a major challenge for the twenty-first century.

This issue lies at the heart of IIMI's plans for the future. Research on producing more food with less water at lower financial and environmental costs involves IIMI in partnerships with many other groups, including sister CGIAR centers. Serendipitously, this kind of partnership is precisely what is envisaged in the "new" CGIAR, which anticipates a growing future focus on key issues of global significance requiring inter-center, interdisciplinary and interregional collaboration.

We look forward to comments from our readers on the articles in this special tenth anniversary issue of the IIMI Review. Your ideas will help us to be sure that our work is covering the highest priority issues for the future of irrigated agriculture in the developing world.

Roberto L. Lenton

Roberto Lenton
August 1994

Demand and Supply of Foodstuffs up to 2050 with Special Reference to Irrigation

M. Yudelman

This is an abstract of a paper commissioned by IIMI in 1993. It analyzes the demand and supply of food in the developing countries up to the year 2050. The paper also includes a discussion on the scope and importance of irrigation, the problems in implementing irrigation projects, and the prospects of further expansion of irrigated agriculture.

Introduction

Projections of future demand and supply of food over the next half century are exercises in "futurology." Projections of demand are based on population growth, income growth and income elasticities. The World Bank provided their best estimates of income and population growth over the next fifty years with the warning that their projections are speculative at best. The projections about supplies also involve conjecture about changes that might occur.

Most of the recent rapid increases in food production have come from increased yields per hectare. In the future, there will be greater pressure to increase yields if demand is to be met from domestic resources. Based on present technologies, it will be difficult to increase yields in Africa and Asia to meet projected food demands by 2050. Without technological advances, especially in rice and wheat production, these regions will almost certainly become larger grain importers. However, major breakthroughs in biotechnology maybe attainable, allowing the genetic potential of the major cereal crops to be increased.

Assured water supplies are essential for raising yields. Except for parts of the Middle East and North Africa, water is not yet a constraining factor in the expansion of irrigation. Nevertheless, sustaining past levels of expansion in irrigation will be problematic. Consequently, greater emphasis will have to be made on using existing water supplies more effectively than at present if yields are to be increased in the future.

Thus, the two major conclusions of this study are that yields of the major cereals will have to increase substantially and that water will have to be used much more efficiently than in the past. The intensification of agricultural production to attain these objectives will lead to greater environmental stress. Balancing the need to increase output with safeguarding the environment will make the task of raising yields more difficult rather than less difficult in the years ahead.

Population Growth

The population of the world has doubled over the last fifty years, rising from 2.5 billion in 1950 to almost 5.3 billion in 1990. During this period, population growth was estimated to be 2.3 percent per year in poor countries and 0.5 percent per year in rich countries. Between 1950 and 1990, the proportion of the world's population living in the poor countries has risen from 60 percent in 1950 to 78 percent in 1990 (Population Reference Bureau 1992).

But, in a demographic transition, the rate of population growth is expected to fall steadily. Projections by the World Bank suggest that the global rate of population growth will average 1.60 percent per year between 1990 and 2000, drop to 1.12 percent between 2000 and 2010, and level out at about 0.83 percent for the following twenty-five years. As shown in Table 1, most of the increase in population will occur in the developing countries. The largest increases are expected in Asia while the most rapid increases are expected in Sub-Saharan Africa.

Thus, contrary to projections made in the early 1970s of increases of 2.6 percent a year by 1990 (Yudelman 1973), population growth rates are now declining. The supply of food, nonetheless, will still need to increase substantially to feed the anticipated rise in numbers of people of 3.1 billion between 1990 and 2025, and 1.6 billion between 2025 and 2050.

Nutrition

The most widely used specifications for a diet that meets basic nutritional needs are those prepared by the FAO-WHO Consultative Group on Nutrition. Based on this group's recommendations for calorie allowances, an average per capita allowance of around 2,200 calories per day is required to meet basic needs.

In 1990, the average daily per capita availability of calories in the developed countries was in excess of 3,400 calories per day. In the developing countries, the average was estimated at 2,400 calories per day,

Table 1. Total population, annual increase and growth rate for the world, less-developed countries and more-developed countries.

Year	World	Less-developed countries	More-developed countries
Total population (millions)			
1,990	5,285	4,074	1,211
2,000	6,204	4,939	1,265
2,010	7,112	5,808	1,304
2,025	8,415	7,078	1,336
2,050	10,035	8,716	1,310
Annual increase (millions)			
	World	**Less-developed countries**	**More-developed countries**
1990-2000	92	86	5.0
2000-2010	90	87	3.9
2010-2025	87	85	2.0
2025-2050	65	65	-
Growth rate (percent)			
	World	**Less-developed countries**	**More-developed countries**
1990-2000	1.60	1.92	0.44
2000-2010	1.37	1.62	0.31
2010-2025	1.12	1.31	0.16
2025-2050	0.83	0.83	-

Source: World Bank.

and 25 developing countries had an average of less than 2,200 calories per person per day and only nine had an average of less than 2,000 calories per day (Table 2). This was a considerable advancement over the figures for the early 1960s when 74 developing countries had an average food availability below 2,200 calories per person per day, and 40 developing countries had an average food availability below 2,000 calories per person per day.

It appears reasonable to assume that today there are about one billion people, close to 20 percent of the world's total population in 1990, who are undernourished. Close to 800 million of the ill-nourished live in developing countries, about 60 percent of which fall into the category of being seriously affected by malnutrition. According to the latest FAO world food survey, the most significant numbers of calorie-deficient consumers live in Asia and in Africa.

The adequacy of any supply of food, however, depends on the composition of individual diets. The FAO has estimated that the global food supply today is more than adequate to meet the basic needs of the global population. If all the available food was distributed equally, supplies could currently support thirteen percent more than the world's present population. But the world's food supply is not evenly distributed, despite recent progress in increasing supplies, and there are still a number of countries that do not have an adequate supply of food to meet pheir basic needs.

If there are no transfers of grain to calorie-deficient areas, there will have to be a substantial increase in the supply of calories to accommodate existing shortfalls and to take into account of the needs of the growing population. The anticipated increase in population of 86 million people a year between 1990 and 2025 would require an average increase of around 17 million tons of grain a year. The projected increase between 2025 and 2050 would require an average annual increase of around 13 million tons a year. Furthermore, if the current deficit of 26 million tons of grain a year is to be erased, there will have to be a sharp increase in production, perhaps as much as 4.9 percent a year, during the period 1990 to 2000. This level would decline to 4.4 percent per year up to the year 2025 and drop again to under 4 percent beyond 2025. The current levels of global food production show an increase approximating 3 percent per year.

The current mechanisms of food transfers rely on markets. Consequently, for calorie-deficient people to acquire food for their needs, they must not only have access to food but they must also have sufficient income to purchase their requirements. As economic growth leads to changes in consumer incomes, the demand for food in the developing countries, and changes in composition of the demand, will increase.

The most important component in the food basket in the developing countries is cereals, which includes rice, wheat, corn, millet, sorghum, rye and barley. Close to 52 percent of the global food supply of cereals is grown in the developing countries, including 94 percent of the world's supply of rice, 50 percent of the world's wheat supply, and around 40 percent of the supply of coarse grains. "Bennett's Law" states that the "staple ratio,"

Table 2. Estimated food availability (kcal/person/day) for selected time periods.

	1961-63	1969-71	1979-81	1988-90	Percent change	
					1961/63-1988/90	1979/81-1988/90
World	2,296	2,434	2,587	2,697	17.5	4.2
Developing countries	1,939	2,106	2,319	2,474	27.6	6.7
Africa	1,995	2,046	2,148	2,205	10.5	2.6
Latin America	2,374	2,514	2,675	2,689	13.3	0.5
Near East	2,233	2,398	2,793	2,924	30.9	4.7
Far East*	1,966	2,049	2,185	2,445	24.4	11.9
China	1,701	2,005	2,323	2,645	55.5	13.9
High-income countries	3,063	3,229	3,333	3,404	11.1	2.1
Western Europe	3,086	3,233	3,371	3,452	11.9	2.4
North America	3,190	3,370	3,487	3,603	12.9	3.3

*Far East excludes China.

Sources: Based on FAO data; Pinstrup Andersen *in* Global Perspectives for Food Production and Consumption, IFPRI 1992.

which is the proportion of calories an individual derives from basic staples, declines with rising incomes. Projections by the World Bank suggest that the demand for all types of cereals will increase by 2.5 percent a year between 1990 and 2000, and with rising incomes, fall to 2.3 percent a year for the succeeding twenty-five years. I suggest that these figures are rather conservative and estimate that demand for cereals could well rise to 3.3 percent between 1990 and 2000 before dropping to 2.3 percent between 2000 and 2035 (Table 3). For wheat, it is anticipated that demand will drop from 3.5 percent between 1990 and 2000 to 2.5 percent between 2025 and 2050. Demand for coarse grains is expected to increase from 2.0 percent to 3.0 percent during the period 1990 to 2000 and fall to 3.0 percent between 2025 and 2050, while demand for rice will steadily fall from 2.7 during 1990 to 2000 to 1.5 percent by the year 2025.

Food Supply

Data from the FAO have shown a steady increase in food production between 1960 and 1990. In the developing countries, per capita outputs of food and agriculture have been increasing at around 3 percent, a rate in excess of pkpulation growth. There have been, though, striking differences in per capita output among the major regions of the world, most notably between Asia and Africa. While the per capita production in Asia rose to 40 percent by 1990, production in Africa dropped by more than 25 percent in the same period.

World trade in agricultural production grew rapidly between 1980 and 1990. The developing countries supplemented their domestic supplies by increasing imports by some 26 percent. Imports of food in 1990 exceeded exports of food by some US$8 million. Cereal, largely wheat and coarse grains, constituted an important component of food imports. The biggest increases in imports, by volume, were in the Middle East and North Africa where the oil boom led to substantial increases in demand for these cereals at a time when domestic production was very modest. Rapid economic growth resulted in heightened imports in East Asia while shortfalls in Sub-Saharan Africa encouraged greater imports into that region. At the same time, South Asia decreased its imports of cereals in response to improved domestic production. I assume that the proportion of cereal imports will not grow substantially in volume over the next thirty or forty years. Instead, governments will look to domestic supplies to provide most of the basic staples, just as they do at present.

Over the last thirty years, agricultural production has shifted its sources of growth. Prior to 1950, most of the increased production came from bringing additional acreage into production. Techniques such as shifting cultivation with reliance on land rotation to restore the fertility of the soil were widely practiced. However, since the 1950s, rising yields per acre have become a more important source of increasing output than expanding acreage. According to recent studies by the International Food Policy Research Institute (IFPRI), between 1960 and 1970, 70 percent of the increase in production of major food crops was attributed to yield increases, and from 1970 to 1980, 80 percent came from yield increases. Most recently, the World Bank estimated that 92 percent of the increases in cereal production in developing countries arose from increased yields (World Bank 1992a).

Increasingly, developing countries are following Western European and Japanese production systems by continuing the shift from land-extensive agriculture to land-intensive agriculture. These systems are dependent on external inputs and on the development of cost reducing technologies. Future increases in output will have to come from the same sources, but with even greater emphasis on yield increases. But the critical question which remains to be answered is, can technology continue to provide the increasing yields required in the future? This question is further complicated by concerns about the sustainability of agricultural development in the developing world, the shortage of available and suitable land, and the availability of adequate water supplies to meet projected future requirements.

Water Supplies

Water is one of the most abundant resources on earth. Ninety-seven percent forms the oceans and 2.2 percent exists as ice and snow in the polar regions. About 0.7 percent of the global supply of water is available as freshwater for domestic, industrial and agricultural purposes, and it is unevenly distributed.

The combination of uneven distribution and rapidly expanding population is putting increasing pressure on available water resources in a number of countries. An informal "yardstick" of water availability based on World Bank experience is that "when available water resources are between 1,000 and 2,000 cubic meters per capita per year, large investments are generally required to meet water demand. However, when water resources are below about 1,000 cubic meters per year, it takes difficult socioeconomic adjustments to cope

Table 3. Growth rate in demand for cereals in developing countries, 1960–2050.

Year	1960-70	1970-80	1980-90	1990-2000	2000-2025	2025-2050
All cereals	3.6	3.9	2.5	3.3	2.3	2.2
Wheat	4.1	5.8	3.7	3.5	3.0	2.5
Coarse grains	3.7	3.5	2.0	3.0	3.2	3.0
Rice	3.3	2.9	2.1	2.7	2.0	1.5

Sources: World Bank, FAO, CIMMYT, IRRI, TAC, and author's estimates.

with such scarcity" (World Bank 1992b). By one count, in 1990, 18 countries had water availability of less than 1,000 cubic meters per capita per year. Nine of these, all lying in the Middle East, had less than 500 cubic meters per capita (Gleick 1992).

It is anticipated that an increasing number of countries will have severe water shortages and face difficult socioeconomic adjustments by 2025. Most of these countries will be in Africa and the Middle East. Projections suggest that the two most populous countries in the world, China and India, will have adequate water supplies while Pakistan, one of the major users of water for irrigation, will be facing shortages. These measurements are, however, macro-indicators of water availability. They do not reveal anything about the availability of water and the location of populations. Consequently, although China and India have ample supplies of water relative to population at the macrolevel, there are many localities within these countries where demand is already putting pressure on existing supplies.

One of the issues which is becoming increasingly important is the competition for water resources between the agricultural sector and industrial and urban consumers. Urbanization is proceeding very rapidly and is expected to increase by 2.5 billion people by 2025, when 60 percent of the population in developing countries will be urbanized. These people will require the same amount of water which would be needed to irrigate 25 million hectares (around 15 percent) of the total irrigated land area in developing countries. To alleviate the pressure on the available water supplies, more efficient use of water in the agricultural sector will be needed.

A relatively small percentage increase in the efficiency of water use in the agricultural sector can contribute significantly to meet the growing demands of municipal and industrial use. For example, as little as 30 percent of the water applied may be used by crops in traditional systems while modern schemes such as drip irrigation achieve efficiencies of around 65 percent. In a typical situation where say 80 percent of the available water is used for agriculture, a 10 percent increase in efficiency in irrigation would provide 50 percent more water for municipal and industrial use. To do this, however, would require a holistic approach to the management of the overall demand for water. The requirement for water-short countries to take up this holistic approach will become increasingly important in the future as an effective means to meet the increasing demands for scarce water resources.

The current levels of global food production show an increase approximating three percent per year.

A further issue of significance bearing on the availability of water is the extent to which some countries rely on "exogenous" water supplies, that is, supplies of water that come from rivers emanating outside of their borders. The Danube, Euphrates, Indus, Nile, Mekong and Tigris rivers all provide water for more than one country. Such examples illustrate the point that the irrigation systems in a number of countries depend on the effective functioning of international treaties. The future development of many countries in Africa are inhibited by the lack of agreed-upon policies for allocating international water resources. Resolving these difficulties will require unprecedented cooperation among various nations. While this may appear problematic, the division of the Indus waters between India and Pakistan may well point the way to the future.

Land Supply

According to FAO estimates, the total land area of the world is estimated at around 13 billion hectares. Of the 7 billion hectares in the developing countries, only about 11 percent of the land area is used for crop production even though, between 1975 and 1990, an additional 46 million hectares were brought under cultivation. There is steady conversion of land into crop land, and a recent study by the World Bank (Crosson and Anderson 1992) has suggested that there is still substantial scope for expansion of land that could be used for crop production. It is suggested that 1.3 billion hectares or 90 percent of the potential new crop land is located in the developing nations. Of this, 95 percent lies in Africa and South America while the remaining 5 percent lies in Central America and the Middle East. Virtually no land is available for expansion in Asia.

Not all of this land, however, will be fully available for agricultural expansion. The most significant constraints to putting this land to use include degradation, salinization and waterlogging. The single most

important cause of degradation is overgrazing by livestock, although deforestation, land-clearing activities and unwise agricultural practices have been contributory factors in the process.

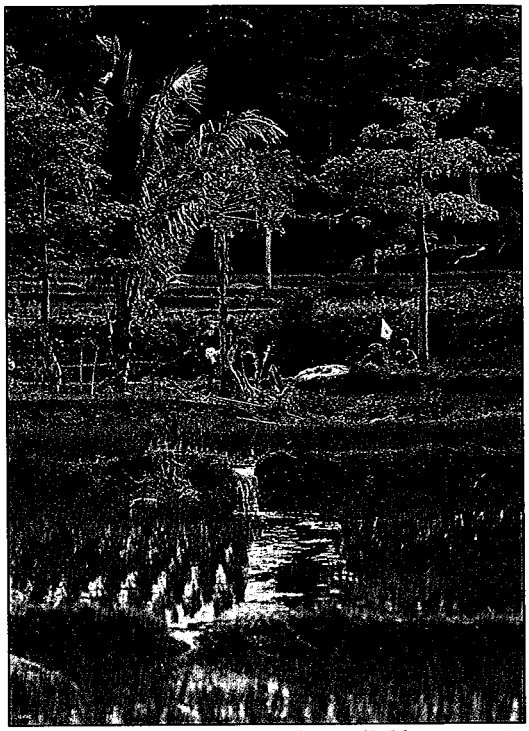
The most serious examples of degradation are found in Africa. As much as 22 percent (494 million hectares) of the region's vegetative cover is degraded. Fortunately, only around 1 percent of this area has been degraded to a point where the land has lost its productive value.

Salinization is a particularly serious problem in the drier areas, especially where there is irrigation. The large quantities of water used for irrigation bring in a corresponding larger amount of salts. Since there is low rainfall, the leaching process of the accumulating salts is inadequate. Salinization is said to be expandinc at a rate of 2 to 3 million hectares a year but since irrigation is said to be expanding at a similar rate, there may well be no effective increase in productive land under irrigation.

Other constraints to agricultural expansion include the difficulties over land rights and economic barriers such as high costs of transportation, land clearing and development. Although there appears to be substantial areas available for expanding crop production in Latin America and Africa, there are very significant constraints which will impede this development in Asia and the Middle East, and it is anticipated that more than 90 percent of the increases in production will have to continue to come from higher yields.

Technology and Yields

The substantial increases in crop yields which have occurred in the latter half of the twentieth century have been largely brought about through the "application of science" to agriculture. This has included the development and utilization of chemical or organic fertilizers and pesticides, and selective breeding whereby successive generations of varieties have been bred incorporating such desired qualities as shorter maturation periods, improved resistance to diseases and pests, and adaptation for different environments. These enhanced yields are the consequence of increasing the ratio of grain to straw rather than increasing the biomass itself.



To alleviate the pressure on the available water supplies, more efficient use of water is needed.

High-yielding varieties and other inputs have been adopted by increasing numbers of farmers in the tropics. Starting from a low base in the 1960s, the use of improved seeds spread widely. By 1991, around 80 percent of the national wheat and rice areas and 50 percent of the corn areas in the major producing countries were planted with improved seeds. It has also been estimated that as much as 90 percent of the irrigated and well-watered areas in the major producing countries were planted with improved varieties of wheat and rice (author's estimates). In many of the non-irrigated areas, the traditional varieties are better suited to the environment; and weather-related uncertainties make it risky for farmers to purchase those inputs needed to obtain high yields. Over time, however, many farmers in all environments have continued to replace the initial improved varieties with "upgraded" varieties. This introduction and spread of the new varieties, along with the increase in the use of fertilizers, pesticides and the spread of irrigation, have contributed to the increase in average yields of the major cereals, especially wheat and rice.

The rate of increase in average yields in the world as a whole has been impressive. For example, yields of wheat rose by 3.1 percent per year in 1960 to 1970, 3.5 percent per year in 1970 to 1980, and by 4.2 percent between 1980 and 1990. Yields of rice rose by 2.7, 1.7 and 2.5 percent, respectively, over the same periods, while yields of coarse grains rose by 3.5, 2.5 and 1.5 percent. Overall, the average annual increase in yields of cereals over the last three decades has been 2.6 percent a year (Table 4).

