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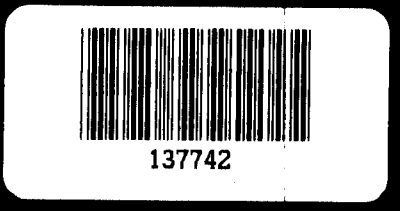
WORLD AGRICULTURE

Factors Influencing Trends in World Agricultural Production and Trade



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Resources, Community, and
Economic Development Division

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January 19, 1989

The Honorable George E. Brown, Jr., Chairman
Subcommittee on Department Operations,
Research and Foreign Agriculture
Committee on Agriculture
House of Representatives

Dear Mr. Chairman:

As requested in your letter of May 31, 1988, we developed information regarding long-range issues affecting world agricultural production and trade and the resulting impact on major U.S. agricultural exports. We paid specific attention to those factors responsible for major structural shifts in global agricultural production and trade patterns occurring over the last 25 years.

This report highlights major changes that have occurred in the major bulk food commodity markets and synthesizes information on factors believed to be responsible for contributing to these changes. GAO's analysis indicates that three important, long-term structural variables are playing increased roles in world agricultural supply, demand, and trade levels for these commodities: (1) world economic conditions (economic growth rates and Third World debt), (2) world agricultural development and trade policies, and (3) technological advances in plant and animal sciences.

The major contributors to this report are listed in appendix I.

Sincerely yours,

John W. Harman
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Executive Summary

Purpose

The United States sustained significant growth in agricultural trade during the 1970s. In the 1980s, however, U.S. agricultural exports declined in volume and market share and commodity surpluses increased during a period of rising world agricultural production, primarily in the developed countries. These less favorable conditions have put pressure on U.S. policymakers to respond to a highly interdependent world agricultural environment.

GAO examined world agricultural production and trade, focusing on the major commodities (wheat, coarse grains, rice, and soybeans). This report discusses the influence on world production and trade of (1) global economic conditions, (2) domestic agricultural policies of some major importing and exporting countries, and (3) agriculture technology. It highlights challenges for policymakers brought about by the interaction of these forces on world agriculture.

Background

World production, consumption, and trading patterns for the major commodities have changed significantly since the 1960s. Some food importing nations have neared self-sufficiency for specific commodities; others have become small net exporters. Some previously minor exporters are now major U.S. competitors, such as the European Community (wheat). Overall, global food production has significantly increased, contributing to increased export competition in a restrained world food market.

After several years of surpluses in major producing countries, the world food supply/demand balance has improved and world prices have risen for some foods in 1987-88. Still, U.S. exports and price levels remain far below those recorded in 1980-81. Recent changes that have contributed to a rise in U.S. agricultural exports—rapid depreciation of the dollar, government-funded export assistance programs, and poor weather-related harvests in other countries—are not necessarily indicative of overall shifts and may have only short-term benefits for the U.S. market share.

Many factors contribute to changes in agricultural commodity supply and demand over time. Many of these produce short-term fluctuations in food production, consumption, and trade—such as adverse weather conditions on crop output. Other factors, such as population growth, are more moderate in their impact on food demand in the intermediate term. However, some factors produce longer-term directional trends for world agriculture. It is these factors that present greater opportunity for meaningful actions by policymakers.

Results in Brief

One major effect of changing global economic conditions between the early 1970s and the 1980s was the reduction of worldwide demand for agricultural imports. Key factors influencing the changed condition were (1) sluggish world and regional economic growth and (2) continued external debt problems in many developing countries.

Nations' agricultural policies have also altered agricultural trading patterns. Many developed countries have subsidized agriculture to protect their market share, and many developing countries have encouraged domestic production to achieve self-sufficiency goals. Such policies have fostered worldwide overproduction of many crops, which has contributed to reduced U.S. agricultural exports.

Advances in agricultural technology have also changed production in the world agricultural market. General agreement exists among agricultural scientists and economists that the United States must retain its technological leadership to compete successfully in international agricultural trade.

On the basis of its analysis of these issues, GAO discusses several major challenges facing U.S. policymakers in dealing with an uncertain international agricultural trading environment.

GAO's Analysis

Influence of World Economic Conditions

In the 1970s, the developing countries fueled a sharp rise in global food imports due to (1) strong economic growth resulting from increased currency earnings from exports and (2) massive lending programs from international banks. The Soviet Union and Eastern Europe imported grains in large volume to improve diets and make up for internal production shortfalls. Also, the declining value of the U.S. dollar lowered food costs for many importing countries, leading to more food imports that particularly benefited U.S. farmers.

In the early 1980s, a strong U.S. dollar, a general world economic slowdown, and debt burdens in many developing countries dampened world trade, including agriculture. The rise in the value of the dollar and high U.S. loan rates established in the Agriculture and Food Act of 1981 affected the price competitiveness of U.S. exports and reduced the ability of debt-laden developing countries to finance imports.

Despite a significant decline in the nominal value of the U.S. dollar against major world currencies since 1985, U.S. agricultural exports have regained only a portion of their value recorded in 1984. Sluggish world economic growth and persistent external debt problems for many developing countries continue to hamper food trade. Resolution of these problems could lead to longer-term improvements in all world trade, including agriculture.

Impact of Agricultural Policies on World Markets

Ironically, in the 1960s many developing countries adopted policies that hindered growth in domestic agriculture. This encouraged the industrialized countries to increase production for export as world demand rose. In the early 1980s, some developing countries began reforms to their agricultural policies to encourage greater domestic food production because of food self-sufficiency goals and unfavorable economic conditions that curbed their ability to buy imported food.

These policy shifts in both developing and developed countries have contributed to reduced agricultural trade levels, led to further trade protectionist policies, accelerated production growth, and created a more competitive trading environment in the 1980s. Major agricultural exporting countries have designed pricing policies to protect foreign market share critical to the survival of their domestic farm sectors. Some importers have constructed policies to protect their developing agricultural sectors and to enhance food self-sufficiency goals.

These policies have culminated in an uncoordinated and highly inefficient world agricultural trading system. For example, the European Community protects its farmers by imposing tariffs and variable import levies on some food imports and granting export refund payments to dispose of surplus production. This depresses world prices, while the United States imposes acreage reductions intended to raise world prices.

Impact of Agricultural Technology

The adoption of improved fertilizers, pesticides, herbicides, and plant varieties over the last 25 years has increased food production worldwide by raising crop yields. The impact, most noticeable in many developing countries, has enabled many to meet more of their food needs.

New agricultural biotechnologies may become commercially available in many developed countries within 10 years. Some technologies emphasize high-quality output with lower input costs; others could further

enhance crop yields. Their successful adoption could directly affect production levels, export competitiveness, and farm structure. Many have the potential for international transfer and adoption; moreover, many countries are pursuing their own agricultural biotechnology agendas. U.S. farmers may be faced with a shorter technological lead over competitors than in the past.

