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Background Paper:

GLOBAL AND REGIONAL FOOD TRENDS AND FUTURE PROSPECTS

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GLOBAL AND REGIONAL FOOD TRENDS AND FUTURE PROSPECTS¹

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and
Rajul Pandya-Lorch²

ABSTRACT

Although food production increases of 39 percent in the 1980s seem impressive, they are less so in the light of population growth. On a per capita basis, 75 developing countries produced less food per person at the end of the 1980s than at the beginning. Except in Africa, 80 percent of the production gains came from increased yields in major cereal crops. The area cultivated has actually begun to decline in some regions. From now on even Africa, which has relied heavily on cultivation of new land for production increases, will have to count on yield gains or pay high financial and ecological costs for expansion into areas not yet cultivated.

Yield trends have climbed steadily upward in all major cereals since the 1960s, but some experts detect a tapering off. Yield growth rates are falling. Stagnation since 1980 in per capita grain production in developing countries is causing concern because factors in addition to population growth are pushing up demand. Expected growth in world feedgrain demand is more than twice the expected population growth.

IFPRI projections suggest that developing countries will increase their cereal production in the coming years, from about 800 million tons in 1988 to 1,200 million tons in 2010. But demands will increase even faster. The gap between cereal production and consumption will widen, and net cereal imports will more than double between 1988 and 2010. A focus on South Asia reveals that the region is expected to switch from being a minor net exporter of cereals in the late 1980s to a net importer by 2010. Wheat imports are the driving force behind the rapid growth in net cereal imports projected in the next two decades in the region.

¹ Paper prepared for presentation at the policy seminar on "Evolving Food Markets and Food Policy," jointly sponsored by the Ministry of Food, International Food Policy Research Institute, and the United States Agency for International Development, Dhaka, Bangladesh, May 2-4, 1994. A version of this report was originally presented at the International Centers' Week of the Consultative Group on International Agricultural Research (CGIAR) in Washington, D.C., on October 25, 1993, and subsequently published as an IFPRI Food Policy Report, *World Food Trends and Future Food Security*, March 1994. We thank our colleagues Mercedita Agcaoili and Mark Rosegrant for providing data from the IFPTSIM model at IFPRI. The assistance of Kene Ezemenari, research analyst at IFPRI, is gratefully acknowledged.

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Developed countries are projected to continue to produce more cereals than they consume in the coming decades, and increasing imports by developing countries are likely to be met without real price increases.

For more than 50 years a combination of rapid production increases and low purchasing power among a large share of consumers have assured that international food prices increased less than other prices. Recent projections suggest that real food prices are unlikely to increase significantly during the remainder of the 1990s. In fact, IFPRI projections suggest that real wheat prices could decline substantially and rice prices marginally in the next two decades. Low food prices in the world market do not necessarily mean that people will be fed. Poor people cannot express their food needs as economic demand. More than 1 billion people live in households that earn less than a dollar a day. Clearly, they are not in a position to convert their food needs to effective market demand.

If a sustainable balance between world food production and food needs (as opposed to food demand) is to be achieved in the coming years, four conditions must be met: (1) Economic growth must resume in those regions, especially Sub-Saharan Africa, where growth slowed down in recent years; (2) effective policies to reduce population growth and to slow rural-to-urban migration must be adopted; (3) resources must be committed to development of rural infrastructure, to expand international and national agricultural research, to provide credit and technical assistance, and to give farmers access to modern inputs; and (4) measures must be developed to manage natural resources and to prevent environmental degradation. Failure to invest today in these components of agricultural development will show up in production shortfalls 10-20 years from now. Lower yield growth rates could substantially increase world prices of major cereals, with consequent adverse effects on human hunger and well-being.

INTRODUCTION

The world food situation has never appeared better. Enough food is being produced today that, if it were evenly distributed, no one should have to go hungry. World food production is increasing faster than population growth; real food prices are at historic lows and have been declining for some time now; and yields of major cereals have more than doubled in the past three decades. Yet, more than 700 million people in the developing world do not have access to sufficient food to lead healthy and productive lives.

This paper asks, What can we learn from current world food trends? Are the production trends of the last 30 years likely to continue? What are the prospects for food demand, supply, trade, and prices? Are we likely to face a future of global food surpluses or one of increasing food scarcity and widespread hunger? Will future efforts to meet food needs be sustainable or will our natural resources be further degraded? Following a review of the current world food production and trade situation, the paper examines factors that will influence future food production and consumption. Future prospects for cereal demand and supply are explored. The paper concludes by identifying those actions that the international community needs to take to facilitate desirable future food trends and to modify undesirable

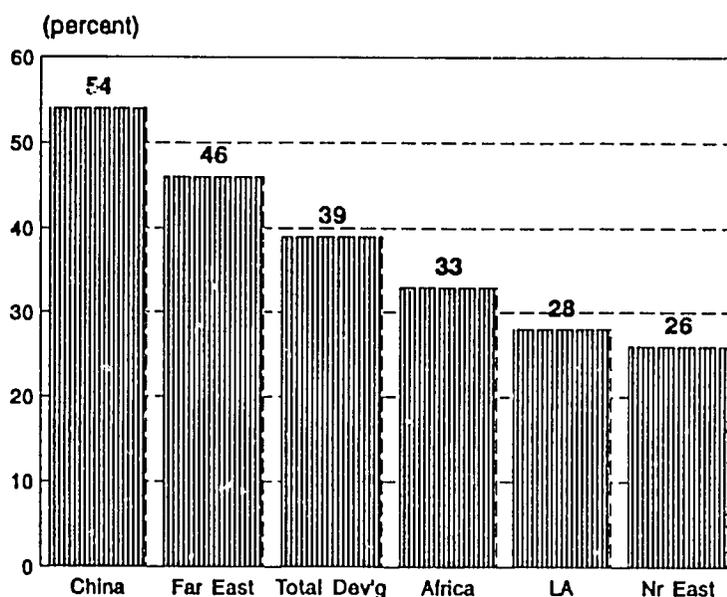
trends for the ultimate purpose of assisting developing countries to achieve improved and sustainable household food security in the future.

FOOD PRODUCTION

Food production increased by 39 percent in developing countries as a whole during the 1980s, with particularly impressive performances in China and the Far East (Figure 1). Even in Africa, where concerns regarding the future food situation are greatest, total food production increased by 33 percent during the 1980s. In fact, total food production rose in 101 developing countries, with 30 countries experiencing increases of 40 percent or more.

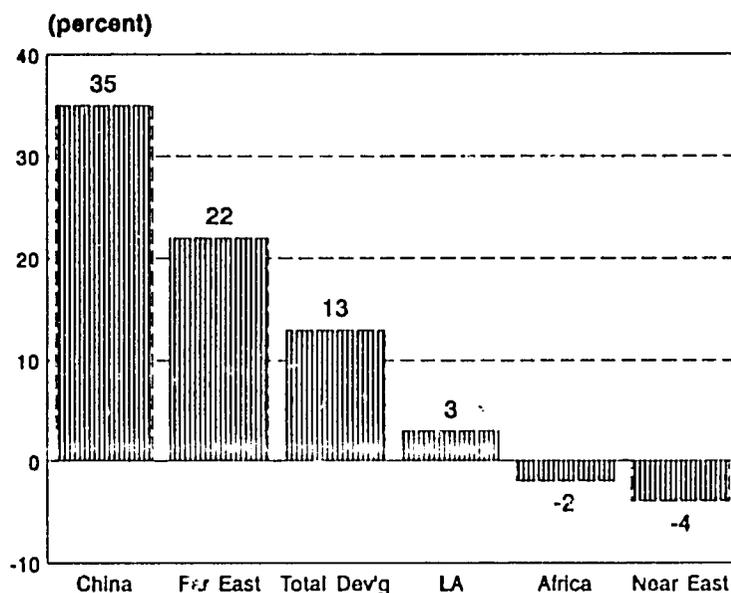
However, food production growth is not so impressive when compared with population growth. During the 1980s, per capita food production increased by only 13 percent in the developing countries as a group, again with China and the Far East leading (Figure 2). In Africa and the Near East, per capita food production declined. In 75 countries, less food was produced per person at the end of the 1980s than at the beginning. Three-fourths of the African countries fell into that category, as did almost two-thirds of the Latin American countries and half of the Asian countries. Fifteen countries experienced reductions of 20 percent or more in per capita food production during the decade. Two-thirds of all developing

Figure 1—Change in total food production, 1979-81 to 1989-91



Sources: FAO, *FAO Yearbook: Production* (Rome: FAO, 1990 and 1991).

Figure 2—Change in per capita food production, 1979-81 to 1989-91



Sources: FAO, *FAO Yearbook: Production* (Rome: FAO, 1990 and 1991).

countries recorded stagnant or reduced per capita food production during 1991-92.³ Africa as a whole experienced a 6 percent fall in per capita agricultural production in 1992 alone.⁴ This reflects serious droughts in southern Africa.

Yield increases were the major source of food production growth in all developing regions except Africa,⁵ contributing about 80 percent of increased cereal production in developing countries as a whole. Yield increases were the only source of China's spectacular food production performance during the 1980s. In cereals, the area cultivated actually declined in China as well as in Latin America. In Africa, by contrast, more than half of cereal production increases during the 1980s came from area expansion. While cultivated area is still increasing in developing countries, it is doing so at a low and declining rate, and increased food production in the future will have to come primarily from increased yields.

³ FAO, "The State of Food and Agriculture 1993" (FAO, Rome, 1993, mimeographed).

⁴ Ibid.

⁵ FAO, *FAO Production Yearbook*.

The most important cereal crops in developing countries are rice, wheat, and maize, which in 1992 accounted for 47, 23, and 19 percent, respectively, of all developing-country cereal production.⁶ Yield increases have been a particularly important source of production growth in wheat and rice and, to a lesser extent, maize, while they have played a much smaller role in sorghum, roots and tubers, and pulses (Figure 3). Yield-expanding technology is vital for enhancing the food production capacity of developing countries, including those in Africa.

