IPC Position Paper No. 3

Attaining Global Food Security by 2025

Published by the
International Policy Council
on Agriculture, Food and Trade
Washington, D.C.
November, 1996

The views expressed in this position paper are those of the members of the International Policy Council on Agriculture, Food and Trade.

To order hard copies of *Attaining Global Food Security by 2025* contact the IPC at:

International Policy Council
1616 P Street, NW, Suite 100
Washington, DC 20036
Tel: (202)328-5056
Fax: (202)328-5133
email: nsmith@rff.org

Foreword

This paper was prepared for contribution to the World Food Summit to be held in Rome on November 13-17, 1996 by the Food and Agricultural Organization of the United Nations. It was discussed by the membership of the International Policy Council on Agriculture, Food and Trade (IPC) on two occasions in 1996. It was initially presented at the 17th IPC Plenary Meeting, May 12-14 in Brussels, Belgium. Then, following further review, it received final approval before a full gathering of IPC members at the 18th IPC Plenary Meeting and Seminar, October 3-6, 1996 in Calgary, Alberta (Canada). The paper reflects the position of the IPC on global food security, and should not be attributed to any other organizations or individuals.

The IPC would like to thank IPC Secretary M. Ann Tutwiler for her time and effort in writing this paper.

Introduction

In the 1970s, supply shortfalls and rising world food prices led the United Nation's Food and Agricultural Organization (FAO) to hold a World Food Summit to develop recommendations to increase global food production and food security. In the 1980s, the focus shifted to excess supplies and falling commodity prices.

In 1993, the FAO called for a World Food Summit to focus on hunger and malnutrition, particularly in Africa. Since then, historically low grain stocks, and high prices have again called into question the capacity of global agriculture to produce enough food to feed a growing population. The delegates to the 1996 World Food Summit will certainly be influenced by these longer term concerns, as well as by the more immediate concerns relating to Africa and other developing countries.

The FAO, in its preparatory documents for the upcoming Summit, states that the goals set forth at its 1974 Summit of eradicating world hunger within a decade have not been met, although there has been some notable progress. While world population grew by 60 percent over the last twenty years, the percentage of undernourished people fell from 35 percent in 1970 to 20 percent in 1990. Per capita energy supplies have risen from 2135 calories per person per day in 1970 to 2475 calories per day in 1990. The number of people living in developing countries with access to adequate food supplies has increased by 1.6 billion, while the number of malnourished people has fallen by 90 million.

Nevertheless, as of 1996, 800 million people remain chronically malnourished. Almost 200 million children suffer from acute or chronic protein and energy deficiencies. Moreover, 88 countries are considered "low income food deficit" countries. Nearly half are in sub-Saharan Africa, a quarter in Asia, and (surprisingly) ten percent in Europe and the Commonwealth of Independent States. Meanwhile, agriculture-related foreign aid commitments have been falling.

The vast majority of the hungry and malnourished suffer from inadequate income, not from inadequate food supplies. The remainder lack food because of war and civil strife that prevent planting or disrupt the distribution of food. Only rarely does a real lack of food supplies (caused by drought or floods) translate into hunger.

To some extent, rising prices and falling stockpiles reflect short term variations in the global supply of foodstuffs, driven by policy decisions and weather. But, to a larger extent, sharply higher prices and historically low food stocks have raised the agricultural community's underlying concerns about the sector’s ability to feed the world's growing population in an environmentally sustainable fashion over the next 30 years. There are some troubling trends:

- World food production is falling in some regions. Between 1960 and 1990, per capita food production fell in sub-Saharan Africa and the Middle East.
- Despite sufficient global food supplies, undernutrition remains a major problem in many parts of the world.
- The rates of increase in agricultural production in the least developed countries may be slowing. Similarly, wheat and rice yield increases are slowing.
- The natural resource base in some regions is under great stress from salinization, deforestation, soil erosion, and the loss of topsoil.
- Funding for public sector agricultural research has stagnated, both at the international and national levels, in many countries.

Public mistrust of science-based agriculture is increasing. This mistrust, and the resulting regulatory and policy decisions it engenders, is dampening the research and investment needed to help agriculture meet the challenge of a growing demand.

The Dimensions of Global Food Supply and Demand

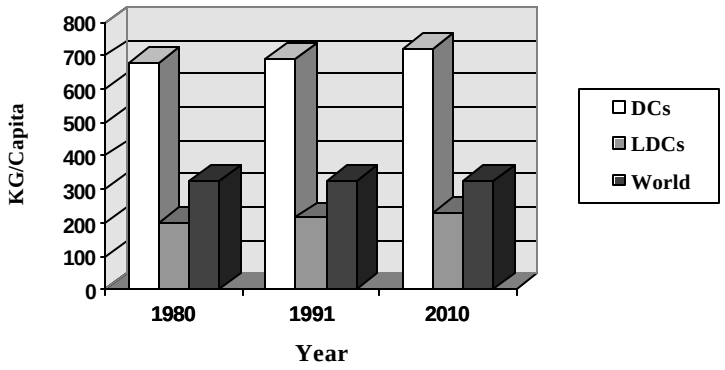
It is important to put the current supply and demand scenario into perspective. Overall, global grain production declined 3.4 percent in 1995. But, grain production rose 2.5 percent in 1994, according to preliminary USDA estimates, the 1996 crop will be 7 percent larger than the 1995 crop, making it one of the largest grain crops in history. In late 1994 and early 1995, a number of significant events coincided—wet weather in the United States and Canada, drought and civil war in sub-Saharan Africa, government set-aside policies in the United States and Europe, declining production in China, falling food production in the countries of Eastern Europe and the former Soviet Union—to bring about a drop in production. Moreover, global stocks had been declining for several years. By 1996, this combination of circumstances led to historically low stocks (approximately 14 percent of annual global demand) and high grain prices.

The slowdown in production growth occurred primarily in the developed countries, largely due to government policies, such as the use of acreage control programs in the United States and the European Union (About 6 percent of the world's cropland has been idled annually by US and EU policies.) Meanwhile, food production in the rest of the world grew and per capita production remained unchanged. By 1996, the end of set-asides in the United States, lower set-asides in the EU, and higher prices combined to set the stage for a significant increase in production.

Over the longer term, food supplies (production and stocks) have kept remarkable pace with food demand. Globally, per capita food supplies increased from 2430 calories per day in 1970 to 2700 calories per day in 1989. A closer look at the historical figures suggests that, for developing countries as a whole, growth rates of per capita production have not been lower in

recent years than during earlier periods. When examined regionally, only Africa saw a decline in its per capita food production over that period. As Exhibit 1 indicates, researchers expect these trends to continue into the next century.

Exhibit I: Per Capita Cereal Production



Source: United Nations, 1993. Cited in "The Outlook for World Food and Agriculture to the Year 2010." International Food Policy Research Institute.

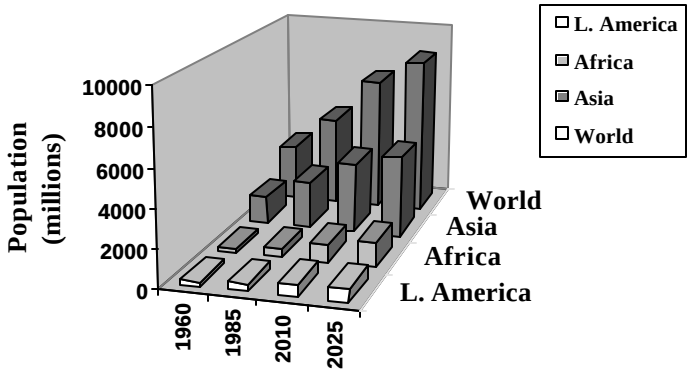
Therefore, in some ways, the high prices and low stocks that have characterized world agriculture in the past two years may be a "blip" and not the beginning of a trend. But, even a short term disruption in supply can last for several years (due to the draw down in stocks and cyclical weather patterns) and can cause significant problems for countries and individuals. During 14 of the last 30 years, global grain demand was met by drawing down stocks. Continued reliance on stockpiles to fill production shortfalls is clearly an unsustainable policy for the future.

