

CROP PRODUCTION CAPACITY: A GLOBAL PERSPECTIVE

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Summary

Two centuries after the publication of Malthus's *Essay on the Principle of Population*, the world's population has increased sixfold and continues to grow. Yet food production has more than kept pace in recent decades, increasing in per capita terms by 0.9 percent annually on a global scale, and even faster in China, India, and other populous developing countries.

Can these trends be maintained in an economically and environmentally sustainable fashion? World population growth rates are declining, but per capita incomes continue to increase, and the share of the world's population living in urban areas is expected to pass 50 percent by 2005. These trends will increase demand for food and other agricultural commodities, and thereby pressures on the earth's land, water, climate, and genetic resources.

Substantial increases in global crop production will be necessary to meet projected increases in demand in the coming decades, even though demand growth is slowing. Both demand and production are projected to grow at about 1.3 percent per year over the next few decades. Since population growth is projected to fall below 1.0 percent per year by 2015, these increases correspond to per-capita production increases of 0.2-0.3 percent per year. A small portion of the increased production will come from expansion of land area devoted to crop production.

The majority of production gains, however, will need to be achieved through improved crop yields derived in turn from increased use of other resources, such as irrigation water and fertilizer, and increased efficiency of resource use through improvements in knowledge and technology. Whether these improvements are achieved will depend critically on the choices made by farmers and policymakers. Recognition of the links between sustainable resource use, agricultural productivity, and food security will strengthen the important role that researchers can play in understanding these choices.

1. Introduction

Two centuries after the publication of Malthus's *Essay on the Principle of Population*, the world's population has increased sixfold and continues to grow. Yet food production has more than kept pace in recent decades, increasing in per capita terms by 0.9 percent annually on a global scale, and even faster in China, India, and other populous developing countries (figure 1).

Can these trends be maintained in an economically and environmentally sustainable fashion? World population growth rates are declining, but per capita incomes continue to increase, and the share of the world's population living in urban areas is expected to pass 50 percent by 2005. These trends will increase demand for food and other agricultural commodities, and thereby pressures on the earth's land, water, climate, and genetic resources.