A steady upward movement of the yield trend is clear for all three major cereals. Mainly stimulated by the green revolution, yields of maize, rice, and wheat more than doubled between 1961 and 1991 in developing countries (Figure 4). Yield increases in Asia were notably high, especially for rice and wheat (Figure 5). Rising from 0.5 tons per hectare in 1961, wheat yields in Asia exceeded 2.5 tons per hectare by 1991. In China, between 1961 and 1991, maize yields increased from 1.2 tons per hectare to 4.6 tons; rice yields tripled from 2.0 to 6.0 tons per hectare; and wheat yields increased sixfold from 0.5 to 3.0 tons per hectare.⁷

Yield performances in Africa, however, were poor and variable for maize, rice, and wheat.⁸ While maize yields in Asia rose from 1.2 to 3.4 tons per hectare during 1961-91, maize yields in Africa rose from about 0.8 to 1.2 tons per hectare. In 1961 China and Africa had similar yields for wheat (0.5 tons per hectare), but by 1991 Chinese wheat yields were double those of Africa (1.6 tons). That Africa has a long way to go to catch up with Asia is painfully obvious. To expand production, African farmers have always relied on bringing new land into cultivation. But continued attempts to expand agricultural land will entail increasing financial and ecological costs. As has happened in most of Asia, Africa will have to rely on increased yields to expand future food production.

Even in Asia, however, there are some signs of trouble. The annual rate of yield increase for the two major crops, wheat and rice, is slowing. Rice yields increased rapidly during the 1960s and 1970s, but since then the annual rate of increase has slowed. It is returning close to the rate prevailing in the early 1960s, declining from 3 percent a year between the mid-1970s and early 1980s to less than 2 percent in the late 1980s.⁹ In Southeast Asia, rice yields have declined by half from an annual rate of 3.2 percent in the 1970s to 1.6 percent in recent years. Even in China, rice yield growth rates have slowed from more than 4 percent per year in the late 1970s to about 1.6 percent a year during the 1980s. Only in India have rice yield growth rates continued to grow. The situation is similar

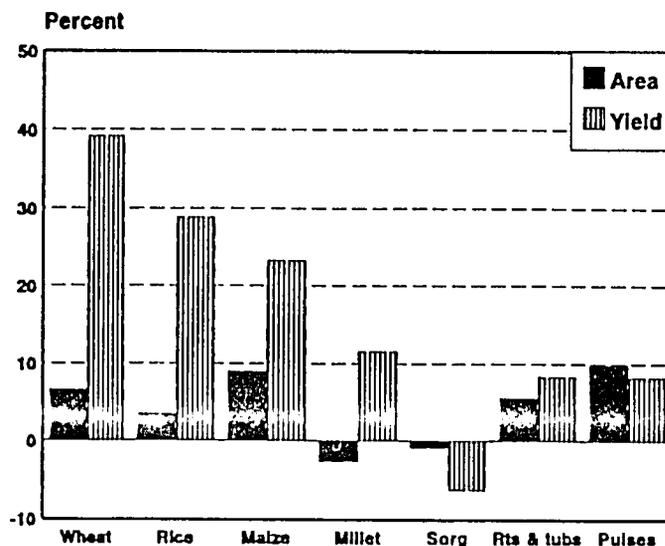
⁶ FAO, "The State of Food and Agriculture 1993."

⁷ FAO, "FAO Agrostat-PC, Population, Production, and Food Balance Sheets Domains;" Plucknett, *Science and Agricultural Transformation*.

⁸ FAO, "FAO Agrostat-PC, Population, Production, and Food Balance Sheets Domains."

⁹ International Rice Research Institute data analyzed in M. W. Rosegrant and M. Svendsen, "Asian Food Production in the 1990s: Irrigation Investment and Management Policy," *Food Policy* 18 (February 1993).

Figure 3—Change in area and yields for selected crops in developing countries, 1979-81 and 1989-91



Source: FAO, "FAO Agrostat-PC, Population, Production, and Food Balance Sheets Domains" (Rome: FAO, 1992, computer disk).

for wheat. Yield growth rates have slowed in Asia as a whole from 4.4 percent in the late 1970s to 2.7 percent in the 1980s.¹⁰ The exception to this trend is Southeast Asia, where yield growth rates increased from -0.8 percent in the late 1970s to 2.8 percent in the 1980s.

In addition to lower growth rates in yields, significant increases in variability in total world grain production are causing concern.¹¹ This variability is partly explained by the increasing similarity of cereal varieties grown across wide areas so that large areas of crops prone to a certain pest, disease, or drought may be negatively affected at one time.

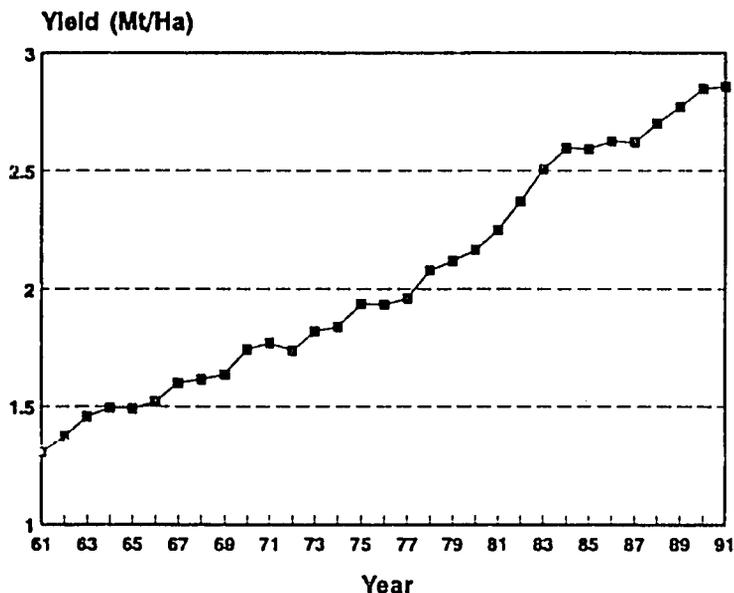
World grain production per person increased steadily during the 1950s, 1960s, and 1970s, but recent trends suggest that there has been a leveling off during the 1980s and early 1990s for the world as a whole (Figure 6) and for developing countries (Figure 7). Some argue that world grain production per person is now declining.¹² Based on statistical tests,

¹⁰ FAO data analyzed in Rosegrant and Svendsen, "Asian Food Production in the 1990s."

¹¹ P. Hazell, "Implications of Grain Trade Liberalization for LDC Food Security," in *Managing Food Security in Unregulated Markets*, ed. R. D. Reinsel, 41-47 (Boulder, Colo.: Westview Press, 1993).

¹² L. R. Brown, H. Kane, and E. Ayres, *Vital Signs 1993: The Trends that are Shaping our Future* (London: W. W. Norton, 1993).

Figure 4—Trend in yields in rice, wheat, and maize for all developing countries



Source: FAO, "FAO Agroatat-PC, Population, Production, and Food Balance Sheets Domains" (Rome: FAO, 1992, computer disk).

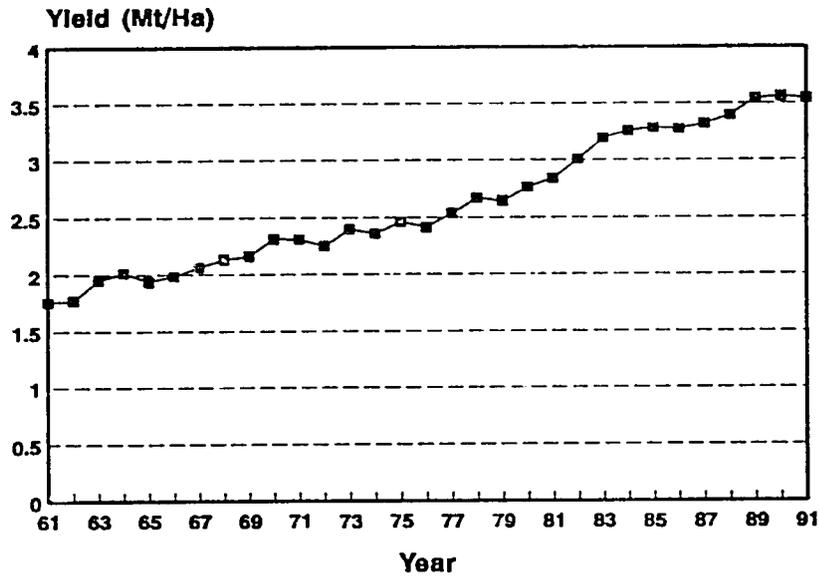
the trend between 1980 and 1993 is best represented by a horizontal line for the world as a whole and for developing countries—a constant rather than declining trend. However, there are indications that the trend in world food production will turn downward if corrective actions are not taken soon.

The recent stagnation and possible fall in world grain production per person should be of serious concern because factors other than population growth will continue to push grain demand upward. For example, the demand for feedgrain increases rapidly once incomes increase beyond a certain level. Whereas projected growth in cereal consumption for food is very close to population growth (Figure 8), expected growth in feedgrain demand is more than twice the expected population growth. Once incomes have reached an even higher point, feedgrain demand levels off. This has happened in the Republic of Korea, for example.¹³ Incomes in most developing countries either are still below the level where feedgrain use increases rapidly or they are now experiencing steep increases.

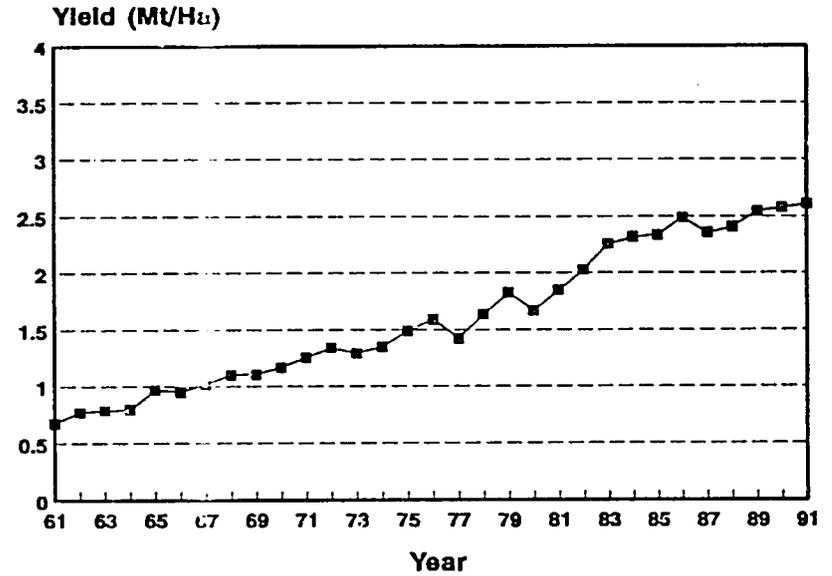
¹³ U.S. Department of Agriculture, personal communication, 1992; and World Bank, "World Development Indicators," World Bank, Washington, D.C., 1992 (computer disk).