It is equally clear that sufficient global food supplies do not always translate into sufficient supplies at the national, or the household, level. In some countries and some regions, the growth in per capita food availability (either produced or purchased) has not been sufficient to improve the dietary status of the general population.

Much has been written on this subject both by popular policy analysts and academicians. Summarizing their predictions, Alex McCalla noted a fairly broad agreement that world population will reach at least 8.5 billion people by 2025 and 10 billion by 2050.

As Exhibit 2 indicates, much of the increased population will live in developing countries. In 1985, 75 percent of the world's population lived in developing countries. By 2025, almost 85 percent will live in developing countries. The largest absolute increase in total population will be in Asia, while the steepest percentage increase will come in sub-Saharan Africa. Most of this increased population will live in the cities of developing countries. The urban population in developing countries is expected to increase from one billion people today to four billion by 2025. Significantly, most of these people will live in coastal areas, removed from rural areas where food is grown. As a result, they may obtain most of their food from imports.

Exhibit 2: Population Distribution



Source: Alex McCalla, World Bank.

McCalla also found a broad consensus that world food demand will at least double by 2025 due primarily to rising incomes in developing countries, and less importantly to population growth. By 2025, developing country grain demand is expected to equal three times the current US grain harvest of 310 MMT.

In addition to rising population and urbanization, most analysts project that per capita incomes will continue to rise in most parts of the developing world. These combined trends will have repercussions for the quantity and character of global food demand, because there is a direct correlation between per capita income and diet. For example, with only one exception, countries with per capita incomes of less than $5,000 consume less than 30 kilograms per capita of sugar per year. Countries with annual per capita incomes of $5,000 to $10,000 consume between 25 and 50 kilograms per capita per year. The same is true for meats and vegetable oils. Countries with per capita incomes below $5,000 (for example, China, Pakistan, Honduras) consume less than 20 grams per capita, per day of animal protein. Countries with incomes between $5,000 and $10,000 (such as Korea) consume 30 grams per capita per day.

As countries move up the income ladder, their demand for sweeteners, vegetable oils and animal protein increases as well. Demand shifts away from roots, tubers and lower quality staple grains such as maize, to higher quality cereals such as rice and wheat, and to livestock products, edible oils, fresh fruits and vegetables. Rising demand for poultry, pork and beef also increases the demand for animal feed.

Agriculture's Challenge: Doubling the World's Food Supply in Thirty Years

If there is widespread agreement on the level of future demand, there is great debate on the future level of global food supply. The FAO, the World Bank and International Food Policy Research Institute (IFPRI) generally agree in their basic prediction that world food production will continue to increase at an annual rate of between 1.3 and 1.8 percent, with a per capita increase of 0.2 percent. The FAO expects annual global food output to rise by 1.8 percent between 1990 and 2010. While this represents a slowdown in the rate of growth in food production from 3 percent in the 1960s to 2 percent in the 1980s, the FAO forecasts an increase in food supplies on a per capita basis. By 2010, the daily per capita food supply available to people in most parts of the developing world could increase from 2,500 calories to 3,000 calories. However, predictions for sub-Saharan Africa indicate that daily per capita food supplies will reach only 2170 calories by 2010.

IFPRI also predicts the world can continue to increase production faster than the growth in population, without price increases. According to IFPRI's projections, world food production could grow at 1.8 percent per year, through 2010, with annual per capita food production growing at 0.2 percent. The World Bank has published similar projections.

At the other extreme, the Worldwatch Institute predicts annual production increases of 0.6 percent, or less than one-third the level predicted by the FAO, the World Bank and IFPRI. That is less than one-fifth of the 2.6 percent annual rate of production increases that have been registered over the last 30 years.

Whose projections are correct? The ability to increase food production depends on several factors. It depends on the availability and quality of physical resources (land, water and fertilizers). It also depends on the ability to increase yields, through the use of scientific research, better education, and better management.

In the last forty years, yield increases have been the principal driving force behind the dramatic increase in global food production. Over that time span, approximately 80 percent of the 110 percent increase in production came from higher yields, which were themselves the result of new high yielding varieties of major grains, a 70 percent expansion of irrigation, and a

threefold increase in fertilizer use. As a result, cereal yields rose from 1 ton per hectare in 1950 to 2.8 tons per hectare in 1993.

What are the prospects that global agriculture will continue to achieve the necessary increases in production, either through an increase in physical resources, or an increase in yields?

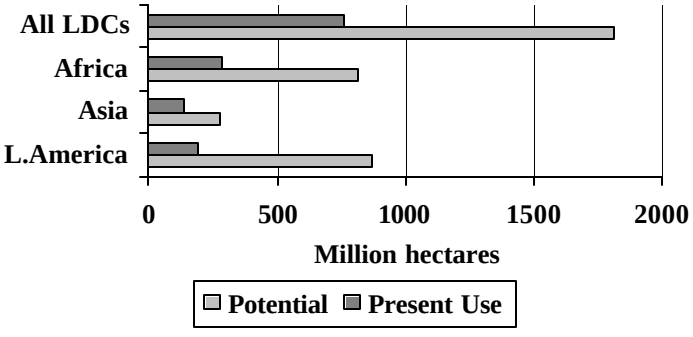
Physical Resources

Over the last forty years, the increase in world food production has been propelled largely by rising productivity, driven in part by increased irrigation and increased use of fertilizer, pesticides and other agricultural chemicals. Land use has also expanded, but has been relatively less significant in increasing production. What are the prospects for these resources in the future?

Land. The supply of land is relatively finite. Most scientists believe that the opportunities to economically expand production by expanding the area devoted to agriculture are very limited, particularly in Asia, where the FAO indicates that 18 key countries are already farming 90 percent of their arable land. Even so, IFPRI estimates there are 2.5 billion hectares of land in developing countries that could support rainfed agriculture. Of that, 760 million hectares of land are already in production in developing countries, of which 120 million hectares are irrigated. Most of this additional land lies in two regions, sub-Saharan Africa and Latin America.

Clearly, not all of this land should be considered an agricultural reserve because of environmental and other reasons. However, new farming methods, including no-till agriculture, could allow some of this land to be cultivated without adverse environmental consequences. Thus, even if a significant portion is not economically or environmentally sustainable, there is still some potential for expanding cultivated land area.

Exhibit 3: Present and Potential Croplan



Source: FAO, 1993 in Pierre Crosson, "Population and Food in the Early 21st Century," IFPRI.

Pierre Crosson of Resources for the Future confirms this analysis. As Exhibit 3 indicates, the supply of potential cropland exceeds the current use by 2.4 times. Thus, even a modest area expansion and improvement in land quality would yield significant results. According to the FAO, a 12 percent increase in cropland in developing countries, coupled with a 10 to 15 percent increase in land productivity by improving soil quality, could yield a 20 to 25 percent increase in food production by 2010. By way of example, Vaclav Smil, from the University of Manitoba, projects that expanding the arable land area alone by 20 percent by 2050 would mean an additional 400 MMT of grain, even at 1990 yield levels.

Water. The amount of water that is readily available for increased irrigation is relatively finite as well. Water withdrawals for irrigation average 90 percent of the total water use in Asia and Africa, 60 percent in South America, and 50 percent in North and Central America. The possibility of finding new supplies of water is limited by declining water tables and by the expense of desalinization.