Challenges for U.S. Agricultural Production and Trade

U.S. policymakers face major challenges in an increasingly uncertain international agriculture trading environment. First, increasing the food demand in developing countries will require effective strategies to address their debt problems and sluggish economic growth. Since many of these countries face trade imbalances, budget deficits, high debt burdens, and stagnant economic growth, U.S. exports—and international trade in general—will remain constrained until these larger economic problems are resolved.

Second, many U.S. and foreign agricultural and trade policies have distorted world markets, leading to excessive market production, inefficient use of resources, and surpluses that depress market prices. International agreements on ways to reduce agricultural subsidies and import barriers—such as those being pursued in multilateral trade negotiations—can help stabilize world markets. If achieved, these agreements could create a more open world agricultural market, where competition depends on production and marketing efficiencies.

Third, the impact of new farm technologies could produce significant changes in global production patterns and the structure of farm sectors in the world economy. Given the potential of agricultural biotechnology developments worldwide, a thorough discussion of U.S. agricultural research and development priorities would be beneficial for future policy deliberations.

Recommendations

This report contains no recommendations.

Agency Comments

This report has been discussed with officials at the U.S. Department of Agriculture. Their suggestions were incorporated into the report where appropriate. Because this is an informational report, GAO did not obtain official agency comments.

Contents

Abbreviations

ARS	Agricultural Research Service
CAP	Common Agricultural Policy
CCC	Commodity Credit Corporation
CPE	centrally planned economy
CRS	Congressional Research Service
DNA	deoxyribonucleic acid
EC	European Community
EEP	Export Enhancement Program
ERS	Economic Research Service
FAO	Food and Agricultural Organization
FAS	Foreign Agricultural Service
GAO	General Accounting Office
GATT	General Agreement on Tariffs and Trade
GNP	gross national product
IARC	International Agricultural Research Centers
IFPRI	International Food Policy Research Institute
LDC	less developed country
mmt	million metric tons
MTN	multilateral trade negotiations
OECD	Organization for Economic Cooperation and Development
OPEC	Organization of Petroleum Exporting Countries
OTA	Office of Technology Assessment
PGH	porcine growth hormones
PSE	producer subsidy equivalent
R&D	research and development
RFF	Resources for the Future
USDA	U.S. Department of Agriculture

Introduction

The 1980s have brought significant changes to world agricultural production, consumption, and trade, particularly affecting the major bulk commodities that are widely bought and sold on the world market, such as food grains and feedstuffs. Demand has fallen in some countries that were once large grain importers; many import less grain, are self-sufficient, or have even become net exporters. Competition among the major exporters, including the United States, has greatly increased. The sources of comparative advantage—land, water, climate, storage, transportation, production and marketing technologies, and extension services—that form the basis for the market competitiveness of U.S.-grown commodities have diminished in importance. Other countries have implemented policies and programs that have increased their exporting competitiveness or, in still other cases, restricted imports and upgraded their own productive capacities. A world economic recession in the early 1980s and continued sluggish economic growth in the developing countries have led to reduced world food demand. As a result, international markets for some major agricultural commodities produced in the United States have shrunk.

Changes in the International Agricultural Marketplace

A historical trend analysis of world agricultural production reveals that the 1960s was a period of agricultural development for many parts of the world; the 1970s a period of significant growth in agricultural production and trade; and the 1980s a time, in general, of agricultural trade stagnation. However, these generalized trends do not apply equally to all countries. For instance, while U.S. exports of coarse grains significantly increased in the 1970s, the market share and export volume of many foreign exporters declined. Conversely, this situation reversed in the 1980s, when most foreign competitors increased production and trade through 1985 while levels in the United States declined.

The international agricultural marketplace of the 1980s is in many ways significantly different from that of the previous two decades. Importers and exporters are much more dependent upon world markets as a source of both supply and demand of agricultural products. To illustrate, wheat and coarse grain imports, amounting to 15.2 percent of grain utilization by major importing countries in 1960, grew to 25.5 percent by 1980. Similarly, wheat and coarse grain exports as a percentage of production in major exporting countries have grown from 20.5 percent to 45.4 percent for the same time frame. These changes are pronounced despite the fact that in the 1980s world demand for food has slowed in comparison with that in previous decades. In 1986, wheat and coarse grain imports as a percentage of grain utilization among major

importers fell to 21.9 percent, while the percentage of production devoted to exports among major exporters fell to 34.1 percent.

International agricultural producers, exporters, and importers are trying to cope with the significant changes in worldwide agriculture. International agricultural trading tensions abound as competing exporters struggle to hold on to existing markets, capture new market footholds, or recapture lost sales. For the first time in the 40-year history of the General Agreement on Tariffs and Trade (GATT), the multilateral trade negotiations (MTN) are seriously addressing agricultural concerns, such as production and export subsidization as well as market restrictions, in hopes of producing a comprehensive and balanced approach to liberalizing trade in agriculture.[1] Comprehensive studies of international agricultural production and trading issues performed by the World Bank, Organization for Economic Cooperation and Development, and the Food and Agriculture Organization of the United Nations have all highlighted production and trading inefficiencies brought about by costly and often contradictory farm policies pursued around the world. The United States Congress reacted to the agricultural crisis by passing the Food Security Act of 1985 and the Omnibus Trade and Competitiveness Act of 1988, one of the most comprehensive trade bills in U.S. history.

Background: Factors Influencing Changes in International Agricultural Production and Trade

Many factors are responsible for the alterations in agricultural production and trading patterns. Although the U.S. agricultural sector still provides a positive balance of trade in value terms, the fact that the positive balance was $26.6 billion in 1981 and only around $7.2 billion in 1987 (measured in current dollars) indicates a marked decline in world market share.[2] (The reversal in U.S. agricultural expansion and dominance is discussed in chapter 2.)

In addressing the causes for this decline, our discussion inevitably must move beyond agricultural production itself and consider other matters

[1]GATT, created in 1947, contains a list of negotiated tariff schedules and principles and rules governing trade among the signatories—presently some 92 countries. The GATT provides a forum where nations can raise, discuss, and settle disputes regarding trade between them; however, it is unable to force signatories to live up to their obligations. The GATT provisions continued to be modified through a series of successive multilateral trade negotiations attended by representatives of the signatories. The current MTN round was launched by a ministerial- level meeting of government representatives in Punta del Este, Uruguay, in September 1986.