Figure 5—Trend in yields for Asia

Rice



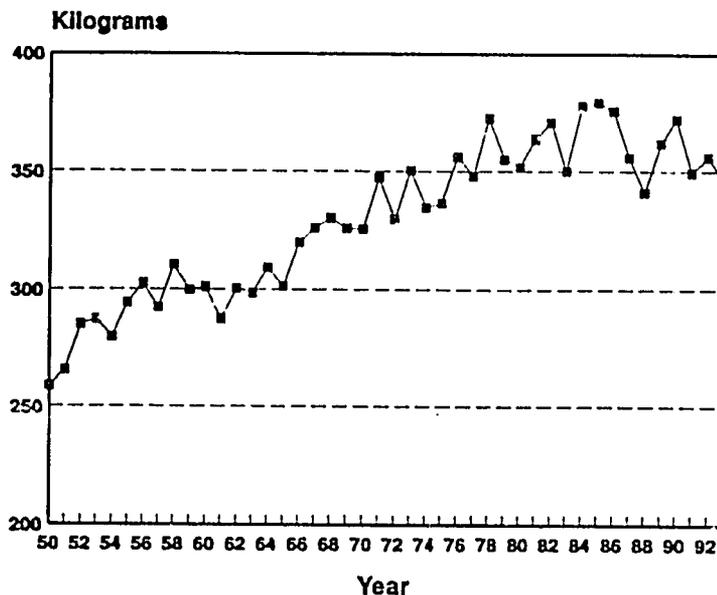
Wheat



8

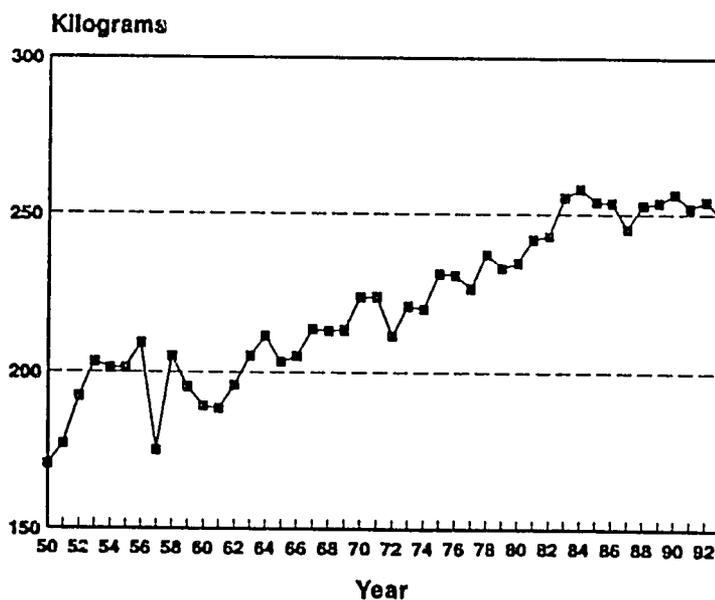
Source: FAO, "FAO Agroatat-PC, Population, Production, and Food Balance Sheets Domains" (Rome: FAO, 1992, computer disk).

Figure 6—World grain production per person, 1950-93



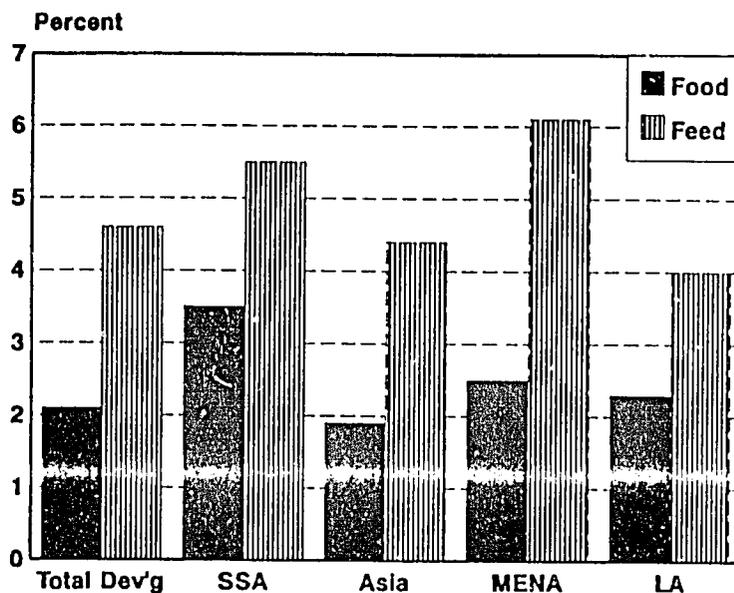
Sources: FAO, "FAO Agroatat-PC, Population, Production, and Food Balance Sheets Domains" (Rome: FAO, 1992, computer disk); FAO, The State of Food and Agriculture 1993 (Rome: FAO, 1993, mimeographed).

Figure 7—Developing-country grain production per person, 1950-93



Sources: FAO, "FAO Agroatat-PC, Population, Production, and Food Balance Sheets Domains" (Rome: FAO, 1992, computer disk); FAO, The State of Food and Agriculture 1993 (Rome: FAO, 1993, mimeographed).

Figure 8—Projected annual growth in cereal consumption for food and feed, 1980-2000



Source: L. Paulino, *Food in the Third World: Past Trends and Projections to 2000*, Research Report 52 (Washington, D.C.: International Food Policy Research Institute, 1986).

INTERNATIONAL FOOD PRICES

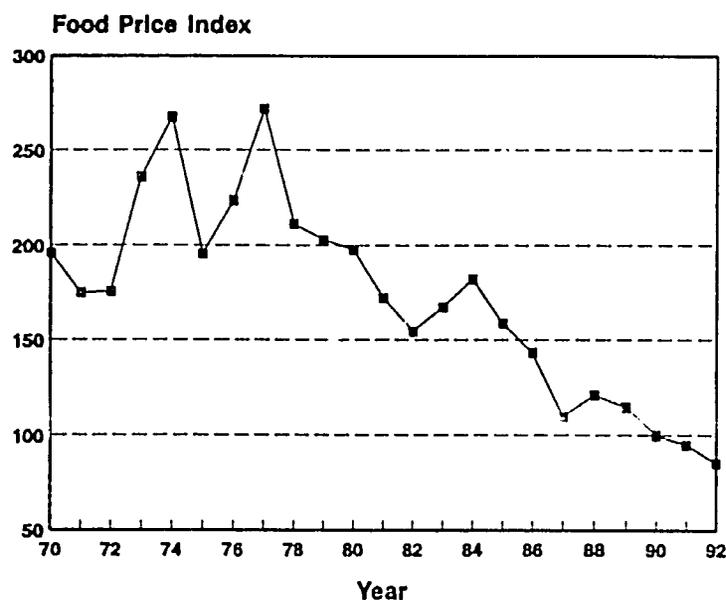
Food prices have been on a downward trend for a long time (Figure 9). For almost 50 years—except for a few short periods such as the food crisis of the early 1970s—global food supplies have been sufficient to assure decreasing international food prices. Low food prices in the world market do not necessarily mean that there are no hungry people. Today more than 700 million people in developing countries do not have access to sufficient food to lead healthy, productive lives. More than 180 million children are underweight.

Poor people cannot express their food needs as economic demand. More than one billion people live in households that earn less than a dollar a day per person. Clearly, they are not in a position to convert their food needs to effective market demand. Since price is a product of both food supplies and economic demand, low prices indicate the persistence of poverty and a lack of sufficient purchasing power as well as increasing food production.

FOOD TRADE AND AID

Developing countries are net food importers, importing about US\$5-10 billion more food than they exported during the mid- to late-1980s. However, during the 1980s, developing countries increased food exports more than they increased food imports. Net food imports in all developing regions declined between 1979-81 and 1989-91. The decline was largest

Figure 9—World food price index, 1970-92 (in constant dollars, 1990 = 100)



Source: World Bank, *World Development Report 1993* (New York: Oxford University Press, 1993).

in the Near East (55 percent) and smallest in Africa (9 percent). Developing countries increased food imports by 30 percent during the 1980s, while they increased food exports by 41 percent.¹⁴ Large increases were recorded in both food imports and exports in the Near East, Far East, and China, with growth in exports cutstripping growth in imports. In Africa, too, food exports grew faster than food imports, but since Africa and the Near East imported much more food than they exported, they remained net importers. Latin America was a net exporter of food.

Cereals form a major component of developing-country food trade. In 1989-91, developing countries imported about 120 million tons of cereals and exported about 32 million tons, resulting in net imports of about 88 million tons. The Near East and Far East are major net importers of cereals. During the 1980s, all developing regions except Latin America experienced a decline in net cereal imports, as cereal exports more than doubled in Africa and the Near East during the 1980s and almost quadrupled in China, while they declined in Latin America.¹⁵ Net imports are a major source of total cereal availability in some developing regions, especially Africa, where one-quarter of available cereals in the late 1980s were net imports. Developing countries' dependence on net imports decreased during the 1980s,

¹⁴ FAO, "FAO Agrostat-PC, Trade Domains," FAO, Rome, 1993 (computer disk).

¹⁵ Ibid.

except for Latin America where the share of net imports in total cereal availability doubled from 5 to 10 percent.

About 15 million tons of cereal food aid were shipped worldwide in 1992/93, up from 9 million tons a decade earlier.¹⁶ According to the World Food Programme, Sub-Saharan Africa is the largest recipient of food aid, followed by North Africa and the Middle East. Food aid shipped to Eastern Europe and the former Soviet Union increased substantially from almost nothing in the mid-1980s to over a million tons in 1990/91.¹⁷ The volume of food aid shipped to Latin America and the Caribbean almost tripled during the 1980s. Food aid for emergency relief peaked in the mid-1980s at the time of the great drought in Africa, declined slightly, and then increased sharply in 1990-91. As the Uruguay Round of the GATT is implemented successfully, food aid may be reduced as food surpluses in developed countries diminish.