The efficiency of water use can be improved through government policy, however. For example, the price of water in most irrigated areas does not reflect the costs of delivery, much less its scarcity value. The cases of California and Saudi Arabia are most celebrated, but underpriced (and, therefore, overused) irrigation water plagues China as well. According to most economists, water prices reflective of scarcity values would improve irrigation methods, force farmers to match crops with available moisture, and encourage more efficient watering techniques. (Of course, higher water prices in the short term could certainly affect food prices, planting decisions, and even the viability of agriculture in some regions. Over the longer term, however, more appropriately priced water would lead farmers to use water more efficiently, and to plant drought tolerant plants in areas with low natural water supply.)

Water can also be used more efficiently. Many small scale, relatively inexpensive irrigation projects in Africa are meeting with some success. Irrigating every other row, better timed irrigation and drip irrigation can yield enormous benefits at relatively low cost. Substituting sorghum for maize can lower water needs by 10 to 15 percent; substituting sunflowers for soybeans can lower water demand by 20 to 25 percent. Smil estimates that if water efficiency were raised by 30 percent over the next 50 years by implementing such modest steps, world grain production could increase by 100 to 150 MMT.

Soil Nutrients. As new, high-yielding seeds which are more responsive to fertilizers have come into use, the role of soil nutrients (nitrogen, potassium and phosphorus) has become ever more important. Without appropriate soil nutrients, these high-yielding seeds cannot perform to

their fullest potential. There appear to be few absolute shortages of soil nutrients. However, the investments required to produce or mine these nutrients can be substantial, particularly for developing countries.

Overall, fertilizer use in developing countries rose from 6.5 kg/hectare in the early 1960s to 82.1 kg/hectare in 1990. For comparison, the average fertilizer use in developed countries was 44.8 kg/hectare in the early 1960s and 116.2 kg/hectare in 1990. Increasing fertilizer use in developing countries, together with training in appropriate applications, could dramatically improve soil fertility and yields in developing countries.

Simply increasing the quantity of fertilizer is not the whole answer. In many countries, modern agriculture has been rightly criticized for over-applying fertilizer, which runs off fields and into streams and rivers. New production methods, such as precision farming, which allows farmers to better target fertilizer applications, and increasing crop rotations, could also improve soils and enhance soil fertility without harming the environment.

More important than the absolute quantity are the mix and quality of these nutrients. The Chinese use poor quality nitrogen, combined with too little phosphorus and potassium, thus offering plants a poor diet. Simply improving the balance between nutrients can result in improved yields, as can improved timing and targeting of applications.

Finally, much biotechnology research has been devoted to developing plants that can "fix" nitrogen in the soil. This difficult area of research has thus far failed to yield significant results, and will require more investment if it is to make a contribution in the future.

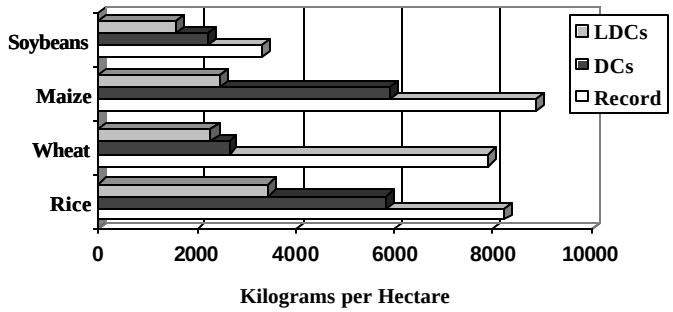
Increased Yields

There are two components of increasing agricultural yields. The first comes from scientific research aimed at improving yields. The second comes from education and extension aimed at translating laboratory yields into the field.

The central debate about the sector's ability to double its food production hinges on whether it is possible to sustain the high yield increases of the last thirty years. Most analysts predict that to double food production and maintain adequate food supplies in 2025, actual yields must increase between 1.4 and 2 percent per year, or about the same rate as in the 1980s. There is substantial research to show that maintaining such yield increases will be possible, but not easy. The International Center for the Improvement of Maize and Wheat, which is part of a network of research facilities spread around the world, indicates that the rate of increase in experimental yields for these two major cereal crops is slowing, in part because of declining investments in research.

Clearly, plant breeding and its extension through biotechnology can make a tremendous contribution to improved yields and reduced inputs. Nothing else on our shelf of existing knowledge promises as much for future crop and livestock yields, for protecting wildlife habitat and avoiding pollution, as biotechnology. Moreover, biotechnology promises to capture very complex science and deliver it in one, simple package—a seed—to farmers. Research into biotechnology has been ongoing for some years. Much of this research is only now beginning to bear fruit. We cannot predict whether biotechnology will bring dramatic increases in yields, or only slow and steady improvements. But, there is a strong consensus that the challenges facing global agriculture will not and cannot be met without biotechnology.

Exhibit 4: Record and Average Yields



Source: Oram and Hojjati, in Population and Food in the Early 21st Century

Continued research is critical to any effort to maintain yield increases; however, there are a number of techniques and technologies already on the shelf that could raise actual farm yields now. As Exhibit 4 indicates, yields in many developing countries are far below the yields obtained in the United States or Europe. For example, Nigeria's maize yields are only two-thirds of those in Mexico, which in turn is only three-quarters of the world average. Even within the United States (where average maize yields are twice the world average) there are wide variations in yields across regions and across farms. So, even without great advancements in science, improving average yields is possible simply by focusing on increasing yields in those countries, regions and farms where average yields are low.

Better education and training can provide many low cost opportunities to increase yields. For example, knowing when to plant a crop can substantially raise yields. Timely planting of soybeans can raise yields by as much as 50 percent. Optimum density of maize plants can raise yields by as much as 2.5 tons/hectare. Crop rotations can also increase yields. The combination of timely planting, at optimal densities, with appropriate rotations could raise yields

by 20 percent or more over the next 50 years. Similarly, proper timing of fertilizer applications can enhance their efficiency, as can proper ratios between nitrogen, potassium and phosphorus.

More expensive ways to increase yields include irrigation, soil testing, improved fertilizer applications and improved fertilizer production. As mentioned earlier, improved fertilizer production is particularly important in China, where much of the nitrogen fertilizer is a highly volatile form of nitrogen that loses its effectiveness quite rapidly. Studies suggest that only half of the nitrogen applied in England is taken up into the soil (the figures for developing countries are lower). Simply improving nitrogen uptake and improving the balance between PKN fertilizer could increase yields significantly.

Pre- and Post-Harvest Waste

While often ignored in the debate over food supplies, reducing pre- and post-harvest losses could be a significant source of additional food. A 1994 study by E.C. Oerke indicates that global crop loss is about 42 percent, with 13 percent due to weeds, 16 percent to pests and 13 percent to disease. Another study puts the total loss at 35 percent. These numbers are in spite of the application of 2.5 million tons of pesticides, herbicides, and fungicides worldwide, coupled with the use of biological and non-chemical controls. It is staggering to think what losses might have been, had there been no use of pest controls. In the United States, crop loss (all crops, including fresh fruits and vegetables) due to pests is estimated at a surprising 37 percent. Even in a country where the use of crop protection chemicals is highly sophisticated, insects reduce harvests by 13 percent, plant disease by 12 percent, and weeds by 10 percent.

Oerke puts global post-harvest losses at 20 percent. Some experts suggest that about a third of LDC harvests are lost due to post-harvest waste. Post-harvest losses, including grain rotting in the fields and "disappearing" between farm and warehouse were widely publicized in the former Soviet Union and by some estimates, represented about 40 percent of the country's harvest.