[2]In 1988, however, improvement has occurred. U.S. Bureau of Census data for fiscal year 1988 showed the U.S. agricultural surplus to be $14.3 billion, nearly double the 1987 figures.

relating to demand and trade. Several dynamic factors work interdependently to influence the level of agricultural supply and demand (particularly exportable supplies and import demand). We briefly review some of the more important ones before addressing three of these factors with significant long-term implications (macroeconomic, agricultural policies, and technology) at greater length in subsequent chapters.

Factors Affecting Agricultural Production

Among the many factors affecting agricultural production are (1) resource availability (i.e., land, water, capital), (2) climate, (3) price incentives, (4) technology, and (5) government policies.[3] Government policies and agricultural technology are the focuses of chapters 4 and 5, respectively; therefore, the discussion below concerns other relevant factors.

Resources. Land expansion has been responsible for increasing levels of agricultural production throughout this century. According to 1980 U.S. Department of Agriculture (USDA) statistics, only one-half of the world's arable cropland is currently being cropped. However, the distribution of available farmland throughout the world is uneven; moreover, costs associated with developing lower quality cropland act as a barrier. One study conducted by Resources for the Future (RFF) indicates that only 15 percent of the anticipated annual growth in world cereal production will result from farmland expansion in the next 15 years. Even though cropland may be declining in importance, soil quality remains an important issue because erosion and loss of soil fertility are major problems in many world areas.

Irrigation has also been important in increasing agricultural production. More than one-half of the increase in agricultural output in the last 20 years is attributable to the introduction or improvement in crop irrigation. In 1980, 15 percent of the world's cropland was irrigated, but this area produced 40 percent of the world's food. Irrigation is especially important to many of the developing countries; two-thirds of the less developed countries' (LDC) crop production is on irrigated farmland. Water constraints continue to serve as barriers to improved and expanded production in many world areas. Financial constraints in some developing countries complicate their situation because irrigation projects normally require large capital investments.

[3]These factors are discussed in Francis Urban, et. al., "Factors Affecting Supply" in World Food Situation, Economic Research Service, USDA Draft Report, 1985.

Large and sustained capital investment in a modern infrastructure—roads, storage facilities, rural electricity, research and extension services, and marketing services—is also important in increasing growth in agricultural production. Most of the developed countries have invested in and improved their infrastructures, thus enhancing food production, distribution, delivery, and marketing abilities. However, the developing countries are at different levels of infrastructural development. In some cases, inadequate transportation and storage facilities complicate domestic food distribution and hinder the development of effective agricultural export sectors.

Climate. Climatic differences play a role in determining types of crop production within countries; for example, the climate in the tropics is not well suited for wheat and corn production. In addition, weather-related conditions and crop damage due to pests and diseases constantly produce abrupt changes in supplies of various agricultural commodities. Adverse weather (drought, flood, freeze) and widespread crop pest or disease infestation in major producer or exporting countries can lead to sharp reductions in food supplies. These temporary production shortfalls can lead to tight supplies and higher world prices. Conversely, unusually favorable weather can boost crop output, leading to "bumper" crops that create excess supplies. A rapid, unexpected increase in supply can create large stockpiles that result in depressed market prices and additional government budget expenses if the stockpiles are maintained through government programs at taxpayer expense (e.g., the United States and European Community).

The U.S. drought during the summer of 1988 highlights the sudden impact that weather can have on agricultural commodity supplies. According to USDA September 1988 estimates, U.S. grain production is forecast to be 31 percent below 1987 levels.[4] The drought-induced reduction in yield was the largest on record, exceeding the 28 percent decline recorded in 1983, another U.S. drought year. This has resulted in sharp reductions in grain stocks both in the United States and worldwide. International commodity prices for wheat, corn, and soybeans have risen sharply, in some cases reaching or surpassing levels of 1980-81.

[4]September 1988 USDA production estimates comparing 1988 with 1987 levels for specific grain crops are as follows: durum wheat—down 47 percent; other spring wheat—down 54 percent; sorghum—down 27 percent; barley—down 46 percent; oats—down 45 percent; and soybeans—down 23 percent.

Farm prices. Farmers worldwide generally respond to favorable prices by increasing production. Even though farm prices are important incentives affecting both production and consumption, they are mitigated by numerous matters related to both supply and demand. For instance, USDA and World Bank data indicate that between 1960 and the mid-1980s, world agricultural commodity prices—in real terms—were on a gentle downward trend. Some years produced exceptions—in 1973-74 large, unexpected Soviet grain purchases caused a temporary sharp rise in some commodity prices. At certain times, however, government intervention measures in some countries—usually in the form of producer price supports or consumer subsidies—have muted the impact of declining world prices.

Variations in general price levels can also have an effect on the costs of inputs used by farmers. Farmers can experience considerable cost increases or savings, depending upon prices they pay for intermediate goods used in the production process. For instance, in 1986 farmers benefited from a decline in cash expenses largely due to a drop in crude oil prices which, in turn, lowered prices for fuel, fertilizers, and other chemical inputs.

Factors Affecting Agricultural Demand

When discussing food demand, one should distinguish between the need for food and the market demand for food. Agricultural economists often attempt to address "effective" demand—that is, not only consumption needs but also the ability of a population to purchase it or the financial capability of a country to import it. In a "market demand" sense, the production of certain bulk food commodities in the 1980s constantly surpassed existing demand. Among the prominent factors influencing world food demand are changes in (1) population, (2) income levels, and (3) prices.

Population. Population growth directly affects agricultural supply/demand relationships. The annual growth rate in global population has been slightly less than 2 percent for most of the last three decades. Obviously, some countries have experienced rates far below or above the aggregate world rate. Most world population projections show growth rates remaining close to existing levels through 2010, with some developing regions experiencing slower growth rates in comparison to the 1970s. Therefore, experts expect population growth to exert a steady, gradual increase in world food needs.

Income levels. Economic growth resulting in higher per capita incomes normally translates into increased demand in the quantity and quality of food. Studies reveal that people with lower incomes tend to spend a greater percentage of any income gain on food than higher-income people. Consumers in higher-income countries consume more food grains because of more disposable income, urbanization, and changing lifestyles. Demand for beef, poultry, and/or swine also increases as incomes rise, expanding the need for greater quantities of feed grains. The effect of rising income levels is especially notable in middle-income developing countries with economic growth in the 1970s and 1980s, such as Taiwan, Korea, Hong Kong, Singapore, Thailand, the Philippines, Malaysia, and Turkey. In short, income growth has great potential for generating long-term changes in food demand.

Prices. Demand for most food commodities is often said to be inelastic; that is, the consumption pattern does not change in response to a price change as much as nonfood products. This relationship is weaker in the developed countries, where a wider variety of food commodities and product substitutes exist. Nevertheless, the demand for some agricultural commodities is more price sensitive than for others. For example, coarse grain demand (as influenced by demand for animal feed) is generally more price elastic that wheat, a food grain. As a result, market demand for some agricultural commodities may increase in response to lower prices caused by oversupply, exchange rate variations, or competitive export pricing policies.

