A VISION OF THE FUTURE WORLD FOOD PRODUCTION AND IMPLICATIONS FOR THE ENVIRONMENT AND GRASSLANDS[1]

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ABSTRACT

Increases in world population, projected to rise to 8 billion by 2020, and the resultant demand for food places great pressure on our agricultural and aquacultural resources. Anxiety about the future is exacerbated by decreasing grain stocks. Production increases of many commodities are projected to be between 1 and 2% per annum and will generally be higher in developing than in developed countries. Cultivatable land area will increase in some areas of the world but not in others. To cope with these challenges, yield increases will be essential and the application of existing knowledge and technologies will not suffice. Accelerated investment in agricultural research will be essential. This research must consider sustainability of production systems, the environmental consequences and, in particular, appropriate technology in less favoured agroecological zones, much of it related to grasslands. Significant public investment in research will still be necessary. Biotechnology should be given a high priority. Land degradation and continuing deforestation will have to be avoided. Increasing and correct use of inorganic fertilizers and greater efficiency in utilization of water resources will also be necessary. Open marketing systems and confusion over the role of governments in this issue must be avoided in future. Providing the appropriate level of aid to developing countries is another challenge. Matching food production with human food requirements will be met provided national and international leaders commit themselves to specific changes in behavior, priorities and policies.

KEYWORDS

Food production, population, technology, sustainability, political choices, research

INTRODUCTION

About 90 million people are likely to be added to the world's population every year over the next 25 years. This is the largest annual population increase in history. By 2020, the world population will have increased by about 40 percent to a total of nearly 8 billion. About 94 percent of the population increase is expected to occur in developing countries, most of it in the cities. Rapid urbanization could more than double the urban population in developing countries to 3.6 billion by 2020, by which time urban dwellers will outnumber rural dwellers. Meeting the increasing and changing food needs resulting from population growth, rising incomes, and changing lifestyles will be a fundamental challenge for the world's farmers.

Developing countries are projected to increase their cereal demand by about 80 percent between 1990 and 2020, while the world as a whole will increase its cereal demand by about 55 percent (Figure 1). Meat demand in developing countries will increase by a staggering 160 percent, and world meat demand will increase about 75 percent. The percent increase in demand for roots and tubers will be slightly lower than that for cereals. These large increases will put tremendous pressures on future agricultural production and marketing and, unless current policies are changed, on the environment.

The projected increase in the demand for cereals, meat, and roots and tubers varies significantly among developing-country regions (Figure 2). Sub-Saharan Africa is projected to increase its demand for these three commodity groups by at least 150 percent. Of note is the very rapid increase in meat demand in Asia.

So, how much of the demand is likely to be fulfilled through developing-country production? In the early 1990s, developing countries had net cereal imports - the difference between consumption and production - of around 90 million tons. We project that these will increase to about 190 million tons by 2020. Because Sub-Saharan Africa is expected to continue its poor production performance relative to population growth, its net import requirements for cereals are projected to triple during this period.

The composition of these additional imports is shown in Figure 3. IFPRI research suggests that the net cereal import requirements of developing countries in 2020 will consist primarily of wheat and maize. There will also be a very large increase in net imports of meat in response to more rapid economic growth in developing countries, especially Asia.

Assuming that our projected production and import requirements are correct, per capita food availability will increase in all regions, but the increase will be very small in Sub-Saharan Africa (Figure 4). By 2020, average daily calorie consumption per person in Sub-Saharan Africa will still be only about 2,100 as compared to 3,000 calories in Asia and 3,500 calories in the developed countries. The largest improvement is likely to occur in Asia, and there is - unfortunately - strong evidence to suggest that some of this improvement will result in increasing obesity and related health problems in that part of the world.

With assistance from the International Center for Living Aquatic Resources Management (ICLARM) and the Food and Agriculture Organization of the United Nations (FAO), we have come to the conclusion that the recent and current overexploitation of marine fisheries is such that it is unlikely that there will be an increase in the catch from marine fisheries between now and 2020. The global per capita fish catch has remained unchanged for quite a few years and now appears to be falling. In fact, a great deal will have to be done to maintain the current output as almost 60 percent of the world's main fish stocks are fully exploited, overexploited, or depleted. The problem is primarily one of virtually free access to fish stocks and rapid increases in technology. Expanded investments in and increases in the productivity of aquaculture are urgently needed along with international arrangements to avoid continued overexploitation of marine fisheries.