Reducing pre- and post-harvest waste will require improvements in the use of modern crop protection chemicals, along with improved biological controls (such as integrated pest management). Better non-chemical controls are also needed, as are improvements in harvesting equipment, drying facilities, storage, food processing, and transportation. In many countries, simply storing grain in rodent and insect resistant bins can reduce wastage significantly. While there are few dramatic steps that can cut pre- and post-harvest losses, the pay-off could be extremely large.

Agricultural Policy

All too often, the impact of public policy is left aside when issues of global food supply (and demand) are discussed. It is nevertheless clear that price supports, supply controls, import barriers, and agricultural taxes all play a critical role in determining supply and demand.

The United States' recently abandoned policy of idling an average of 10 percent of its arable land (14 million hectares in recent years) has robbed the world of some of its most productive agricultural resources. The EU's current policy of idling 6.4 million hectares, or 12 percent of its land (down to 5 percent in 1997), coupled with the use of export taxes during much of 1996, also constitute policy decisions that reduce global grain supplies. Policies which tax imported fertilizer and other inputs also curb yield increases in many countries.

On the other side, high price supports in the EU and the US during the 1980s led to surpluses of grain. Often, these surpluses found their way onto world markets, at subsidized prices, where they destroyed production incentives in the less developed countries, not to mention in countries that either chose not to, or did not have the wherewithal to, subsidize their exports. Equally, some of the food aid that resulted from these surpluses was marketed inappropriately, and depressed prices to developing country farmers, undermining the ability of developing countries to grow food domestically. Developing country exporters were also hurt by these surpluses, when the prices for their commodities fell on world markets.

Fertilizer subsidies in the Soviet Union and Central and Eastern Europe led to high application levels that were unsustainable after the subsidies evaporated. Equally, meat subsidies in the Soviet Union and in Central and Eastern Europe, skewed demand and led to higher feedgrain consumption than was sustainable without consumer subsidies. Ironically, today, because of a combination of trade policy and industrial policy, prices for agricultural inputs in these countries are higher than world prices, and commodity prices are lower.

Policies in many developing countries have also acted to reduce food supplies. Many developing countries operate cheap food policies. To keep food costs low for politically important urban consumers, less developed countries have reduced incentives to rural farmers. Overvalued exchange rates have also made imports cheaper than domestically produced food. Finally, developing countries' strong bias in favor of urban areas has manifested itself in investment policy as well. New schools, health clinics, roads and water systems tend to be built in urban areas. Not only does this investment attract people to urban areas where food demand tends to be satisfied by imports, it makes it difficult for farmers to market and distribute their food outside of rural areas.

In recent years, both the US and the EU have undertaken significant policy reforms which will affect global food supply, although in different directions. In the US, the elimination of

supply controls will likely expand production of the major grains, most notably maize and wheat, adding about 2.4 million hectares to the production base. In the EU, the use of supply controls to offset the effect of high internal prices has dampened production.

While often left out of discussions on agricultural issues, macroeconomic policies can have just as large an impact on food production and availability as agricultural policies. In the 1970s, loose monetary and fiscal policies in the United States fueled a cheap dollar, making US food products purchased with borrowed US dollars relatively cheap on the world market. (The fact that many developing countries overvalued their currencies simply compounded the impact of a cheap dollar.) High food imports undermined local production in a number of countries. This set of macroeconomic policies essentially stimulated food production in the developed countries, and penalized production in developing countries.

In sum, policy and public investment matter a great deal in determining where food is produced, and whether global food supplies are in surplus, are sufficient, or are in shortage.

Translating Global Food Security into Regional and National Food Security

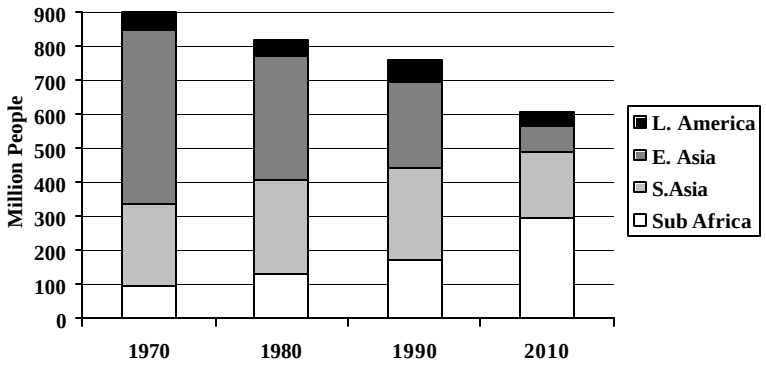
Global food security does not necessarily translate into regional, national or individual food security. Food security, the ability to grow and/or purchase needed food supplies, depends on much more than the sheer quantity of food available. Clearly, the resources necessary for agricultural production are not spread evenly around the world. Land, water, and climate favor agricultural production in North America, Europe, South America and Australia. Population density will make it difficult for many countries in Asia to produce adequate food and feed supplies, while a combination of erratic rainfall, weathered soils and harsh climate will make it difficult for many countries in sub-Saharan Africa to produce adequate food and feed supplies to feed their populations.

The uneven distribution of natural resources, combined with high income growth and dietary improvements in many countries, will expand developing countries' net grain imports between now and 2010. For example, Asia's imports of wheat are expected to rise from 24.7 MMT in 1988 to 47.6 MMT. Asia's maize imports are expected to rise from less than 1 MMT in 1988, to 14.5 MMT. Similarly, North Africa's wheat imports are predicted to rise from 22.9 MMT to 34.6 MMT over the same period, while maize imports will almost double from 6 MMT to 11.5 MMT. Only in Latin America are wheat imports expected to fall.

For many countries, financing these food imports will not pose any problems. But for others, where per capita incomes are falling or where foreign exchange earnings are insufficient, purchasing sufficient quantities of food to meet demand will be a huge challenge. As Exhibit 5 indicates, the number and proportion of malnourished people has been falling since 1970.

Nevertheless, by 2010, there will still be an estimated 600 million chronically undernourished people. By far, the bulk of these people will live in sub-Saharan Africa. In fact, of all the regions, only sub-Saharan Africa shows an increase in the number of malnourished people.

Exhibit 5: Chronic Undernutrition



Source: Alexandros, N. "The Outlook for World Food and Agriculture to 2010. In Population and Food in the Early 21st Century." IFPRI

It is widely recognized that ample food supplies are a necessary but insufficient cure for hunger and malnutrition. At the national and individual level, the problems of hunger and malnutrition have little to do with food production, and much to do with national or individual purchasing power. In preparatory documents for the 1996 World Food Summit, the FAO notes that the countries that have above average economic growth rates have all been successful in raising per capita food supplies. The countries with below average economic growth rates were unable to increase their per capita food availability.

More often than not, developing countries which were able to increase their per capita food supplies did so by increasing food imports. For example, over the last decade, some of the fastest growing developing countries were net food importers, because rising incomes fueled higher food demand, and their foreign exchange earnings enabled them to buy food on the world market. The fact that they were net food importers is evidence of growing wealth, abundant international purchasing power, and rapid dietary improvement. On the other hand, many low income countries could not afford to import food (except in the form of foreign aid). They balanced supply and demand at relatively low levels. The countries which saw their per capita incomes fall because of slow economic growth and high population growth also experienced declining per capita food availability.

Whatever the outlook for global food production, most of the world's developing countries will become more dependent on cereal imports.

A Special Caveat for Africa

Of all the world's major regions, only sub-Saharan Africa has been unable to keep food production in line with population growth. Harsh climate, heavily weathered soils, desertification, inadequate infrastructure, war, political instability and anti-farmer, anti-rural policies all have kept food production growing at just 2 percent per year—below Africa's annual population growth of 3 percent. Of 41 African countries, thirteen had declining cereal yields in the 1980s, while fifteen faced declining yields in root crops and tubers.