Other Factors Affecting the Agricultural Sector

Changes in macroeconomic conditions have become increasingly important to agriculture as it has become more capitalized and more dependent on international markets. Agriculture has become increasingly vulnerable to variations in interest rates, exchange rates, inflation levels, international economic growth rates, and country indebtedness. Furthermore, domestic agricultural policies have become important elements acting to restrict or stimulate world food trade. Various macroeconomic issues and agricultural policies affecting agriculture are discussed in chapters 3 and 4, respectively. The linkage between agricultural prices and production and variations in interest rates and exchange rates, however, is briefly discussed below.

Interest rates. Agricultural production normally requires large initial capital expenditures on land and equipment. Since these production

costs are often incurred before revenues are received, agriculture is sensitive to both the availability and cost of credit.[5] During the 1970s, low real interest rates contributed to the boom in world agriculture in at least three ways. First, farm commodity prices were increasing in real and nominal terms, and farmland values were increasing rapidly. Low-cost credit was readily available and accelerated investment in land and machinery used in agricultural production. Second, since most agricultural inputs are financed with credit, the low interest rates lowered production costs and made it easier to expand output. Third, the accumulation and holding of commodity stocks became relatively inexpensive with the low real rates of interest.

This situation reversed by 1980 as real interest rates began to rise. Farmers were hurt who had borrowed heavily to expand or enter production, especially when commodity prices fell. In the early 1970s, interest rates constituted less than 8 percent of agricultural expenses; by 1982, this had increased to 16 percent. Importers, especially the developing countries, were impaired by the decline in loan availability and the need to channel a greater portion of their revenues to finance rising payments on short-term debt.

Exchange rates. Between 1970 and 1979, USDA estimates conclude that U.S. agricultural exports were put in a favorable position by a 30-percent depreciation in the real agricultural-trade-weighted dollar exchange rate. However, large movements in the value of the U.S. dollar have presented major problems for world agriculture in the 1980s.[6] Besides motivating increased government intervention in world markets, the appreciation of the dollar also triggered changes to U.S farm price support policies in 1985. The high value of the dollar raised the exchange value of the U.S. loan rate well above market-clearing levels. When export demand fell in the early 1980s, the U.S. domestic price of grain suddenly dropped to the loan rate, and a substantial portion of domestic production was purchased by the Commodity Credit Corporation (CCC) to support the loan rate.

[5]See John Kitchen, Suchada Langley, Ralph Monaco, and J. Michael Price, "Effects of Monetary and Fiscal Policy on U.S. Agriculture," Economic Research Service, USDA, Agricultural Information Bulletin Number 517, May 1987, and Agricultural Finance Situation and Outlook Report, Economic Research Service, USDA, AFO-27, March 1987.

[6]See Stephen W. Hiemstra and Mathew Shane, "Monetary Factors Influencing GATT Negotiations on Agriculture," Economic Research Service, USDA, Foreign Agricultural Economic Report Number 236, April 1988.

Faced with a high dollar, U.S. farmers suffered low incomes while foreign producers earned record-high incomes. With world grain prices falling to within 5 percent of the European Community's (EC) domestic support price, the normally high cost of the EC agricultural policy was significantly reduced. Of course, the rapid fall in the value of the dollar starting in 1985 had opposite effects. U.S. agricultural exports became more competitive. Conversely, EC agricultural support programs became quite expensive. Farmers in other countries—like Australia—were confronted with world surpluses after investing heavily in agricultural production in the earlier part of the 1980s.

After examining the supply and demand trends in major bulk food commodities,[7] we focus on three factors with extended influence on variations in agriculture supply and demand: (1) world economic conditions (ch. 3), (2) national and international agricultural development and trading policies (ch. 4), and (3) farm technology improvements (ch. 5). These types of factors have always influenced agricultural production and trading patterns and policies, but in the 1980s they have played a larger and much more volatile role than in the past. Understanding these changes can add to prospects for policy improvements in the future.

Objective, Scope, and Methodology

The overall objective of our study is to analyze factors influencing changes in global production and trade of four major agricultural commodities—wheat, coarse grains, rice, and soybeans—over the last 25 years.[8] In doing so, we noted changes in production levels and the specific factors contributing to those changes. Rather than focus on production levels in isolation, we also examined other trade-related indicators, such as imports and exports, as well as indicators of production performance, such as surpluses and yields.

Our analysis is a synthesis of official USDA crop production and trade data; published reports and manuscripts from a wide range of public and private agricultural economists and trade experts; econometric forecasts from USDA, the World Bank, and Wharton Econometrics; and interview information. We obtained historical world data relating to crop production and trade from USDA's Economic Research Service (ERS). In

[7]Specifically, we address wheat, coarse grains, rice, and soybeans.

[8]These four commodity categories were chosen because of their dominant position in both world and U.S. agricultural volume trading. In addition, all four have often been cited as examples of U.S. agricultural exports for which the United States has lost market share and/or experienced increased foreign exporting competition.

addition, we obtained detailed production information from USDA's Foreign Agricultural Service (FAS) and technology-related background from the Agricultural Research Service (ARS). Agricultural production and trade data change constantly. Except where noted, most of the figures used in this report were as of December 1986, the latest available at the time of our review.

We consulted with a wide range of experts in agriculture to ensure a balance of the many different points of view on trade and policy issues. We talked to officials at the Department of State, the Food and Agricultural Organization of the United Nations, the Congressional Research Service, and the Office of Technology Assistance. We also interviewed private sector officials from various multinational trading companies, Resources for the Future, and the International Food Policy Research Institute (IFPRI). We participated in seminars addressing farm technology and trade issues presented by USDA, the American Enterprise Institute, and the National Academy of Sciences.

We performed our work primarily from July 1986 through December 1987, with updates through September 1988, in accordance with standard government auditing practices. The views of responsible officials at USDA's Economic Research Service were sought during the course of our work and are incorporated where appropriate.

Changes in the Major International Commodity Markets, 1960-86

New producer, exporter, and importer countries have emerged on the international market over the last 25 years, creating a constantly changing supply and demand scenario. This chapter focuses on historical production, demand, and trading trends for major grains and oilseeds—wheat, coarse grains, rice, and soybeans—paying particular attention to the role of the United States in these markets. These commodities dominate domestic agricultural production in many countries and carry enormous economic and political weight. They also are among the most significant commodities traded on the international market in terms of volume and value.