Whether the application of these technologies to agriculture can continue to provide the basis for sustaining high rates of growth in yields is uncertain. The application of biotechnology, especially genetic engineering, is said to hold a promise. However, there is a lot of speculation and uncertainty as to when agricultural biotechnology will begin to make an impact. Genetic engineering is expected to produce virus-resistant varieties of rice not much later than the year 2000, and fungi- and virus-resistant wheat may take only a few years more. The time frames for developing agricultural diagnostics, genetic mapping, particularly for such traits as drought resistance and salinity, are hard to predict. For the foreseeable future though there will have to be continued reliance on traditional plant breeding to develop higher-yielding varieties of the main food crops. This implies that there be sustained support from agricultural research in the tropics.

Table 4. Contribution of increases in area and in yields to growth of cereal production, in developing regions and in high-income countries, 1961–1990.

Country group	Increase since 1961-1963 (percent)			Current yield,
	Total	Attributable to area increased	Attributable to increased yields	1989–90 (tons/ha)
Developing countries	118	8	92	2.3
Sub-Saharan Africa	73	47	52	1.0
East Asia	189	6	94	3.7
South Asia	114	14	86	1.9
Latin America	111	30	71	2.1
Middle East and North Africa	68	23	77	1.4
Europe and former USSR	76	–13	113	2.2
High-income countries	67	2	98	4.0
World	100	8	92	2.6

Source: World Bank, World Development Report 1992.

Irrigation

According to FAO, there were close to 868 million hectares of arable land in use in the developing countries as a whole in 1989/90, and 173 million hectares or 19.9 percent of this arable land was irrigated. The distribution of irrigated lands is heavily concentrated in Asia with 131 million hectares or 78.2 percent of all irrigated land in the developing countries. The Middle East and North Africa have 18.6 million hectares or 10.7 percent of the irrigated area, Latin America and the Caribbean have 14.07 million hectares or 8.1 percent of irrigated area, while Sub-Saharan Africa has 5 million hectares or only 3 percent of the irrigated land in the developing countries (Table 5).

Estimates suggest that less than half of the irrigation in developing countries is in the humid tropics. In these climatic zones, agriculture usually requires supplementary water from irrigation when it is not available in the crop growing season. This supplementary water makes it possible to attain high annual yields with double, or even triple, cropping per irrigated hectare. At the other end of the climatic spectrum, the arid and semiarid tropics and the cool subtropics with winter rainfall in the Mediterranean Region of the Middle East and North Africa, lies the remaining 50 to 55 percent of the irrigated area. In these climates, it is too dry to have any intensive cropping without irrigation. While irrigated systems in the humid tropics differ from those in the semiarid tropics, both have one important common impact on agricultural development. By providing regular and timely supplies of water, irrigation reduces the risk of crop losses from uncertain rainfall. This encourages farmers to invest in land improvements and to use "purchased inputs" to increase production. The expansion of irrigation has gone hand in hand with the spread of modern varieties of seed, and the widespread use of fertilizers and pesticides. In addition, in many areas, the expansion of irrigation has provided a basis for the growth of investment in "off-farm" related agro-industries and distribution facilities.

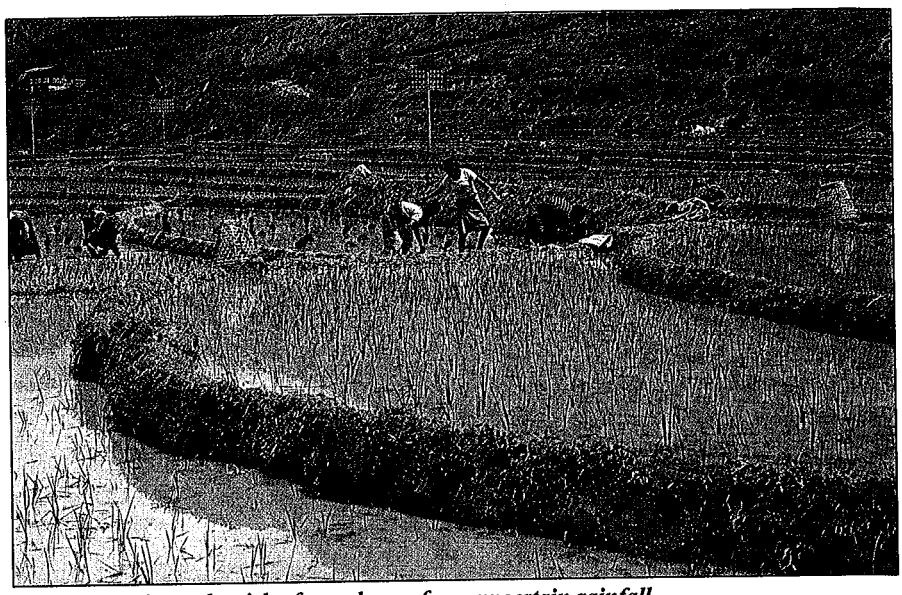
Irrigation schemes can be diverse and vary greatly in size and scope. The range can be highlighted by contrasting the situation in the Indus Basin in Pakistan with that in parts of West Africa. Pakistan possesses the world's largest contiguous surface distribution system, comprising the Indus River and its major tributaries, 3 large storage reservoirs, 19 barrages, 43 main canals, 12 link canals and about 89,000 watercourses. The total length of the canal system is about 58,300 km of conveyance facilities. Watercourses from channels and field ditches amount to more than 1.62 million km in length (Ahmad and Kutcher 1991). In all, the 16 million hectares of canal-commanded areas provide water for millions of farmers who are linked together by being part of a distribution network that is largely controlled by a centralized management system.

In all of Sub-Saharan Africa, only about 5 million hectares are irrigated (less than one third the area in Pakistan) and this area consists largely of small-scale schemes that rely largely on conserving water that comes from short, heavy seasonal rainfall. Irrigation is usually based on water harvesting, using earthen or stone bunds to trap water, to provide moisture to irrigate very limited perimeters, seldom more than one or two hectares in area. The irrigated

Degradation, salinity and water logging are the most significant constraints to agricultural expansion.

perimeters are widely dispersed and are used for grain, vegetable and fruit production with very little in the way of purchased inputs. There is little organized control or management over a dispersed irrigation effort (Yudelman 1991).

There is a large number of different irrigation schemes in Asia, Latin America and Africa. These schemes take many forms and embody a wide range of systems that rely on impounded surface water, run-of-the-river approaches, or water lifted from aquifers. There has been a significant development in irrigation technology, especially in Asia, in recent years, with the widespread use of small power-driven pumps to lift water from aquifers, canals, and rivers for use on agricultural plots. The use of these pumps has been important in improving water use and efficiency and even in encouraging the use and marketing of water for irrigation. However there is a growing need to ensure the "pump revolution" does not deplete the natural resource base by drawing down available underground water supplies.



Irrigation reduces the risk of crop losses from uncertain rainfall.

Table 5. Developing countries with an irrigated area of more than 100,000 ha.

	Irrigated area in '000 ha	Percentage of cropped land that is irrigated		Irrigated area in '000 ha	Percentage of cropped land that is irrigated
East + South Asia			***Latin America***		
China	45,349	47	Mexico	5,150	21
India	43,039	27	Brazil	2,700	3
Pakistan	16,220	75	Argentina	1,760	5
Indonesia	7,500	36	Chile	1,265	29
Thailand	4,230	20	Peru	1,250	33
Bangladesh	2,738	24	Cuba	896	26
Vietnam	1,830	28	Ecuador	550	20
Philippines	1,620	19	Colombia	515	10
South Korea	1,400	64	Venezuela	264	9
North Korea	1,353	50	Dominican Republic	225	15
Myanmar	1,010	10	Bolivia	165	5
Nepal	943	28	Guyana	130	26
Sri Lanka	560	29	El Salvador	120	16
Malaysia	342	7	Costa Rica	118	22
Laos	120	13			
Middle East + North Africa			***Sub-Saharan Africa***		
Iran	5,750	30	Madagascar	900	29
Afghanistan	2,660	33	Nigeria	865	3
Egypt	2,585	100	Zimbabwe	220	8
Iraq	2,550	47	Mali	205	10
Turkey	2,220	8	Senegal	180	3
Sudan	1,890	15	Ethiopia	162	1
Morocco	1,265	14	Tanzania	155	3
Syria	670	12	Somalia	116	11
Saudi Arabia	435	15	Mozambique	115	4
Algeria	336	5			
Yemen	310	21			
Tunisia	275	6			
Libya	242	11			
Israel	214	40			

Source: FAO Production Yearbook 1990.

Contribution of Irrigation

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. 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 (28.5 percent of the value of all production) was produced on irrigated land. More than 30 percent of all food production (valued at around US$96 billion) was grown under irrigation. Perhaps, irrigation's largest contribution to both consumers and producers is that an estimated 46.5 percent of all grain and 57 percent of the total value of the most widely grown basic staples (rice and wheat) were produced under irrigation (Table 6).

On a regional basis, it is estimated that around 60 percent of the value of crop production in Asia is grown on irrigated land. This includes about 80 percent of Pakistan's food, 70 percent

Table 6. Estimates of values of food and agricultural crop production and percentages grown on irrigated land in developing countries, 1988-89.

	Value (US$ billion)		Percentage grown on irrigated land
	Total	Irrigated	
All crops	364.2[1]	104.1[2]	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

[1] TAC.
[2] Author's estimates.

of China's food and over 50 percent 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 the 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 percent, is grown under irrigation, but half of the crops grown for export in Chile and Peru are irrigated. Madagascar produces more than 20 percent 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 percent of its total food production on irrigated land.

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 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 total food output, especially in Asia.

Expansion of Irrigation

There has been a rapid expansion of land under irrigation, especially in the 1960s and 1970s, though in recent years the rate of expansion has slowed down. Between 1960 and 1990, the land area under irrigation rose by 74 million hectares with the total under irrigation reaching 174 million hectares by 1990. The largest increases were in Asia where irrigated area, mostly in Pakistan, India and China, increased by 60 million hectares.

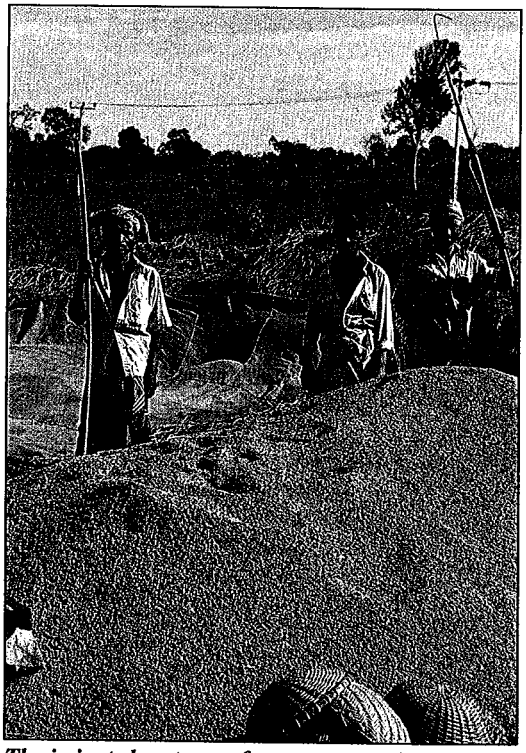
Recent trends suggest that it is unlikely that past high rates of irrigation development will continue. An important reason for the slowing down of investment in expanding irrigation has been the unfavorable economic outlook for new irrigation projects, especially for large-scale surface irrigation projects. There is a general view that most of the "best" sites with "low-cost opportunities" for impounding water for redistribution have been exploited. For example, between 1966 and 1988, real capital costs for the construction of new irrigation systems in Asia have risen by between 70 percent and 160 percent per hectare. At the same time, the value of agricultural output from many of the large-scale irrigation projects has not increased, and in some cases has actually declined compared with earlier periods. This is most evident in the case of rice, the most widely grown of all crops under irrigation.

The decline in investment in new irrigation projects is leading to a paradoxical situation: more irrigated land will be required to meet the increasing demand for food; however, if investments are to be guided by the economic criteria used at present, then these investments may not be forthcoming. Given the long lead time between planning a large project and its full implementation, this could lead to a situation of shortage in the future. If investment decisions were to include special allowances for promoting food security, then due account could be taken of the link between growth in irrigation and the future supply and price of rice.

There are other reasons for the reduction in investment in irrigation. Some of these include doubts about the success of past projects. These doubts include concerns about the environmental impact of dams and tubewells, degradation of natural resources, and the financial viability of past investments.

Problems in Implementing Irrigation Projects

There have been a number of evaluations, by bilateral and multilateral agencies and national governments, of the problems in implementing irrigation projects. Many of the issues raised by these evaluations have contributed to the reluctance to invest in expanding irrigation. In 1990, a World Bank evaluation looked at irrigation investments made in the 1960s, 1970s and early 1980s. This evaluation analyzed a number of Bank-supported irrigation projects from 5 to 12 years after completion of the funding of these projects. Included in the study were 21 irrigation projects in 14



The irrigated sector performs an essential task in meeting the basic food needs of billions of people in the world, especially in Asia.

countries initiated and implemented between 1970 and 1986. All were intended to increase food production and involved a total investment of some US$1.8 billion (World Bank 1991).

The general conclusions of the evaluation suggested that "though the projects were beneficial, they performed much less well than expected." Most of the projects had made important contributions to national food supplies, raised the income of low-income farmers and improved the average family income and standards of living of those working in the irrigation schemes. However, the impact on income distribution among the beneficiaries of these projects was mixed, depending in large measure on the patterns of landholding in the areas served by the projects; where the pattern was skewed, the distribution of benefits tended to be skewed. The projects also contributed to the enhancement of the physical environment by reducing the extent of periodic flooding, and by propagating fish and wildlife in and around some of the reservoirs that were constructed.

Despite these positive results, the evaluation pointed to a number of problems in the implementation of these projects which highlighted the larger concerns about the effectiveness of investment in irrigation. The "low" returns on capital, problems of operation and maintenance, low efficiency of water use, low levels of water charges and revenues, the spread of soil salinity and siltation, problems of health and resettlement of displaced persons have lessened the enthusiasm for expanding irrigation. These concerns also indicate some of the major issues that need further investigation and that have to be addressed to make existing systems more effective, a necessary requirement if yields are to be raised to meet the projected demand for food production in the years ahead.

Potential for Expanding Irrigation

There have been several estimates of the physical potential for expanding irrigation. Most of these estimates are based on criteria that center on agroclimatic conditions where controlling water would lead to increased output from productive but underutilized soils. The estimates that have been made suffer from the limitations of available data. There are wide differences in some of these estimates. For example, FAO estimated that there are 3.5 million hectares of land available and suitable for irrigation in Zambia while the World Bank estimated that the potential is only 12 percent of that amount or 420,000 hectares (Olivares 1987). Most of the estimates, though, agree that there is scope for expansion (though some countries, in areas such as the Middle East and North Africa, are beginning to reach the outer limits of expansion from available water supply).

There is potential for further expansion among the countries with the largest areas under irrigation. In India, an estimate made by the government in 1981 indicated that the ultimate potential for irrigation was 113.5 million hectares of which 45.6 million hectares were unexploited. This figure, however, did not include the potential for expansion from what would be very costly interbasin transfers of water from water-surplus areas to water-deficit areas, which could well add a further 25 million hectares to the total potential. Similarly, in China, there is still a potential for large-scale expansion of irrigation though far less than in India. China has the potential to irrigate 60 million hectares or around 25 percent above the current area irrigated. This does not include the potential from the south-north transfer of water from the Yangtze River Basin to the Yellow River. Nor does it include very large areas of degraded lands that could be made suitable for irrigation in the future.

There is also potential for expansion in many of the smaller countries of the world. A study that included seven countries in Sub-Saharan Africa concluded that from 4 percent to 67 percent of the irrigated area in each country was being exploited and that the irrigable area could be expanded fourfold. Within the region, only the Sudan is anywhere close to exploiting more than two thirds of its potential.

One comprehensive estimate of the overall potential for expansion in the developing countries prepared by the World Bank and the United Nations Development Programme (UNDP) concludes that there is scope for a 59 percent increase in area under irrigation in the developing countries as a whole (Table 7). The largest potential for increase (69 million hectares) is in Asia, especially in India

Table 7. Presently irrigated land and land with irrigation potential.

	Presently irrigated	Potentially irrigable	Potential increase
	1,000 ha		Percent
Less-developed countries	186,000	110,500	59
Global			
Africa	11,025	18,175	165
North	7,560	1,640	22
Sub-Saharan	3,465	16,535	477
Latin America	16,235	22,865	141
North and Central	7,035	2,865	41
South	9,200	20,000	217
Asia	58,380	69,420	44
Near East (Middle East)	18,315	5,185	28
Far East	40,065	64,235	46

Source: World Bank/UNDP (1990).

and China. This is followed by South America with 20 million hectares, mostly in Brazil. Sub-Saharan Africa has a potential to increase its irrigated area by more than 470 percent, from a reported 3.4 million hectares to 16.5 million hectares, the largest potential increase being in Angola. The most limited opportunities for expansion are in the Middle East, Central America and North Africa.

On the face of it, there appears to be considerable scope for expanding irrigation. Theoretically, an expansion of 110 million hectares could provide an additional 300–400 million tons of grain or enough to provide the basic diet for between 1.5 billion to 2 billion people. Based on current trends, though, this would require an investment of US$500–1,000 billion. Further, as is pointed out below, the potential appears to be inadequate to sustain recent rates of expansion beyond 2025.

The Irrigation Potential

The expansion of irrigation has been a major factor in the rapid growth of food production in 1960–90. During these years, the irrigated area grew from 100 million hectares to more than 170 million hectares. Irrigation has been especially important in the production of high-yielding varieties of rice and wheat (with 57 percent of the value of these two most important cereals being produced on irrigated lands). About half of the irrigated area is in the arid, semiarid or Mediterranean agroclimatic zones where there are limited alternatives for crop production without irrigation.

The expansion of irrigation has been impressive; but if past rates of increase in the expansion of irrigation are continued, phen the prospects are that the available potential will be exhausted well before 2050. This is most notable in the case of Asia, the region most dependent on irrigation for its food supply. Between 1960 and 1990, the area under irrigation grew from 87 million hectares to 147 million hectares, or at a rate of 1.82 percent a year; the rate of growth slowed down between 1980 and 1990 when the area under irrigation rose by 1.26 percent a year, from 129 million hectares to 147 million hectares. The World Bank/UNDP estimates that a potential exists to irrigate 228 million hectares. If irrigation were to expand at the same pace as it has over the past 30 years then all irrigation potential will be exhausted by 2015; if it expands at the much slower rate of the last decade then the potential will be exploited by 2025.

The prospects of a limitation on the expansion of irrigation in Asia is disconcerting as the increase in irrigation in that region has been one of the engines of agricultural growth. It is probable that rising costs will slow down irrigation expansion well before the limits are reached. This will raise the premium on improving the efficiency of all irrigated agriculture to meet future demand.

There is potential for increasing the area under cultivation in all the regions of the tropics. The biggest pressure for expanding irrigation is in the land-scarce countries of Asia where there are limited prospects for increasing yields in nonirrigated areas. All in all, it is probable that irrigation will expand at a slower rate than in the 1960s and 1970s but at a rate closer to that in the late 1980s, when the rate of expansion had slowed to an additional one to two million hectares a year. In this event, the area under irrigation will expand to between 205 million and 240 million hectares by 2025.

A slower rate of expansion of irrigation would make it necessary to improve the efficiency of existing irrigated systems if yields are to be increased as needed in the future. This will include improving the timeliness of irrigation deliveries to farmers, saving water through greater efficiencies in conveyance and ensuring that the saved water is redistributed to be used effectively, and reducing losses from salinity and waterlogging. The combined effects of improving efficiencies could lead to substantial production benefits. In the future too, improved conveyance efficiency will have to be accompanied by improved use of water at the farm level. Over the long run, this could well involve changing on-farm technologies as well patterns of production to use scarce irrigation water on less-water-intensive crops.