According to IFPRI, the need for net cereal imports in sub-Saharan Africa will increase from 9 MMT to 27 MMT by 2010, despite relatively strong growth in cereal production in Africa. There are many reasons for the size of this gap. While population growth is beginning to slow in many regions of the world, population growth is still rising in Africa. While China's population will increase by 45 percent between 1990 and 2050, Africa's will increase by 280 percent. Due to this booming population growth, Africa will face the sharpest rise in food needs of any region in the world. At the same time, per capita income growth has been falling in most African countries, and with it the ability of many individuals to purchase, and many countries to import, food. Children in sub-Saharan Africa seem particularly at risk, because of the anticipated high population growth in that age group.

Some experts disagree with this pessimistic view of sub-Saharan Africa. George Abalu, in a critique of several projections, points out that agricultural production and exports from Africa over the last two decades have been growing at rates well above the long term averages of the 1970s and early 1980s. He rightly points out that, even within sub-Saharan Africa, there are large disparities among countries. Moreover, most global projections ignore the role of root and traditional crops that are prevalent in the African diet. Abalu also points out that new seeds and new techniques are taking hold in Africa, especially in countries where economic incentives have been supportive.

The FAO Summit's focus on Africa, then, is extremely relevant and important. Even if some of the points made by Abalu and others are correct, it is clear that many countries in Africa will face enormous challenges in feeding their populations in the coming decades.

China's Role in the World Food System

As the world's most populous country, China's role in future world food demand has attracted special attention. The Worldwatch Institute has argued that China will be unable to produce enough food to satisfy its domestic demand, due to increasing environmental stress, and disinvestment in agricultural research. The Worldwatch Institute has argued that domestic

demand will spill into the international arena, where China will need to purchase 200 MMT of grain annually. This would drive up world food prices and divert trade from other, less developed countries.

China's economists, as well as many other food experts, dispute these drastic predictions. Chinese researchers have long argued that China would remain close to self-sufficient in grains. Since 1989, China's net imports of grain have been falling, and China has actually been exporting maize and soybeans in some Asian markets. Some analysts also expect China to begin supplying rice to the Asian market in the twenty-first century.

Many pessimistic projections of China's productive capacity also assume a much lower amount of arable land than seems to be the case. Evidence presented by Chinese scholars indicates that the Chinese arable land area may be underestimated by as much as 25 to 40 percent. This also implies that Chinese yields (which were considered high by developing country standards) are probably overestimated. Thus, the potential for China to increase its production through yield increases is probably larger than previously thought. Also, much of the land that has been diverted from cereal production in recent years has been put into other crops and acquaculture and has not been lost to food production.

While China's rapid urbanization and the attendant rise in urban incomes have attracted attention, it is worth pointing out that most of China's population is still very rural and has witnessed relatively slower income growth. China's rural residents still have a very traditional diet, with almost half of the family's food being grown on family plots. According to the UN, in 2030, 40 percent of China's population will still be rural. Therefore, the predictions for rapid growth in food demand are probably overstated, based on the largely rural nature of China's population.

Also, in time, the rapid increases in urban food demand may begin to level off, even as the nature of demand shifts from raw to processed products. The Chinese government is poised to begin reducing government subsidies for housing, education and health care. When it does, the urban population will be forced to divert some of the income that has fueled food demand into other daily living expenses.

Even so, per capita demand for meat is expected to double by 2020, and the proportion of grain going to feed animals is also expected to double. While reliable statistics are difficult to find, according to USDA, between 1990 and 1996, Chinese meat production (which serves as a useful proxy for demand) rose from 25 MMT to 47 MMT. Poultry production also rose from 3 MMT to 9 MMT over the same period.

According to IFPRI, China's grain demand is expected to rise 1.7 percent per year in the 1990s, while China's production is expected to increase at 0.6 percent. As a result, annual

food imports should reach 40 MMT by 2000, and should stabilize at 43 MMT by 2020. Even under extremely adverse circumstances, IFPRI predicts China's annual grain imports would not exceed 100 MMT. While China's likely grain imports of 43 MMT are three times the current level, they are far less than the 200 MMT predicted by the Worldwatch Institute.

Predictions of a major breakdown in China's grain supply assume virtually no reaction by Chinese authorities to falling production or to rising food imports. Given China's historic commitment to food self-sufficiency, this is a dubious assumption at best. In 1994 and 1995, the government responded decisively to rising grain imports with increased agricultural investment and a provincial responsibility system. China also began courting international seed companies to invest in the Chinese market. While the provincial responsibility system is questionable from a policy perspective and seed companies may be reluctant to invest in China without greater protection for their intellectual property, these moves show China's commitment to its agricultural sector.

Although research and investment funding have fallen over the past several years, Chinese authorities are reviewing the country's commitment to agricultural research. In addition, multilateral lending institutions are investing in China's agricultural sector. The World Bank has committed over $1 billion to improve China's grain handling and transportation infrastructure.

China does face some huge environmental problems caused by rising salinity and erosion. Although these are serious problems that China must address, Rozelle and his colleagues show that salinization and soil erosion would have to accelerate to five times current rates for there to be any significant impact on agricultural output.

Thus, according to most experts, China will provide the bulk of its own food supplies. Predictions that China's food and feed demand will significantly raise world prices, or disrupt the international trading system are seriously overstated. China's grain demand will certainly increase, fed by rising incomes, and rising population. However, China has productive resources to produce a substantial share of its food needs, and it has a strong enough economy to purchase the food imports it needs on the world market. So, even though China's grain imports will increase threefold over the next 30 years, China will not "starve the world."

What Must be Done?

Even if it is physically and technically possible to feed 8.5 billion people by 2025, there is no reason for complacency. The public and private sector's response to this challenge is vital. Even though global supplies will be adequate, they are not likely to be distributed among nations and regions in proportion to demand. Improving global food security depends on increasing yields through scientific research and agricultural extension; reforming policies that penalize farmers;

and operating an open trade system which allows food supplies to be distributed to food deficit countries.

Agricultural Research and Extension

Perhaps the greatest impediment to increasing agricultural production in the coming decades are calls by some activists to reverse the contribution of science and technology to agriculture. Admittedly, some agricultural practices are detrimental to the environment and, in the long term, detrimental to agriculture itself. Some have contributed to soil erosion, and to excessive chemical run-off into streams and waterways. These practices must be reformed. However, the future challenges facing agriculture can only be met by improving the scientific and technological base of production.

The Role of Research. Mankind has been manipulating agriculture since Neolithic times to ensure its survival. Many new technologies are simply more efficient extensions of the age-old techniques of plant and animal breeding. The goal of all agronomic research is to improve yields, enhance hardiness, increase tolerance, shorten maturation time, and strengthen pest and disease resistance. In recent years, another goal of agronomic research has been to improve the environment by reducing the need for some kinds of pesticides, herbicides, fungicides and fertilizers. Technology can also improve the environment by promoting crop rotations that replenish the soil, and by increasing the efficiency and uptake of soil nutrients, thereby preventing chemical run-off.

While the role of modern science and technology in agriculture is often criticized, the role they play in preventing malnutrition and disease is often forgotten in countries with adequate food supplies. Certainly, the general increase in food supplies over the past 30 years has improved nutrition and avoided starvation in many countries. The incidence of starvation in countries such as Bangladesh and India has declined markedly in recent decades as a result of improved rice varieties. (According to IFPRI, reverting to the old varieties would result in 400 million undernourished people in India alone.) The improved availability of fruits and vegetables also reduces the incidence of such diseases as scurvy and vitamin A deficiency blindness.