FACTORS INFLUENCING FUTURE FOOD PRODUCTION AND CONSUMPTION

Global and regional food production and consumption during the next 10-20 years will be influenced by a large number of factors. Changes in the following four sets of factors are likely to be particularly important:

1. Economic growth and economic policies,
2. Population growth and urbanization,
3. Rural infrastructure, agricultural production technology, and access to modern inputs, and
4. Natural resource management and environmental considerations.

The expected impact of each of these factors on future food production and consumption is considerable.

Economic Growth and Economic Policies

Economic growth in the developing world has differed widely across regions. Where growth has been slow in recent years, especially in Sub-Saharan Africa, it is critical to

- complete structural adjustment and economic reforms;
- remove external barriers to growth such as trade distortions and subsidies in developed countries;
- liberalize trade and remove market distortions;
- enhance access by the poor to land, capital, and technology;

¹⁶ FAO, *Food Outlook* (December 1993).

¹⁷ World Food Programme, *Food Aid in Review* (Rome: WFP 1992).

- expand investment in rural infrastructure, health, education, and agricultural research and technology;
- facilitate sustainability in agricultural production; and
- reverse the decline in international assistance to agriculture.

Growth in real per capita income during the 1980s was disappointing for developing countries as a whole (Table 1). However, the low average rate of growth covers large variations among regions. The high rates of economic growth in Asia are expected to continue through the 1990s, while incomes in Sub-Saharan Africa are expected to keep pace with population growth.

Future economic growth depends on internal policies as well as on the international environment. The extent to which current structural adjustment and economic reforms in Latin America, Sub-Saharan Africa, the Commonwealth of Independent States (CIS), Eastern Europe, and selected countries in Asia and the Middle East are carried to a successful completion at an appropriate speed and sequence is of paramount importance for future economic growth in those countries. The World Bank¹⁸ estimates that a 50 percent reduction of the current trade protection by Japan, the European Union, and the United States would result in an increase of US\$50 billion in export revenues to developing countries, which is roughly equivalent to the total official economic aid from Organization for Economic Cooperation and Development (OECD) countries to developing countries. The largest share of this economic gain (54 percent)¹⁹ would be captured by the Far East.²⁰

Trade liberalization is an integral part of structural adjustment and economic reforms in most developing countries. Historical trends of extensive protection are being replaced by a large degree of trade liberalization in many Latin American countries, with expected positive effects on economic growth. However, the sustainability of Latin America's trade liberalization policies is in danger because they are not being matched by trade liberalization in the United States, Europe, and Japan. Failure to achieve sizable reductions in agricultural protection in OECD countries would make it difficult for Latin America to continue its elimination of nontariff barriers and large reductions in tariffs. The result will be reduced economic growth and increasing unemployment and poverty in the region.

Improved human resources and enhanced access by the poor to other productive resources will help reduce poverty and food insecurity and encourage higher economic growth. Policies that will expand investment in rural infrastructure, primary health care, education, agricultural research and improved production technology, technical assistance, and credit are urgently needed to enhance income earnings, food security, and nutritional status

¹⁸ World Bank, *Global Economic Prospects and the Developing Countries 1992* (Washington, D.C.: World Bank, 1992).

¹⁹ World Bank, *World Development Report 1993* (New York: Oxford University Press, 1993).

²⁰ World Bank, *Global Economic Prospects and the Developing Countries 1992*.

Table 1—Annual growth in real per capita income, by region, 1980-2000

Region	1980-89	1990-2000
	(percent)	
Sub-Saharan Africa	-0.9	0.3
East Asia	6.3	5.7
South Asia	3.1	3.1
Latin America	-0.5	2.2
Middle East/North Africa	-2.5	1.6
Developing countries	1.2	2.9

Source: World Bank, *Global Economic Prospects and the Developing Countries, 1992* (Washington, D.C.: World Bank, 1992).

among the rural poor and to reduce unit costs of food production for the benefit of both the rural and urban poor.

Policies are needed to pursue the triple goal of poverty alleviation, increased productivity in food production, and sustainability. No attempts will be made to detail such policies here but such a list would include policies to improve water management, expand agricultural research, and deal effectively with externalities resulting in land degradation and deforestation. In addition, policies are needed to protect the rural and urban poor from both chronic and transitory food insecurity in the short run. Such policies would include targeted food and cash transfers of various types, labor-intensive public works programs, and emergency relief. International food aid may play an important role.

In the poorest of the developing countries, including virtually all of Sub-Saharan Africa, effective population policies focused on family planning and reduced rural-urban migration are urgently needed. However, such policies will be fully successful only if accompanied by alleviation of poverty and improvements in education, primary health care, and nutrition. While investment in urban infrastructure, including social infrastructure, must be accelerated to accommodate the rapid urban population growth and avoid further expansions in urban slums and associated misery, rural development, including enhanced income-earning opportunities for the poor and access to primary health care, is critical to reduce migration of poor rural residents to urban areas. Provision of education in rural areas may accelerate migration but the migrants are less likely to end up in slums.

In low-income developing countries, agriculture is the most effective and frequently the only viable lead sector for overall economic growth. Agricultural growth stimulates economic growth in nonagricultural sectors, which, in turn, results in increased employment and reduced poverty. Unfortunately, international financial support to agricultural development has decreased sharply during the 1980s and early 1990s. A recent study shows that real external assistance to agriculture in low-income countries declined from US\$12 billion in 1980 to US\$10 billion in 1990, while the share of agriculture in development assistance declined from 20 percent in 1980 to 14 percent in 1990.²¹ At the same time, no real advances have been made to reduce the negative effects on developing-country agriculture from the protection of OECD agriculture. A reversal of the downward trend in international support for developing-country agriculture is urgently needed not only to assure future food supplies and protect natural resources, but also to facilitate general economic growth in low-income developing countries. This is also critical for expanding export markets for both agricultural and nonagricultural commodities from OECD countries.

Although an economically healthy agricultural sector is usually a necessary condition for the alleviation of rural poverty, it is not sufficient. In most developing countries, the rural poor derive a large share of their income from sources other than agriculture, although some of these income sources depend on agriculture directly or indirectly.²² Furthermore, many of the rural poor are net buyers of food. Thus, while policies to stimulate expanded agricultural production will be beneficial to some of the rural poor, others will be either unaffected or negatively affected. Policies that increase food prices for the net-food-buying rural poor are an example of the latter.

The emphasis should be on low-cost rather than high-cost agriculture. Technological change and improved rural infrastructure are among the most effective ways to facilitate production expansions at reduced unit costs. Large production expansions can be obtained even under very adverse conditions if costs are of little concern. As a result of high prices and heavy investments, Saudi Arabia increased wheat production from virtually nothing prior to 1980 to more than 4 million tons by 1992 (Figure 10). Net imports of more than 0.5 million tons in 1982 were converted to net exports of almost 2 million tons in 1991. In low-income developing countries, high-cost agriculture conflicts with the need to assure that low-income consumers have access to sufficient food.

Population Growth and Urbanization

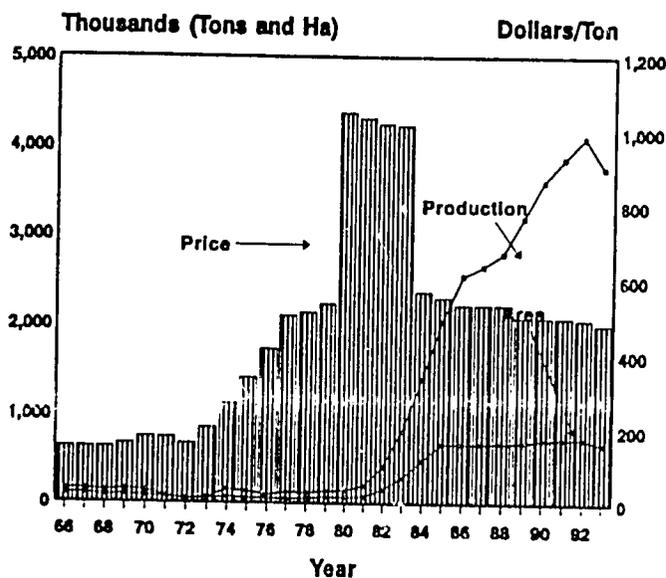
If progress in economic growth is not to be undermined by rapid population growth and excessive urbanization, effective population and migration policies are necessary to complement growth-oriented policies. Such policies must focus on

- universal access to family planning information and technology; and

²¹ J. von Braun, R. F. Hopkins, D. Puetz, and R. Pandya-Lorch, *Aid to Agriculture: Reversing the Decline*, Food Policy Report (Washington, D.C.: International Food Policy Research Institute, 1993).

²² P. Webb and J. von Braun, "Ending Hunger Soon: Concepts and Priorities" (International Food Policy Research Institute, Washington, D.C., 1993, mimeographed).

Figure 10—Wheat production, area, and prices in Saudi Arabia, 1966-93



Source: Ministry of Agriculture and Water, Agricultural Trade Office, Riyadh, Saudi

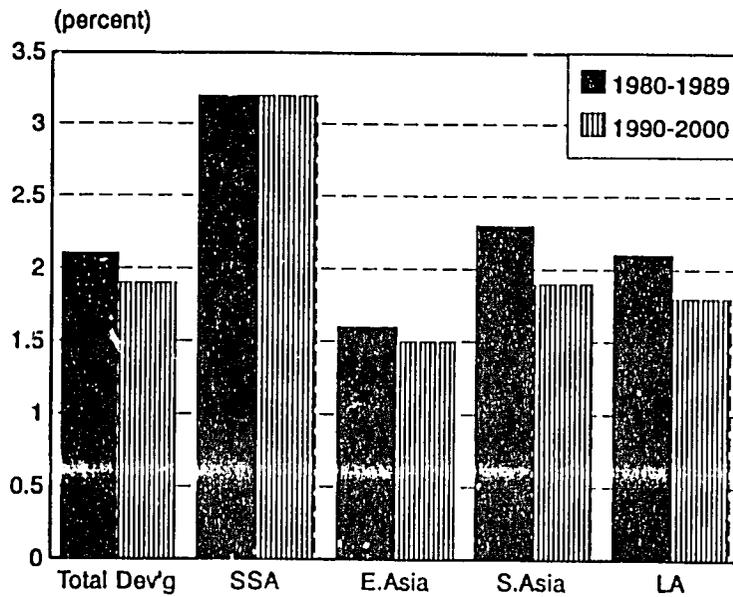
- incentives to reduce rural-urban migration, such as provision of employment in rural areas and stimulation of agricultural and nonagricultural growth in rural areas.