Notwithstanding the rapid increases in maize and wheat prices during 1995 and the first half of 1996, we believe that the long-term trends for real food prices will continue to fall. As Figure 5 shows, prices for wheat, rice, maize, beef, and roots and tubers are projected to fall significantly in real terms between now and 2020.

World grain stocks have decreased markedly during the last 10 years (Figure 6) although they have recuperated slightly from a low of about 13 percent of annual world consumption in mid-1996. Rapidly falling cereal prices during the 1980s and early 1990s have contributed to the falling stock levels. Changes in the European Common Agricultural Policy and the GATT agreement have also contributed to lower stocks, and world grain stocks will be considerably lower in the future than they have been in the past. This is likely to be reflected in the availability of food aid, which is

currently about one-half of the level it was four years ago. Lower future grain stocks may imply larger price fluctuations in the future, because the buffer available in periods of bad weather and production shortfalls in general will be smaller.

FUTURE FOOD PRODUCTION

While the world is far from approaching the biophysical limits to food production, there are indications that growth in food production has begun to lag. For instance, food production increases did not keep pace with population growth during the 1980s and early 1990s in 49 developing countries with a population of one million or more (FAO, 1995). The annual rate of growth of global grain production also dropped from 3 percent in the 1970s to 0.7 percent during 1985–95. In addition, yields of rice and wheat have been constant for the last few years in Asia, which is a major producer (Pinstrup-Andersen, 1994).

World cereal production is projected to grow on average by 1.5 percent per year between 1990 and 2020, meat production by 1.9 percent, and production of roots and tubers by 1.4 percent (Rosegrant et al., 1995). Production growth rates are expected to be substantially higher in developing countries than developed countries. Cereal production is projected to grow at an average annual rate of 1.9 percent in developing countries (compared to 1.0 percent in developed countries), meat production at 2.9 percent (compared to 0.9 percent in developed countries), and production of roots and tubers at 1.7 percent (compared to 0.8 percent in developed countries). Aquaculture production, which doubled between 1984 and 1992, is projected to increase at a slower rate between 1990 and 2020, and marine fish catches are likely to be no higher than current levels in 2020 (Williams, 1996).

Existing technology and knowledge will not permit production of all the food needed in 2020 and beyond. Yield increases will have to be the source of most of the food and feed production increases as cultivated area is likely to decline in many developed countries and only marginally increase in developing countries, except in Sub-Saharan Africa and Latin America where some significant expansion of area is still possible. Similarly, as pressures on grasslands mount, increasing feed efficiency must be sought.

THE IMPORTANCE OF RESEARCH

Some of the yield and efficiency increases will occur as more inputs are used and as production methods are improved. However, accelerated investment in agricultural research is essential to achieve the required productivity increases. Low-income developing countries are grossly under-investing in agricultural research compared with industrialized countries, even though agriculture accounts for a much larger share of their employment and incomes. Their public sector expenditures on agricultural research are typically less than 0.5 percent of the value of agricultural production, compared with about 1 percent in higher-income developing countries and 2–5 percent in industrialized countries. Growth in public sector expenditures on agricultural research in developing countries has slowed to 2.7 percent per year in the past decade, compared with 7.0 percent in the 1960s (Pardey et al., 1991). Many developing countries are now reducing their support for agricultural research. In Africa, agricultural research expenditures per scientist have fallen by about 2.6 percent per year since 1961 (Pardey et al., 1995).

Accelerated agricultural research aimed at more-favored areas will reduce pressures on fragile lands in less-favored areas. Future research for the former must pay much more attention to sustainability than in the past to avoid a continuation of extensive waterlogging, salination, and other forms of land degradation. However, a continuation of past priority on more-favored agroecological zones is inappropriate and insufficient to achieve the goals of poverty alleviation, improved food security, and appropriate management of natural resources. The relative allocation of research resources to more-favored areas and areas with agricultural potential, fragile lands, poor rainfall, and high risks of environmental degradation (less-favored) must be changed in favor of the latter. A large share of the poor and food insecure reside in agroecological zones with high risks of environmental degradation. In low-income developing countries, poverty, rapid population growth, low agricultural productivity, and poorly-defined ownership and user rights to natural resources are the major causes of land degradation, deforestation, and inappropriate use of water. Attempts by households to meet basic needs for survival in the short run take priority over longer-run sustainability.