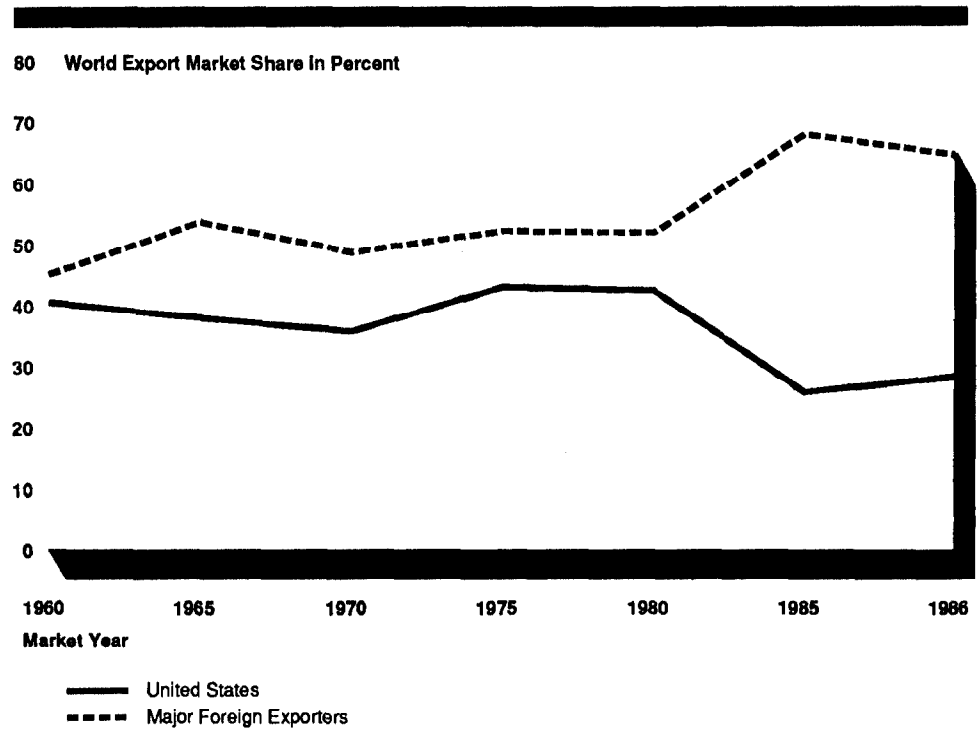
Wheat Production and Trading Patterns

Almost three quarters of the world's wheat has historically been produced in China, India, the United States, Canada, the USSR, Australia, and the EC. The smaller producers, such as Canada and Australia, have historically produced wheat for foreign customers. Since 1960, more and more U.S. wheat production has also been for export purposes, reaching 73 percent of total production in 1980. Between 1980 and 1986, however, the percentage of production going toward exports declined. Perhaps the most significant shift over the last 25 years occurred in the EC and Argentina. In 1985, the EC exported 42 percent of its wheat production, compared with 9 percent in 1960. EC wheat production more than doubled during this time period, from 29.7 million metric tons (mmts) to 66 mmts. Argentina now exports 50 percent of its wheat production, compared with just 20 percent as recently as 1970. Argentina's wheat production also grew rapidly from 4 mmts in 1960 to 13.2 mmts by 1984 before declining in 1985 and 1986.

As figure 2.1 illustrates, U.S. wheat export market share declined in the 1960s, regained strength during the 1970s, and significantly declined again during the first half of the 1980s. In 1960, three countries dominated the world wheat export market: the United States (41 percent), Canada (22 percent), and Australia (15 percent). The U.S. export volume alone was almost equivalent to that of all major export competitors. By the end of the 1970s, three important developments had occurred: (1) an unprecedented expansion in U.S. wheat exports, (2) significant growth in EC wheat exports and its establishment as a major foreign exporter, and (3) export domination (95 percent of the world market) by five wheat producers—the United States, Canada, Australia, Argentina, and the EC.

Due to a combination of factors, U.S. wheat exports consistently declined in volume as a percent of the world export market from 1981 to

Figure 2.1: World Wheat Export Market Share: United States and Major Foreign Exporters, 1960-86



Major foreign exporters include Canada, Australia, EC, and Argentina

Source: Economic Research Service/USDA. Percentages calculated by GAO.

1985.[1] U.S. wheat export levels in 1985 were the lowest since 1971, and world market export share was the lowest since 1960. Conversely, foreign wheat exporters managed to stabilize or increase wheat exports. Australia and Argentina, in particular, experienced significant export growth. Most important, between 1980 and 1986, the four major foreign exporters—Australia, Argentina, Canada, and the EC—increased their combined market share from one-half to about two-thirds.

Just as the importance of wheat producers and exporters shifted from 1960 to 1986, so did that of wheat importing nations. The world wheat import market changed in terms of (1) the number of major importing nations, (2) the location of major markets, and (3) import volumes for

[1]These factors included the strong value of the U.S. dollar in foreign exchange markets (making U.S. exports more expensive), a U.S. wheat export price well above average world prices due to domestic pricing policies, increased production and export competition from major foreign exporters, and reduced demand in many traditional U.S. markets (i.e., Latin America) hit by debt crises and economic stagnation. In 1986, the U.S. market share improved slightly to approximately 28 percent.

certain countries. In the 1960s, India and the centrally planned economies (CPE) of the USSR, China, and Eastern Europe made up the bulk of the import market, with Brazil, Egypt, and Japan the other major markets. Except for the CPEs, the United States held substantial market shares in each, especially India (on average, about 80 percent).

By the end of the 1970s, four significant changes had occurred in importing trends:

- The USSR and Eastern Europe became significant wheat import markets and served as a bonus outlet for stepped-up production levels in the United States and Europe. The magnitude of the purchases made by the Soviets revealed to suppliers and importers alike the impact that a large, single purchase could have on the international market as world wheat prices almost doubled.
- India, the world's largest single importer of the 1960s, began to taper off its wheat imports by the end of the decade due to dramatic increases in domestic production. This represented a major market change, especially for the United States since it had supplied the bulk of India's wheat imports during the 1960s.
- Subsidies created by the EC's Common Agricultural Policy (CAP) encouraged production within the Community and emphasized intra-EC trade. The United States, in particular, lost sizable export volumes to traditional EC customers.
- A shift in the importance of other import market sources emerged. The USSR, North Africa (mainly Egypt, Morocco, Algeria, and Tunisia), the Middle East (Iran and Iraq), and parts of Asia (South Korea and Indonesia) witnessed wheat import growth.