Conclusion

For decades, the world's destiny seemed bleak. The population bomb was ticking and the world's food basket seemed increasingly bare. Thomas Malthus' 200-year old warning seemed larger than life. That future is here now, and so far, food supplies have not, as Malthus predicted, been overtaken by human numbers. The population bomb has been defused and growth rates are beginning to decline. Technology has helped improve yields and the food basket seems half full rather than half empty. Unfortunately, the good news is not so good. The steadily improving human conditions that the world has taken for granted these last two decades could take a turn for the worse. Malthus' prediction still looms around the corner. The population growth rate might be declining but in real numbers the world will have another 4 to 5 billion mouths in another 50 years. The demand for food is increasing, albeit at a lower rate than in the past. Although the supply of foodstuffs is adequate to meet today's demand, production per person has stopped growing over the last 10 years. Most of the irrigable land has been exploited and funding for agricultural research has declined sharply in the last 5 years. Problems of land rights, nutrition, and distribution of foodstuffs further complicate the scenario.

The future places a heavy burden on governments and agricultural research organizations. Governments must fund and facilitate agricultural research institutions that, in turn, must utilize all available resources to the maximum advantage. Institutions such as the International Irrigation Management Institute (IIMI), have a mandate to help improve the

effectiveness of irrigation systems so that irrigated agriculture will make the fullest possible contribution to meeting the needs of the 8 to 10 billion inhabitants in the developing countries in the middle of the next century.

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2020 Vision—Dramatic Changes in the World Agricultural and Industrial Production Systems

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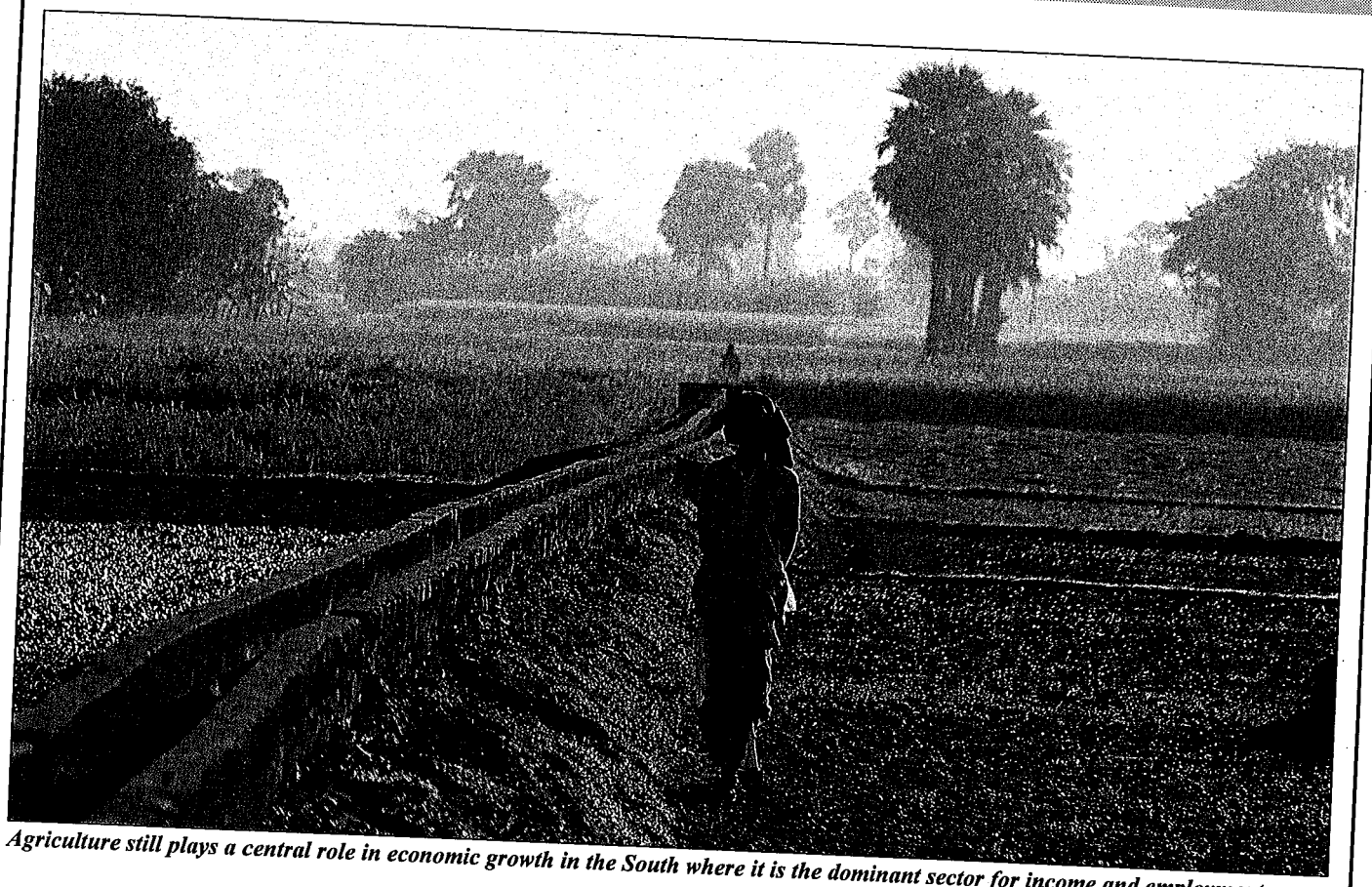
Food from the North, Goods and Services from the South

"In the conventional writing on economic development, it is generally assumed that the industrialized world will produce the manufactured goods and supply financial services and the developing world will produce the primary commodities.... I have just returned to England after spending six months travelling overseas and this experience has convinced me that the tropical and subtropical developing world will, in 20 or so years time, produce the bulk of the manufactured goods, and the temperate world will produce the bulk of the food." (Carruthers 1993)

This experience led to the development of a thesis that formed the platform for this paper. In essence, it was argued that we are seeing a switch in the global production base which will lead to the cities of the South producing the bulk of manufactured goods and services (e.g., routine banking, insurance, travel, software development, etc.) and the North supplying the bulk of their food; local food supplies will increasingly fail to satisfy Southern urban demand because of continuing rapid population growth of the cities. Expansion of area cropped is virtually finished; yield increases now depend mainly on institutional reform and management improvement which will be much more difficult to achieve than using new seeds and nitrogen fertilizer which provided the green revolution to wheat and rice. Public and private agricultural research in the North and the South, it was argued, will continue to receive diminishing resources, and new biotechnology appears to stumble along with few practical innovations and with growing consumer resistance. All in all the prospect for a second phase of the green revolution is remote (see Carruthers [1993] for the full text).

This thesis, would appear consistent with the views of a growing number of politicians, economists and others who argue for a shift of resources away from irrigation and indeed from other big agricultural or rural investments, in favor of urban priorities, especially, in the manufacturing and social sectors. They worry little about food imports and indeed see merit in trade-led growth as a precondition for poverty alleviation. Although industrial growth in the developing world is vitally important, we will claim in this article that continuing investment in irrigation and other agriculture developments are important components of any urban-based development strategy. We call for a recognition of the positive contribution of irrigated agriculture in terms of income, employment, and at least potentially, for environmental protection.

The argument presented below comprises three strands. First, that as the process of development progresses, the structure of an economy in terms of



Agriculture still plays a central role in economic growth in the South where it is the dominant sector for income and employment.

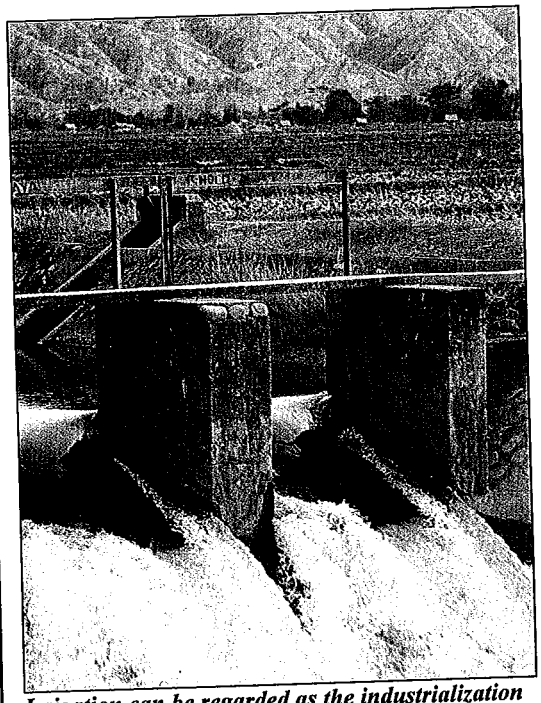
production, consumption, and trade changes markedly. Second, that the resulting changes in the relative proportions of the factors of production, both within and between countries, initiate important shifts in the comparative advantage of sectors within and between countries. Third, that a vibrant agricultural sector, which itself is dependent upon technological change, will stimulate and support the changes outlined above. Agriculture still has a central role to play in economic growth in regions within the South where it is the dominant sector for income and employment. Indeed, irrigation can be regarded as the industrialization of agriculture. The injection of capital and the intensification of production should produce a shift in the yields to a new plateau, releasing resources to support other elements in the economy.

The Sectoral Decline of Agriculture

Following research by Chenery and Syrquin (1975), it is now widely recognized that one indicator of a country's development is the *successful* transformation of its economy. Chenery (1979) defines transformation as the set of changes in economic structures required to sustain a continued increase in income. With regard to the agricultural sector, transformation is characterized by a declining contribution to GDP, a decreased proportion of the total workforce engaged in agriculture and a reduced proportionate contribution to external trade. Thus, implicitly, the manufacturing and service sectors' relative contributions increase. It is a serious mistake, however, to assume that the agricultural sector contracts in absolute size during this transformation or that it can be a passive sector, a resource reserve to be mined of its resources as urban needs grow.

The "Patterns of Development Approach" to analysis of change (after Chenery and Syrquin 1975) is a series of comparative studies of various countries which identifies similarities and differences in economic structures at different levels of development as denoted by the level of per capita income. These observations can then be analyzed to develop and test a number of underlying processes found in all countries undergoing development. Chenery (1979) used Kuznet's framework, which, by analyzing the elements of national accounts, measured changes in the sectoral composition of production, consumption, investment and trade as income rises.

The value of comparisons between countries can of course be exaggerated. Variation in social objectives, the choice of government policies, the country's resource endowments, country size with respect to trade, and access to external capital will inevitably cause the outcomes of the development processes to differ somewhat (Johnston and Kilby 1975). This makes it difficult to make generalizations about the South since its many countries are in different phases of development and on somewhat different pathways.



Irrigation can be regarded as the industrialization of agriculture.

The original analyses were, however, based upon the observation that the structure of the economy of countries at the same level of development, as characterized by per capita GDP, had a high degree of similarity. As per capita income increases, primary industry declines in relative importance. Average per capita GDP in the South rose by 2.7 percent per annum over the three decades to 1990. Asia, to which most of the research related, achieved growth rates of 5.7 percent in the 1970s and 7.3 percent in the 1980s, and, as might be expected, has seen faster growth in its industrial sectors than in its agricultural sectors. However, in Sub-Saharan Africa, similar growth rates have not been achieved, and the structure of the economies is roughly the same now as it was 30 years ago. What is the outlook for the next few decades?

The World Bank forecasts that over the next 40 years, the South's average income could triple in real terms from today's US$750 (as in Cote d'Ivoire) to about US$2,500 (similar to Mexico now, 1992 prices) (World Bank 1992). The Bank's report recognizes that substantial regional differences may persist. In East Asia, per capita income could increase to US$3,300, but in Sub-Saharan Africa, the regional outlook is much less optimistic and per capita income is likely to increase to only US$400.

The argument of this paper relating to change is therefore necessarily general in its interpretation recognizing that the rate of change in economic structures will differ across and within regions. The commentary also assumes a "favorable" (i.e., neutral) policy environment, but recognizes that some regions will take longer to undergo structural transformation because of unfavorable macroeconomic policies. In reality, some are at risk of never managing sustained GDP improvement.

What then are the implications for a country's comparative advantage in food production given that "industrialization," that is the relative growth of the manufacturing and service sectors, will occur as economic growth and per capita GDP increases? Within agriculture, will we see a parallel increased capitalization with increased use of fixed capital including irrigation equipment and increased use of variable recurrent investment such as fertilizer, crop protection and the rest? Will this investment be labor absorbing or labor displacing?

Changing Comparative Advantage

Neoclassical economics, presently the dominant theory supporting public policy in most of the world, suggests that within a country comparative advantage in a certain sector is determined by the domestic resource endowments. According to the primary model (Heckscher-Ohlin-Samuelson described in Ethier 1988), a country will export commodities requiring intensive use of the country's relatively abundant factors of production. For example, initially, a country with a low capital-to-land ratio will export primary commodities and, as capital accumulates, there will be a shift towards the production of more capital-intensive manufactured goods and, as described in the previous section, agriculture's relative contribution to external trade falls.

This transformation is likely to begin quite early in the development process when there are low levels of capital per labor unit. The first manufactured goods will be labor intensive, such as, textiles and clothing. As capital accumulates, so will the capital intensity of manufacturing, and we may see a shift in due course to the manufacturing of complex items such as cars. Indeed, by Rybczynski's Theorem, "at constant prices, an increase in one factor endowment will increase by a greater proportion the output of the good intensive in that factor and reduce the output of the other good" (Ethier 1988).

As industrialization begins, agriculture does not remain static. Investment in agriculture includes irrigation investment and this process is stimulated by the growth of effective demand—demand backed up by money—in the emerging urban sector.

But what about the comparative advantage between countries? The application of the theories of comparative advantage, when discussing the agricultural sector, is complicated. The theories rely upon assumptions of free trade and upon the validity of the free market assumptions of perfect information, lots of buyers and sellers, and homogeneity of products. It could be hypothesized that with the shift towards freer trade (post-GATT), better telecommunication, computer technology and so forth, then the information is more perfect, products are generally more standardized, and even copied. Thus, these assumptions are less farfetched than they at first appear. Capital is accumulating in many of the technologically more advanced developing countries and can be readily moved from North to South, and yet wage rates are still low due to the relatively large and growing work forces. Work forces of the South are

becoming more highly skilled and technology can migrate quickly and easily. It is therefore likely that in the future, comparative advantage in manufactured goods will reside in the South rather than in the North.

The real practical value of this theory of comparative advantage is difficult to assess, for the model assumptions are essentially static in nature but the questions we have posed are concerned with the long-run changes in comparative advantage. Long-run changes are more likely to be driven by the propensity to save and by population growth than by relative factor endowments. However, the concept of revealed comparative advantage has been found useful in examining the trade performance of individual countries.

Another interesting aspect of comparative advantage relates to technical change. The influence of technological advance upon trade is sometimes described in terms of a product cycle (Vernon 1966, discussed in Abbott and Thompson 1987). A new product, often highly technical, is developed in the North because of its comparative advantage in R&D (as characterized by the proportion of scientists in employment, the expenditure on R&D, the degree of product differentiation, etc.). The product is initially produced at home for the domestic market because direct communication between producer and consumer is essential to the development of the good. As development of the good proceeds and the good is perfected, production expands and an export market develops. Eventually, the good becomes standardized and constant communication between buyer and seller declines in importance relative to lower production costs. Production therefore begins to take place abroad where lower labor costs allow mass production, first displacing exports and then causing a reversal of trade, with imports going back into the original country (Ethier 1988). It is the speed of completion of the cycle which has increased since Vernon's observation. A new high-tech carbon fibre fishing rod maybe developed in Massachusetts, but nowadays as high-tech travels fast, it can be manufactured in Jakarta, to high quality standards perhaps a month later.

Within the agricultural sector, we also see technical change. The "green revolution" was essentially a seeds and fertilizer revolution that moved fast because the innovations were profitable, cheap to acquire and could be broken down into small-scale packages for on-farm trials. Today, we are in the middle of a plastic revolution shifting from the agriculture of the North to the South, with cheap plastic increasingly used to convey, apply and drain water, to mulch soils, and to package products. High quality products developed in the North such as mangetout peas, green beans, spring onions and fresh herbs are being grown all the year round in the South and air freighted for sale on supermarket shelves.

Agricultural export growth may not continue to flow from South to North. If we assume a simple, two-sector global economy, and if the South's comparative advantage does indeed change in favor of industry, the most intensive user of the country's relatively abundant resource, now capital (and/or urban labor), then agriculture, now has a comparative disadvantage. If the South then has a comparative advantage in the production of industrial goods, then by default, the North must have a comparative advantage in basic agricultural production.

This is all very well in principle, but such a shift in a region's production base is unlikely unless the relative profitability of production is favorable. The optimal pattern of production and trade for a country is determined by the relationships between the opportunity cost of producing a given commodity and the price at which the commodity can be imported or exported. Is it likely that the demand for food from the South for the North's exports of temperate food will rise to a degree as to make temperate food production and export profitable even in the absence of subsidies? Perhaps more importantly, will the South's consumers be able to pay for such imports?

Much of the future increase in production will have to come from increased yield rather than crop area.

Consumption and Production Trends

What evidence is there that the South will need to import more food from the North in years to come? To answer this question it is necessary to compare future consumption and production patterns.

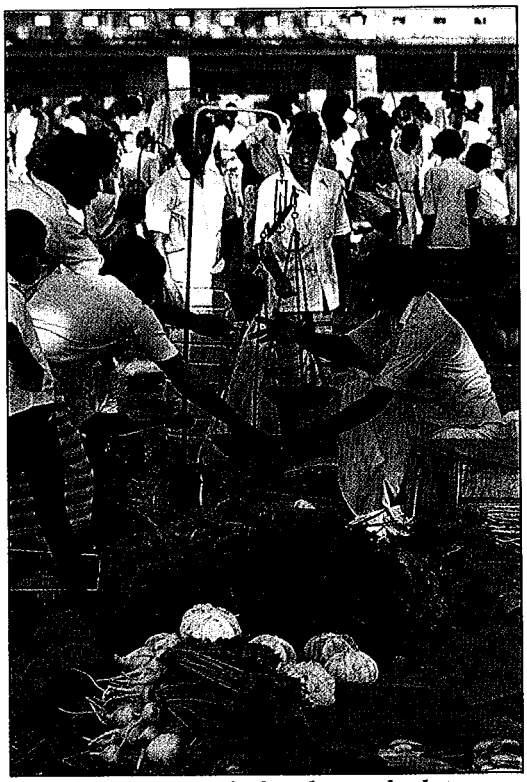
Over the past two decades, growth rates in consumption in the South have exceeded those in the North. Over the period 1970-84, world growth rate in consumption was running at 2.9 percent, with the OECD at 1.8 percent and LDCs at 4.0 percent, albeit from a low level. Thus the share of world consumption increased from 43.7 to 50.1 percent in LDCs and fell from 35.1 to 30.1 in OECD countries (Brown and Goldin 1992).

In addition, there has been a shift in the pattern of consumption from staples to animal products as incomes have risen.

The causes of the growth and shifts in consumption can be disaggregated into: (i) population growth, (ii) income growth, and (iii) income elasticities of demand for food.

Urbanization provides a focus for the discussion of the three criteria. Urbanization is in part a result of changing economic structure; manufacturing tends to be urban based and has thus created a new market for food. Traditionally, a large proportion of the population was engaged in subsistence farming. Urbanization has created new demand patterns. Urbanization in Asia is well documented, but even in Africa where urbanization has been relatively less apparent forecasts indicate that in 30 years' time there will be at least 30 cities with greater than one million inhabitants and several with populations of over ten million (World Bank 1989). This view is however contentious with other commentators seeing little evidence of this occurring and preferring the scenario of many relatively smaller cities (e.g., Trotter 1992).

The associated income growth in many urban areas has created additional demand. One commonly cited estimate is a 100 million tonne increase in cereal consumption for a one percentage point increase in the GDP growth rate of LDCs (Brown and Goldin 1992). In part, this is due to the increased use of cereal for animal feed, which the FAO predicts to rise even faster than direct consumption of cereals (a 5.5 percent increase per year as opposed to a 1.9 percent annual increase in direct consumption). Indeed, the share of total cereal consumption by livestock is forecast to increase from the current 15 percent to 24 percent by the year 2000.



Growth in the nonagricultural sector leads to increased demand for food.