According to the United Nations, the current world population of 5.5 billion will increase to approximately 10 billion by 2050. Although the annual growth rate is falling for the world as a whole, the population increase during the next 20-30 years, of slightly less than 100 million people a year, will be the largest ever. Approximately 97 percent of this increase is projected to occur in the Third World, with Africa alone accounting for 34 percent of the growth. Thus, although reductions in annual population growth rates have begun to occur in Asia and Latin America, they are insufficient to counter the absolute increases (Figure 11).

The rate of growth is particularly strong in urban areas (Figure 12), and it is projected that approximately 44 percent of the population of developing countries will reside in urban areas by 2000, up from 22 percent in 1960 and 31 percent in 1980 (Figure 13).

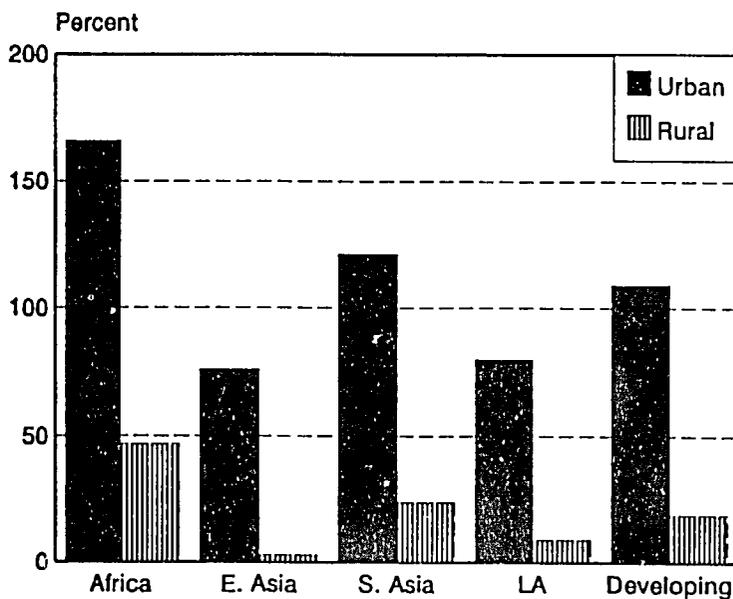
Population growth rates of these magnitudes will greatly increase the need for food and other basic necessities, severely constraining efforts to improve per capita income and well-being in developing countries. It is unlikely that Sub-Saharan Africa will be able to cope with such large population growth without significant increases in poverty and decreases in the overall standard of living. Although past and current famines in the region have been blamed on droughts, wars, and adverse agricultural policies, they are largely an outcome of already high rates of population growth and widespread poverty. Failure to significantly reduce

Figure 11—Annual population growth, 1980-2000



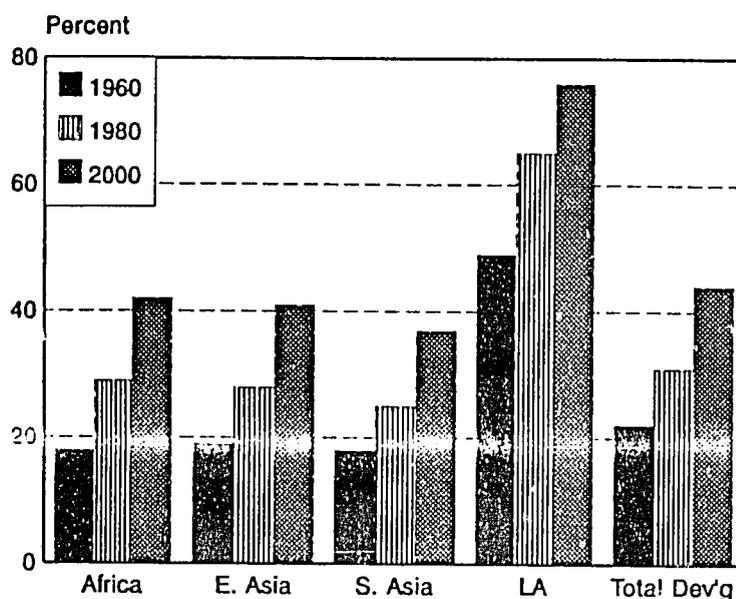
Source: World Bank, *World Development Indicators 1992* (Washington, D.C.: World Bank, 1992, computer disk).

Figure 12—Projected increase in urban and rural populations, 1980-2000



Source: United Nations, *World Economic Survey 1993: Current Trends and Policies in the World Economy* (New York: UN Department of Economic and Social Information and Policy Analysis, 1993).

Figure 13—Percent of population living in urban areas



Source: United Nations, *World Economic Survey 1993: Current Trends and Policies in the World Economy* (New York: UN Department of Economic and Social Information and Policy Analysis, 1993).

population growth within the next 20 years will render all other development efforts insufficient to avoid much greater human misery in the future than has been seen in the region so far.

Rapidly growing urban populations in the Third World will place severe pressures on the food marketing systems, including transportation, storage, processing, grading, and market information. In many developing countries, particularly in Sub-Saharan Africa, massive investments in physical infrastructure in both rural and urban areas will be needed to support the feeding of the urban population. Current efforts undertaken as part of economic reforms in many African countries to strengthen efficiency and competition in agricultural marketing through the private sector must be enhanced and the appropriate role of government must be identified.

Urbanization will accelerate the dietary transition associated with increasing incomes. Increasing opportunity cost of women's time; changes in food preferences caused by promotions, advertising, and changing lifestyles; and changes in relative prices associated with rural to urban migration will change food demand from basic staples such as sorghum, millet, maize, and root crops to cereals such as wheat and rice (which require less preparation time), fruits, foods of animal origin, sugar, and processed foods. Rapid increases in the demand for livestock products will have severe repercussions for the demand for cereals as already discussed.

Rural Infrastructure, Agricultural Production Technology, and Access to Modern Inputs

Continued progress in all three of these areas is critical to future food security.

- Resources must be committed to infrastructure construction and maintenance. Labor-intensive public works programs are a viable mechanism for building roads, reforesting areas, and engaging in soil conservation projects, while creating employment and income in rural areas.
- International and national agricultural research must continue to develop yield-enhancing production technology, especially in maize, millet, and other crops, as well as build tolerance or resistance in crops to pests and adverse climatic conditions.
- Farmer access to modern inputs must be facilitated through provision of credit and technical assistance. Inputs must be made available to all farmers on time and in required amounts.

The importance of investments in rural infrastructure within the context of rapid urbanization has already been established. Even without rapid urban growth, however, such investments are needed in many developing countries, particularly the poorest ones, to facilitate agricultural and rural development. Improved rural infrastructure enhances access to export markets, modern production inputs, and consumer goods. It reduces marketing costs, promotes exchange between intracountry markets, reduces spatial and temporal price distortions, and, in general, increases efficiency in production and marketing.

However, while essential, effective rural infrastructure alone is not enough to assure agricultural and rural development and rapid increases in food production in developing countries. Yield-enhancing production technology is of critical importance. Although opportunities for expansion of agricultural production into lands not currently under cultivation still exist in some countries, such opportunities are so limited that they would probably not be able to counter losses of current agricultural lands to alternative uses on a global level. Furthermore, attempts to expand agricultural production into new lands would, in most cases, require large investments in technology, tools, and materials and would increase the risk of land degradation and deforestation. Thus, future increases in food production must come primarily from higher yields per unit of land rather than from land expansion.

The dramatic impact of agricultural research and modern technology on wheat and rice yields in Asia and Latin America since the mid-1960s is well known. Less dramatic but significant yield gains have been obtained from research and technological change in other crops, particularly maize. Large yield gains currently being obtained in many crops at the experimental level offer great promise for future yield and production increases at the farm level. In addition to affecting yield levels, research resulting in tolerance or resistance to adverse production factors such as pests and drought and research on new varieties and hybrids better suited for various ecological conditions reduce risks and uncertainty and enhance sustainability in production through better management of natural resources and reduced environmental risks (through reduced use of chemical pesticides and avoidance of irreversible land degradation).

Even if the positive impact on sustainability and natural resource management is ignored, investment in national and international agricultural research has been shown to produce large economic gains relative to costs (Tables 2 and 3). The distribution of economic gains among groups in society varies among countries and over time, depending on a number of issues related to markets, institutions, and policies. Gains captured by producers and agricultural workers contribute to employment, growth, and investment in agriculture and rural areas both directly and indirectly through growth linkages, while gains captured by consumers enhance purchasing power and facilitate employment and economic growth through lower wages and increased demand for goods and services. Depending on the structure of the economy, poverty would be alleviated in both rural and urban areas.

Accelerated investment in agricultural research and technological improvements is not only necessary and urgent, it is the only viable option to assure sufficient food to meet future needs and demands at reasonable prices without irreversible degradation of natural resources. While the large past and current economic benefits from agricultural research reflect traditional research methods, the recent development of biotechnological methods is likely to accelerate the research process, that is, reduce the time needed between initiation of research and expected impact, and greatly enhance the opportunities for improved and higher-yielding plants and animals.

In addition to land, water is another natural resource becoming increasingly scarce in many production environments. Efforts to meet future food needs and demands while

Table 2—Annual rates of return (RR) to agricultural research, by region

Region	Less Than 10 Percent RR	More Than 50 Percent RR
	(percent of programs analyzed)	
Africa	20	40
Asia	3	63
Latin America	7	46

Source: R. E. Evenson and M. W. Rosegrant, "Determinants of Productivity Growth in Asian Agriculture: Past and Future," Paper presented at the 1993 American Agricultural Economics Association International Pre-Conference on Post-Green Revolution Agricultural Development Strategies in the Third World: What Next? Orlando, Florida, August 1993.