The low priority given to research to develop appropriate technology for less-favored agroecological zones in the past is a major reason for the current rapid degradation of natural resources, including grasslands, and high levels of population growth, poverty, and food insecurity. Much more research must be directed at the development of appropriate technology for these areas. Outmigration is not a feasible solution for these areas in the foreseeable future simply because of the large numbers of poor people who reside there and the lack of alternative opportunities elsewhere. Strengthening of agriculture and related nonagricultural rural enterprises is urgent and must receive high priority.

While privatization of agricultural research should be encouraged, much of the agricultural research needed to achieve food security, reduce poverty, and avoid environmental degradation in developing countries is of a public goods nature and will not be undertaken by the private sector. Fortunately, while private rates of return may be insufficient to justify private-sector investment, expected high social rates of returns justify public investment. The major share of such investment should occur in the developing countries' own research institutions (NARS); there is an urgent need to strengthen these institutions to expand research and increase the probability of high pay-offs.

The centers under the auspices of the CGIAR have a well-defined role to play in support of the work by NARS, namely to undertake research of a public goods nature with large international externalities and to strengthen the research capacity of the NARS. The CGIAR centers have recognized the importance and urgency of research to assure sustainability in agricultural intensification through appropriate management of natural resources. Thus, management of natural resources, germplasm conservation, and germplasm enhancement are given high priority in current and future research by the centers. Research institutions in the industrialized nations have played an extremely important role by undertaking basic research required to support strategic, adaptive, and applied research by the international centers and the NARS and by providing training for developing-country researchers. Collaboration among developed-country research institutions, CGIAR centers, and NARS in developing countries is widespread but further strengthening is required to fully utilize the comparative advantages of each of the three groups for the ultimate benefit of the poor in developing countries.

Biotechnology research in national and international research systems should be expanded to support sustainable intensification of agriculture in developing countries. Effective partnerships between developing-country research systems, international research

institutions, and private- and public-sector research institutions in industrialized countries should be forged to bring biotechnology to bear on the agricultural problems of developing countries. Incentives should be provided to the private sector to undertake biotechnology research focused on the problems of developing-country farmers.

IMPLICATIONS FOR NATURAL RESOURCES AND GRASSLANDS

Natural resources and agricultural inputs are critical determinants of food supply. Degradation of natural resources (such as soils, forests, marine fisheries, water) undermines production capacity, while availability of and access to agricultural inputs (such as water, fertilizer, pesticides, energy, research, and technology) determine productivity and thereby production.

Although information on the condition of the natural resource base is weak and incomplete, there are growing concerns about the extent, rate, and effects of degradation of natural resources such as soils, forests, marine fisheries, and water. Preliminary estimates suggest that since 1945, about 23 percent of the 8.7 thousand million hectares of agricultural land, permanent pastures, and forest and woodlands have been degraded (Oldeman, 1992). Of these degraded lands, about 750 million hectares could be restored through good land husbandry and 900 million hectares through significant on-farm investments, while 300 million hectares of severely degraded lands would require major engineering investments. Much of the degradation is taking place on agricultural lands: soil degradation has affected 74 percent of agricultural lands in Central America, 65 percent in Africa, 45 percent in South America, and 38 percent in Asia (Oldeman, 1992). Overgrazing, deforestation, and inappropriate agricultural practices account for most of the degradation. To a large extent, these result from, or are exacerbated by, inadequate property rights, poverty, population pressure, inappropriate government policies, lack of access to markets and credit, and inappropriate technology.

About 8 percent (154 million hectares) of the world's tropical forests were cut down during the 1980s (Alexandratos, 1995). Of these, about half were in Latin America and the Caribbean, a quarter in Africa, and another quarter in Asia and the Pacific. Rates of deforestation were most rapid in Southeast Asia and in Central America and Mexico, averaging about 1.5 percent a year.

Clearing of land for agriculture to meet food needs of small-scale, poor farmers accounted for roughly two-thirds of the forests cut down in the 1980s (Sharma, 1992). Such forest conversion, driven by food insecurity, is likely to continue, particularly in Africa, unless farmers have alternative ways of meeting food needs. And these food needs will accelerate with population growth.