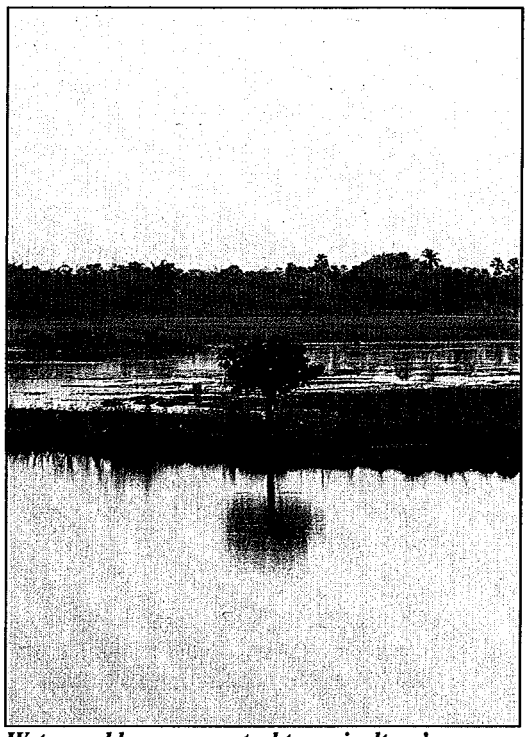
This is a result of the assumed higher income elasticity of demand for animal products than for basic foods. However, forecasting income elasticities is problematic. Generally, a national average is used which reflects assumptions about income distribution. But if we consider that the income elasticity of demand for cereals is high for the poor, moderate for middle-income groups, but high for the rich (a derived demand from grain-fed meat), the actual level of income distribution is very important. However, forecasters generally believe that overall consumption growth will decelerate to some degree (down to 3.1 percent per annum in LDCs and 0.8 percent per annum in OECD, to the year 2000), perhaps on the assumption of a deceleration in population growth rates.

It is harder to get agreement on production estimates. The data show that for the South as a whole, gross food production growth rates have exceeded population growth rates. However, as consumption demand is composed of more than that stimulated by increased population, it does not necessarily mean production has kept up with consumption demand. In addition, in the regions where in recent years domestic food production has exceeded consumption, this does not guarantee that it will be sustained in the future.

In the 24 years to 1985, gross food production grew at 2.5 percent per annum. This was primarily due to the green revolution technology, but there was a broad divergence within the South, and also across the range of cereals. For example, wheat production grew at an annual rate of 6.5 percent, as compared to coarse grain production which increased at only 2.1 percent per annum.

However, a significant decline in the rate of growth of LDC production is forecast to the year 2000 (Brown and Goldin 1992), as much of the future increase in production will have to come from increased yield rather than crop area. As recognized elsewhere (Carruthers 1994), much of the easy yield increasing gains, essentially a response to nitrogen, has already been achieved.

If these food forecast trends are borne out, there will be an increasing deficit within the South's food equation. Predictions about future food import requirements are difficult to establish, but the majority of forecasts fall within the range of 100 to 200 million tonnes of cereal by the year 2000, up from 65 million tonnes now (Brown and Goldin 1992). Beyond 2000, there is no basis for rejecting the assumption that the gap will widen still further. The imports will have to originate in the North which has the



Water problems are central to agriculture's difficulties.

proven production capacity and the appropriate mix of infrastructure, rural institutions and farm management skills to realize the production potential. Therefore, while most agricultural trade is currently between OECD countries, it will become increasingly dominated by exports from developed to developing countries.

Will the South be in a position to pay for the increased imports? Certainly, it will if the forecast of a trebling in per capita income occurs. However, this income rise is contingent upon the process of economic development continuing. While in many of the more developed countries of the South the process is in full flow, for many of the lower income countries the process has barely started and the barriers to growth are all too evident. We appear to be witnessing the reinforcing elements of successful economic growth and its reciprocal, the negative effects of the poverty trap.

The Role of the South's Agriculture

Development is creating the conditions for the emergence of a comparative advantage for the industrial sector of the South. This development will increase the demand for imports to the South to feed the growing cities and also enable them to pay for it. The potential for sustained development and hence rising income, especially in the early stages when agriculture is the largest sector of the economy, hinges critically on the ability of the agricultural sector to fulfil its traditional role and contribute capital and labor to the emerging industries.

Agriculture thus has a crucial role to play in promoting the shift in the production base, but the proportionately declining sector does not necessarily mean a contracting sector. Mellor (1973) states that there still needs to be 4–5 percent per annum growth in agricultural production to have beneficial effects on the economy as a whole. He discusses the differing effects of a stagnant, as opposed to vibrant, agricultural sector. He remarks that it is difficult to achieve continuous net resource flows from a technologically stagnant agriculture. If resources are invested productively in the nonagricultural sector, then growth there leads to increased demand for food and particularly so if more of the poor are employed. A highly inelastic supply from a stagnant agriculture leads to increases in the relative price of food and therefore resources flow back to agriculture where returns on investment have risen. However, this also makes food imports relatively more attractive and these imports (especially if subsidized in the country of origin) may prevent increased agricultural production. Growth in the nonagricultural sector could be inhibited by scarcity of foreign exchange if food imports are high.

Compare this to a vibrant agricultural sector with continuous technical change, including increases in irrigation effectiveness, which permits some expansion in demand for commodities to be met without higher relative agricultural prices. In this event, net transfers of resources from agriculture can take place to increase employment in nonagricultural sectors and there are no incentives to reverse the domestic terms of trade towards agriculture.

What is the scope for capital transfer from the agricultural sector to the rest of the economy, given that there has been some degree of capital formation in the agricultural sector?

According to Johnson (1991) there must be an increase in factor productivity if agriculture is to contribute to economic growth. Given that land and increasingly labor are the abundant factors in the early stages of the development process, Johnston and Kilby (1975) concluded that intersectoral productivity differentials are greatest at the beginning of the development process and narrow as income per capita increases. In addition, they noted that labor productivity is lowest in agriculture but grows at a faster rate phan in other sectors. Today, 5 percent of the worlds's farmers produce half of the world's food. These farmers reside in the North.

In the early stages of development, it is unlikely that the nonagricultural sector can expand to absorb all population growth and, therefore, the size of the agricultural labor force will increase (Mellor 1973). Mellor cites Dovring (1966), who argued that the farm labor force does not decrease in absolute numbers until fairly late in the development process. If labor fails to move out of agriculture in an optimal fashion then what are the implications for economic growth?

In the absence of a sustained increase in agricultural output, agricultural labor productivity will fall. If agriculture is to contribute to overall increased economic productivity, there has to be a marked rise in factor productivity, and land-saving and labor-absorbing techniques such as irrigation have an important part to play. This is particularly so given the rapidly rising populations of working

age and the unfavorable capital-labor ratios in manufacturing.

Research in the North shows that technical change does not necessarily mean more investment. Less than half the growth in the North can be explained by additional capital investment. Most economic growth comes from existing capital stock being used better through improved resource management. Emulating this experience and finding new and more productive ways to use existing facilities is the great challenge facing irrigation managers, farmers and all those involved in the production process today.

Getting higher productivity from the existing capital stock through improved ways of working, better management, enhanced education and training for all the workforce are ways in which irrigation will realize its potential contribution—a potential that increases daily as advances in complementary areas such as agronomy and engineering come forward. We do not need 2020 vision to recognize that new resources are clearly going to be extremely scarce for many years to come.

Conclusions

It is likely that as income rises structural changes in the economies of the South will lead to increases in and changes to the pattern of food consumption demand. It has also been shown that consumption is likely to outstrip production in the South whether the economies grow or stagnate, necessitating food imports from the North. It is thus conceivable that in the next decades we will see increasing incentives for the North's food producers to increase production (perhaps with less subsidy), given that an increasingly urbanized and industrialized South will be in a position to pay for these imports.

However, it is recognized that not all countries of the South, in particular those in Sub-Saharan Africa, will see substantial rises in per capita incomes. This is partly because of a high rate of population growth but also because growth in GDP will be slow. A primary reason for this is that agriculture in these countries has not played a productive role—irrigation is relatively unimportant, the topography presents problems and new schemes are costly. Water problems are central to agriculture's difficulties. Rainfall is inadequate and highly variable. Yet a vibrant agriculture is essential, and, under the assumption of a favorable macroeconomic policy, as land becomes scarcer, technological change in favor of some forms of land and water saving, labor using technology appears to be a key. In Sub-Saharan Africa, if this option is not widely available, then food production on concessionary or commercial terms is inevitable.

At present, irrigated agriculture provides one third of the world's food production. Perhaps two thirds of the future incremental production will come from irrigated land (Carruthers 1994). However, we do not anticipate or call for an increased rate of capital-intensive investment in irrigation infrastructure but we do need to see more achieved with what is presently developed. What we conclude with our 2020 vision is that in 25 years' time, the North will supply much of the urban food needs of a more developed South which will, in turn, provide the North with much of its requirements for industrial goods and services. There will still be a need for capital flows from North to South and perhaps some increased agricultural investment in the poorer countries if livelihoods are to be protected and other broader poverty-reducing developments are to be stimulated.

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Irrigated Agriculture Beyond 2000: Institutional Adaptation and Transformation[1]

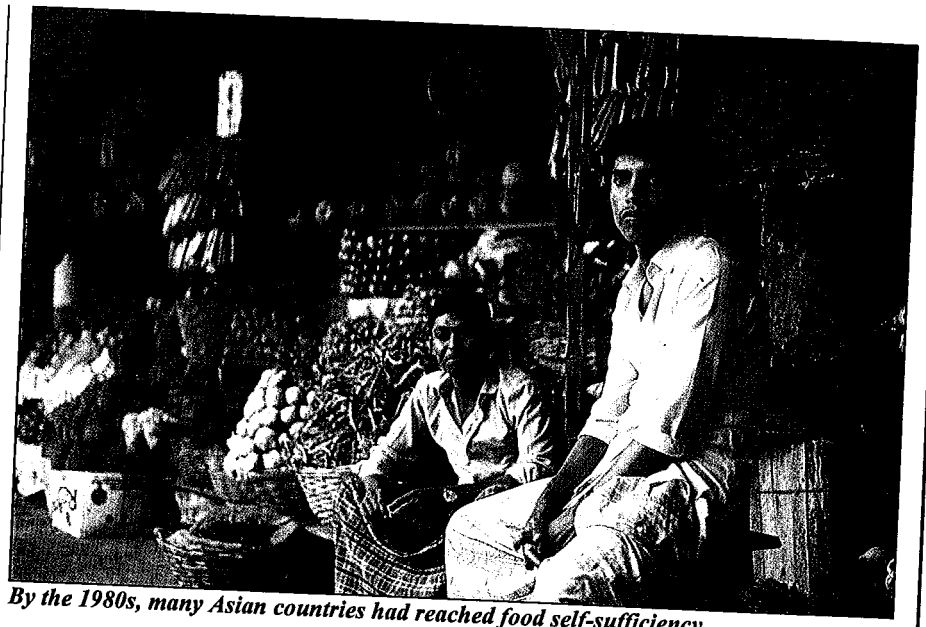
D. Hammond Murray-Rust and Douglas J. Merrey

Introduction

The rapid development of irrigated agriculture during the past three decades has been achieved with remarkably little change in the institutional setting for agriculture, in organizational arrangements, or in irrigation technologies.

It is unlikely, however, that this slow rate of institutional transformation can continue much longer. Dramatic changes in agricultural policies, the reduced profitability of food grain-based agriculture, the rapid increase in competition for scarce water and other resources, all create pressures on institutions to change. These changes will include two basic types: a) internal changes in organization, procedures and general operational performance of existing irrigation management agencies to try to make irrigated agriculture profitable and an efficient user of scarce resources; and b) transformations in the nature of the institutions themselves that will result in a variety of institutions very different from the traditional, paternalistic public works organization.

During the coming decades there will have to be considerable testing and observation of different modes of ownership of irrigation infrastructure and alternative organizational arrangements to provide irrigation water and other services traditionally provided by governments. Possibilities include utilities (publicly or privately owned), private corporations, farmer-managed commercial ventures, stronger links with agribusiness, and decentralized planning and management bodies for water allocation and utilization, all of which contrast with current institutional arrangements. The irrigation sector will no longer be treated as separate from and more privileged than other water-using sectors; it will be increasingly integrated and in competition with domestic and industrial users.



By the 1980s, many Asian countries had reached food self-sufficiency.

Although we primarily use Asian examples, the discussion in this paper also applies to developing countries in other regions, especially West Asia and North Africa.

Institutional Response to Changes in Irrigated Agriculture

The 1960s marked the start of one of the greatest revolutions mankind has seen. Faced with the specter of mass famines throughout Asia, vast sums of money were provided for *agricultural research;* for production of *improved inputs* in the form of high yielding seeds, fertilizers, pesticides and other agricultural chemicals; and in the provision of millions of hectares of *new irrigated lands.*

The results of these investments were dramatic. By the 1980s many Asian countries had moved from being net importers of food grains (Indonesia was the world's largest importer of rice in the early 1960s) to conditions of *food self-sufficiency.* With the overall threat of starvation effectively eliminated, at least at national level, some countries began to experiment with a range of different scenarios for the irrigated agriculture sector.

Typically, these policy changes related to the production side of agriculture: crop diversification became a policy common to many Asian countries because rice was sufficiently abundant that prices stagnated, or were deliberately kept low as a subsidy for urban consumers. Policies aimed at changing cropping patterns have not, by and large, been

[1]An earlier version of this paper was presented at the DSE-IIMI-UPM Strategy Workshop on Irrigated Agriculture in Southeast Asia beyond 2000, 5–9 October 1992. The paper has been substantially revised for the *IIMI Review.* The authors are Senior Irrigation Specialist and Senior Irrigation Management Specialist, respectively, in the Research Group at IIMI Headquarters.

as successful as the simpler policy of national rice self-sufficiency. This is partly a reflection of soil and other physical conditions that make changing from rice to nonrice crops difficult, partly because many farmers have chosen to continue to enjoy the relative security, albeit with low profits, of rice production, partly because of off-farm income opportunities or labor shortages, and partly because the institutional requirements to support crop diversification are different than those for intensive support for monocropping.

Monoculture is easy to support institutionally: the range of inputs required is limited; farmers can quickly adapt to a particular cropping technology; marketing and pricing can be relatively easily focussed and controlled; and extension agents can focus on a single package of advice. But progress in shifting to a diversified cropping system that maintains overall food security and also raises farmers' incomes has proven difficult and disappointing in the present institutional setting.

At the same time, the glamour of large investments in irrigated agriculture has faded; during the past decade there has been a dramatic decline in irrigation investments by the major donors (Rosegrant and Svendsen 1993). Lending institutions began to seek alternatives such as support for *privatization* of government services and institutions, *sector support* rather than specific infrastructure projects, and *structural readjustments* that aim at reducing public service expenditures as a way of easing the debt burdens of countries. Yet, in the irrigated agriculture sector, the response to these changes has been small compared to those in other sectors that have a more commercial, profit-making orientation.

The pressures diverting investment and interest away from a relatively conservative and slow-growing irrigated agriculture sector are only going to grow stronger: *competition* for profitable investments, the attraction of *high returns* in the industrial sector, the willingness to begin *reducing subsidies* for operation and maintenance of facilities for irrigated agriculture, greater awareness of the *economic value of water* in different sectors, are all forcing agencies concerned with irrigated agriculture to take a new look both at how they go about their day-to-day business, and how they organize themselves to do this efficiently and effectively.

These changes are occurring in a context where even countries relatively well-endowed with water resources, such as those in Southeast Asia, are increasingly concerned about shortages and the imperative to divert water from irrigation to other uses. Twenty countries in West Asia and Africa with 200 million people and high population growth rates are currently classified as water-short in an absolute sense (Postel 1992). Further, while at the present moment food grain prices are low and supplies seem adequate, there is growing concern that this is a temporary phenomenon. With rising populations, many with rapidly increasing incomes, the demand for food may, in the near future, outrun the diminishing capacity for increasing production (Yudelman 1993; Samad et al 1992).

The next section of this paper discusses selected areas in which changes are urgently required, and a few options for reorienting existing irrigation management agencies through internal modifications. The succeeding section considers several options for more fundamental reform. Some of the options for incremental change could pave the way for or accompany more fundamental reforms.

Institutional Modification to Meet Future Challenges

The model of a public works type of organization proved highly effective in meeting the expansionist challenges of the past few decades. Construction dominated institutional thinking, and O&M was treated as a poor relation. Organizational dynamism was generated through the development of projects that carried with them opportunities to expand departmental budgets, increase staff and establishment, and the chance to see concrete results in a short period of time.

As the number of opportunities for projects diminishes, organizations find themselves facing a potentially difficult choice. Some organizations have attempted to continue to develop new project proposals, both because this is what they are comfortable with and because it is the only way in which staff levels can be maintained. No agency voluntarily cuts staff. However, the search for money to finance new projects is difficult: money is scarce, projects are frequently more complex, and they are often marginal in terms of economic returns compared to investments in other sectors.

Other organizations have taken the harder decision, namely, to make internal modifications to enable them to meet the challenges imposed on them from outside. The following selection of internal modifications is not comprehensive, nor is it suggested that any one agency has to adopt all of them. They represent options or choices that policymakers at sector-level and senior managers of concerned agencies can consider in an effort to keep their own organizations alive and responsive into the future.

Performance Responsiveness: Breaking the Administrative Mode

Many irrigation agencies have been able to continue to attract both project and recurrent funding support with little regard for actual performance levels. Effectiveness and efficiency of water use, of staff, or of the O&M budget are rarely assessed in an objective way, using feedback from reliable data on performance.

A general lack of responsiveness to performance, and often rather low levels of performance, are characteris-

tic of agencies that are administrative or bureaucratic in nature. In these institutions the concern is with the management of inputs and ensuring conformity with rules and regulations rather than on whether a set of objectives is being fulfilled.

All well-managed organizations have some kind of cycle of setting objectives, establishing short-term operational targets, monitoring performance against targets to assure the targets are met, and periodic evaluation to determine whether the objectives were both appropriate and feasible (Murray-Rust and Snellen 1993). Yet most irrigation agencies have great difficulty defining their objectives clearly, setting targets and monitoring results routinely. Under such conditions performance data are rarely collected systematically, are rarely accurate, and the gap between formal rules—"myth"—and "reality" steadily widens.

Responsiveness to performance is not limited to output from irrigation systems or the irrigated agriculture sector. It is also concerned directly with the *performance of individuals* in the agencies, in terms of their efficiency, their capacity to set objectives, fulfill targets, and to be honest about their own inputs into the management process. This means not only a greater focus on human resource development, including management training that redefines roles and relationships within an agency; it also has to address rewards and incentives, and accountability.

An administrative orientation gives little reward for *personal initiative and innovation.* Promotion is based on longevity of service rather than on performance, compliance with rules is given greater recognition than innovation. Salaries are based on rank and years of service rather than contribution to the organization's objectives. There may be specific disincentives for those who try to work hard, try out new ideas, and search for change and dynamism.

The contrast with business is striking, yet it is the world of business and privatization that is attracting the greatest investment and interest these days. At least in part, this is because the financial risks and potential benefits can be more clearly identified, and there is less chance of supporting inefficient monopolistic enterprises.

Assessing Performance

The shift towards a more performance-oriented institution requires useful and effective performance measures. Traditionally there has been a great emphasis on the measurement of *agricultural output,* normally incorporating such indicators as irrigated area, yield, cropping intensity, or irrigation intensity. In part, this reflects the economic focus of new project development where there is significant pressure from donors or lenders to ensure that expected project benefits have been achieved; in part, it reflects the concern to achieve agricultural sector objectives.

However, performance assessment measures for other aspects of the concerns of agencies are much less well developed. It seems surprising that with increasing concern over water resources, and the loss of water from the agricultural sector to other sectors, measures of *water use efficiency* and *water delivery performance* are rarely used by irrigation management agencies. Practical methodologies for assessing water use efficiency and water delivery performance exist; if the objectives and targets are clearly specified, useful performance assessment measures can be readily identified (Bos et al 1994). But these measures are rarely used in routine management—in fact some agencies do *less assessment* of water delivery performance than they used to in the past.