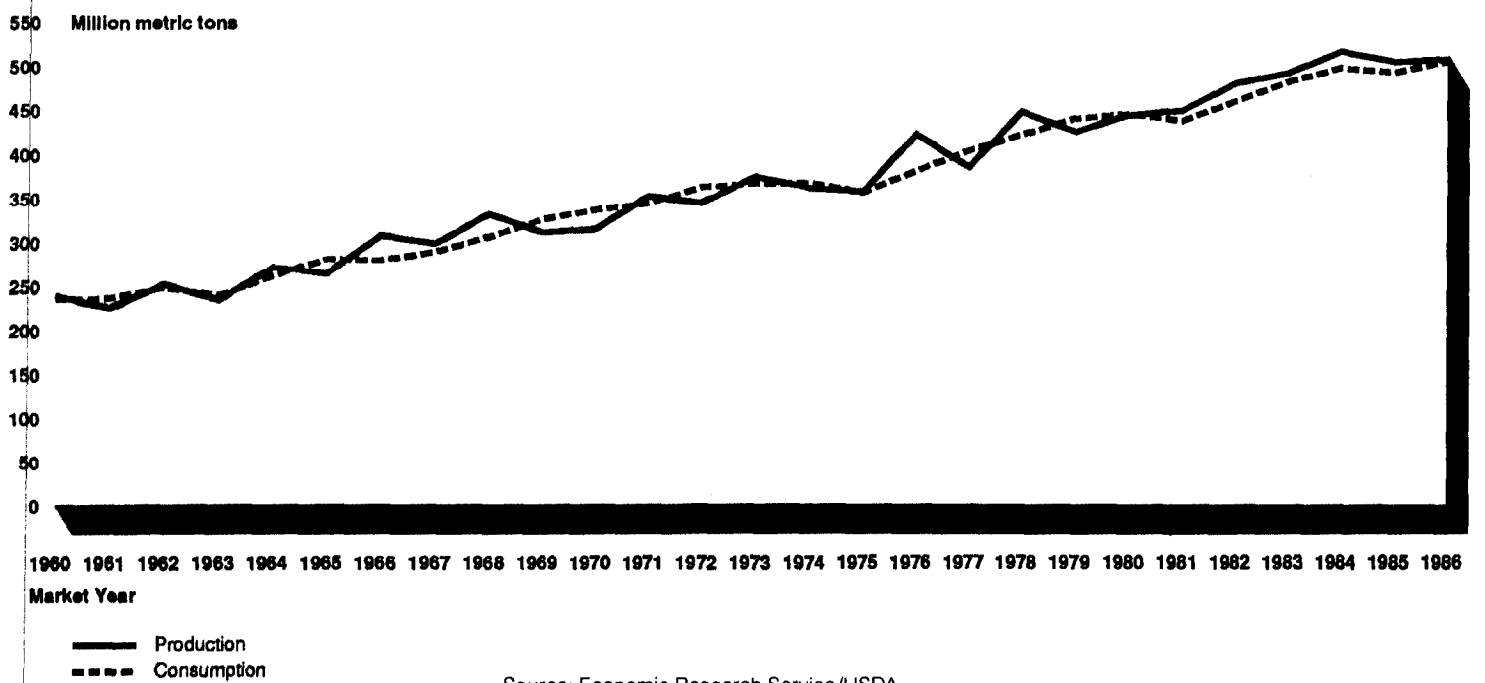
From 1980 through 1986, these import trends solidified. Traditional U.S. wheat importers—Eastern Europe, Japan, and Latin America—reduced or stabilized import levels. India and the United Kingdom have both become net wheat exporters. The USSR, North Africa, the Middle East, and parts of Asia have become the major import markets. As a result, today's world wheat import market is composed of concentrated "pockets" of countries; shifts in the importing requirements for just a few of these countries could have tremendous impact on the trading volume of major wheat exporters.

Increases in foreign crop production have contributed at least to a constricted world market with greater competition among food exporters. A USDA report analyzing the major determinants for U.S. wheat exports during the period from 1961 to 1983 found that wheat production in the

importing countries explained the greatest variance in the volume of U.S. wheat exports.[2]

Finally, between 1960 and 1980, world wheat production fluctuated above and below consumption levels. This trend is graphically illustrated in figure 2.2. However, between 1980 and 1986, unlike any other period since 1960, world wheat production continued to surpass consumption. Many agricultural economists and analysts partly attribute this overproduction to the isolation of both major exporters and importers from world price changes. Although somewhat erratic, the nominal world price of wheat has declined steadily since 1980 while real world prices have more or less declined since 1974, except for the period from 1977 to 1979.[3] In 1986, real wheat prices were only one-third the 1974

Figure 2.2: World Wheat Production Versus Consumption, 1960-86



Source: Economic Research Service/USDA.

[2]See Carlos Arnade and Cecil Davidson, Export Demand for U.S. Wheat, Agriculture and Trade Analysis Division, Economic Research Service, USDA, Staff Report No. AGES870616, July 1987.

[3]The nominal price is the price expressed in current dollars, while the real price, expressed in constant dollars, is the price adjusted for inflationary changes.

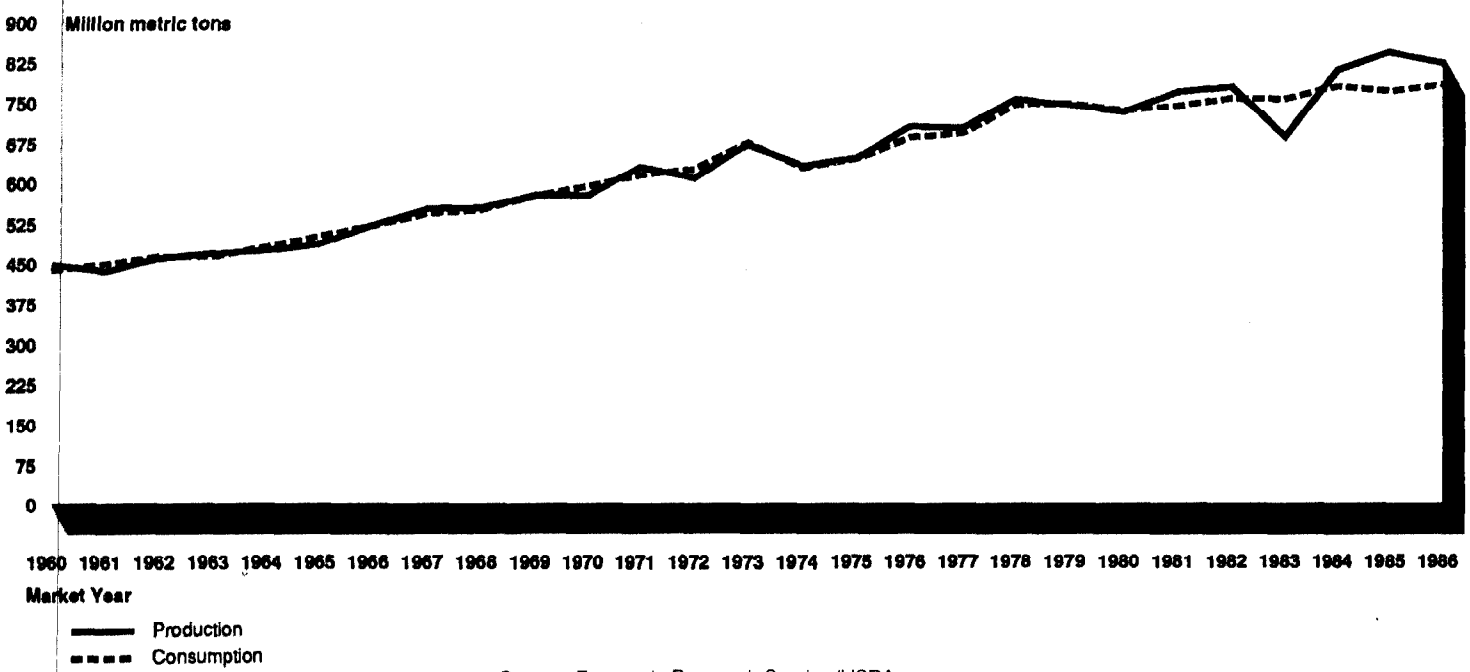
level. Today, four of the five top wheat importing countries use state trading institutions for controlling imports (the fifth, which does not, is the EC). These government organizations can exercise significant control over import levels through government-established prices and purchasing criteria.