Table 3—Annual rates of return (RR) to agricultural research, by commodity

Region	Less Than 10 Percent RR	More Than 50 Percent RR
	(percent of programs analyzed)	
Wheat	7	43
Rice	0	68
Maize	0	31
Other commodity programs	12	53
Aggregate research programs	1	62

Source: R. E. Evenson and M. W. Rosegrant, "Determinants of Productivity Growth in Asian Agriculture: Past and Future," Paper presented at the 1993 American Agricultural Economics Association International Pre-Conference on Post-Green Revolution Agricultural Development Strategies in the Third World: What Next? Orlando, Florida, August 1993.

promoting sustainable economic growth and poverty alleviation, including agricultural research and government policy, must pay increasing attention to the efficiency of water use, sustainability of water management practices, and investment in establishing and maintaining irrigation facilities.

Last but not least, farmers must have access to modern inputs such as improved livestock, crop varieties and hybrids, fertilizers, and pest control measures, as well as to credit, technical assistance, and improved farm management practices. These are essential components of a successful strategy to meet food production and development goals. Efforts to enhance farmers' access to modern inputs must recognize the role of women in farming and marketing and design the programs accordingly.

Natural Resource Management and Environmental Considerations

Research, technology development, incentives, and regulations are needed to prevent environmental degradation. These measures include appropriate water management policies, reduction of subsidies that encourage wasteful use of inputs, better definition of ownership and user rights to resources including land, education of farmers to encourage appropriate use of technology and resource conservation, and the provision of alternatives to resource-degrading inputs and techniques. Since poverty is a major source of degradation, poverty eradication is justified also on environmental grounds.

The recent surge in public and private concerns about negative environmental effects of economic growth and development may, if sustained, have important implications for agricultural development and future food production and consumption. Of particular concern is the need to avoid degradation of natural resources such as land and water, as well as deforestation, water contamination, and health risks associated with the use of chemicals. Since most of the current and potential resource degradation and environmental contamination result from situations in which those who cause and possibly benefit from degradation do not pay the costs, neither the market nor the individual producers and consumers are likely to incorporate preventive measures into their behavior. Only when sufficient damage has been done to influence significantly current or future production costs will market and producer behavior change. The state is more likely to undertake preventive measures either through publicly funded research and technology development or through incentive policies and regulations. Extensive waterlogging, salination, and associated land degradation and productivity losses resulting from inappropriate water management are of particular concern in large parts of Asia.

In developing countries, poverty, rapid population growth, low agricultural productivity, and poorly defined ownership of and user rights to resources are the major risk factors associated with the degradation of natural resources. Attempts to meet basic needs for survival in the short run take priority over longer-term sustainability. Rural poverty combined with low yield capacity of crops and livestock and poorly defined land ownership lead to unsustainable exploitation of fragile lands, including those where rainfall is low. Where land is scarce and population pressures are strong, deforestation is an appealing solution for poor rural households to mitigate short-run food and income shortfalls. However, the ultimate consequences are likely to be reduced forest land, soil erosion, changing rainfall patterns, and general reductions in the productive capacity of the land.

Yield-enhancing agricultural technology is the most promising avenue to sustainable agricultural production. Higher yields on land with high production potential will reduce the pressure on fragile land and, together with better definition and distribution of land ownership and user rights, will reduce deforestation and desertification. Agricultural research and technology can develop production methods that will help maintain land quality and productivity over time. And appropriate agricultural technology and production practices for drought-prone areas may buffer the negative effects of low and variable rainfall on food security in addition to reversing current trends of land degradation.

Agricultural research has already made great progress in developing plants that are tolerant or resistant to various pests and in biological pest control, thus reducing the need for chemicals. The efficiency of chemical pest control methods has been greatly increased and contamination and personal safety risks have been reduced. Accelerated research could further reduce the dependence on chemical pest control and the risk of contamination.

As population, poverty, and food demand continue to grow, failure to develop and implement appropriate technology in production and marketing will lead either to more food insecurity and hunger, for which the current generation of poor people will pay, or to further degradation of natural resources, for which future generations will pay. Future food demands

can be met and production capacity can be sustained only if (1) investment in appropriate research and technology is accelerated; (2) decisions on problems such as resource ownership and user rights and the needs of future generations are either incorporated into production and consumption decisions or effectively dealt with by government policy; and (3) poverty is significantly reduced or eradicated.

In view of the large risk of irreversible degradation of our natural resources and the urgent need to assure sustainable agricultural production to meet future food demands, it is difficult to understand why investment in the most promising solution, agricultural research and technology, is decreasing. While government policy and regulations are essential to assure compatibility between production and environmental goals, they will have only limited success unless accompanied by appropriate technology.

PROSPECTS FOR CEREAL DEMAND, SUPPLY, TRADE, AND PRICES

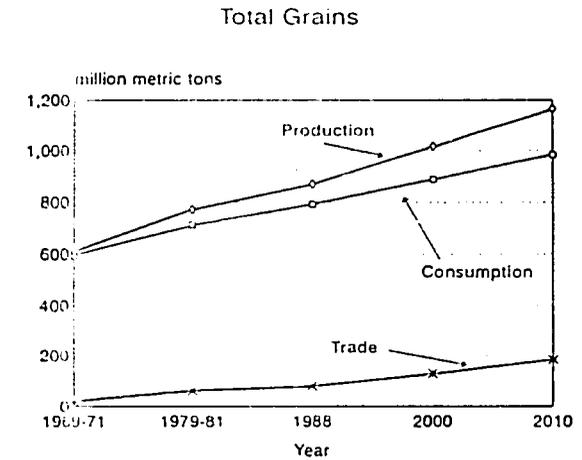
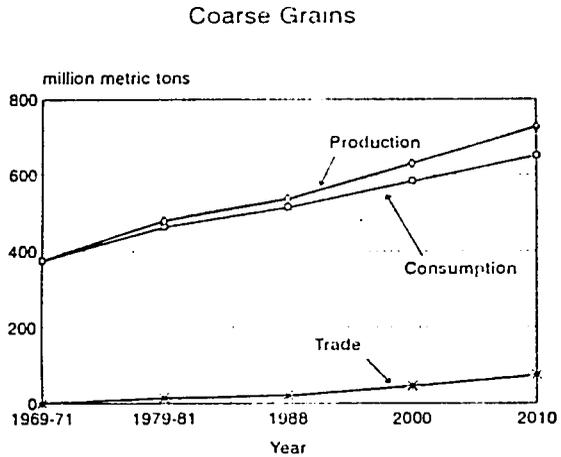
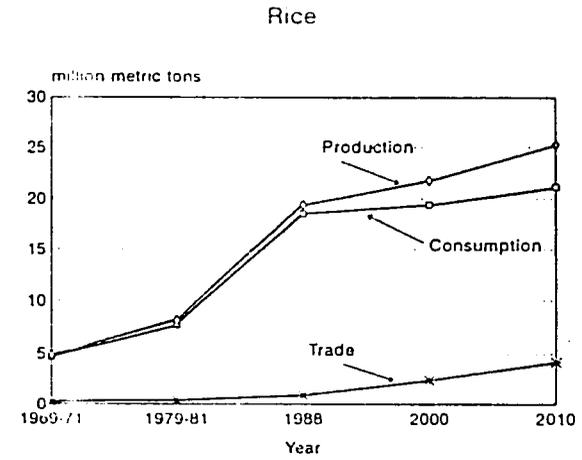
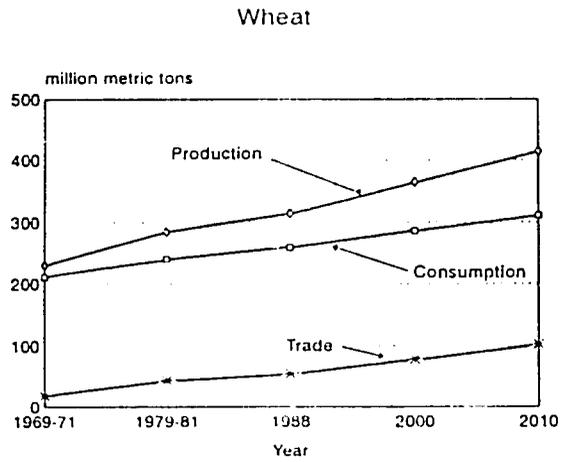
Having reviewed the expected impact of the most important factors that could influence future food consumption and production, what are the prospects for food demand, supply, trade, and prices in the coming decades? IFPRI projections²³ suggest that developed countries as a group will continue to produce more cereals than they consume and will more than double their net cereal exports from 80 million tons in 1988 to 180 million tons in 2010 (Figure 14). Growth rates for per capita maize production are expected to exceed 1 percent per year over the entire period, while growth rates for wheat, rice, and other coarse grains are expected to range between 0.5 percent and 1.0 percent and to increase between the first and second half of the period (Table 4).

Developing countries are likely to increase their cereal production from around 800 million tons in 1988 to 1,200 million tons in 2010, but will still consume more than they produce (Figure 15). Per capita production growth rates of the major cereals are positive and increase over time (Table 4). The gap between cereal production and consumption is expected to widen and can only be filled by net imports, which will become increasingly important: the share of total cereals consumed that originates from net imports is projected to rise from 9 percent in 1988 to 13 percent in 2010. Wheat will constitute over 55 percent of net cereal imports in 2010, but coarse grain imports are projected to triple during 1988-2010 and their share of net cereal imports to increase from 28 percent to 42 percent over the period.

South Asia is expected to switch from a minor net exporter in the late 1980s to a net importer by 2010 (Figure 16). The rapid growth in net cereal imports is driven mainly by wheat imports, which are projected to increase from about 3 million tons in 1988 to 20 million tons in 2010. Between 1988 and 2000, net wheat imports are projected to grow by over 12

²³ These projections are generated from the International Food Policy and Trade Simulation Model (IFPESIM) developed at IFPRI and are based mainly on projected growth rates of population, urbanization, improvements in general economic conditions, and increases in food production through further yield increases. The IFPESIM model is a representation of a competitive agricultural market for crops and livestock.