Similarly, in spite of increasing concern over the level of funding, particularly for O&M, expressed at numerous forums on irrigation management issues, few agencies use *financially based performance measures.* This is the equivalent of a business continuing to produce a product without assessing the costs of production and distribution. Such "businesses" used to exist in the former Soviet Union. Irrigation management is big business; and basic business management principles need to be adopted for assessing and improving performance.

Changing Operational and Maintenance Procedures

Many irrigation agencies have found it difficult to modify operational or maintenance procedures in response to changing water availability or new agricultural policies. For example, although many Asian countries have adopted policies of crop diversification away from rice to other potentially more profitable crops, the operational procedures of most agencies have not changed. The requirements for crops other than rice are sufficiently different in terms of overall water requirements and scheduling that alternative operational practices need to be adopted. These practices require more intensive operations and monitoring, with more precision in terms of the timing and amounts of water delivered.

Agencies that do not make these changes in response to farmer interest in growing other crops end up delivering more or less the same volumes of water along canals irrespective of whether rice or nonrice crops are being grown. A contributing factor to this situation is that agencies that continue functioning in an administrative mode are more concerned with calculating theoretical water requirements than assessing the situation in the field and making operational adjustments accordingly.

Maintenance procedures rarely change, even though the available budget may be inadequate or inappropriate. Instead, the *quality, frequency and quantity of maintenance work* are continuously reduced as budgets decline. The seriousness of this trend has been masked because of the comparative ease of securing funds for *rehabilitation* of deteriorated systems. As resources become more scarce, managers will be forced to be

more efficient and focussed in the use of limited maintenance budgets.

Some authors (e.g., Burns 1993) have recently argued that many of these problems can be overcome by introducing more structured system designs, in which a volume of water that is less than the total potential crop requirement is delivered through ungated proportional dividers. The argument is that in such systems every farmer will know what is coming, and the management tasks are minimized to be consistent with the capacities of administrative irrigation agencies. Systems with this design are observed to work well in northwestern India, but not everywhere; the conditions under which they work well may not be universal. Further, in diversified cropping systems structured water delivery systems may limit the potential cropping pattern. Finally, the performance of structured systems is especially sensitive to maintenance; they therefore require a very high level of maintenance to perform according to design, and there is no evidence that public agencies could mobilize sufficient funds to maintain systems to the necessary standard.

Technical Skill Development

Many irrigation agencies are less well equipped to manage systems effectively than they were before the recent period of expansionism. This is partly because many staff members of the agency have been more involved with design and construction than with operation and maintenance, and partly because the lack of concern with actual performance results in staff not using certain special skills.

This is probably seen most clearly in respect to hydrology and hydraulics within a number of irrigation agencies. The *capacity to measure water,* which was already scarce, has declined significantly in recent years in many agencies. The capacity to use forecasting and other techniques to better assess probable water supplies is also noticeable by its absence. Irrigation management agencies cannot argue their case effectively for maintaining their share of scarce water supplies if they cannot measure it very well.

Similarly, few agency staff have experience or training in alternative scheduling arrangements, and thus are likely to follow routine procedures for canal operation rather than adopt innovations.

In another direction, the capacity to adopt modern technology is relatively limited. Only slowly are computers being adopted for day-to-day operational support. Because remote sensing or use of Geographic Information Systems is almost unknown, opportunities for more rapid data retrieval and processing are being missed. This reflects the lack of interest in measuring performance, or improving efficiency of operation or maintenance, as well as the inadequate technical capacity of agency staff. There is a depressing record of projects that introduce modern conveyance and control technology in irrigation systems and then let it fall into disrepair, either because agencies are unable to provide adequate operation and maintenance, or because the new technology was not appropriate for the conditions.

Although some agencies have encouraged their staff to obtain more technical training in recent years, the impact on overall performance to date is minimal in most cases.

Reorganization to Meet New Priorities

Changes in sector-level objectives and priorities have rarely been reflected in changed organizational structures of agencies. An institution intended to fulfill one set of objectives may be poorly equipped to meet changed objectives or priorities.

Many irrigation agencies are still structured for construction of new projects. The rapid decline of new irrigation development and greater concern for water resource management and financial efficiency have not been reflected in institutional structures. For example, design divisions still exist even where design work is limited or non-existent. System design is frequently undertaken far away from the site itself, thereby limiting opportunities for inputs by system managers and water users; managers charged with system operation and maintenance commonly inherit a system without prior contact with the design staff, and design staff have often had no operational experience which they can incorporate into their subsequent work. This separation may have made rapid progress in meeting construction targets possible, but has in many cases led to systems poorly designed to meet modern performance expectations.

Many irrigation agencies still retain an incentive system that favors attention to new construction over system management. With the shift in expectations to improving water supply performance, agencies must reform their incentive structures to encourage staff to respond to these new requirements. Similarly, single-discipline civil engineering departments need to recruit staff with other skills to improve system management.

In many countries there is a strong trend towards promoting irrigation associations and turning over responsibility for management of lower portions of systems to farmers. Some countries have also implemented joint decision making at higher levels of large irrigation systems. But few irrigation management agencies have reorganized themselves to work effectively with farmer associations, limiting the impact of this reform on performance.

Research Capacity

In comparison with commercial enterprises with the same gross turnover, the irrigation sector spends remarkably little on research and development for new ways to improve service and resource use efficiency. The agricultural sector has, by

comparison, spent a great deal more on seeds, fertilizer and plant protection technology research.

Where agencies do have a research wing it is almost inevitably hydraulic research or involved with refining existing knowledge of crop water requirements. There has recently been some acceptance of research that aims at improving existing procedures and activities. In a number of countries this is the type of research carried out by IIMI in its initial phase of work. However, this approach is limited in its capacity to bring about change: it may improve efficiency but there is little institutional change involved.

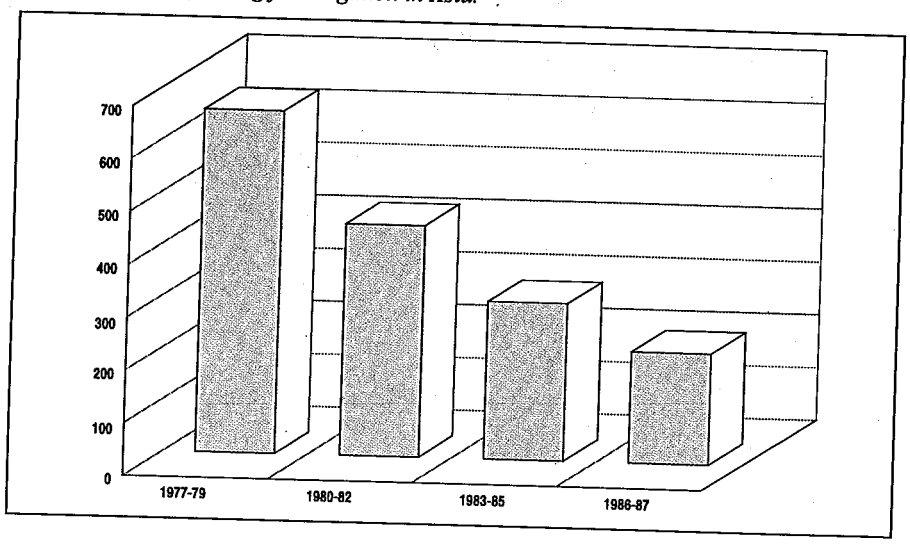
More fundamental collaborative research activities are much rarer. Typically these involve an agency articulating its long-term policies and objectives, and then sitting together with universities and other research institutions to try to find solutions. The capacity of irrigation agencies to collaborate with research organizations is small, and there are few institutionalized opportunities for manager-researcher interactions. Irrigation agencies have a limited capacity to identify research needs, determine what research has been done, and make use of research results. This is severely constraining the capacity to innovate and adapt to changing pressures.

Finally, there are few—if any—irrigation organizations that have "think tanks" or similar visionary groups that can help senior policymakers in their task of deciding what directions to pursue, and what the implications are of different alternatives.

Institutional Transformation

In recent years there have been a number of dramatic changes that fundamentally affect the nature of irrigation organizations. These changes result from major shifts either in government policy towards the irrigated agriculture or rural sectors, or in the basic philosophy regarding the appropriate role of government itself.

Decline in donor funding for irrigation in Asia.



Almost every country seems to be in the process of change or experimentation with organizational forms in various sectors. The following is an overview of some of the options for restructuring irrigation management institutions; each of them is being attempted in a few countries in Asia and elsewhere. None of them is mutually exclusive.

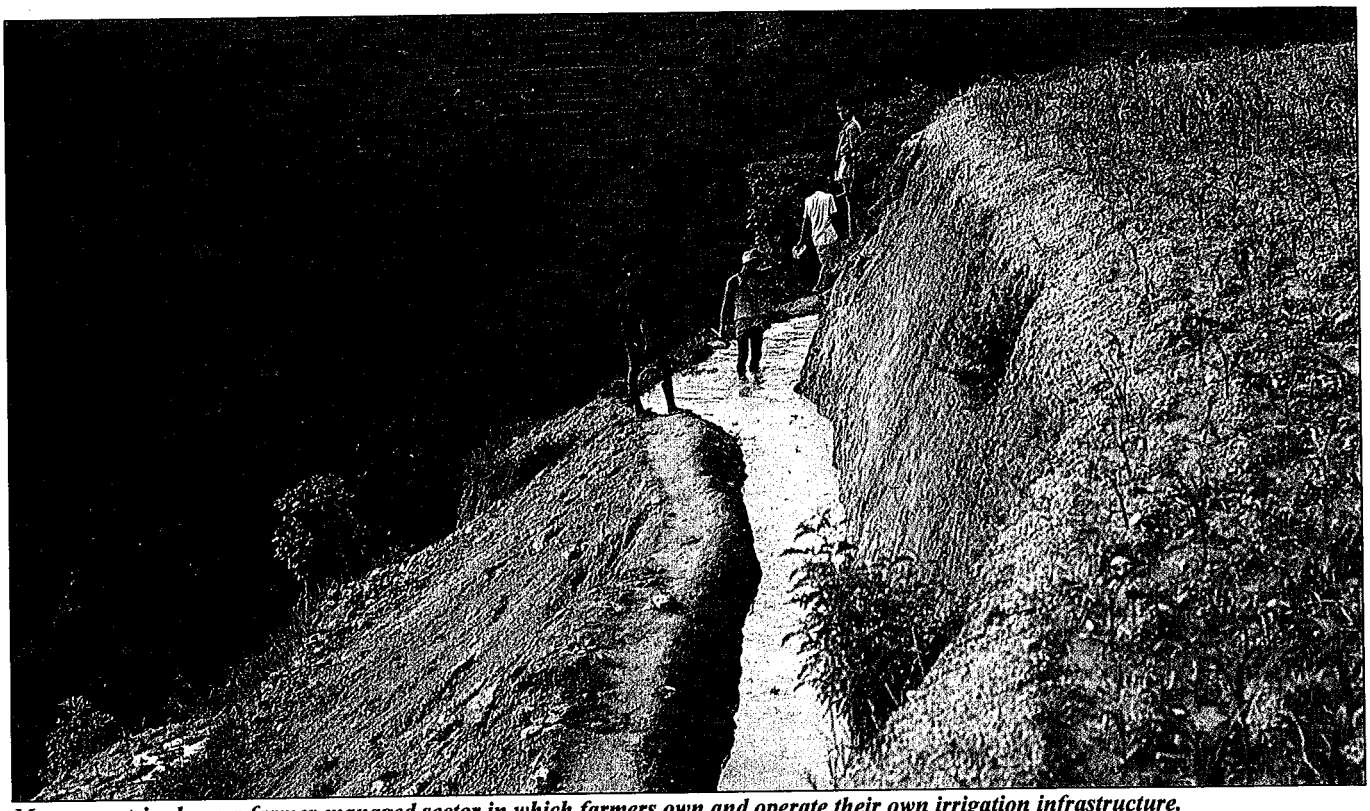
A few simple principles underlie successful irrigation management organizations. These include the necessity for *clarity* in regard to water rights and responsibilities; *accountability* of water managers and users; *transparency* of decision-making processes and financial flows; *incentives* for achieving high performance; and *financial viability* of organizations charged with irrigation management responsibilities.

Decentralization

Responsibility for irrigation management and provision of agricultural support services is being transferred from central government to provincial, regional or even local levels in many countries. This type of change has two sets of implications. The first is that control over staff responsible for operation and maintenance of systems may pass to the local civil administration, taking them away from the relative security of a technologically oriented agency.

The second is that adherence to nationally developed regulations, guidelines and procedures may weaken. In principle, this provides the opportunity for greater flexibility and innovativeness by O&M staff. It may also provide fewer opportunities for transfer, and more focus on the less glamorous but essential O&M tasks because the smaller administrative center may generate fewer project funds. On the other hand it creates additional challenges to ensure adherence to safety and performance standards.

"Decentralization" is a concept that is better applied to particular tasks or functions, and not necessarily to *all* functions. For example, river basin management and inter-sectoral allocation of water often needs *more*, not less centralization. The overall model that emerges is one of greater local accountability and responsibility for shorter-term functions such as O&M and seasonal and annual planning, and stronger central control for resource allocation and for safeguarding both long-term sustainability and diverse interests through stronger and more effective regulation. This will be an important challenge for the future.



Many countries have a farmer-managed sector in which farmers own and operate their own irrigation infrastructure.

Turnover of Operational Responsibility

Joint management of irrigation systems has spread throughout Asia and other regions to a considerable degree. Although transferring responsibility for operation and maintenance of increasingly large portions of irrigation systems to farmers or water users seems to be an attractive solution to financial and manpower problems within agencies, this has proven an elusive goal.

A significant reason for this relates to the changed role of agencies. When farmers' O&M responsibilities were confined to within a tertiary block, agencies had little direct incentive to involve them in true joint decision making. There were, and still are, nominal attempts at consultation, but in practice the technical concerns of the government agencies still outweigh the interests of farmers in most cases.

It will be a major challenge for irrigation agencies to actually transform themselves from this rather paternalistic mindset to respond effectively to more democratic institutions like the irrigation districts or associations similar to those found in some countries of eastern Asia, Europe or America. Policymakers and irrigation managers may have believed in the past that farmers would carry out the expensive and unglamorous O&M work at tertiary levels, allowing the agencies to continue business as usual. However, effective turnover will require sharing of authority as well as responsibility with farmer organizations.

It seems unlikely on present evidence that agencies are really capable of making such a dramatic change. There is comparatively little evidence to date that agencies have made the change in attitude in the policy planning-resource allocation processes that precede and support routine operation and maintenance decisions. The same decision-making processes are unlikely to be effective in supporting a significant change in roles between agency staff and water users.

Restructuring Existing Irrigation Agencies

An increasing number of countries have initiated planning if not action to radically reform their existing irrigation agencies. Most cases of restructuring programs are found in countries which find themselves under increasing financial pressures, and face serious water scarcity issues. In this approach, countries may decide that certain regulatory or service functions should remain in the public sector, but that the public sector agency must be reformed so that it can provide services more cost effectively. Thus, irrigation departments which have had a heavy emphasis on construction may be transformed into multi-disciplinary agencies providing water supply and advisory services to farmers and other customers. Integrated river basin authorities may be reduced in size to focus on a few critical areas, with social and agricultural support functions transferred to other entities.

These changes go beyond the internal modifications discussed earlier in the paper. Whatever the form of the

newly structured public agency, ensuring its financial viability, structuring its finances to provide incentives for the agency to be performance- and customer-oriented, and structuring the internal incentive system to encourage improved performance of personnel and organizational units will be pre-requisites for success.

Privatization

A recent trend in certain countries has been the privatization of state monopolies. A few years ago it would have been almost inconceivable to imagine telephone companies, national airlines, domestic water and other typical monopolies being offered for sale to private investors.

If irrigated agriculture is in principle profitable then it can also be considered a potential candidate for privatization. It may involve changes in *water rights,* so that operating companies can charge for their services as wholesalers of water to individuals or groups of water users.

Such changes are increasingly occurring in respect to urban water supplies. Assuming that the water resource will in future be treated as a single commodity, it is likely that irrigation water sales will be included in the total package. The experience of the United States and Europe is that it is very difficult to deregulate one part of the water industry (normally urban and industrial water) while protecting another (water for agriculture).

One form such restructuring may take is to create regulated water supply utilities, on the model of electric, gas, and domestic water utilities. Utilities may be privately owned through share holders, or publicly owned. Their important characteristic is they are autonomous and operated on business principles to provide a service. Because they are monopolies, effective regulation strictly separated from provision of the services is essential, but strengthening regulatory functions requires legal changes that have proven difficult to achieve.[2]

Many countries have a "farmer-managed irrigation sector" in which individuals or groups of farmers own and operate their own irrigation infrastructure. In many cases such "private" schemes are believed to be operated rather efficiently, and at no cost to the government. There is no reason in principle why government-owned systems, particularly those with a clearly identifiable water source, cannot be "privatized" as farmer groups become stronger, as long as effective regulatory institutions are in place.

Commercialization

The ultimate change in irrigation institutions is the commercialization of the irrigation sector. This may be hastened if there is demand to adopt modern irrigation technology. In Europe and the United States the growth of sprinkler, drip and trickle irrigation is almost entirely the result of individual farmers interacting with commercial companies. In addition to providing the irrigation equipment, the same companies are involved in providing extension advice, computerized irrigation scheduling packages, and other facets of the technological package.

This type of change may require larger farm sizes than those found throughout most developing countries at present, but if the trend of land abandonment associated with industrialization continues, it is not impossible to envisage land consolidation into larger commercial units directly linked to agribusiness concerns. Indeed, agribusiness may take over the operation of the land.

Conclusions

It is not possible to propose a single model for irrigation institutions applicable to all countries. The appropriate institutional framework must reflect the complexity of the social, political, cultural and economic conditions of each country.

Some countries may adopt a policy of general disengagement from control over resources, preferring privatization, market forces, or other economic principles to guide their policies. Others will feel that the need for continued food security, the desire to stem urban growth, or the continued support of the rural sector merit some elements of subsidy, control or centralized direction.

One thing, however, seems certain. Change is coming and it cannot be resisted. The apparent immovability of the economies of the former Soviet Union and Eastern Europe has demonstrated that major changes in attitudes to publicly managed enterprises can occur in a remarkable short time frame. This does not mean that the same rate of change will—or should—occur in Asian or other developing countries, but it is incumbent on policymakers and planners to understand the forces affecting irrigated agriculture, identify appropriate goals and the policies, institutions and strategies required to achieve them, and guide their implementation, while being prepared to adjust to new issues that were not predicted.

Acknowledgement

A special thanks to Chris Perry, IIMI, whose thought-provoking comments led us to try to make the paper clearer than it was.

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[2]Creating markets in water is another institutional option that may be applicable to a greater extent than previously assumed; this option deserves a separate paper.