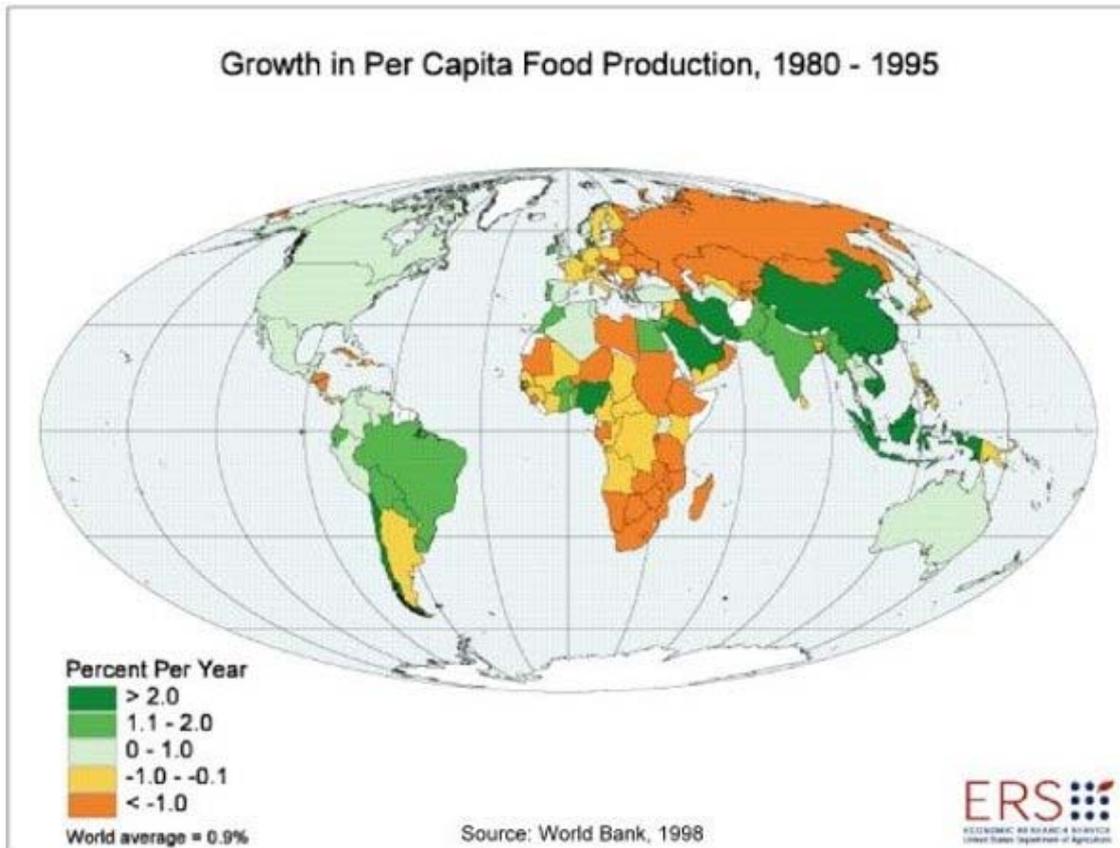


Figure 1. Growth in Per-Capita Food Production, 1980-1995

In contrast to a narrow Malthusian view, it is important to recognize that increased demand generates incentives to increase production. Increased demand puts pressure on commodity prices to rise, which gives farmers incentives to use productive resources in greater quantity or with greater efficiency. How increased production actually occurs, in terms of its impacts on the environment and on food security, will depend on the markets that mediate these incentives.

It is critical, therefore, to understand how markets themselves are shaped by policies and institutions, including those relating to the ownership, use, and exchange of resources used in agricultural production. Appropriate policies and institutions are necessary to shape incentives so that patterns of increased production and improved distribution address nutritional needs and environmental concerns in addition to satisfying market demands.

The general point to be made is that “crop production capacity” is not a fixed quantity but rather a flexible construct that is meaningful only in relation to pressures generated by changes in demand. In order to understand prospects for future growth in crop production, it is thus essential to begin with a review of prospects for changes in demand.

These issues are addressed in this article by reviewing the challenges posed by increasing demand for food crops and other agricultural commodities (section 2), the

status of the various resources used in meeting these challenges to date (sections 3 and 4), the prospects for increasing crop production in the future (section 5), and the critical role of institutions, policy, and research in achieving the necessary production growth (sections 6 and 7).

Information is drawn primarily from recent reports and statistical databases of the Food and Agriculture Organization (FAO) of the United Nations, the International Food Policy Research Institute (IFPRI), the United States Department of Agriculture (USDA), the World Bank, and the World Resources Institute (WRI).

2. Trends in Demand

Demand for agricultural commodities by a household, country, or any other group of people is determined by the number of people in the group of interest, their needs and preferences, and the opportunities and constraints they face in seeking to satisfy those needs and preferences. Global demand for agricultural commodities has grown rapidly over the past several decades as a result of growth in population, income levels, and other factors.

2.1. Population

The world's population nearly doubled over the past four decades, growing from 3.1 billion people in 1961 to 6.0 billion in 1999 (figure 2). This represents an average annual increase of 1.8 percent, or 76 million people. Most of this growth occurred in the developing countries of Africa, Asia, and Latin America.

Growth was particularly rapid in Africa, where population grew at an average annual rate of 2.7 percent over the period (to 767 million), and Latin America, which grew at 2.6 percent annually (to 511 million). Asia's population grew more slowly, at 2.0 percent per year, but totalled 3.6 billion in 1999.

Global population growth has slowed in recent years, from its peak of 2.1 percent annual growth in the late 1960s to 1.4 percent per year in 1998. Annual growth rates declined most sharply in the East Asia and Pacific region, from 2.7 percent in 1970 to 1.1 percent in 1998. Growth rates were lower to begin with in high-income countries, and declined from 1.0 percent to 0.6 percent per year over the same period.

Growth rates remain highest today (above 2.0 percent) in Africa and the Middle East. Declining population growth rates result from a combination of factors, including changes in income, education, health, and employment patterns -- particularly those of women.

Many of these factors reflect positive developments in living conditions and opportunities, but some, such as AIDS, impose severe burdens on households and societies already functioning at the margins of subsistence.