Coarse Grain Production and Trading Trends

The United States has consistently been the largest single coarse grain producer in the world for three decades. (Coarse grains include corn, barley, sorghum, rye, oats, and mixed grains.) As with wheat, coarse grain production is concentrated in a handful of the world's nations—the United States, USSR, the EC, China, Eastern Europe, India, Canada, and Argentina—which account for nearly 80 percent of the world's coarse grain production in a normal year. Production in the major foreign exporters—Argentina, France, Canada, and Australia—has grown rather rapidly over the last 25 years.

From 1960 to 1980, world coarse grain production and consumption closely mirrored each other (see fig. 2.3). Beginning in 1980, however, world production began to surpass consumption. In 1983, the combination of the U.S. Payment-In-Kind program, which took a large amount of

Figure 2.3: World Coarse Grain Production and Consumption, 1960-86

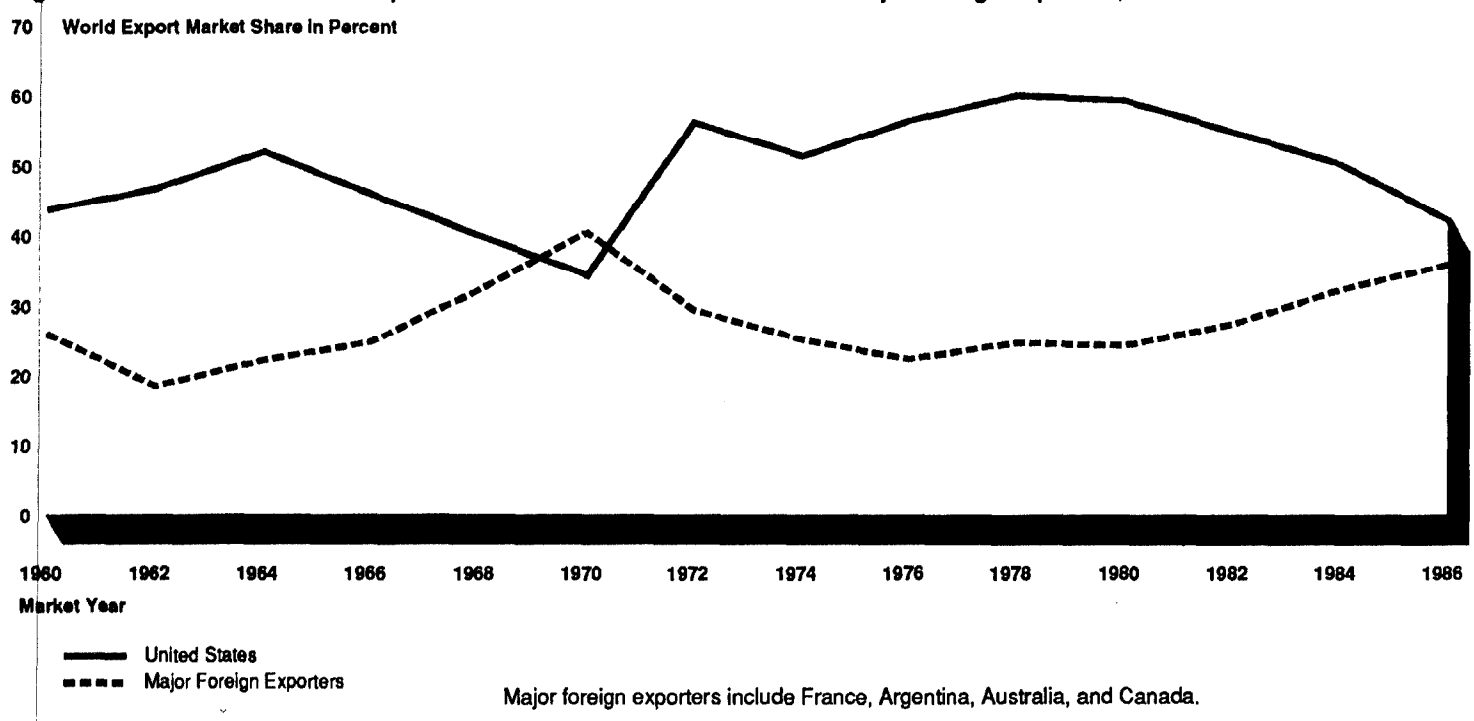


Source: Economic Research Service/USDA.

acreage out of production, and one of the worst U.S. droughts in 50 years was responsible for a large drop in world production. In 1984, normal production patterns resumed in the United States and, combined with production increases in foreign producing countries, resulted in a tremendous surge in output. As figure 2.3 shows, this production surge was unlike any other pattern in the past 25 years. When demand fell in 1985, production continued upward, producing sizable surpluses of many grains, particularly corn.

As shown in figure 2.4, coarse grain exports have followed divergent patterns for the United States and its major exporting competitors. Although the United States often supplied between 40 and 50 percent of the world's import needs during the 1960s, the major foreign exporters increased production and devoted larger portions to exports. By 1970, the four major foreign exporters (France, Argentina, Australia, and Canada) as a group had surpassed the U.S. world export market share. This pattern reversed itself in the 1970s; the United States took advantage of

Figure 2.4: World Coarse Grain Export Market Share: United States Versus Major Foreign Exporters, 1960-86



Major foreign exporters include France, Argentina, Australia, and Canada.