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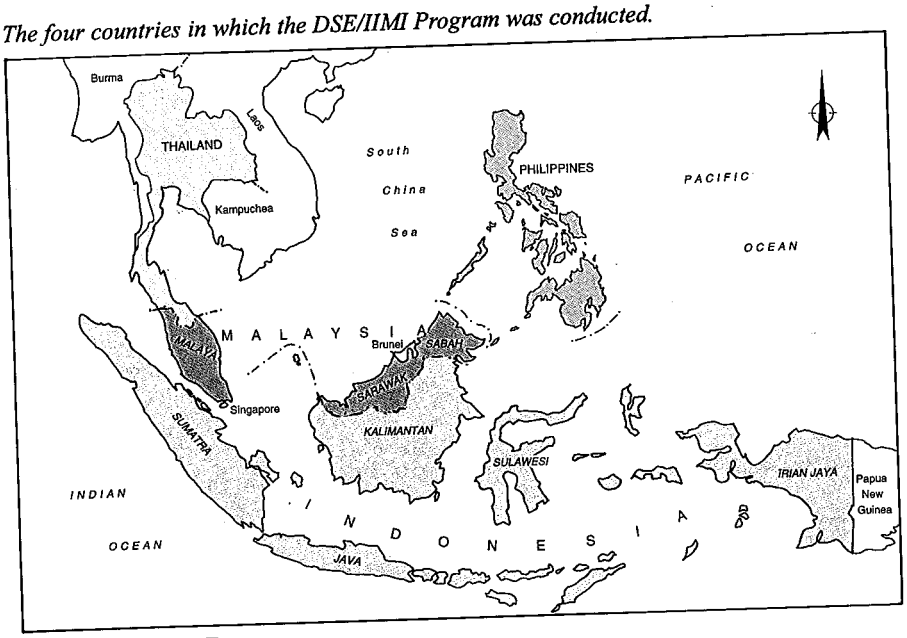
DSE/IIMI Program of Dialogue and Training for Management of Irrigation, 1990–94

Charles L. Abernethy[3]

This joint program by DSE (German Foundation for International Development) and IIMI addressed issues of irrigation management and policy in four countries of Southeast Asia which are all significant users of irrigation: Indonesia, Malaysia, the Philippines and Thailand. Together, these four countries operate about 14 million hectares of irrigated land, or about 6 percent of the world's irrigation, and they produce 15 percent of the world's rice.

The program was diverse. It was built around two principal elements: one-week workshops for senior management and policymaking people, at which the larger issues and the challenges of newly emerging problems could be debated; and training courses of the order of three or four weeks for middle managers, in which practical ideas for the solving of current problems could be delivered. Associated with these two main styles of discussion, the program also comprised research grants to individuals, support for participants at international meetings, a study tour to compare management methods used in the very different environment of North Africa, and other sorts of activities. In all, 23 major events were conducted over 4 years, and over 600 people could participate.

The four countries in which the DSE/IIMI Program was conducted.



From the regional participants' viewpoint, the format of the program had some particular advantages. There are many government departments which have some kind of involvement with irrigation. Their perspectives and attitudes differ, according to the nature of their involvement: construction, operation, agricultural production, revenue and expenditure, training, natural resource conservation, social welfare, and each may be handled by a different arm of a government. The workshops of the DSE/IIMI Program sought to bring together people from all parts of this functional spectrum. Participants appreciated the wide-ranging interactions that resulted.

Participants also found that the regional dimension gave a fresh character to the events. Physically, the Southeast Asian region is one of the most homogeneous, in regard to its irrigation resources. Rainfall is

[3]Senior Technical Advisor, IIMI.

substantial over most of the region, and there are steep mountain systems delivering silty rivers to large alluvial plains, where rice cropping has traditionally predominated. However, in spite of these and other kinds of physical similarity, there is great disparity in the institutional and financial frameworks that the four countries have chosen to adopt. The workshops in the program enabled people to look closely at these management differences, and form opinions about why the differences have arisen and whether there is evidence that any of the management systems performs better than the others.

From IIMI's viewpoint too the program was a stimulating experience. More than half of IIMI's global international staff participated in it. The benefit to the Institute was not just that the program provided a channel for transmitting the Institute's ideas to an audience who were in positions where such ideas could be used practically. That was valuable; but IIMI also benefited greatly from receiving feedback about the relevance of those ideas, from highly experienced groups of irrigation managers.

Although irrigation is a traditional and familiar activity throughout Southeast Asia, and 24 percent of all agricultural land is irrigated, it now faces numerous stresses, which force the irrigation management leadership to contemplate radical policy adjustments. Among the principal stresses are the reduced rewards that farmers obtain from irrigated agricultural production; the efforts of governments to reduce and eliminate subsidies and apply the principle of "user pays;" and the steady reduction of per capita water resources, which, accompanied by growth of water demand in both the industrial and household sectors, is leading to threats to the quantity, quality and stability of irrigation water supplies.

All of these can be seen as, to some degree, the penalties for past successes, inherited from times when the primary objective in irrigation was to augment food production. Production of rice in the region rose 33 percent in the decade of the 80s alone, after other striking gains in the preceding 15 years, and is now at a level of about 230 kg/person/year. Prices fell in response to these gains, and to the steady reduction of price controls or market interventions by governments. Farmers began to leave the land and farmers' children ceased to go into agriculture, largely in reaction to the disparity in rewards as between the agricultural and urban/industrial sectors; so in that same decade of the 80s, agricultural population in the region declined from 58 percent to 50 percent of the total.

At the same time, general economic growth of 5.7 percent/year implied the rapid emergence of other competing uses of water; and loss of forest cover from upper catchments caused a shift in the seasonality of water flows, with a greater propensity for dry-season deficits. Society began to form the view that irrigation farmers were a privileged group, having access to an important natural resource and enjoying the benefits of past public investments in irrigation facilities, so they ought to pay the costs of these things.

Thus Southeast Asian irrigation is undergoing a large adjustment of its management objectives. Production is no longer so dominant; financial objectives such as farm profitability, cost reduction and cost recovery from users have now come to the forefront,

Some basic statistics of the four countries.

	Year	Units	Indonesia	Malaysia	Philippines	Thailand	Region
Population	1991	000	187,758	18,344	63,916	56,474	326,492
Growth of population	1980-90	%/Y	2.01	2.66	2.59	1.77	2.12
Agricultural population	1991	000	81,765	5,399	29,397	33,747	150,308
Growth of agriculture population	1980-90	%/Y	0.19	-0.06	1.55	0.67	0.54
Country area		000 ha	181,157	32,855	29,817	51,089	294,918
Cultivated area	1990	000 ha	22,000	4,880	7,970	22,140	56,990
Irrigated area	1990	000 ha	7,600	342	1,560	4,300	13,802
Cultivated land per person	1990	ha	0.12	0.27	0.13	0.40	0.18
Renewable water resources		km^3/Y	2,530	456	323	179	3,488
Renewable water per person	1990	m^3/Y	13,730	25,490	5,180	3,210	10,910
Gross domestic product	1991	mill.US$	116,476	46,980	44,908	93,310	301,674
GDP per person {	1991	US$	620	2,561	703	1,652	924
{	1991	PPP$	2,720	6,530	2,900	3,740	3,150
Agricultural GDP	1991	mill.US$	22,465		9,489	11,063	
GDP per person in agriculture	1991	US$	275		323	328	
Paddy production	1989-91	000t/Y	44,724	1,650	9,483	19,172	75,029
Paddy production per person	1989-91	kg/Y	243	92	152	344	235

Sources: World Development Report 1993; FAO Production Yearbook 1991; World Resources 1992-93; Human Development Report 1992.
Note: Y = year; mill. = million.

with natural-resources management objectives grouped under the general heading of "sustainability" not far behind. The institutions required to attain these new objectives, it has already been found, are not quite the same ones that were found adequate for the challenges of the past.

These stresses and changes have been vigorously debated in all the events of the DSE/IIMI Program. Questions have been addressed such as: what are the future goals? what are the necessary characteristics of the institutional system? how shall performance be defined and measured? what human resources development is needed so that the relevant institutions will have the skills, attitudes and knowledge that the new situation calls for? how will government organizations interact with farmers' organizations?

Perhaps the best way of indicating the tendency of current ideas about some of these matters is through the regional synopses that were developed at the conclusion of the Langkawi Workshop on the future of irrigated agriculture, and the Chiang Mai Workshop on the institutional framework.

DSE-IIMI ACTIVITIES IN IRRIGATION MANAGEMENT

Franz Heim[4]

Initial Contact

Collaboration between the Food and Agriculture Development Centre (ZEL) of the German Foundation for International Development (DSE) and IIMI dates back to 1986 when DSE conducted a workshop on "Irrigation Improvement" together with the Royal Irrigation Department (RID) of Thailand. The then Director General of IIMI, Dr. Thomas Wickham participated in this national workshop as a resources person. The outcome of this workshop was a set of recommended changes in the irrigation sector covering issues in the field of engineering, socioeconomics and institutions. The then Director General of RID stated in the foreword to the proceedings of the workshop that "full support will be given to carry out the recommendations with the limit of available manpower and budgetary resources."

Commencement of the Program

Based on the results of a DSE workshop on "Needs for Training and Dialogue in Irrigation Management in Southeast Asia" conducted in the Philippines at the end of 1987, a series of programs on Dialogue and Training in Irrigation Management in Southeast Asia was planned and forwarded to the Federal Government of Germany for financing. The basis of this series was the proposals developed during this workshop by irrigation experts from the Philippines, Indonesia, Malaysia and Thailand.

In October 1989, the program was approved by the Ministry for Economic Cooperation (BMZ) of the Federal German Government. It began in January 1990 with an appraisal mission for preparation of the DSE program on irrigation management in Southeast Asia. The mission's first visit was to IIMI headquarters, as the leading agency in the field of irrigation management. This was followed by visits to other relevant institutions in Southeast Asian countries. Discussions on possibilities for joint dialogue and training activities took place which led to a Memorandum of Understanding between IIMI and DSE/ZEL with the objective of designing and conducting a 5-year program of dialogue and training through which both agencies will work with irrigation professionals in Indonesia, Malaysia, the Philippines and Thailand to address current issues in irrigation development throughout the region.

Highlights of the Program

The most outstanding events in this program of dialogue and training include the following:

Workshop on New Trends and Policies in Management

The workshop on New Trends and Policies in Irrigation Management held in Colombo, was attended by sixteen high-ranking decision makers in the field of irrigated agriculture from Southeast Asia. This event also included a study tour for the participants. Some of the conclusions of the workshop participants, included:

- Laws related to water resources must be responsive to current needs. They require to be updated, disseminated and enforced particularly to address issues arising from changing water resources and environmental constraints.
- We must aim to manage irrigation schemes rather than just administer them. For this, procedures are required for the timely collection, processing and analysis of data to monitor output and operational performance and to enable timely corrective action.
- Future irrigation development and management efforts need the active participation of farmers at appropriate levels from planning to O&M. The participants favored an institutional structure in which

[4]Head, Agricultural Engineering Section, DSE/ZEL.

eventually operational control at certain levels would be integrated to the extent possible under a board of farmers' representatives.

- The irrigation sector is experiencing a period of rapid policy changes. Irrigation agencies need to respond to these changes by adopting new frameworks, attitudes and procedures to address the changing relations that should now exist within agencies, and between agencies and farmers. It was agreed that training is a prerequisite in this process.
- Irrigation schemes require constant human intervention to remain sustainable. Management strategies for improving performance and maintaining sustainability should address institutional strengthening through incentives, training, motivation and other such approaches. Countries face threats to sustainability. These include institutional weaknesses, economic competition and weaknesses of funding mechanisms.

Workshop on Management Orientation in Irrigation Engineering Curricula in Southeast Asia

This regional workshop took place at the Asian Institute of Technology (AIT) in Thailand. Twenty nine senior staff of agricultural, irrigation and civil engineering faculties of Southeast Asian academic institutions participated in the workshop. Participants from the four countries represented at the workshop identified the issues currently affecting irrigated agriculture, which needed to be included in the engineering curricula of these countries. These issues are:

- farmer participation and farmer/agency relationships;
- institutional and policy changes taking place in the region;
- management issues in the field of water management;
- the economics and financing of irrigated agriculture; and
- setting objectives and assessing performance.

Workshop on Irrigated Agriculture in Southeast Asia Beyond 2000

The Strategy Workshop on Irrigated Agriculture in Southeast Asia Beyond 2000 brought together 56 senior persons from national institutions, organizations and companies and also resource persons from international organizations such as the International Rice Research Institute (IRRI), the International Food Policy Research Institute (IFPRI), the Food and Agriculture Organization (FAO), and IIMI to develop options and recommendations for policy, research, education and development of irrigated agriculture in the next century. This objective was achieved through a mixture of subject- and country-oriented sessions in which four country statements and one regional statement were developed. Changes required to ensure sustainable irrigated agricultural production in the next century include:

- policy issues;
- laws and institutions;
- human resource development;
- capital investment in irrigation; and
- supporting infrastructure.

In addition, issues of regional cooperation and collaboration with international agencies were addressed.

Workshop on Institutional Framework for Irrigation

This workshop took place in Thailand and had as co-organizer the Royal Irrigation Department. In this workshop, each country group defined objectives and changes relevant to their own institutional irrigation sector. Topics discussed included; organizations, governance, legal issues, financing options, and farmers. Methods and strategies of implementing the proposed objectives and changes were also outlined by the various country groups.

Workshop on Diagnosing Training Needs and Designing Training and Teaching Programs for Irrigation Management

A national workshop in Indonesia followed by a consultancy mission on the issue of Diagnosing Training Needs and Designing Training and Teaching Programs for Irrigation Management resulted in a number of recommendations for urgently needed changes.

- To change the existing engineering concept of water management to the broader concept of irrigation system management to anticipate future dynamics in the use of irrigation water.
- To enrich the curricula of irrigation engineering institutions through management courses.
- To revise and adapt to local conditions all training courses in the field of irrigation.

Irrigation agencies are called on to provide a system of incentives and rewards to motivate engineers to work at project sites through a career development system. A basic management course on concepts and techniques of management and a special course on irrigation system management were developed which can be included in the curricula for irrigation engineers.

Two of the training courses conducted jointly during these four years were focused on Planning, Monitoring and Evaluation of Irrigation Performance and Management of Rehabilitation and Modernization of Irrigation Projects. Both courses used irrigation projects as learning laboratories and were very successful in providing skills and knowledge to participants.

The comments of two participants regarding the usefulness of these courses are given below:

As an irrigation engineer I found that the course was excellent and I have gained more knowledge, skills and experience. These are very useful for improving my job. Thank you for giving me this valuable opportunity.

The workshop approach was in a sense geared towards encouraging trainees to use the same approach to their jobs back home and I think most of them would make a change in their work attitudes.

Conclusion

Most of the events under this DSE/ IIMI Program were held in the Southeast Asian region and the others in Germany. IIMI took part in 15 of these programs. As part of the program 12 fellowships were awarded to provide opportunities for young irrigation professionals to study specific problems in irrigation management.

As a result of this program, target-oriented planning and performance assessment were introduced in projects and agencies to improve irrigation performance as well as irrigation rehabilitation and modernization.

Increased attention is being given to the role and importance of water users and user organizations involvement in managing irrigation. In each of the four countries, two young irrigation professionals have been given an opportunity to study the difference in management arrangements for diversified cropping.

Management has become a part of training and teaching curricula for irrigation engineers in the region. Several irrigation projects are increasingly being managed in a professional way in accordance with the principles of irrigation management as developed by the participants in the DSE-IIMI Program on Dialogue and Training.

QUOTES FROM PARTICIPANTS

Langsy Sayvisith, director General, Department of Irrigation and Micro-Hydropower (DOI), Ministry of Agriculture and Forestry, Laos. (A delegation from Laos was invited as observers to the workshop in Chiang Mai.)

We appreciate being invited to this workshop in Chiang Mai. These workshops are important because they expose us to the experiences of others in the region. We see that many countries have improved as a result of changes in their approach to irrigated agriculture, as in the case of Australia. We too are open to such change and don't want to be rigid. We want especially to transfer the responsibility of implementation to the farmers, the villagers, and the beneficiaries in the region. Our job is only planning, policymaking, and developing the regulations that will govern the irrigation sector. We want to centralize some of the responsibilities and transfer others to the regions, the provinces, and to the projects. We are very interested in exchanging ideas with IIMI because we have had very little direct contact with IIMI. The DSE/IIMI workshops gave us our first exposure to IIMI. In the future, I am sure that we will learn more and benefit from IIMI's workshops and publications.

Dr. Lockman Soetrisno, Rural Sociologist, Indonesia.

Two years ago Franz[5] came to my office and I asked him how we could improve the curriculum of the civil engineering program in Indonesia because sometimes when the civil engineers design irrigation systems these designs are rejected by the farmers. So, I asked him if something could be done in terms of a curriculum change and he responded very fast. In two months we had the first seminar at the AIT in Bangkok. DSE invited Malaysia, Thailand, Indonesia, and the Philippines. At that time I was surprised that my colleagues from other countries shared the same problems and concerns. Fortunately, the first country chosen for curriculum reorientation was Thailand and then Malaysia and last was Indonesia. We still have to talk amongst ourselves in Indonesia about the results of this.

Jose A.Galvez, Vice President, NIA Consultant, NIA, Quezon City, the Philippines.

The major contribution of these workshops is that I feel they provided a venue for the different agencies in the country to get together. Another important contribution is the discussions on irrigation problems and the difficulties of the irrigation agency. This will be a very important contribution because, for instance, in the Philippines these different agency representatives seldom see each other. There is no forum through which these people working in the different agencies get together and talk about irrigation and irrigation problems. This is a venue where we have a national view of what is going on in the irrigation sector.

Dr. Apichart Anukularmphai, Managing Director, A & R Consultants Co. Ltd., Bangkok.

I have been participating in a number of these workshops, and in my opinion the program itself addressed some really important issues in irrigation development and I think most countries in this region have an agricultural base and many countries are still investing heavily in irrigation management, so I think the subject matter is very relevant. As for the contribution, I can see that it was a very important thing and that it provided a forum for participants from different countries to exchange experiences and ideas and also served as a peer consultation group. In addition, the resource persons injected some new ideas. So I think all these things will stimulate new thinking and it will probably have some effect on each country's program. Participants will probably take the new ideas and suggestions presented at these meetings and put them into practice in their own agencies.

[5]Franz Heim was one of two primary organizers of the DSE/IIMI Program of Dialogue and Training for Management of Irrigation.

Future Trends of Southeast Asian Irrigated Agriculture: A REGIONAL SYNTHESIS

The following statement was developed in the closing session of the Strategy Workshop on "Irrigated Agriculture in Southeast Asia beyond 2000," which was held at Langkawi, Malaysia, from 5 to 9 October 1992, and attended by people from many national and international departments and organizations concerned with the future of irrigated agriculture in Indonesia, Malaysia, the Philippines and Thailand. The meeting was sponsored by the German Foundation for International Development (DSE) and the International Irrigation Management Institute (IIMI), as part of a joint 5-year program in the region. They were joined in sponsoring this event by the Universiti Pertanian Malaysia (UPM).

Preamble

In their Vision Statements and Implementation Plans, the four country groups stressed that irrigated agriculture will continue to be an important sector of all the national economies. All countries aim to ensure that irrigated agriculture is a profitable enterprise and to expand the roles of private-sector participants. It was agreed that in this context the private sector encompasses individual farmers, farmers' organizations and commercial businesses.

Continued on page 34

DSE/IIMI Program of Dialogue and Training for Management of Irrigation Systems, 1990–94

EVENTS IN THE PROGRAM

(‡ indicates that IIMI participated in conducting the event)
(† indicates that the event involved a single country)

19 April – 15 May 1990
Management of Irrigation Projects
Feldafing, Germany

22 – 27 October 1990
Upper Watershed Management
Yogyakarta, Indonesia

20 October – 17 November 1990
†‡ Management Orientation in Irrigation Engineering Curricula
Serdang, Malaysia

15 – 18 November 1990
‡ New Trends and Policies in Irrigation Management
Feldafing, Germany

8 May – 11 June 1991
‡ Management of Irrigation Projects
Colombo, Sri Lanka

23 September – 11 October 1991
‡ Farmer-Managed Irrigation Systems
Chiang Mai, Thailand

28 October – 15 November 1991
†‡ Training of Trainers for Irrigation Management, Kajang, Malaysia

14 October – 2 November 1991
† Curriculum Development for Irrigation System Management, at Kasetsart University
Kamphaeng Saen, Thailand

4 – 7 November 1991
‡ New Trends and Policies in Irrigation Management, Colombo, Sri Lanka

25 – 29 November 1991
‡ Management Orientation in Irrigation Engineering, Curricula, AIT, Thailand

4 – 22 May 1992
‡ Monitoring and Evaluation of Irrigation Performance
Chiang Mai, Thailand

2 – 30 July 1992
Management of Irrigation Projects
Feldafing and Zschortau, Germany

14 September – 2 October 1992
† Training of Trainers for Irrigation Management, Surat Thani, Thailand

5 – 9 October 1992
‡ Irrigated Agriculture in Southeast Asia Beyond 2000
Langkawi, Malaysia

13 – 15 October 1992
‡ Inventory of Farmer-Managed Irrigation Systems, Tagaytay, Philippines

15 October – 30 November 1992
‡ Study Tour on Irrigation Management for Diversified Cropping
Egypt and Morocco

22 – 25 June 1993
†‡ Diagnosing Training Needs and Designing Training Programs for Irrigation Management
Yogyakarta, Indonesia

5 – 9 July 1993
‡ Management of Rehabilitation and Modernization of Irrigation Systems
Manila, Philippines

12 – 30 July 1993
‡ Planning, Monitoring and Evaluation of Irrigation Performance, Baguio, Philippines

11 – 29 October 1993
‡ Management of Rehabilitation and Modernization of Irrigation Systems
Chiang Mai, Thailand

2 – 5 November 1993
‡ Institutional Framework for Irrigation, Chiang Mai, Thailand

27 January – 25 February 1994
Training Materials for Irrigation Management
Feldafing, Germany

2 – 6 May 1994
‡ Service Orientation in Irrigation Management
Feldafing, Germany

Policies concerning food security and rice self-sufficiency, at both regional and national levels, are generally viewed as significant factors in determining the future prospects of irrigated agriculture.