Equally important, by increasing yields, improved plant varieties and modern agriculture have reduced the amount of land required for food production. Currently, about 15.5 million square kilometers is devoted to agricultural production worldwide—the same amount of land that was in production in 1960. Without the introduction of high-yielding varieties of rice, maize and wheat, and the improvement in yields from fertilizers, crop protection chemicals and irrigation, the world would require 41.4 million square kilometers to produce the same amount of food. In other words, modern agriculture has saved 25.9 million square kilometers of land

from reduced soil erosion and deforestation, and has made it available for wildlife habitats, biodiversity and carbon sinks.

Sometimes technology points to less technical solutions. The use of conservation tillage in the United States, Canada, Western Europe, Australia, Brazil and Argentina, and even for rice in Indonesia, has dramatically cut soil erosion by 50 to 90 percent (and, ironically, has increased yields of some crops because it allows for denser plantings). Sometimes, the solution lies in more technology. Global Positioning Satellite Systems will allow modern farmers to adjust fertilizer applications by the square meter to adapt to their soil's particular needs. Electronic sensors and enhanced information processing can also improve the productivity of animal agriculture.

Governments have an important role to play in the public's acceptance of scientific advances in agriculture. If new technologies are to be adopted, they must be accepted by consumers and farmers. Governments can allay public concerns by establishing irreproachable approval processes for new technologies that are based on sound science, and by supporting the fruits of scientific research.

Governments also have a role to play in funding agricultural research. In many countries, public sector funding for research has been declining for many years due to budget pressures. These pressures have not subsided. This is tragic. Countless studies have shown that the economic returns to agricultural research are estimated to be at least 30 percent, and for some crops, up to 200 percent. Most studies indicate that the single most important variable affecting supply-demand projections is not the level of demand growth, income growth or population growth, but the level of public and private investment in research.

IFPRI suggests that reduced investment in agricultural research would cut cereal production by 6 percent overall, and by 10 percent in developing countries. Instead of continuing their long term downward trend, commodity prices would rise, sometimes quite substantially. The number of malnourished children would increase by 50 million. On the other hand, if funding of national and international agricultural research grows by $750 million annually, cereal production would increase by 95 MMT. The number of malnourished children would decline from 184 million to 109 million. The greatest beneficiaries would be the countries in Asia, Latin America, and North Africa.

If global food security is to be improved, the level of public sector agricultural research funding must be restored and increased. Priorities for research include increasing yields of rice, wheat, maize and oilseeds, but also of staple crops such as cassava, millet, sorghum, and pulses; improving farm management practices; and improving natural resource management. Additional priorities include the development of varieties that are salt and drought tolerant and that are more responsive to fertilizers. Improving the efficiency of livestock feeding and irrigation would

also go a long way toward increasing available food supplies. Biotechnology will play a critical role in achieving higher yields, reducing the need for scarce inputs, and improving disease, insect and drought resistance.

However, not all research is, or should, be funded by the public sector. The private sector has invested tremendous resources in developing new seeds and new technologies for production agriculture. Often, private sector research is more responsive to the needs of farmers in the field, because of its commercial focus. The type and level of investment is responsive to a number of factors controlled by government. For example, lack of intellectual property protection reduces the incentives for private companies to develop new plant varieties or new technologies if they have no assurance that their property rights (patents, plant variety rights, etc.) will not be infringed. Proposals to provide free seeds and technology, or to otherwise deny private firms the ability to make a profit from their investment will also reduce the incentive to devote resources to research. Also, overly lengthy or complicated approval processes can stall innovation.

The Role of Extension. All the research in the world is useless if farmers do not know about it. As demonstrated earlier, their is substantial research already on the shelf that farmers have not yet adopted. In the past, extension was primarily a government and/or university function. Unfortunately, as with research, government funding for extension is also declining in many parts of the world.

Although it is not a direct substitute for government/university extension services, private companies are finding it profitable to conduct extension as a means to promote new seeds, technologies and equipment. Many companies have well-trained sales and technical support personnel conducting farmer training, creating demonstration plots, and providing technical assistance. Many times, corporate technical staff work closely with local government extension workers and agronomists. In many countries, where funds for extension are not available, corporate technical support may be the only extension service available to farmers.

Educating farmers about new methods and technologies is the only way for yield increases to get from the demonstration farm to the field. Governments should work in tandem with companies, as well as with universities and farmers themselves, to improve extension and education services.

Domestic Agricultural Policy Reform

Most developing country economies depend on agriculture for the bulk of their income and employment. Therefore, the base of economic development must, in most cases, spring from agricultural development. Farmers in developing countries need appropriate incentives if they

are to adopt new farming methods, and to grow food profitably. Policies that artificially raise the price of critical inputs (such as fertilizer) and artificially lower the prices of farmers' commodities, must be reformed. Policies that artificially lower the price of water should also be reformed, to ensure efficient use of limited water supplies.

In tandem with improving incentives for farmers, developing countries need to enhance rural employment opportunities. Since the root of hunger and malnutrition is poverty, improving rural employment is the first and best way to improve individual food security. Reversing the urban bias in public investment and infrastructure is critical to this effort. Removing barriers to private (indigenous and foreign) investment is also important. Rural jobs are needed to absorb labor that is released from farms, and also to provide income for families to purchase food. (A side benefit from increased public and private investment in the food sector will be reduced losses from pre- and post-harvest waste.)

It is not only developing countries that need to undertake policy reforms. The Uruguay Round Agreement, and the direction it sets for domestic agricultural policy reforms in developed countries, should improve global food security on several levels. Artificial barriers to trade and export subsidies maintained by many developed countries have depressed world prices, and robbed farmers in developing countries of the incentives they need to produce. Other policies, such as export taxes, have raised world prices, imposing a burden on food importers. When supplemented by supply control policies, border protection can also lead to reduced production and, in some years, this combination has exacerbated production shortfalls.

The Uruguay Round Agreement should begin to reverse the worst impacts of these policies. By improving market access and forcing reforms in domestic policies, the Agreement should improve global price stability in many commodities. Second, by phasing down export subsidies, the Agreement will limit the surplus commodities that countries can dump on world markets. This should result in stronger world prices for food exporters, and for farmers around the world.

Prohibitions to farming environmentally sustainable land should be lifted. In the past, US land set-asides have encouraged environmentally fragile land into production in other countries. The new US farm bill, by bringing good land back into production, is a step in the right direction. To the extent that such prohibitions are components of supply control policies to maintain (artificially high) commodity prices, farm income should be supported by direct policy measures as authorized under the Green Box of the Uruguay Round Agreement.

Food security often comes down to individual consumers' access to income and the price of food. The temptation among many governments is to attempt to control the price of food and to insulate consumers from world market price fluctuations. Governmental efforts to insulate consumers from food price fluctuations (as was done in the Soviet Union) ultimately backfire as

consumers hoard products and do not respond to higher prices by shifting consumption to commodities that are in adequate supply. Ultimately, such policies exacerbate food shortages. This does not mean that some assistance to consumers is not warranted or desirable. Food vouchers (such as food stamps) and "food for work" programs are useful instruments to combat hunger borne of inadequate incomes. Unfortunately, many of the policies and programs that can help low income consumers are expensive and difficult to manage.

An Open World Trading System

It is clearly each nation's responsibility to satisfy its citizens' food needs, but this does not necessarily imply that all countries can or should strive to produce all their food at home. All countries, developed and developing alike, must strive to improve their agricultural productivity and make effective use of their natural resources. Nevertheless, because global resources are not evenly distributed, not every country will be able to produce enough food and feedstuffs to satisfy its demand.