Current and future 'hot spots' of severe environmental deterioration include (Scherr and Yadav, 1996):

- the river basins of the Indus, Tigris, and Euphrates in the Middle East (salinization);
- the foothills of the Himalayas (water erosion);
- the forest margins of the lower Amazon (overgrazing and nutrient loss);
- the periurban areas of Mexico City (pollution from agricultural chemicals);
- humid lowland areas of Africa (nutrient depletion, acidification, and erosion); and
- sub-humid, semi-arid border zone of West Africa (migration from dryland degradation.

Depletion of soil nutrients is a serious environmental problem and a critical constraint to food production in Sub-Saharan Africa. The use of inorganic fertilizers will have to be substantially increased to meet food needs, although organic sources can and should make a larger contribution to supply plant nutrients. While the negative environmental consequences of fertilizer use and production must be avoided, in low-income developing countries the problem is not excessive, but insufficient, fertilizer use. The major task is to promote a balanced and efficient use of plant nutrients from both organic and inorganic sources at farm and community levels to intensify agriculture in a sustainable manner.

There are several major water-related challenges. New sources of water are increasingly expensive to exploit because of high construction costs for dams and reservoirs and concerns about environmental effects and displacement of people. Efficiency of water use in agriculture, industry, and urban areas is generally low. There are mounting pressures to degrade land and water resources through waterlogging, salinization, and groundwater mining. Pollution of water from industrial effluents, poorly treated sewage, and runoff of agricultural chemicals is a growing problem. Unsafe water, compounded by inadequate or nonexistent sewage and sanitation services, is a major cause of disease and death, particularly among children, in developing countries. Inappropriate policies, distorted incentives, and massive subsidies provide water at little or no cost to rural and urban users, encouraging overuse and misuse of water. Water for irrigation, the largest use, is essentially unpriced. The overarching challenge is to treat water as the scarce resource it is.

Crop production losses from pests are significant; reduction of these losses would notably contribute to improving food supplies. However, past practices of pesticide use cannot be sustained. Concerns are multiplying that pesticides compromise human health; contaminate soils and water and damage ecosystems; exterminate species; and lead to pesticide resistance, pest resurgence, and evolution of secondary pests. Moreover, evidence shows that overuse of pesticides leads to decreased food production. Environmentally sound alternatives must be developed and adopted. Available pest control means must be combined to achieve effective pest control with little or no negative environmental effects or health risks.

MARKETS, TRADE, AND ASSISTANCE

The efficient functioning of markets, especially agricultural input and output markets, supported by governments that have the capacity to perform their role, is of critical importance. In recent years, many countries have embarked upon market reforms to move away from state-controlled, or parastatal, organizations toward reliance on private firms operating in free markets. While clearly desirable, such reforms must be undertaken with care, taking into account the organizational structure of the affected markets. In many cases, inefficient parastatals are being replaced by oligopolistic or monopolistic private firms, with little or no benefits to farmers or consumers. The ongoing and unprecedented transition from controlled to market economies and from patrimonial to open political systems has generated confusion about the appropriate role of government and weakened the capacity of governments to perform needed functions.

In many regions, especially Sub-Saharan Africa, food marketing costs are extremely high. Lowering these costs through investment in improved transportation infrastructure and marketing facilities (which

also increase competition) may be as important in lowering food prices to consumers as increasing agricultural productivity. Many countries have made considerable improvements in recent years, but investments in infrastructure, especially transport and communication, which are considered the leading elements, are far below needed levels.

The increasing integration of developing countries into the global economy through international trade will considerably benefit developing and developed countries through expanded markets, job creation, and income generation. Many developing countries have gained enormously from increased participation in world markets as world trade has become increasingly liberalized. However, for a few countries — especially the low-income, food-importing countries — global trade liberalization and policy reform in agricultural subsidy policies in developed countries is a mixed blessing. They gain from increased access to developed-country markets, but they are less able to compete in those markets than other, better situated, developing countries. And they lose from increased food prices that may occur in the medium term with cutbacks in agricultural subsidies in the developed countries.

Without increased domestic resource mobilization — savings and investment — developing countries will not be able to accelerate the investments in economic growth and human resources that underpin future food security. For the low-income countries, the vicious circle of poverty still exists_low income leads to low savings, low investment, low growth, continued poverty, and continued low savings. In Sub-Saharan Africa, the share of GDP devoted to investment has fallen in the past two decades from 20 to 16 percent, while the domestic savings rate has fallen from 18 to 15 percent. These rates are not high enough to significantly raise economic growth rates.