It was agreed that, in the development of policies for increased private-sector roles, there should be safeguards for the interests of low-income groups in existing farm communities.

Areas of Common Concern for the Region

Common features of the country groups' discussions and statements form two clusters:

1. Adjustments of the public/private sector balance and relationships in irrigated agriculture, in the direction of increased private-sector roles; and
2. Planning and management of water resource use, with particular reference to the care of the environment and to improving conservation and beneficial application of the water resources, with due regard to competing uses of water.

Roles and Relationships of the Public and Private Sectors

Common concerns in the first category included:

- ❑ enhanced participation by organized farmers in management decisions and actions;
- ❑ commercial involvement of private-sector firms;
- ❑ development of human resources, especially preparation of the farm community for the opportunities of more entrepreneurial roles and attitudes;
- ❑ development of appropriate skills and attitudes, suitable for new functional relationships, among staff of irrigation agencies; and
- ❑ reduction of the operational role of public-sector irrigation organizations, accompanied by increased public-sector actions on strategic management.

Management of Water Resources

Common concerns in the second category included:

- ❑ efficient use of water, especially by raising the performance of existing irrigation systems;
- ❑ development of procedures (legal or regulatory) for allocation of access to water resources;
- ❑ mechanisms for maintaining water quality, including control of applications of agricultural chemicals and of waste outflows from the growing industrial sectors;
- ❑ social and economic measures for maintaining upper watershed lands and forests in a condition that sustains the productive potential of downstream irrigated areas;
- ❑ identifying and pursuing environmentally sound goals in the disposal of surplus irrigation water; and
- ❑ identifying the social and economic value of water, and incorporating that intrinsic value into plans for its utilization.

Possible Actions at the Regional Level

Actions desired at the regional South-east Asian level, in regard to these two main clusters of future concerns, are principally in the areas of information exchange and networked research. These actions may include the sharing and use of information and experiences from countries outside of, as well as within, the region.

Examples of the kinds of information needed include:

- ❑ evidence of the costs and benefits experienced under different models of public/private sector interaction in other countries;
- ❑ ways to enhance the availability of private capital to irrigated agriculture, without impairing the interests of traditional farm communities;
- ❑ impacts of alternative models of production relationships that may develop in the nongovernment sector, such as group farming and contract farming;
- ❑ organizational systems for optimizing the benefits and the rate of adoption of appropriate technological and management innovations;
- ❑ groundwater resource identification and utilization; and
- ❑ experiences of public institutional frameworks and laws for water resources allocation, monitoring and control.

World Environment Day Celebrations in Colombo

IIMI celebrated World Environment Day on Monday, 6 June 1994, with a symposium on the environment with special reference to water. The event was co-sponsored by IIMI, the Ministry of Environment and Parliamentary Affairs (MEPA) and the Sri Lanka Association for the Advancement of Science (SLAAS). Speakers included: Dr. Wimal Wickramasinghe, Minister of MEPA; Dr. Roberto Lenton, Director General IIMI; Dr. Devanesan Nesiah, Secretary MEPA; and Prof. J.B. Disanayaka of the University of Colombo. A special presentation on the Shared Control of Natural Resources (SCOR) Project was also made by officials from IIMI's Sri Lanka Field Operations Office.

A poster to mark IIMI's Tenth Anniversary was formally released the same day when it was presented to the Hon. Minister by Dr. Roberto Lenton.

DSE/IIMI Foundation Stone for New ASEAN Water Resources Council

The aim of the DSE/IIMI Program was to contribute to a greater understanding of the factors that influence irrigation performance.

The DSE/IIMI Program on Dialogue and Training for Irrigation Managers came to an end with a final workshop, at Feldafing, Germany during 2–6 May 1994. During the week, senior participants from Malaysia, Thailand, the Philippines, and Indonesia, took the initiative to convene an extra session to discuss building a follow-up to the DSE/IIMI Program. The outcome was a proposal to establish an ASEAN Water Resources Council. This was entirely a regional initiative that was inspired and facilitated, but not promoted, by the DSE/IIMI Program. A request was also made for a BMZ grant of DM 150,000, to facilitate the start-up phase. The BMZ response is not yet known.

Within the framework of the DSE/IIMI Program, a total of 25 workshops, seminars, study tours, consultancy missions and training courses were held from 1990 to 1994. Participants at these events were primarily from Thailand, Indonesia, the Philippines and Malaysia. The program was funded by the German Foundation for International Development (DSE). IIMI provided program support and coordination by selecting topics, locations and formats as well as choosing participants and external resource persons.

The program was targeted at: operational and administrative decision makers; managers, mid- and high-level staff of irrigation and line agencies, irrigated-agriculture teachers and trainers. The overall aim of the program was to contribute to a greater understanding of the factors that influence irrigation performance. The program wanted to go beyond the technical aspect of irrigation performance and promote a goal-oriented, open, socio-technical approach to irrigation management.

There were three workshops and two courses conducted in 1993. In Thailand, in November 1993, a workshop on developing an "Institutional Framework for Irrigation" was attended by academics, agency officials, irrigation experts and specialists from the four participating countries. Representatives from IIMI were in attendance to guide the proceedings and provide support to the development of a framework. Also attending, for the first time in the program, was a team of observers from Laos. The workshop successfully developed objectives and recommended changes with regard to governance, legal, organizational, financial and farmer operations.

Other events included an Indonesian national workshop on "Diagnosing Training Needs, and Designing Training and Teaching Programs for Irrigation Management" in Yogyakarta, Indonesia, and a regional workshop on "Management of Rehabilitation and Modernization of Irrigation Systems" held in Manila, the Philippines. There was also a regional course conducted in Baguio, the Philippines on "Planning, Monitoring, and Evaluation of Irrigation Systems," and a regional course in Chiang Mai, Thailand on "Management of Rehabilitation and Modernization of Irrigation Systems."

1994 was devoted principally to the evaluation of the entire series of events and to the completion of publications. Although it is too early to judge the extent of the program's accomplishments, it is clear that the program proponents and the participants were satisfied with the overall experience. The proposal to establish a Water Resources Council for the ASEAN region, is the most significant indicator of the DSE/IIMI Program's impact.

The participants' own evaluations of the DSE/IIMI series of events and their impacts have been very positive. The scale and duration of the program and the nature of the participants were such, that it is likely that a significant proportion of the ideas generated in these discussions will be given due consideration.

As a consequence of this program, Irrigation Management has already been integrated into the training and teaching curricula for irrigation engineers in Thailand, Indonesia, and

the Philippines. Twelve fellowships have been awarded to young professionals to provide them with opportunities to study specific problems in irrigation management. Relationships developed have led to an exchange of students on a regional basis.

Links forged amongst program participants have also facilitated the exchange of experiences and ideas. Productive links have not only been forged intraregionally but also intranationally. As a participant from the Philippines put it:

There is no forum (in the Philippines) by which working people in the different agencies get together and talk about irrigation and irrigation problems. The DSE/IIMI Program on Dialogue and Training has given us an opportunity to get a national view of the state of the irrigation sector. Furthermore, we were surprised to find that the problems we face were shared by our colleagues in the region. Since we share similar problems we can also share the solutions. This shared experience can reduce the time we take to realize and tackle an issue by ten to twenty years.

PROPOSAL

Establishment of an ASEAN Water Resources Council

Background/Rationale

Starting in 1990, series of workshops, conferences and seminars discussing water resources-related issues have taken place under the initiative of the German Foundation for International Development. Participants are professionals in the field of water resources from the ASEAN region, particularly the Philippines, Indonesia, Malaysia and Thailand.

A high level of awareness on the critical issues confronting the scarce water resources was generated among the participants. The present situation of rapid population growth is creating an increasing degree of competition among the different sectors of water users as well as increasing the rate of water quality deterioration caused by improper waste disposal. Public apathy in the conservation and quality preservation of water resources and lack of sensitivity on the part of the governments on what is happening in handling of water resources issues led to a consensus among representatives of the concerned countries to form an institution that could take the lead role in properly addressing the issues in a more concerted manner. A gloomy scenario will surely happen if nothing positive is done to counteract the present trend as soon as possible.

The above premises considered, the establishment of an ASEAN Regional Water Resources Council is hereby proposed.

The regional dimension is justified through the following:

- ❑ sharing of knowledge
- ❑ exchange of research results and developing a database on regional water resources
- ❑ exchange of policies
- ❑ resolutions of an ASEAN Water Resources Council have more weight toward policy and the public
- ❑ less expenses/costs on addressing common problems; only one council/center and not four need to be supported to address common problems
- ❑ pooling of resources and reduction of duplication
- ❑ to act as channel for coordinating international inputs.

Objectives

In general the Council will be tasked to take the lead role in addressing water resources related problems of development, conservation, utilization and quality preservation in the region.

Specifically the Council will be mandated to:

a) provide collective effort in the solution of water resources problems confronting the region

b) facilitate sharing of experiences and enhancing mutual support and cooperation among member countries

c) formulate mechanisms/strategies towards increasing public awareness and cause changes in the attitude of concerned government agencies in the handling of the country's water resources

d) develop tools for the maximization/ optimization of utilization of water resources.

Organizational Setup

The Council will be composed of countries within the ASEAN region willing to cooperate in addressing water resources issues in the region. The possibility of having the Council within the ASEAN structure will be looked into.

Funding

To be sustainable and effective the council must be supported financially by the member countries, but only to a certain extent in order not to be totally dependent on external support. However, to obtain attention and support of the officials of individual countries it is very important that something tangible has been done by the Council. In this regard it is necessary that start-up funds be solicited from external agencies.

Initial Plan of Action

1. A pro tem secretariat will be set up in Bangkok/Thailand to coordinate initial activities of the Council.

Continued on page 38➥

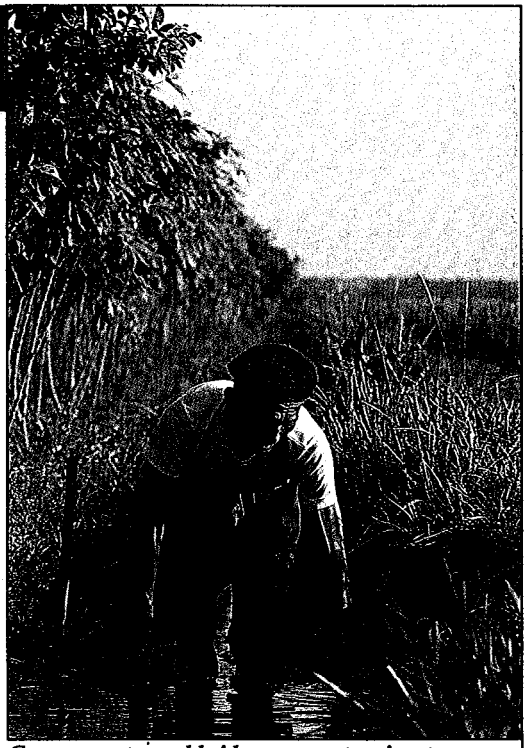
News Briefs

International Conference on Irrigation Management Transfer

Governments worldwide are facing great difficulty in effectively and sustainably managing the operation and maintenance (O&M) of public irrigation systems. This is combined with a widespread desire by governments to reduce subsidies to irrigation. Hence, governments are now turning to community-based institutions to either take over or help manage irrigation systems. As a result, the transfer of both complete and partial management for irrigation systems from governments to local organizations, and a subsequent reduction in the role of public irrigation organizations in day-to-day management of the system, are the most important trends in irrigation management today.

Numerous governments are now either formulating policies or implementing programs to transfer irrigation management to farmer associations or to third-party organizations which are accountable to farmer associations. For larger public irrigation systems, these transfer programs often involve partial transfer, with the public organization retaining management control of the water source and the main distribution canals, and the farmer organization being responsible for management of the secondary and minor canals and within distribution blocks. Other transfer programs, especially those involving smaller irrigation systems, consist of complete management transfer from the public agency to the farmer organization.

Given the widespread pressures for rapid adoption of irrigation management transfer, governments are often attempting to formulate transfer programs without the benefit of prior experience and knowledge about the experiences of other countries. An International Conference on Irrigation Management Transfer scheduled to be held in Wuhan, China from 20 to 24 September 1994, will bring together planners, practitioners and researchers to exchange information about their experiences with, and results from, irrigation management transfer (IMT).



Governments worldwide are now turning to community-based institutions to either take over or help manage irrigation systems.

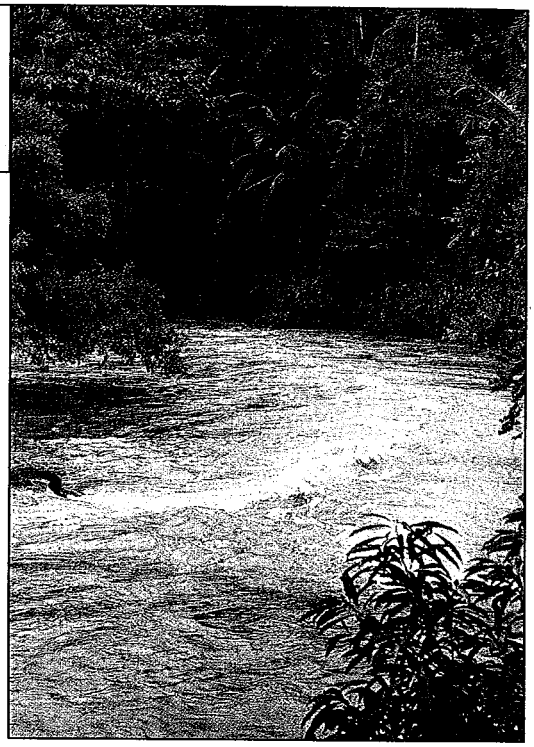
The organizers have decided to hold the conference in China because of its dramatic and distinctive approach to irrigation management devolution. Of particular interest for this conference are the Chinese approaches towards local financing of irrigation and the institutional arrangements for ensuring accountability between the farmers, irrigation district management and government.

The purpose of the conference is to enhance the capacity of officials, managers and researchers to formulate, implement and assess management transfer policies and programs. The target audience will include policymakers and planners considering irrigation management transfer options for their countries; policymakers, planners, managers and researchers who already have direct experience with irrigation management transfer; and staff of development agencies, donors and international banks involved in or planning future irrigation management transfer programs.

Two kinds of papers will be presented at the conference: Research Papers and Discussion Papers. Research Papers would normally be more formal or systematic presentations of the processes and results of an irrigation management transfer program. Discussion papers would be shorter and less formal than Research Papers and would focus on implementation and policy issues associated with actual irrigation management transfer programs. Two field trips will also be arranged to illustrate various aspects of irrigation management transfer in China.

The main conference organizers are IIMI and the Wuhan University of Hydraulic and Electrical Engineering (WUHEE), the premier hydraulic engineering university in China. Other organizers include the Hubei Association of Science and Technology (HBAST), Hubei Hydraulic Engineering Society (HBHES) and the United Nations Food and Agriculture Organization (FAO). The Ford Foundation, FAO and IIMI will be funding the conference.

PROJECT ON SHARED CONTROL OF NATURAL RESOURCES



SCOR is primarily concerned with the management of natural resources.

In recent years, resource degradation has reached critical proportions in Sri Lanka. Although there are several reasons for the intensification of resource degradation, it is essentially an institutional and socioeconomic problem. The lack of an appropriate resource management strategy has contributed to a rapid escalation of the problem.

The Shared Control of Natural Resources (SCOR) Project was conceived to specifically tackle problems associated with resource degradation. Inaugurated in September 1993 at IIMI Headquarters in Sri Lanka, SCOR seeks to develop innovative means of arresting the land degradation process while providing protection incentives to users. SCOR is primarily concerned with the management of natural resources including water conservation, and the arrest of land degradation. SCOR will study soil erosion and other land degradation problems and make observations that will facilitate proper management of land resources. SCOR will also contribute to the data available on the extent and nature of land degradation.

The SCOR Project is being implemented by the Government of Sri Lanka with the active participation of the Ministry of Forestry, Irrigation and Mahaweli Development and the Ministry of Lands together with other agencies within the purview of the Ministries concerned with Agriculture, Environment, Planning and Provincial Councils. Private sector agencies such as nongovernmental organizations (NGOs) and user organizations are also playing a significant role in its implementation.

The main objectives of the SCOR Project are:

- ❑ To improve the incentives and institutional arrangements for intensifying land- and water-related activities in two pilot watersheds;
- ❑ To urge resource user groups and officials to consider environmental implications of land and water management and to internalize them in decision making;
- ❑ To improve available information and increase awareness of the capacity of the land and water base for production and protection; and
- ❑ To strengthen the capacity of government and nongovernment agencies in planning for land and water resources management in an integrated manner, gradually transforming the strategy of development from a "project" to "program" mode.

Phase I of the SCOR Project was launched in October 1993 and would continue until the middle of 1995. The first phase of this two-phase, six-year project, is sponsored by the United States Agency for International Development (USAID). The process of project implementation is facilitated by IIMI. SCOR is being implemented in two pilot watersheds of the Nilwala Ganga Watershed in the Southern Province and the Huruluwewa Watershed in the North Central Province covering about 30,000 hectares (ha). Since implementation began, land and water management activities in the two pilot watersheds have been initiated. These activities include mobilization for establishment of stream gardens; restoration of tank ecosystems; adoption of conservation bunds and alley planting; awareness and training.

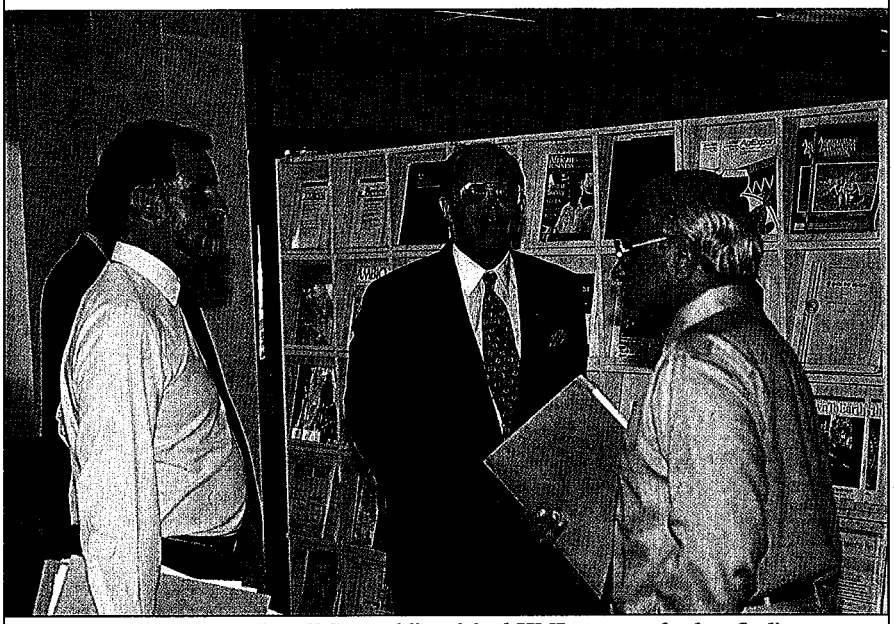
Speaking at the inauguration ceremony of the SCOR Project, Mr. Terrance Liercke, the Director of USAID-Sri Lanka, said that SCOR will provide an "excellent opportunity to put into practice ideals and principles" that formed the core of USAID. He added that similar programs where control of natural resources was shared with user groups were extremely successful in Peru, Costa Rica, Russia, and several other countries.