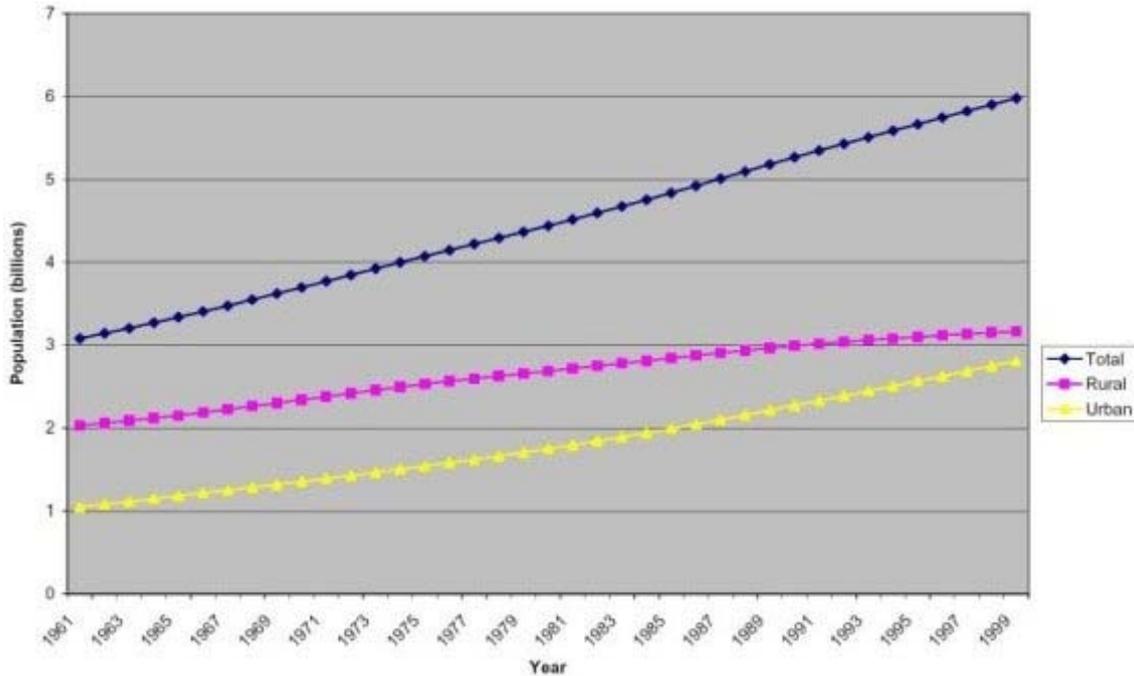


Figure 2. World Population, 1961-1999

World population growth is projected to continue slowing in the coming decades, from about 1.3 percent per year at present to 1.0 percent per year by 2015 and 0.7 percent per year by 2030. Nevertheless, world population is projected to reach 7.5 billion by 2020 and 8.9 billion by 2050. Absolute additions to population are 77 million people per year at present, and will still be 58 million per year in 2030, virtually all of which will occur in the developing countries.

(see: **population**)

2.2. Income

Demand for agricultural commodities depends strongly on income levels. As incomes rise from very low levels, demand for basic food staples increases rapidly at first, and then more slowly. As incomes continue to rise and basic food needs are met, demand increases for a wider variety of higher-value agricultural commodities, including fruits, vegetables, and livestock products.

The World Bank reports that global average per-capita income in 1998 was \$5,276 (as measured by Gross National Product (GNP) in constant 1995 US dollars), but income levels vary widely both between regions and countries and within regions and countries. Regional average incomes in 1998 ranged from \$437 in South Asia and \$535 in sub-Saharan Africa to \$27,911 in high-income countries. Intermediate levels were reported in East Asia and the Pacific, with \$1,092, and in Latin America, with \$3,883. Even greater disparities exist within each region.

Growth in per-capita income also varies by region. Between 1961 and 1998, per-capita income grew at an annual average rate of 1.8 percent worldwide, but regional growth rates ranged from 0.4 percent per year in sub-Saharan Africa to 5.2 percent per year in

East Asia and the Pacific. Intermediate annual growth rates of 1.6 percent and 2.7 percent were observed in Latin America and the high-income countries, respectively.

The United States Department of Agriculture (USDA) projects world GDP growth at 2.8 percent per year between 1998 and 2003, accelerating to 3.2 percent per year between 2004 and 2009, as Asian economies recover from the financial crisis of the late 1990s and as performance improves in parts of Central and Eastern Europe. World Bank assessments indicate global average increases in per capita income on the order of 1.9 percent per year over the next decade, although most of this will originate in the developed countries.

IFPRI projects that total income in the developing world will increase at an average annual rate of 4.3 percent through 2020. Per capita incomes are projected to increase in all developing regions (including sub-Saharan Africa), and to double overall to more than US \$2,200 (representing an average increase of 2.9 percent per year).

2.3. Urbanization

As noted above, demand for agricultural commodities depends on factors such as population, income levels, and individual tastes and preferences. While tastes and preferences are difficult to measure, they tend to change in predictable ways with observable phenomena such as population movements from rural to urban areas.

IFPRI notes that as people move from rural to urban areas, they tend to consume more diverse diets, shifting away from coarse grain staples towards increased consumption of rice or wheat, fruits, vegetables, animal products, and processed foods. This increase occurs above and beyond that associated with changes in income.

