Food Security and the Challenge to Agriculture in the 21st Century

Despite improvements in health, nutrition, and other factors important to the human condition, by the year 2025 as many as 1,000 million people of a projected 8,000 million could suffer from malnutrition. Many advances have been made, but the challenge of providing food security for all remains massive and complex — an endeavor that involves production, trade, income, social safety nets, and much more. Many approach this complexity one element at a time, perhaps focusing on food supplies, food demand, technologies, or policies. No single approach, however, can adequately address the most pressing issues facing the world in the 21st century — the levels of economic and social development that are necessary to attain global food security.

Given that food needs in developing countries could nearly double in the next 30 or 40 years, the challenge to the global agricultural system is enormous. Food security, however, is about more than having adequate supplies of food — every human should have continuing and affordable access to enough food to lead a normal, healthy, and productive life. Food security must first be considered at the household level — does a family generate sufficient income to acquire the food it needs? To meet this requirement, reducing poverty so that families can afford to buy food is paramount. The challenge of reducing poverty is both national and international, and in the developing world it remains predominantly rural in nature.

It is now generally accepted that food security has three components — availability, access, and effective use of food to achieve nutritional security. Each is a necessary condition, but only a marriage of the three can assure food security for all. This Note discusses the challenge of global food security, first by reviewing past performance, and then addressing the challenges of demand, supply, and access.

Performance to Date
Before projecting into the future for the next 25 to 30 years, it is worthwhile to review how well we did during the past 30 years, during which world food needs doubled. We consider food availability and access, and nutritional use.

Availability
Despite periodic predictions of imminent shortages, the world did remarkably well in expanding food
production between 1960 and 1990. World cereal production more than doubled, per capita food production increased 37 percent, daily caloric intake increased 35 percent, and real food prices fell by almost 50 percent. Regionally, average daily caloric intake per person increased significantly in the Middle East and North Africa, East Asia, and Latin America to levels of 2,700 calories per day or higher. South Asia, where food production grew more slowly, still suffered from significant undernutrition, and Sub-Saharan Africa actually experienced a decline in per capita food availability. Production increases came from three sources—increasing biological yields, intensifying the use of land (for example, irrigated acreage in developing countries doubled), and expanding the area under cultivation.

**Access.** Despite an overall effective global performance, undernutrition remained a serious problem. During 1969 to 1971, 920 million people, equivalent to 35 percent of the developing world population, were undernourished. In the 1990s, FAO estimated that 840 million people, equivalent to 20 percent of the developing world population, were undernourished. There was progress in relative terms, but in absolute terms the number of undernourished people diminished very little. In addition, regional performance varied widely. During 1969 to 1971, 76 percent of the undernourished lived in Asia (51 percent in East Asia) and 11 percent in Sub-Saharan Africa. During 1990 to 1992, 60 percent lived in Asia (30 percent in East Asia) and 25 percent lived in Sub-Saharan Africa.

**Nutritional Use.** Although firm data are unavailable, it is likely that in the 1960s over 1,000 million people suffered from a deficiency in one or more micronutrients (vitamin A, iron, iodine, zinc, or copper). In the early 1990s, estimates are that 1,600 million people are at risk of iodine deficiency and about 2,000 million are affected by iron deficiency.

### The Demand Challenge

In less than 10 months, we will enter the 21st century. By 2025, the world's population will approach 8,000 million people, an increase of 2,500 million from the 1990s. Nearly all of this increase will be in developing countries. The increase in the number of people to feed is only part of the challenge. As incomes grow, so does the demand for food. A modest growth in income could result in food needs nearly doubling in developing countries during the next 30 to 40 years. Furthermore, shifting population patterns mean that by 2025 the urban population in developing countries will increase by about 2,000 million people. The combination of population growth, rising incomes, and urbanization will significantly alter the composition and characteristics of food demand.

Developments on the demand side raise fundamental questions on the supply side. Can the world produce enough food to feed 8,000 million people, and at the same time reduce the number of undernourished to below the current level of 800 million? Will we break away from the mind-set of equating food security with national food self-sufficiency and instead ask where the food should be produced? Can the food system of the future meet the challenge of processing, distributing, and storing a nutritious food supply for hundreds of millions more people in the next century? Finally, does the world have a trading system that will allow increasing quantities of food to flow from surplus to deficit areas?

### The Supply Challenge

Views on the challenge of meeting future food security diverge strongly as the period of projection is lengthened. Those using economic projections or simulation models, which are based mainly on historical trends, tend to project a sufficient global food supply until at least 2020. Those projecting on the basis of resource availability and environmental constraints, who could be called ecological modelers, are generally much more pessimistic. The most extreme views combine resource constraints with pessimism about increasing biological yields and foresee serious problems ahead.