International assistance has a critical role to play in supporting developing countries as they implement the actions required to achieve food security and embark upon broad-based economic development. Private flows to developing countries have increased substantially since the late 1980s. Most of these flows, however, go to a small number of medium-income, semi-industrial countries in Latin America and Asia. Poorer countries, especially in Sub-Saharan Africa, are left out and depend much more on aid flows. However, official development assistance (ODA) to developing countries is slowing. Driven by cuts in foreign assistance in 17 countries, ODA from the OECD countries has dropped significantly since 1993. Assistance from non-OECD countries has dropped even more significantly; Arab OPEC countries provided 25 percent of world ODA in the early 1980s but contributed less than 2 percent in 1993. Assistance to developing-country agriculture declined in real terms from $12 billion to $10 billion during the 1980s. Given observed trends in aid availability, developing countries are challenged to devise strategies for accomplishing their goals with less aid.

CONCLUDING COMMENTS

This paper deals with production and environmental aspects of the future food situation. The most important aspect, however, is whether hunger and malnutrition can be eliminated and whether everybody will have access to enough food for a healthy and productive life. Our vision is of *a world where every person has access to sufficient food to sustain a healthy and productive life, where malnutrition is absent, and where food originates from efficient, effective, and low-cost food systems that are compatible with sustainable use of natural resources* (IFPRI, 1995). We believe this vision can be achieved by the year 2020 if national and international leaders commit themselves to specific changes in behavior, priorities, and policies. The action proposed in this paper form part of what is needed (see IFPRI, 1995 for a fuller description of the 2020 Vision action plan).

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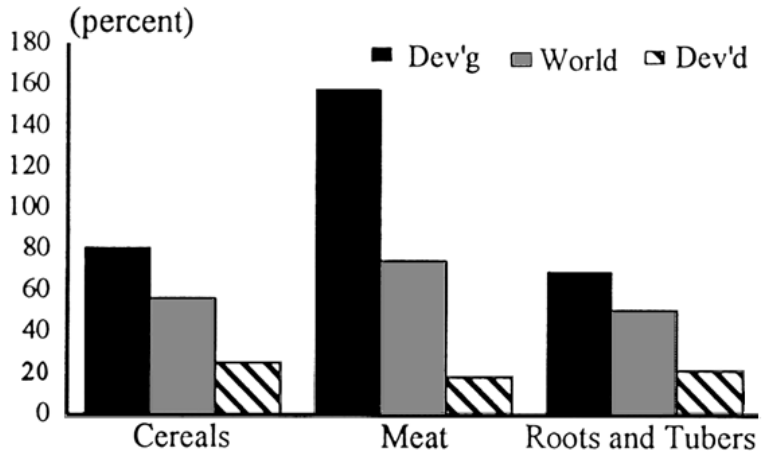
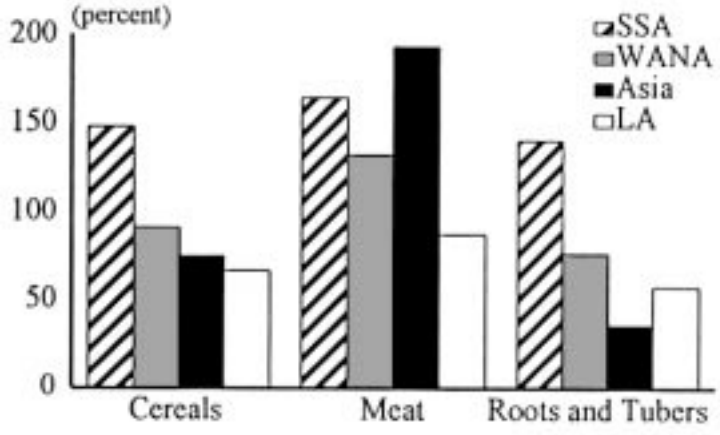
Figure 1
Percent increase in total demand, 1990-2020