Thus, an open and free world trade system is a critical component of improving global food security. It allows countries in one region to offset supply shortfalls with plentiful supplies from other regions. It lowers total costs to consumers, and allocates production to where it can be done most efficiently, and in an environmentally sound manner.

But, freer trade in agriculture alone is not sufficient. For some (particularly land scarce) countries, food security would be better assured if they exported manufactured goods or services and used the proceeds to purchase food that would be relatively more expensive to grow domestically. This means, of course, that developed countries must be willing to import these products. All too often, developed countries impose restrictions on the imports of developing country products (for example, textiles and footwear) compromising the ability of developing countries to earn sufficient foreign exchange to import food.

In the future, the international community needs to build on the successes of the World Trade Organization and the Uruguay Round to insure that the developing countries become fuller participants in the global trading system, and that developed countries open their markets to developing countries' goods and services.

Many countries are reluctant to adopt an open trading regime for fear of exacerbating rural depopulation. It is feared that allowing food imports will displace farmers, who will migrate to urban areas, resulting in unacceptable social and political upheaval. Such concerns are understandable, and they must be addressed. However, it is often developing countries' agricultural and investment policies—and not their trade regimes—that are contributing to rural

depopulation and rapid urbanization. Instead of promoting agricultural development, many developing countries penalize it.

As countries open their borders to trade, they must also implement policies that reverse any urban bias. They must bring much needed infrastructure and investment to rural areas and discontinue policies that disadvantage their domestic farmers. This will not only improve the rural economy, but will help attract investment to rural areas and promote the development of off-farm employment that can absorb labor as it is released from agriculture.

Assured Access. In order to counter political demands for self-sufficiency, food exporting countries must also take responsibility to ensure that supplies to the commercial market are not threatened by supply controls, embargoes, trade suspensions and export taxes. Food exporters must provide food deficit countries with assured access to supplies. Equal treatment for domestic and international customers must be a fundamental principal of world food trade.

Food Aid. Moreover, the world's food exporters should take steps to ensure that food aid commitments are not compromised in times of high prices and short supplies. Food aid should not decline when there are food shortages, as is so often the case. In the future, food aid commitments could be made in terms of foreign exchange which developing countries can use to purchase necessary food supplies on the world market. Facilities, such as the International Monetary Fund's Compensatory Financing Facility, should be enhanced to help developing countries deal with high commodity prices that may threaten their ability to purchase sufficient quantities of food. Instead of holding expensive grain stocks as insurance against national crop failures, countries would be better off "storing" foreign exchange reserves.

Infrastructure. Currently, about 10 percent of world food production enters international trade. Most scenarios have the volume of trade (if not the share of grain traded on world markets) doubling by 2010, and doubling again by 2025. Unfortunately, many countries are physically unable to handle current food import or export volumes. Thus, trade and domestic policy reforms must be accompanied by physical investments. If the volume of trade must double by 2010, many food importing countries (and some food exporting countries) will need improved infrastructure to handle the imports and exports. In this way, public and private, domestic and international investments in ports, roads and railroads can contribute to a country's food security. Developing rural-urban transportation links is also critical as societies become more urbanized. Intra-regional transportation links within large countries, and between countries, can also improve food security in places like China and sub-Saharan Africa.

African Focus

While much of the media attention is focused on the challenges presented by China, the region with the most pressing food problems is sub-Saharan Africa. Africa's climate is very harsh. Desertification deprives farmers of badly needed land. Rainfall is highly variable in much of the region. African soils—the world's oldest exposed land—are very low in natural nutrients. Per capita water availability is expected to fall 82 percent in Kenya by the year 2050, to 6 percent of the level predicted in China. There is inadequate public investment in agricultural research, infrastructure and training. The lack of all-weather roads leaves many people without access to markets during extended rainy seasons.

While not dismissing the needs of other regions, the sheer size of the projections of malnourished people in Africa should encourage national and international efforts aimed at improving productivity in Africa. Particular focus should be placed on crops such as sorghum, millet, and maize, and on technologies and techniques that are transferable to the land and water conditions faced by African farmers.

Conclusions

It appears that the world can produce sufficient quantities of food to feed an additional 5 billion people by 2050, but not without considerable investment in the agricultural sector. It is also clear that even with adequate global food supplies, such supplies will not be evenly distributed across countries and regions. Finally, it is equally clear that there are no "magic bullets." Small, incremental advances across a number of factors (land area, water efficiency, fertilizer efficiency, yield increases, pre- and post-harvest waste) are needed to enhance global and national food security.

There is a strong role for public policy in making these improvements reality. In particular, governments should renew their commitments to agricultural research and investment, and they should put in place policies that encourage economically and environmentally sustainable production. Governments should vigorously defend these policies against irresponsible assaults on agriculture and agricultural technology. Developing countries should strive to reverse the urban bias that has come to dominate public policies and investments in so many countries. Developed countries should continue to reform their policies as outlined in the Uruguay Round Agreement. Lastly, all countries should maintain an open global trade environment that allows for the best distribution of global resources.

Bibliography

Agra Europe, *EU Set-aside Area Put at 6.4m ha in 1995/96*, 1996.

Alexandratos, Nikos., *China's Projected Cereals Deficits in a World Context*, Forthcoming in Agricultural Economies.

Avery, Dennis T., *Can a More Populous World Afford to Eat Well?*, Hudson Institute, Speech to Monsanto International Business Conference, 1995.

Avery, Dennis T., *Farming to Sustain the Environment*, Hudson Institute, Briefing Paper, 1996.

Avery, Dennis T., *Higher Yield Agriculture is an Environmental Necessity*, Feedstuffs, 1996.

Blumenthal, Gary., *Growth Perspectives in the Meat Sector*, World Perspectives, Inc., 1996.

Brookins, Carol L., *Agricultural Trade Policy*, World Perspectives, Inc., 1996

Brookins, Carol L., and Blumenthal, Gary, *Agricultural Trade Policy and Politics*, World Perspectives, Inc., 1996.

Brookins, Carol L., *Food Scare: Fact or Fiction?*, World Perspectives, Inc., 1996.

Brookins, Carol L., *Outlook for China's Meat Production*, World Perspectives, Inc., 1996.

Brookins, Carol L., *World Food Summit*, World Perspectives, Inc., 1996.

China: Can Asia and the World Feed the Hungry Giant?, Oil World, No. 49, Vol. 38, 1995.

Daily, Gretchen, *Foreclosing the Future*, People & the Planet, Volume 4, No. 4, 1995.

de Vries, Penning, F.W.T. and van Keulen, H., Rabbinge, R. and Luyten, *Biophysical Limits to Global Food Production*, International Food Policy Research Institute, Washington, DC, 1995.

d'Olne, A.E., *Agricultural Technology and Food Security*, comments on *Attaining Global Food Security by 2025*, 1996.

Dyson, Tim, *Be Wary of Gloom*, People & the Planet, Volume 4, No. 4, 1995.

Feeding China: Today and Into the 21st Century, The Center for International Affairs, Harvard University, a conference held in Cambridge, Mass., 1996.

Feeding 10 Billion People in 2050, a Report by the Action Group on Food Security, 1994.

Food Security Assessment, Food and Agriculture Organization of the United Nations, WFS 96/TECH/7, Provisional Version, 1996.

Hall, David, *Energy and Food for All*, People & the Planet, Volume 4, No. 4, 1995.

McCalla, Alex F., *Agriculture and Food Needs to 2025: Why We Should Be Concerned*, Consultative Group on International Agricultural Research, Sir John Crawford Memorial Lecture, International Centers Week, Washington, DC, 1994.