Figure 14—Production, consumption, and trade of wheat, rice, coarse grains, and total grains in developed countries



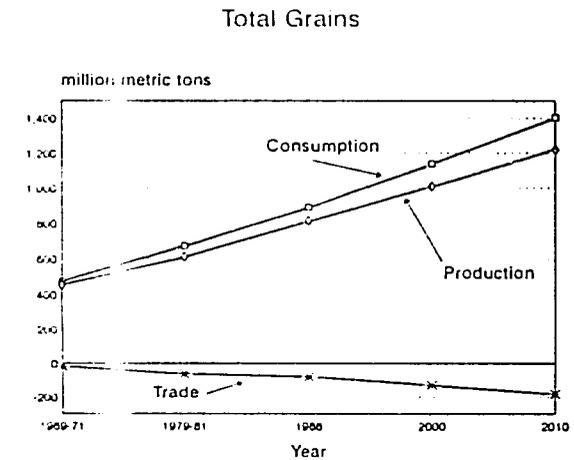
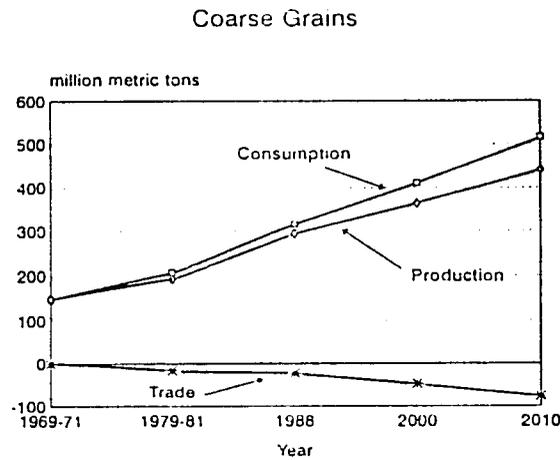
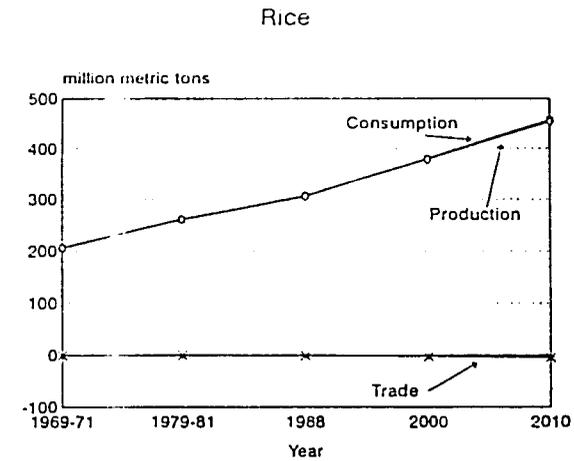
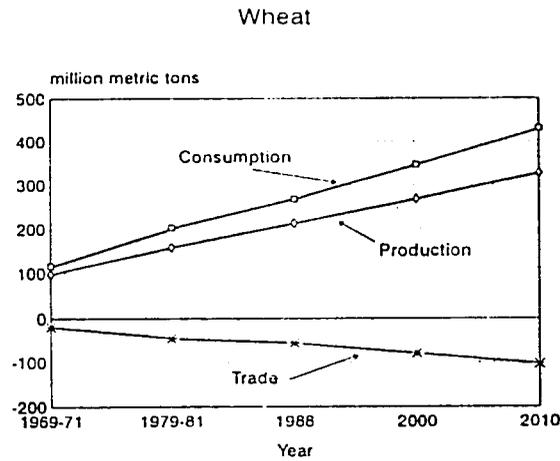
Note: Positive trade volume indicates net exports (production exceeds consumption), while negative trade volume indicates net imports (consumption exceeds production).

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Table 4—Projected per capita production growth rates of wheat, rice, and coarse grains

	1988-2000	2000-2010
(percent per annum)		
A. South Asia		
Wheat	0.13	0.02
Rice	0.07	0.01
Maize	-0.40	-0.01
Other coarse grains	-0.18	-0.02
B. Developing Countries		
Wheat	0.32	0.35
Rice	0.16	0.15
Maize	0.19	0.25
Other coarse grains	0.14	0.23
C. Developed Countries		
Wheat	0.77	0.76
Rice	0.51	1.01
Maize	1.13	1.13
Other coarse grains	0.59	0.71

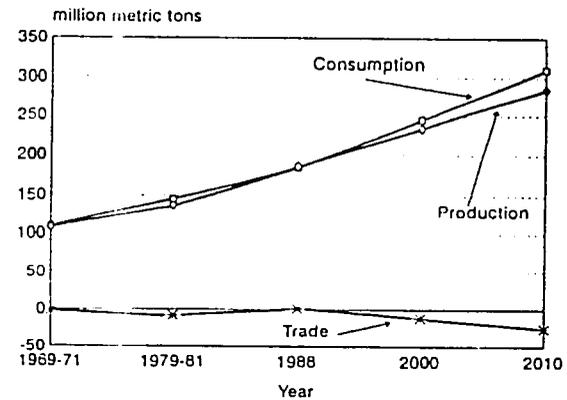
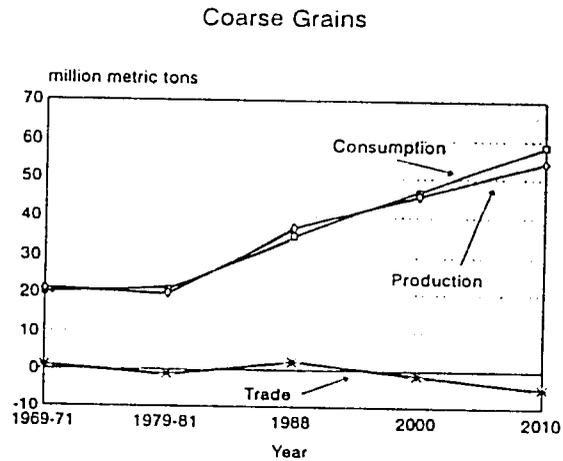
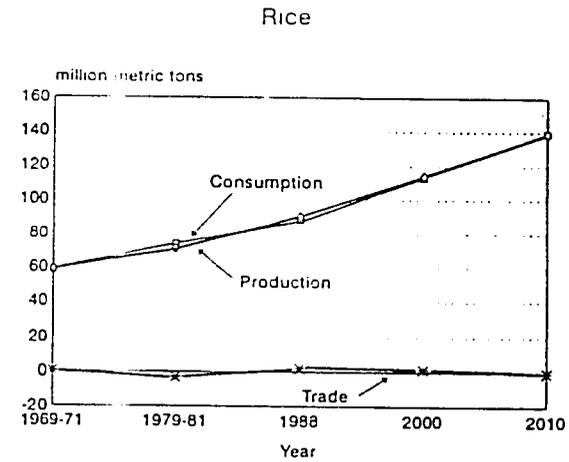
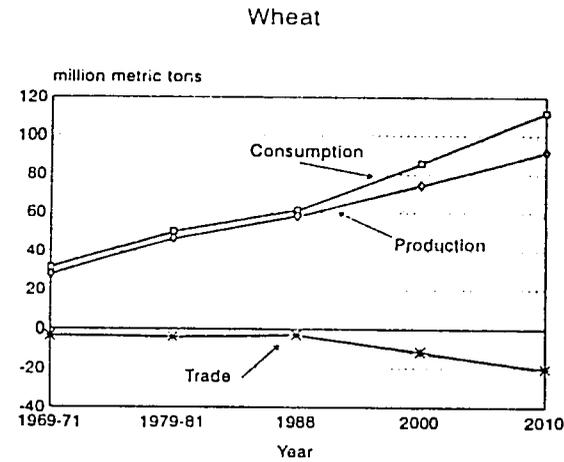
Figure 15—Production, consumption, and trade of wheat, rice, coarse grains, and total grains in developing countries



Note: Positive trade volume indicates net exports (production exceeds consumption), while negative trade volume indicates net imports (consumption exceeds production).

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Figure 16—Production, consumption, and trade of wheat, rice, coarse grains, and total grains in South Asia



Note: Positive trade volume indicates net exports (production exceeds consumption), while negative trade volume indicates net imports (consumption exceeds production).

percent per year, slowing down to 6 percent per year in 2000-2010 (Table 5). The region is also expected to shift from a net exporter of rice and coarse grains to a net importer of these commodities by 2010. Underlying this major shift are rapid increases in income—a per capita income growth rate of 3 percent per year is projected for the period 1990-2010²⁴—and slow growth in production relative to population growth, resulting in low per capita production growth rates for wheat and rice and negative per capita production growth rates for maize and other coarse grains (Table 4). Moreover, except for rice, the area cultivated under major cereals declines slightly over the period 1988-2010.

Underlying these projections are assumptions that yields will continue to rise between 1988 and 2010. For instance, it is assumed that wheat yields in South Asia will grow 2.19 percent per year over this period, maize yields by 1.65 percent, rice yields by 1.92 percent, and yields of other coarse grains by 1.96 percent.²⁵ Area cultivated, by contrast, is projected to decline over this period except for rice.

Where are food prices headed? If the original goals of the Uruguay Round were achieved and agricultural subsidies and trade distortions are significantly reduced in the European Union, the United States, and Japan, available estimates suggest a 10-15 percent increase in real agricultural prices on the world market. However, there are several reasons why price increases will be limited or not occur at all: any reductions in agricultural trade distortions in the European Union, the United States, and Japan are likely to be small and spread out over a long period of time; there are strong indications that enhanced supply management rather than freer markets may occur in these countries, keeping domestic production at levels higher than free markets will justify; and it is likely that Eastern Europe and the former Soviet Union will increase agricultural production considerably faster than demand during the next ten years, releasing significant volumes of grain on the world market and depressing international prices.

Most recent projections conclude that it is likely that real food prices in the international market will decrease during the next 15 years. The IFPTSIM model projects declining real prices for major cereals during the 1988-2010 period (Figure 17), ranging from a 40 percent decline in wheat prices to a 25 percent decline in the average price for maize and other grains, and to a 7 percent decline in the rice price. However, if the assumptions underlying these projections are incorrect, world prices may change in very different ways. Simulations suggest that if the population growth rate were to be 20 percent higher, real world prices for rice would increase while the prices for wheat, maize, and other grains would decline by considerably less than projected in the baseline scenario described above.²⁶ Slower yield

²⁴ M. W. Rosegrant and M. Agcaoili, "Global Food Demand, Supply, and Price Prospects to 2010." Paper prepared for the Roundtable Meeting on Population and Food in the Early 21st Century: Meeting Future Food Needs of an Increasing World Population, International Food Policy Research Institute, Washington, D.C., February 14-16, 1994.