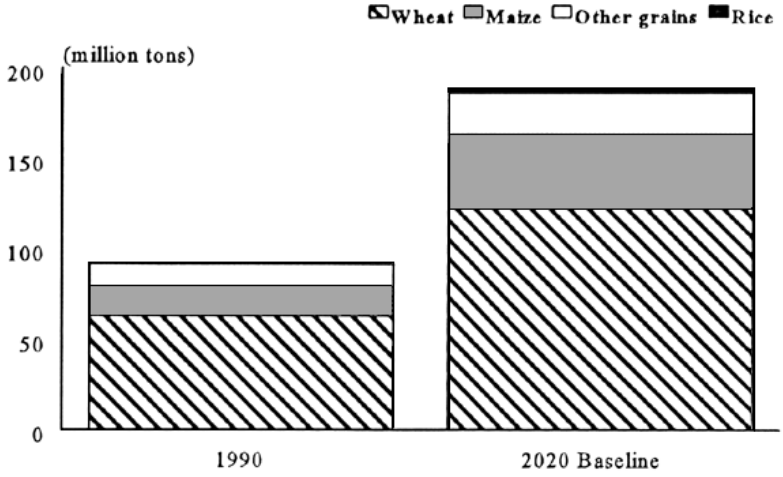
Source:Rosegrant, Agcaoili-Sombilla, and Perez (1995).

Figure 2
Percent increase in total demand in developing regions, 1990-2020



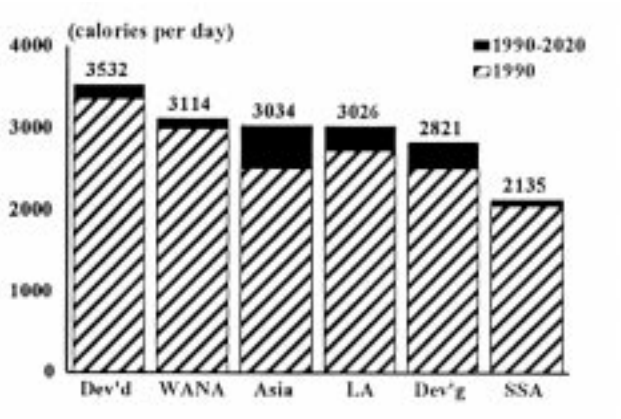
Source:Rosegrant, Agcaoili-Sombilla, and Perez (1995).

Figure 3
Composition of imports



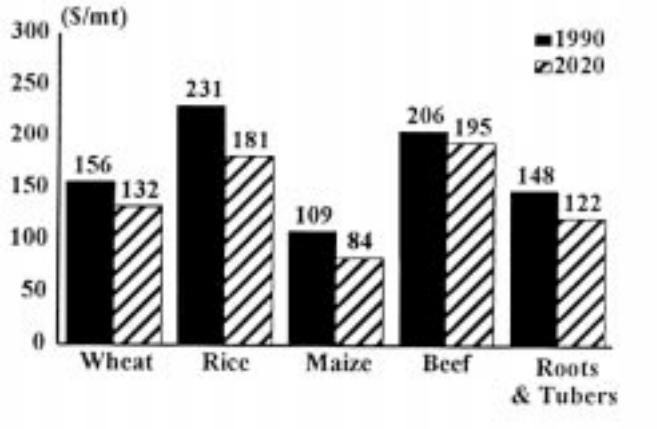
Source:Rosegrant, Agcaoili-Sombilla, and Perez (1995).

Figure 4
Per capita food availability, 1990 and 2020



Source: Rosegrant, Agcaoili-Sombilla, and Perez (1995).

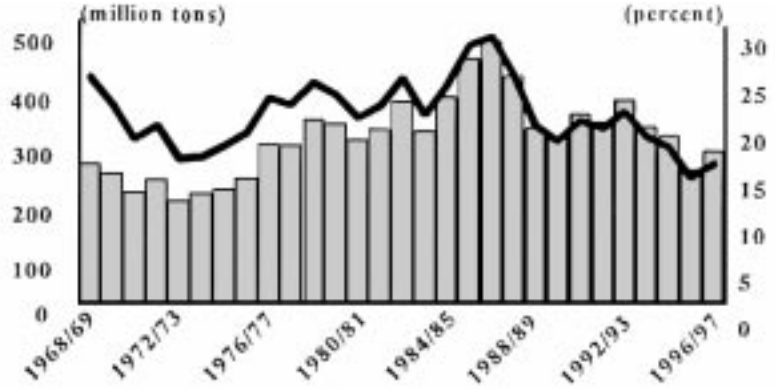
Figure 5
Projected world prices (in 1990 dollars)



Source: Rosegrant, Agcaoili-Sombilla, and Perez (1995).

Note: Beef prices are $/100 kilograms.

Figure 6
Global grain stocks: Level and percent of consumption, 1968/69–1996/97



Source: USDA (1996).