➥ *Continued from page 36*

2. In each member country a sectoral Council will also be set up not later than August 1994.
3. The pro tem secretariat composed of representatives of the member countries will meet in Bangkok in early November 1994 to discuss the plans and programs of the Council as well as budgetary matters.

Note: This proposal is subject to ratification by the relevant authorities. This proposal is entirely the initiative of program participants from the four ASEAN countries and is not sponsored, guided or implemented by the German Foundation for International Development (DSE) or by the International Irrigation Management Institute (IIMI).

VISIT TO IIMI HEADQUARTERS By CGIAR Chairman, DR. ISMAIL SERAGELDIN



CGIAR Chairman, Dr. Ismail Serageldin, visited IIMI as part of a fact finding mission to several CGIAR centers in Asia.

"There are over a billion people in the world today who are hungry and malnourished and we will have another billion mouths to feed in the next ten years" said Dr. Ismail Serageldin, the World Bank's Vice President for Environmentally Sustainable Development. Dr. Serageldin who is also Chairman of the Consultative Group on International Agricultural Research (CGIAR) was in Colombo, Sri Lanka from 29 January to 2 February 1994 to visit IIMI as part of a fact-finding mission to several CGIAR centers in Asia.

"It is up to us to articulate the vision of feeding another billion people. We are all working for the impoverished people of the world and we cannot tolerate any slack. We must convince the donors of the importance of the mandate that has been given to the CGIAR in the past and of the urgent need to renew the dedication and commitment through that mandate. We must take our case to the public and not just to the specialists and political decision makers, and I will be happy to be your ambassador," he said.

During his visit to Sri Lanka, Dr. Serageldin met with the President and Prime Minister and several Ministers, to brief them on worldwide developments in his areas of competence. Dr. Serageldin also delivered a speech on sustainabhe Development with special reference to Human Development. While at IIMI, Dr. Sergeldin met with Research and Program staff who briefed him on issues and challenges that affect irrigation management and of IIMI's response to them. Presentations were also made on IIMI's efforts towards salinity management in Pakistan, and policy reform and natural resources management in Sri Lanka.

First External Program Review of IIMI Completed

IIMI's first external Program Review as a full member of the Consultative Group on International Agricultural Research (CGIAR) was completed recently. The review team headed by Prof. Bernard Tinker (UK) comprised Prof. Jan Feyen (Belgium), Prof. Alain de Janvry (France) and Mr. Sirinivasan Umapathy (India). Two consultants, Mr. D. Norman Uphoff (USA) and Mr. Dan Carroll (USA) assisted the panel on program and management aspects respectively. Mr. Amir Kassam of the TAC Secretariat and Ms. Elizabeth Fields of the CGIAR Secretariat served as resource persons.

The review process commenced in November 1993 with the visit of the review panel to IIMI headquarters in Colombo. This was followed by a visit of selected members of the panel to IIMI's field operations in Sri Lanka and later in India, Pakistan, Burkina Faso, Niger, Nigeria, and the Philippines to review field activities including meetings with national partners and collaborators. The main phase of the review was carried out in Colombo during March-April 1994.

The review panel's analysis shows that the case for an international research program on irrigated agriculture is overwhelming on food security grounds. This emphasizes the importance of irrigation management research, especially in relation to possible water scarcity. IIMI's research program has been oriented towards field work and impact. The panel believes that this should continue and IIMI should aim for maximum impact in the near term, but a strategic element has to be added on science as IIMI is a CGIAR Center. IIMI has grown at a rapid rate. The Board has strong membership but it may need to strengthen its operating procedures. The panel is of the opinion that IIMI needs to develop institutional relationships because it cannot successfully accomplish its goals without them. These relationships must be forged with national irrigation agencies and research institutions, as well as with international institutions both within and outside the CGIAR. The panel has found that IIMI has had useful impact already and needs more. It also needs to improve strategic science and science quality. The panel believes that IIMI can do both these things.

IIMI TAKES STEPS TO INITIATE PROGRAMS IN MEXICO

During the past one and a half years IIMI has been exploring the possibility of expanding its activities into Latin America with a view to contribute to improving irrigated agriculture in this region.

Although in many Latin American countries the irrigated component of the agriculture sector is relatively small, from the point of view of production and share of agricultural investment, the importance of irrigated agriculture is greater.

Mexico, with 5.2 million hectares (ha) under irrigation (which represents about 21 percent of its total cropped area), has the largest irrigated area in Latin America. This accounts for approximately 32 percent of the total 16 million ha of irrigated area in the region.

Mexico is currently engaged in an important process of making its large irrigation systems, "distritos," self supporting through increased user participation in operation, maintenance, and administration/ management. The plan calls for transferring over to the farmers those systems that have reached an adequate socioeconomic level. Under this program, 1.9 million ha is expected to be handed over to the farmers before 1995.

To initiate activities in Mexico, IIMI represented by its Director General Dr. Roberto Lenton, signed a Memorandum of Understanding (MOU) with the Institutuo Nacional de investigaciones Forestales y Agropecuarias (INIFAP) represented by its then Vocal Ejecutivo, Dr. Ernesto Samayoa-Armienta. The MOU calls for both institutions to plan, promote, coordinate and implement irrigation-related collaborative research projects. It also calls for joint organization of regional and/or local events of interest to both organizations, and to exchange and publish information related to this cooperation.

A similar document was signed between IIMI and the Colegio de Postgraduados (CP), in late October 1993, with emphasis on joint research projects, activities geared towards training and related institutional development, and strengthening of national research capacity. Dr. Lenton and Dr. Rafael Rodriguez-Montessoro, as Director General (DG) of Colegio signed the document.

To develop its program in Mexico, IIMI is engaging the services of an irrigation specialist, with broad experience in the area of irrigated agriculture in Latin America, to be posted to Chapingo. In addition, other IIMI staff with experience in the area will be providing support to the emerging program.

IIMI has also signed an MOU with its CGIAR sister center in Mexico—The Centro Internacional de Mejoramiento de Maiz y Trigo (CIMMYT)—for provision of administrative support to the program. The respective DGs Dr. R. Lenton and Dr. D. Winkleman signed the agreement on 22 October 1993.

IIMI is looking forward to this new challenge and looks upon this effort as an initial step in establishing a broader set of activities in the Latin American and Caribbean (LAC) region.

PUBLICATIONS

COUNTRY PAPERS

Charles Nijman

Irrigation Decision-Making Processes and Conditions

Country Paper - Sri Lanka - No.9
ISBN 92-9090-140-3
May 1993. xxxiv + 314p
A5. Softcover.

This paper, which is a companion document to " Irrigation Management Processes and Conditions" by the same author, presents a detailed study of decision-making processes and managerial conditions of the Kirindi Oya Irrigation and Settlement Project in Sri Lanka, adopting a management perspective in the analysis of the performance of this major irrigation system in Sri Lanka. It documents the decision-making processes during project identification, feasibility assessment, system design and system operation. A systematic analysis of the interaction between system performance, decision-making processes and their managerial conditions has resulted in recommendations for improvement and has demonstrated the far-reaching changes required in the interaction among the donors, the government and the agencies to develop commitment and accountability toward irrigation system performance. While these findings and recommendations are derived from one case study, they have much wider validity.

D.J. Bandaragoda

The Role of Research-Supported Irrigation Policy in Sustainable Irrigated Agriculture: An Interpretive Precis of the Case of Pakistan

Country Paper - Pakistan - No.6
ISBN: 92-9090-163-2
October 1993. xiv + 68pp.
A5. Softcover.

Over the past few decades, Pakistan's irrigated-agriculture environment has gradually changed. The emergence of waterlogging and salinity, the advent of groundwater development, the proliferation of private tubewells, the establishment of new project-based facilities, the demand orientation of farm-level irrigation operations due to improved agricultural practices, and the limitations on overall availability of good quality water, have all added different dimensions to this gradual change. To meet the demands of this changing situation, Pakistan embarked upon several research efforts and policy initiatives. The paper outlines seven selected state interventions which were fed by both research efforts and policy initiatives. Results of these interventions were of varying degrees of success. Where research and policy proceeded hand in hand, and interacted more closely, the results appeared to be more positive.

D. Hammond Murray-Rust; O.T. Gulati; R. Sakthivadivel; V.B. Prajapati; P.L. Shukla

Improving Irrigation Performance through the Use of Management Information Systems: The Case of Mahi Kadana, Gujarat, India

Country Paper - India - No.1
ISBN: 92-9090-305-8
July 1994. xix + 85pp.
A5. Softcover.

This paper describes the development and implementation of a Management Information System for the Mahi Kadana Irrigation Project in Gujarat, India. It describes the sequential process of modification of field-level data collection procedures by low-level staff of the Gujarat Irrigation Department, the development of improved methods for communicating these field-level data in a timely and efficient manner to mangers at section and subdivision levels, and the development of a data processing package that transfers field-level data into information to be used by mangers in improving performance into the future. The second part of the paper demonstrates how the output from the computer package can be used to develop performance reports and tables and graphs that describe the current performance achievements of the system. In addition, the package generates bills for irrigation service for all farmers in the system. The generic nature of the Management Information System used in Mahi Kadana makes it highly suitable for adoption throughout the State of Gujarat, other States in India and in other countries. This work was undertaken as a collaborative activity between IIMI and the Water and Land Management Institute (WALMI) in Anand, Gujarat. The entire project was carried out with the full collaboration of the Gujarat Irrigation Department.

RESEARCH PAPERS

D. Hammond Murray-Rust and W. Bart Snellen

Irrigation System Performance Assessment and Diagnosis

ISBN: 92-9090-192-6
July 1993. 20 + 148pp.
B5. Softcover.

This monograph provides a framework for use in the assessment of irrigation system performance and diagnosis of the primary causes of different levels of performance actually achieved. The framework is tested using 15 case studies of irrigation performance in a range of countries in Asia, Africa and South America with a number of different design and management environments. Using this framework it is possible to identify where there are shortcomings in existing approaches to objective setting, implementation, monitoring and evaluation, and to guide irrigation mangers towards remedying these deficiencies. The focus is on hydraulic performance in the main canal system, but it also includes agricultural performance and issues of environmental sustainability in its scope. One conclusion from the study is that systems with simple management objectives and simple physical design generally perform considerably better than more complex systems, even though complex systems have higher potential for good performance.

Advancements in IIMI's Research 1992
A selection of papers presented at the Internal Program Review

ISBN 92-9090-199-3.
October 1993. vii + 312pp.
B5. Softcover.

Mark Svendsen and Douglas Vermillion

Irrigation Management Transfer in the Columbia Basin: Lessons and International Implications

Research Paper - No. 12
ISBN 92-9090-303-1
June 1994. xix + 94pp.
B5. Softcover.

This is a study of the transfer of irrigation management from the US Government Bureau of Reclamation to farmer-controlled irrigation districts in the Columbia River Basin Project, Washington State, USA. It assesses the conditions motivating and shaping the transfer, the nature of the change process, perspectives of the different groups involved and the effects of management transfer on the hydrologic, agricultural, economic and financial performance of irrigated agriculture in the Project. Comparisons are made with conditions in developing countries.

MONOGRAPHS

P.S. Rao

Review of Selected Literature on Indicators of Irrigation Performance

ISBN: 92-9090-198-5
October 1993. xiii + 75pp
B5. Softcover

This paper reviews much of the available literature on indicators of irrigation performance, with special reference to water delivery performance. It is intended primarily as a

guide to researchers, though irrigation mangers will also find it useful. The main conclusions of selected authors are summarized and placed into an overall context; and the issues they raise, as well as some of the gaps, and the types of performance indicators discussed in the literature are critically discussed. The paper concludes with a suggested minimum set of indicators for irrigation performance assessment.

Robert Yoder

Locally Managed Irrigation Systems: Essential Tasks and Implications for Assistance, Management Transfer and Turnover Programs

Monograph No.3
ISBN 92-9090-194-2
March 1994. vii + 97pp.
B5. Softcover.

This monograph examines the construction, operation and maintenance tasks that shape the nature of locally managed irrigation systems. Most of the examples are drawn from surface diversion systems. International interest in the institutions, organization and functions of locally managed irrigation has increased in recent years, as ideas are sought for development programs of three kinds: direct assistance to existing locally managed irrigation systems, turnover of entire publicly owned systems to local management, and transfer of partial management to farmer groups within larger systems that remain publicly controlled. The objective of the book is to identify relevant experiences and lessons for staff who are responsible for working with locally managed systems in each of these types of programs. A series of examples are used to illustrate the broad range of institutions irrigators have developed to accomplish essential irrigation tasks. The discussion shows the implications that these tasks have for irrigation development programs.

WORKING PAPERS

Itakura, Jun and Abernethy, Charles L.

Water Management in a Tank Cascade Irrigation System in Sri Lanka

First Seasonal Report of TARC-IIMI Joint Project 1991/1992 Maha Season
Working Paper No.24.
ISBN 92-9090-300-7
November 1993. 58pp.
A4. Softcover.

Muralidaran, V. and Krishna, K.V.S.M.

The Dynamics of Irrigation System Performance: A Comparative Study of Two Secondary Canal Reaches in Mahi-Kadana, Gujarat.

Working Paper No.25.
ISBN 92-9090-301-5
December 1993. x + 68pp.
A4. Softcover.

Strosser, Pierre; Afaq, Rana M. and Garces, Carlos

Changes in Water Duties and Their Impact on Agricultural Production: The Case of Girsal Minor.

Working Paper No.26.
ISBN 92-9090-165-9
December 1993. x + 30pp.
A4. Softcover.

Malik, Saleem M. and Strosser, Pierre

Management of Private Tubewells in a Conjunctive Use Environment: A Case Study in the Manawala Distributary Command Area, Punjab, Pakistan.

Working Paper No.27.
ISBN 92-9090-164-0
December 1993. vii + 38pp.
A4. Softcover.

Bandaragoda, D.J. and Rehman, Saeed ur

Institutional Perspectives of Land Reclamation Operations in Punjab: A Case study of the Lower Chenab Canal (East) Circle Area

Working Paper No. 28.
ISBN 92-9090-306-6
June 1994. xv + 60pp.
A4. Softcover.

WORKSHOP PROCEEDINGS

Performance Measurement in Farmer-Managed Irrigation Systems

Proceedings of an International Workshop of the Farmer-Managed Irrigation Systems Network

Editors: Shaul Manor and Jorge Chambouleyron

ISBN 92-9090-193-3.
November 1993. xxxiv + 266pp.
B5. Softcover.

SHORT REPORT SERIES

Short Report Series on Locally Managed Irrigation - Report No.2 "Privatization of Irrigation Schemes in New Zealand"

Peter J. Farley

Program on Local Management, IIMI
February 1994. v + 14pp.
B5. Softcover.

Short Report Series on Locally Managed Irrigation - Report No.3 "Chilean Water Policy"

Renato Gazmuri S.

Program on Local Management, IIMI
February 1994. v + 9pp.
B5. Softcover.

Short Report Series on Locally Managed Irrigation - Report No.4 "Irrigation Management Turnover in the Philippines: Strategy of the National Irrigation Administration"

C.M. Wijayaratna and Douglas L. Vermillion

Program on Local Management, IIMI
April 1994. v + 23pp.
B5. Softcover.

Short Report Series on Locally Managed Irrigation - Report No.5 "Irrigation Management Transfer in Colombia: A Pilot Experiment and Its Consequences"

Douglas L. Vermillion and Carlos Garces-Restrepo

Program on Local Management, IIMI
June 1994. v + 18pp.
B5. Softcover.

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IIMI Annual Report 1992

ISSN 1017-5954
October 1992. 110p. A4. Softcover.

IIMI Review. Volume 6 No.2.

(Edición En Español)
ISSN 1021-830
November 1992. 24p. A4. Softcover.

IIMI Review. Volume 7 No.1.

ISSN 1012-831X.
May 1993. 24p. A4. Softcover.

IIMI Review. Volume 7 No.1.

(Édition En Français)
ISSN 1012-831X.
April 1994. 24p. A4. Softcover.

IIMI Review. Volume 7 No.1. (Edición En Español)

ISSN 1021-0830
November 1993. 24pp.
A4. Softcover.

IMIN Bibliography: A Selected Bibliography on Irrigation Management

ISSN 1015-1680
Volume 6
November 1993. 173p+indexes.
A4. Softcover.

(Documents entered in the Irrigation Management Information Network Database, 1992).

NEWSLETTERS

FMIS. Newsletter of the Farmer-Managed Irrigation Systems Network

ISSN 1012-988X
September 1993. No.12. 32p.
A4. Softcover.

FMIS. Boletín de la Red de Sistemas de Riego Administrados por los Agricultores

ISSN 1012-0849
October 1993. No.11. 28p.
A4. Softcover.

Bulletin du Reseau Irrigation Afrique de l'Ouest

ISSN 1017-110X
No.003. April 1993. 40pp.
A4. Softcover.

Bulletin du Reseau Irrigation Afrique de l'Ouest

ISSN 1017-110X
No.004. June 1994. 44pp.
A4. Softcover.

STAFFING

Professor Gaylord Skogerboe was appointed as Director for Pakistan in August 1993. Professor Skogerboe has an outstanding reputation in the field of irrigation management. A graduate of the University of Utah, with B.S. and M.S. degrees in civil engineering, Professor Skogerboe was formerly Director of the International Irrigation Center at Utah State University, a position he occupied since 1984. Prior to his appointment at Utah State, Professor Skogerboe served for many years on the faculty of Colorado State University, during which time he served as Project Coordinator for the Water Management Research Project in Pakistan. In addition to his extensive work in Pakistan, Professor Skogerboe has undertaken consultancy assignments in several countries around the world, including Sri Lanka, the Philippines, Brazil and Bolivia.

Dr. Christopher Perry, Senior Economist, the World Bank, has been seconded to the IIMI staff for a period of two years from 1 January 1994. During his stay with IIMI, Dr. Perry will be attached to the Performance Program based at IIMI headquarters. Dr. Perry received a B.Sc. degree in mechanical engineering from Imperial College, London and a Ph.D. in economics from Stirling University in Scotland. A recognized authority on irrigation development and management in India, Dr. Perry has spent over eight years (from 1980 to 1984, and again from 1990 to 1993) on the Bank's irrigation program in India, including the National Water Management Project, and more recently the new-style State Water Resource Projects. In addition, Dr. Perry has worked with the Bank on irrigation management in Egypt and served on the staff of the Intermediate Technology Development Group (ITDG) in the UK.

Mr. Flemming Konradsen has joined the Research Division as an Associate Expert in March this year. Mr. Konradsen, a Danish national was previously at the Danish Bilharziasis laboratory. He has also worked in Zimbabwe, Malawi, Japan, and Chile. At IIMI, he will work on IIMI's new Health and Irrigation Program for a period of two years.

Dr. Kazunori Kato has joined IIMI as an Irrigation Specialist for an initial period of two years on secondment through the Japanese International Cooperation Agency (JICA). During his period at IIMI, Dr. Kato will be attached to IIMI's Performance Program. He is a specialist in Water Resources Development and Irrigation with B.Sc., M.Sc., and Ph.D. degrees in Agricultural Civil Engineering obtained from Tokyo University. He has extensive international experience, having served from 1977 to 1989 with the Nippon Koei Company Ltd. in various overseas assignments, and from 1989 to 1993 with the Institut Pertanian Bogor in Indonesia as Visiting Professor. Since returning to Japan, Dr. Kato has been conducting research at Tokyo University.

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