Of the world population increase of 3.0 billion people between 1961 and 2001, roughly two thirds occurred in urban areas. The world's urban population grew from 1.0 billion people to 2.9 billion over the period, representing an average annual increase of 2.6 percent (figure 2). Africa's urban population grew at an average annual rate of 4.5 percent over the period, while Asia's urban population grew at an average rate of 3.6 percent.

In both regions, urban areas now account for about 37 percent of total population, and rural populations continue to grow, albeit more slowly than urban populations. In other regions, rural population growth has slowed or even reversed, and urban populations account for both the majority of population and the bulk of population growth. Urban areas today account for about three quarters of the total population in Latin America, Oceania, Europe, and North America.

Most of the projected increase in global population over the coming decades will be added to urban areas. The world's urban population today is approaching total rural population (3.2 billion people), and is expected to surpass it within the next two decades. The developing world's urban population is expected to double by 2020, to 3.4 billion people -- representing over half of the developing world's total population.

2.4. Future Demand

Just as demand for agricultural products has historically been determined by factors such as population, income, and urbanization, these factors will play a critical role in shaping demand in the future. Projected changes in these factors have been used by experts at several institutions to project future demand for various agricultural commodities.

Based on projected changes in population, urbanization, and income, IFPRI projects that global demand for cereals will increase by 39 percent between 1995 and 2020 (1.3 percent per year), to 2,466 million tons per year. Demand for meat is projected to increase by 58 percent (1.8 percent per year), to 313 million tons per year, and demand for roots and tubers is projected to increase by 37 percent (1.3 percent per year), to 864 million tons per year.

About 85 percent of the increased demand for cereals and meat is projected to come from developing countries. Over half of the increased demand for cereals is projected to come from Asia, with China alone accounting for 25 percent, while 58 percent of the increased demand for meat is projected to come from Asia, with China alone accounting for 41 percent. Developing countries are projected to account for 97 percent of the increased demand for roots and tubers, with 43 percent of the total accounted for by sub-Saharan Africa.

FAO projections are broadly similar. FAO projects that total demand for agricultural commodities will increase at an average annual rate of 1.5 percent over the next three decades, down from 2.2 percent per year over the past three decades. The corresponding rates are higher (to 1.9 percent from 3.6 percent) in developing countries, and lower (to 0.5 percent from 1.1 percent) in developed countries. FAO projects cereal demand to increase at an average rate of 1.2 percent per year globally over the next three decades (vs. 1.6 percent per year in developing countries and 0.6 percent per year in developed countries), down in each case by about half relative to the preceding three decades.

Demand for meat is also projected to grow at rates slower than historic averages, down from 2.9 percent per year for the world as a whole over the past three decades to 1.4-1.9 percent per year over the next three decades. In developing countries, demand for meat is projected to grow at an annual rate of 2.0-2.8 percent over the next three decades, down from 5.1 percent per year over the past three decades, due in part to slowed economic growth in some countries and cultural and religious restrictions (e.g. on beef and pork consumption) in others.

FAO projects that oilcrops demand will expand the fastest of all commodity groups over the next three decades, at around 2 percent per year through 2030 (compared with 4 percent annual expansion since 1967). Animal feed currently accounts for about 44 percent of global cereal production and 66 percent of global maize production.

In sum, demand for agricultural commodities continues to grow, but projected rates of growth in demand are slowing. As will be shown in section 5, they are also well within

the range of crop production growth rates achieved over the past several decades. Whether crop production will keep pace with future increases in demand at acceptable economic and environmental cost will depend on the availability of productive resources and on the market incentives, policy measures, and research investments that influence how those resources are used.

3. Sources of Production Growth: Natural Resources

Natural resources important for crop production include land, water, climate, and genetic resources. These are discussed in turn below.

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Biographical Sketches

Keith Wiebe is an economist and Deputy Director for Communications in the Resource Economics Division of the U.S. Department of Agriculture's Economic Research Service (ERS) in Washington, DC. He received his B.A. in economics from Carleton College, and his M.A. and Ph.D. in agricultural economics at the University of Wisconsin-Madison. Prior to joining ERS in 1992, he was a post-doctoral research associate at the University of Wisconsin's Land Tenure Center. His program of work at ERS includes research on property rights, resource use, land degradation, conservation policy, agricultural productivity, and food security, as well as coordination of the Resource Economics Division's publications program.

Pierre Crosson is a senior fellow and resident consultant in Resources for the Future's (RFF) Energy and Natural Resources division in Washington, DC. For the last twenty years his research has focused on issues relating to sustainable agricultural production systems. Much of this has dealt with the United States, but for some ten years now he has become increasingly concerned with the same range of issues in the developing countries. His research has been widely published, some of it jointly with his colleague at the World Bank, Jock Anderson.