²⁵ Data generated by Rosegrant and Agcaoili.

²⁶ Rosegrant and Acqaoili, 1994.

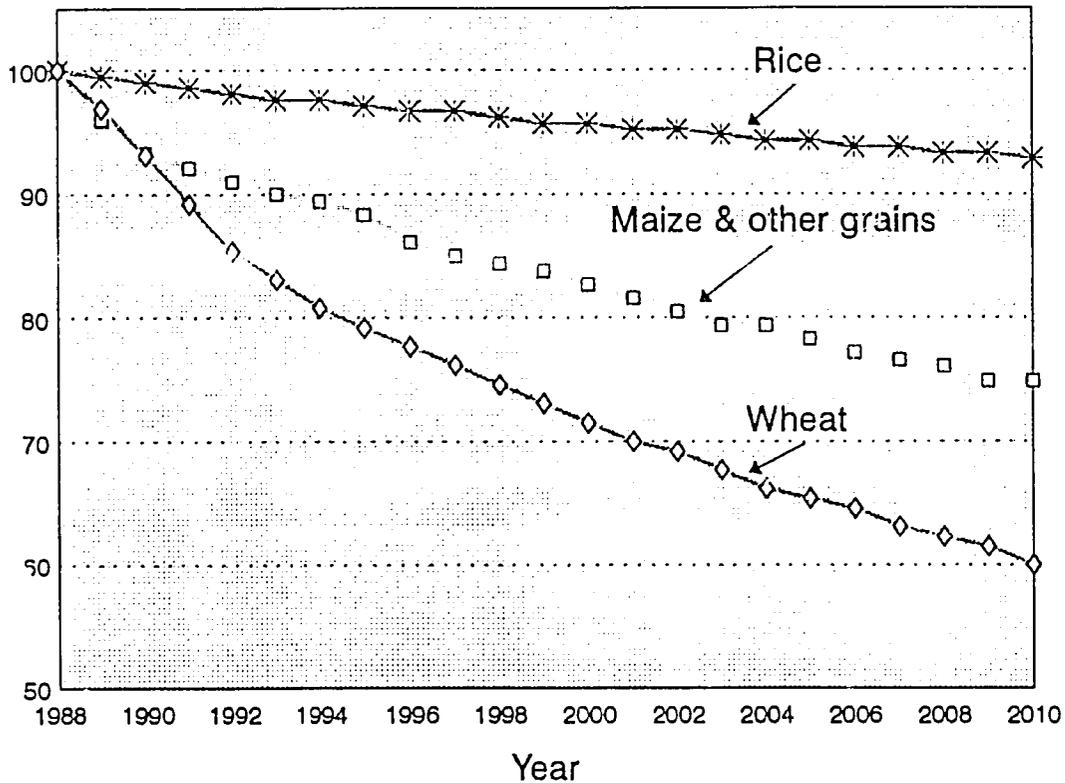
Table 5—Projected growth rate of production, consumption, and trade, 1988-2000

	1988-2000			2000-2010		
	Prod	Cons	Net Trade	Prod	Cons	Net Trade
(percent per annum)						
A. South Asia¹						
Wheat	2.05	2.85	12.15	2.12	2.68	5.84
Rice	1.99	2.07	-2.77	1.99	2.14	n.a.
Maize	1.50	2.26	5.40	1.79	2.45	4.38
Other coarse grains	1.73	2.41	-4.43	1.75	2.29	-12.40
B. Developing Countries¹						
Wheat	1.95	2.18	3.03	2.02	2.18	2.69
Rice	1.78	1.81	8.16	1.81	1.84	5.76
Maize	1.81	2.13	5.95	1.91	2.29	5.30
Other coarse grains	1.76	2.33	7.06	1.90	2.33	4.62
C. Developed Countries						
Wheat	1.25	0.82	3.03	1.26	0.83	2.69
Rice	0.98	0.42	8.15	1.51	0.86	5.76
Maize	1.61	1.34	5.95	1.63	1.27	5.30
Other coarse grains	1.07	0.75	7.06	1.21	0.89	4.62

Note: n.a. = not available because there was shift between net export and net import status.

¹ Growth rates for net trade refer to changes in net imports.

Figure 17—Index of projected world prices for wheat, rice, and maize and other grains, 1988 = 100



growth rates could have major impact on world prices: simulations show that a 25 percent reduction in yield growth rates would lead to 25-30 percent increases in world prices for major cereals.

In sum, the outlook for developed countries is favorable. They will continue to produce more cereals than they need, driving down world prices. However, even at lower prices, the outlook for the group of developing countries, particularly for some groupings such as Sub-Saharan Africa, is not favorable. Although total consumption of cereals in developing countries as a group is projected to increase 58 percent between 1988 and 2010, per capita consumption of cereals is projected to increase only 10 percent. In South Asia, the disparity is even greater: a 68 percent increase in total consumption of cereals contrasts with an 11

percent increase in per capital consumption over 1988-2010. Thus, even at lower prices, it is quite likely that many people will continue to go hungry.

CONCLUDING COMMENTS

International real food prices continue to decline, large food surpluses continue to exist in the European Union and the United States, and there is reason to believe that the former Soviet Union and Eastern Europe will expand food production and possibly reduce consumption during the next 10 years and perhaps beyond. Yields of wheat, rice, and maize are increasing in Asia and parts of Latin America, and a few African countries have shown an ability to rapidly expand food production in response to favorable policies and technologies. World stocks of cereals are about 300 million tons or 17 percent of annual consumption. Although lower than in the mid-1980s, this is considerably higher than the levels immediately prior to the food crisis of the early 1970s (Figure 18). On the basis of these indicators, one might conclude that there is no serious problem.

But population growth will outstrip growth in food production in Sub-Saharan Africa for a long time to come unless more is done to accelerate agricultural growth. Between now and 2000, the population will grow at more than 3 percent a year, while food production is likely to grow at 2 percent or less a year. By the year 2000, the production shortfall is estimated to increase to about 50 million tons of grain equivalent, up from the current level of about 14 million tons.²⁷ The region will not have the necessary foreign exchange to import such large amounts of food. And African governments will not be able to count on enough food aid to make up the difference. If current trends continue, the World Bank estimates that by the year 2020, Africa will have a food shortage of 250 million tons, which is more than 20 times the current food gap.²⁸

Poverty is expected to increase rapidly in the coming years. Sub-Saharan Africa's share of the world's poor is expected to increase from the current 19 percent to about 28 percent in 2000. Furthermore, the number of underweight children is expected to increase in the 1990s in Sub-Saharan Africa even under the most optimistic assumptions made by the United Nations.

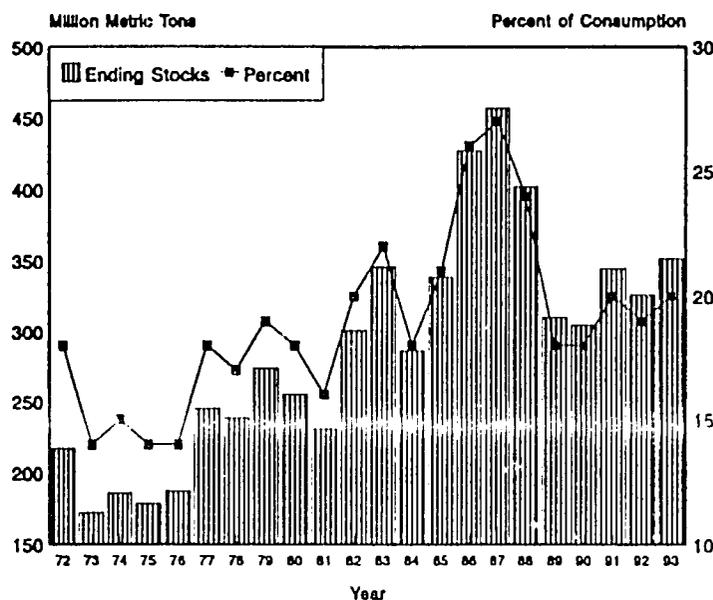
Asian demand for cereals is estimated to grow at an annual rate of 2.1 percent between now and the year 2000, whereas cereal production is expected to grow at 1.9 percent per year.²⁹ Some Asian countries will generate sufficient foreign exchange to deal with production shortfalls through expanded imports. Others will not.

²⁷ J. von Braun and L. Paulino, "Food in Sub-Saharan Africa: Trends and Policy Challenges for the 1990s," *Food Policy* 15 (December 1990): 505-517.

²⁸ World Bank, *Sub-Saharan Africa: From Crisis to Sustainable Growth* (Washington, D.C.: World Bank, 1989).

²⁹ *op. cit.*

Figure 18—World stocks of grain, 1972-93



Sources: FAO, "FAO Agrost-PC, Population, Production, and Food Balance Sheets Domains" (Rome: FAO, 1992, computer disk); FAO, The State of Food and Agriculture 1993 (Rome: FAO, 1993, mimeographed).

Large areas of land are rapidly being degraded and deforested. And the principal reasons for environmental degradation—poverty, high population growth, and limited access to appropriate agricultural technology—are not being dealt with effectively.

About 700 million people are food insecure; for them the food crisis has arrived. For the 10-12 million preschool children who died last year from hunger and diseases related to malnutrition, the food crisis came and went. One-third of the preschool children of the Third World are unable to grow to their full potential and face increased risk of death and disease.

The mass starvation that was predicted for Asia in the 1970s and 1980s did not occur because science was effectively put to work to expand crop yields. However, past yield increases came about because people with foresight made appropriate decisions. The failure to expand investments in agricultural research and technology development during the 1980s and early 1990s indicates that such foresight no longer prevails. Given the long lag time between investment in agricultural research and the resulting production increases, failure to invest today will show up in production shortfalls 10 to 20 years from now. The problems associated with environmental degradation will present themselves sooner. The slight increases in per capita consumption projected to occur during the next 15 years will be threatened, and it is possible that many people will continue to go hungry.