The very nature of projections that use compounding growth rates of population and income compared to compounding growth rates of yield means that food gaps grow rapidly if the growth rate of demand exceeds the growth rate of supply. On the other hand, if supply growth rates exceed demand growth rates, food prices fall. The latter has been the predominant outcome in the 20th century. Several recent simulations have projected that by 2015 the global cereal or food balances will increase by 1.5 to 1.7 percent per year, area harvested will increase modestly, global grain demand will grow more slowly, and trade in grains will increase. These studies expect real grain prices to remain constant or decline.
There are contrary views presented by other researchers, who argue that there is only a small backlog of unused agricultural technology, fish production has reached its biological limits, and rangeland carrying capacity has been exceeded. They further argue that the demand for water is pressing its hydrological limits, fertilizer responsiveness is declining, and much of the cropland especially in China is being lost to degradation, urbanization, and industrialization. The resulting conclusion is very pessimistic, with greatly expanded trade as the only possible solution, which they also see as problematic.

How can these economic optimists and ecological pessimists reach such different conclusions when projecting potential food supplies? Assuming that they generally agree on the demand side scenario, the reasons can be found in the four critical projection parameters — yields, area harvested, intensification, and resource constraints. Most likely, the optimists are too optimistic and the pessimists are too pessimistic. Reality suggests that feeding 2.500 million more people requires long-term growth in agricultural output, which must come primarily from rising biological yields rather than from expanding cultivated area or increased irrigation.

Why? Because most fertile land is already under cultivation, and the really suitable and low-cost areas for irrigation have already been exploited. Additionally, population growth and urban expansion will lead urban and industrial interests to compete for land and water. Therefore, doubling yields in complex farming systems without damaging the environment is the long-term viable option — as well as an enormous challenge.

This is a worldwide technological, political, and economic challenge. We require new technology that allows the development of new high-yielding and environmentally sustainable production systems. More of the same input-intensive monoculture will not do. The political and economic challenge can only be met if international and domestic policies, institutional frameworks, and public expenditure patterns are conducive to sustainable agricultural development.

**The Access Challenge**

Supply and demand are only part of the food security challenge. The third challenge is access to food. Here, the issue is clearly to reduce poverty. Seventy percent of the poor people in the developing world still live in rural areas, so meeting this challenge means improving the productivity and profitability of millions upon millions of small farms.

To meet this formidable challenge, farmers will need new and appropriate technologies. The role of biotechnology will be critical if it can be applied to the crops of complex farming systems in the tropics and subtropics. As we break away from a heavy focus on basic food crops — rice, wheat, maize — to more diversified production systems involving all crops, animals, and trees, research needs are likely to be expansive.

If the challenge of improving the well-being of farmers can be met, we then have the rationale to encourage farmers to be more effective stewards of the world’s natural resources. Virtually all of the arable land and most of the fresh water in the world is managed or used by farmers, which means that advancing the welfare of rural communities by improving the profitability of agriculture is a triple win situation. Healthier rural communities reduce poverty, improve natural resource management, and improve food security.

Diverse foods were available in this Ghanaian market. Can the food system of the future meet the challenge of growing, processing, distributing, and storing a nutritious food supply for hundreds of millions more people in the next century?
Surely these daunting challenges must be taken seriously as we move into the 21st century. But we must ask the question, can they really be met? On the production side, yes — but there are four big 'ifs':

**If** we develop sustainable production systems capable of doubling output. This requires attacks on all fronts — ecology, soils, agronomy, breeding, farm management, pest management, and many other disciplines. We cannot focus only on the yields of single commodities. It is an unprecedented challenge for agriculture and biological science, particularly in tropical and subtropical areas.

**If** we implement domestic and international policies and institutions that do not discriminate against agriculture, and provide appropriate incentives to farmers around the world.

**If** we continue to invest in public agricultural research — through groups such as the CGIAR, for example — and build stronger partnerships with the private sector to tap the enormous potential of modern molecular biology to benefit small-scale and poor farmers around the world.

**If** we stay the course in removing obstacles to freer agricultural trade. The Marrakech Agreement of 1994 put agriculture under the rules of GATT/WTO for the first time. It requires tariffication of all non-tariff barriers, reduced domestic support, reduced import barriers, and lower export subsidies. This levels the playing field significantly for developing countries, which must be able to use world markets as they move away from the notion of self-sufficiency.

They must also be assured of access to reasonably stable markets. Therefore, the agricultural negotiations scheduled for 1999-2000 should focus on reducing protection levels in OECD countries, which would improve access to markets for developing countries. These developments will all help make the food supply available. On the access side, clearly the challenge is to improve education and rural well-being, as well as focus on policies that will generate income for poor people, most of whom still live in rural areas. This will require particular attention to education (especially for women), health, and infrastructure, and increasing the productivity of the agricultural sector.

**Further Reading**


This Note was written by Alexander McCalla, Director of Rural Development for the World Bank. The Rural Development Note series summarizes good practices and key findings about topics related to rural development. The ideas posed in this series do not necessarily reflect the policies of the World Bank. These Notes are distributed widely to Rural Family staff and are also available on the Rural Sector website (http://essd.worldbank.org/essd, then select Rural Development > Thematic Teams > Rural Strategy & Policy). If you are interested in writing a note, please email your idea to Nwanze Okidegbe (nokidegbe@worldbank.org). For additional copies, please contact Melissa Williams at (202) 458-7297. Edited by Seth Beckerman, design and layout by Condello Design, both of Pittsburgh, PA. Photographs by Curt Carnemark, World Bank.