Mielke, Siegfried, *China: Can Asia & the World Feed the Hungry Giant?*, Oil World No.

49, Volume 38, 1995.
Mitchell and Ingro, *The World Food Outlook*, Draft Paper, International Economics Department, World Bank, 1993.
Oerke, E.C. and Dehne, H.W. and Schonbeck, F. and Weber, A, *Crop Production and Crop Protection: Estimated Losses in Major Food and Cash Crops*, Elsevir, New York, 1994.
Pinstrup-Anderson, Per and Garrett, James L., *Rising Food Prices and Falling Grain Stocks: Short-Run Blips or New Trends?,* 2020 Brief 30, International Food Policy Research Institute, 1996.
Plumb, Henry, *Food Security: A Problem of Policy, Not Supply*, 1988.
Rosegrant, Mark and Agcaoili, Mercedita, *Global and Regional Food Demand, Supply and Trade Prospects to 2010*, International Food Policy Research Institute, 1994.
Rosegrant, Mark and Agcaoili-Sombilla, Mercedita, and Perez, Nicostrato D., *Global Food Projections to 2020: Implications for Investment*, Food, Agriculture, and the Environment Discussion Paper 5, International Food Policy Research Institute, 1995.
Rozelle, Scott, Huang, Jikun and Rosengrant, Mark, *Why China Will Not Starve the World*, Choices Magazine, First Quarter, 1996.
Sanderson, Fred, *World Food Prospects to the Year 2000*, Butterworth & Co., 1984.
Siamwalla, Ammar and Valdes, Alberto, *Food Insecurity in Developing Countries*, International Food Policy Research Institute, Reprinted from Food Policy, Vol. 5, No. 4, 1980.
Smil, Vaclav, *How Many People Can the Earth Feed?*, Population and Development Review, Volume 20, Number 2, 1994.
Thompson, Robert, "The Role of Trade in Food Security and Agricultural Development," *The Role of Markets and the World Food Economy*, ed. Johnson, D. Gale and G. E. Schuh, Westview Press, Boulder, CO, 1983.
USDA and Agriculture Canada, *Food Security Situations and Issues - A North American Perspective*, 1996.
USDA Economic Research Service, *Food Aid Needs and Availabilities Projections for 2005*, GFA-6, 1995.
Yudelman, Montague, *Feeding 10 Billion People in 2050*, a report by the Action Group on Food Security, 1994.
World Food Summit, Basic Information, Food and Agriculture Organization of the United Nations, No. 4, 1995.
World Food Summit, Draft of a Policy Statement and Plan of Action, Food and Agriculture Organization of the United Nations, 1995.

International Policy Council Members (1996)

Lord Plumb of Coleshill
Chairman, International Policy Council
Member and Former President of European Parliament (United Kingdom)

Allen Andreas
Counsel to the Executive Committee of the Board of Directors and Vice President, Archer Daniels Midland Company (United States)

Bernard Auxenfans
Group Vice President and General Manager, International Division, Monsanto - Crop Protection Business (France)

Brian Chamberlin
Former Agriculture Counselor, New Zealand High Commission in London and Special Agricultural Trade Envoy. President, Euroa Farms Limited (New Zealand)

Kyung-Shik Cho
Former Minister of Agriculture, Forestry and Fisheries. Chairman, Information Centre for Agriculture, Forestry and Fisheries (Korea)

Csába Csáki
Senior Agricultural Advisor, Europe and Central Division, Agricultural Industry and Finance, The World Bank, and Professor, Budapest University of Economic Sciences (Hungary)

Pedro de Camargo Neto
Vice President and Former President, Sociedade Rural Brasileira (Brazil)

Aart de Zeeuw
Former Chairman, Agricultural Negotiations Committee, GATT
(The Netherlands)

Glenn Flaten
Past President, International Federation of Agricultural Producers. Manager, Flaten Associates, International (Canada)

Sir Michael Franklin
Former Permanent Secretary, Ministry of Agriculture, Fisheries and Food. Member of the Board of Directors, Whessoe PLC and Whitbread & Co. (United Kingdom)

Dale Hathaway
Former Undersecretary for International Affairs and Commodity Programs, USDA. Executive Director, National Center for Food and Agricultural Policy (United States)

Wilhelm Henrichsmeyer
Professor and Director, Institute for Economics and Agricultural Policy, University of Bonn (Germany)

Alexandre Ivashchenko (Observer)
Professor, Academy of Foreign Trade of Russia and Provimi/Central Soya (Russia)

Rob Johnson
Corporate Vice President, Public Affairs, Cargill, Inc., and member of the Council on Foreign Relations and the Agricultural Policy Advisory Committee (United States)

Dean Kleckner
President, American Farm Bureau Federation (United States)

Kazuya Kodama
President, Tokyo Grain Market Research, Inc., and Chairman, Futures Industry Association-Tokyo Chapter (Japan)

Weimin Li (Observer)
Section Chief, Institute of Agricultural Economics, Chinese Academy of Agricultural Sciences (CAAS) (China)

Georges-Pierre Malpel
Director General, Unigrains (France)

Liberty Mhlanga
General Manager and Director, Agricultural and Rural Development Authority (Zimbabwe)

Bill Miner
Former Assistant Deputy Minister, Department of Agriculture. Senior Research Associate, Centre for Trade Policy and Law (Canada)

Rolf Moëhler

Former Deputy Director General, European Commission, DG VI (Germany)

Antonio Navarro
Former Member, European Parliament and Coordinator of Agriculture Committee of the European Democratic Group (Spain)

Joachim Rathke
Group Managing Director, N.V. Vandemoortele International, Belgium (Germany)

Alberto Santos de Hoyos
Senator from Nuevo León State and Chairman of Empresas Santos (Mexico)

Michael Shanahan
Former Deputy Chairman, Australian Wheat Board. Chairman of Directors, Pivot Fertilizers (Australia)

Jiro Shiwaku
President, Livestock Industry Promotion Council (Japan)

David Swanson
President and CEO, Countrymark, Inc. (United States)

Rob Tazelaar
Chairman and President, Product Boards for Livestock, Meat and Eggs. Former Member, Parliament and European Commission, DG VI (The Netherlands)

Bob Thompson
President and CEO, Winrock International Institute for Agricultural Development (United States)

Tom Urban
Chairman and Chief Executive Officer, Pioneer Hi-Bred International. Inc. (United States)

Ann Veneman
Secretary of the California Department of Agriculture. Former Deputy Secretary of the US Department of Agriculture (USDA) and Deputy Under Secretary of Agriculture for International Affairs and Commodity Programs (United States)

Claude Villain
Inspector General, Ministry of Finance (France)

S.M. Wahi
Vice President, National Institute of Agriculture (India)

Anthony Wylie
Director General, Fundación Chile (Chile)

Jorge Zorreguieta
Former Secretary of Agriculture. President, Argentine Sugar Producers Council (Argentina)

The Mission of the International Policy Council on Agriculture, Food and Trade

The International Policy Council on Agriculture, Food and Trade (IPC) is dedicated to developing and advocating policies that support an efficient and open global food and agricultural system—one that promotes the production and distribution of food supplies adequate to meet the needs of the world's growing population, while supporting sound environmental standards.

◊ ◊ ◊

Founded in 1987, the IPC is an independent group of leaders in food and agriculture from 20 developed and developing countries, including formerly centrally planned countries. Members are chosen to ensure the Council's credible and impartial approach, and include influential leaders with extensive experience in farming, agribusiness, government and academia. The IPC meets twice annually to develop policy recommendations to address the critical issues facing the world's agricultural system. It then conveys its recommendations directly to policymakers through its personal contacts and through a variety of papers and studies. The IPC also convenes task forces and holds conferences and seminars.