Source: Economic Research Service/USDA. Percentages calculated by GAO.

its productive capacity to dramatically expand production and dominated the world export market while foreign grain exports declined. The 1980s once again has produced yet another exporting trend reversal, mirroring the pattern of the 1960s, which was characterized by declining U.S. grain exports and increasing foreign exporter market share.

It is the coarse grain import market, however, that has undergone significant transformation over the last 25 years. In 1960, the top five coarse grain importers were the United Kingdom, the Netherlands, Italy, West Germany, and Japan. As coarse grain production rose in the EC countries and quickly replaced imports, importing patterns changed. In 1985-86, the top five importers were Japan, the USSR, Saudi Arabia, Taiwan, and South Korea. Likewise, top U.S. coarse grain importers (in volume terms) have also changed. In 1960, the top five were the Netherlands, West Germany, Poland, Israel, and South Korea; in 1986, the top five importers were Japan, Mexico, Taiwan, South Korea, and Egypt—all of whom possess close economic and political ties to the United States.

Changes in the international coarse grain market in the 1980s have had serious ramifications for the United States. The drop in exports has been much more severe for the United States than for its competitors. U.S. world market export share stood at 60 percent in 1980; by 1985, this had tumbled to 38 percent.[4] Conversely, export market shares for the EC, Australia, Argentina, and Canada generally improved in the mid-1980s compared with the previous decade. As of 1986-87, Argentina was the single largest foreign exporter of coarse grains. Furthermore, minor exporters—China, Thailand, and South Africa—also experienced export growth in the 1980s. In short, despite an 11-percent decline in the value of total world agricultural exports between 1981 and 1985, most foreign exporters increased their market shares while the United States consistently faced decreasing exports.[5]

Since 1986, the U.S. has raised its share of world coarse grain trade. In 1987, according to USDA, increases in the U.S. export market share came at the expense of other exporters, especially Australia, Argentina, and Thailand.[6] At the same time, several EC countries, in addition to France,

[4]According to USDA, U.S. coarse grain exports improved by a little over 10 mmts in 1986-87, raising market share to nearly 57 percent.

[5]World grain trade declined by 2 percent on an average annual basis between 1980/81 and 1986/87. For the same time frame, rice trade fell by less than 1 percent on an average annual basis.

[6]World demand remained sluggish, but U.S. commodity programs helped raise export volumes; however, due to low prices, there was little net impact on exports in value terms.

are rapidly approaching self-sufficiency in grains. This will undoubtedly force the French to find external markets for their grain and increase the international competitiveness of the grain market.

Rice Production and Trading Trends

The developing countries of the world are the world's largest producers, consumers, and importers of rice. In 1986, they produced 56 percent and consumed 57 percent of the total world rice output. Because of increased fertilizer usage, adoption of high yielding varieties, and effective government programs, rice production has significantly expanded in Southeast Asia since the 1960s. In addition, the LDCs imported nearly 78 percent of all rice traded on the world market in 1986.

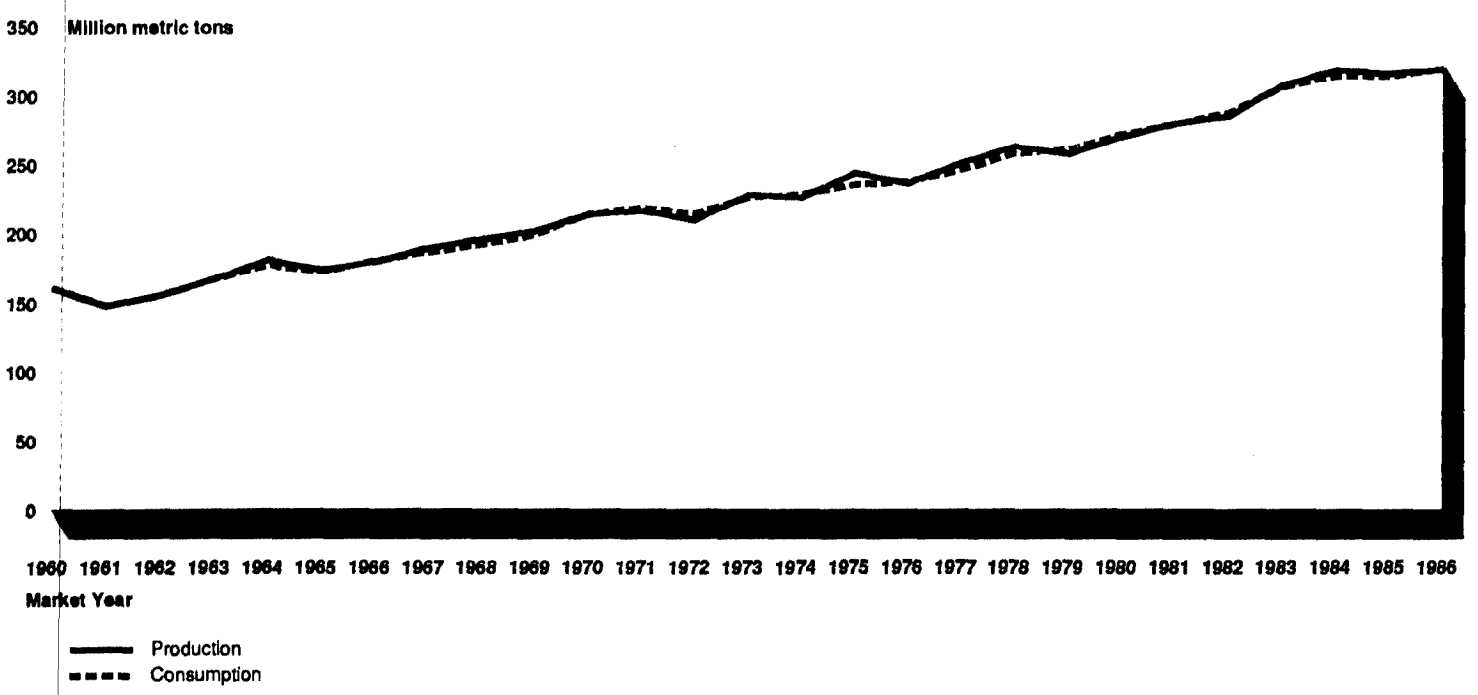
As figure 2.5 shows, world rice production has doubled since 1960, rising from 160 mmts to 320 mmts in 1986. World consumption has generally lagged slightly below production levels, resulting in a slow, gradual buildup of rice stocks, mostly in the consuming nations, such as Indonesia, India, and South Korea. However, in the 1980s, a shift occurred toward the United States as a major world holder of rice reserves. U.S. rice exports fell in light of reduced world demand, competition from other major exporters, and high prices due to U.S. farm policy.

The world's major rice producers are China, India, Indonesia, Bangladesh, Thailand, and Japan. Because of strong domestic demand, however, only two of these countries are major rice exporters— Thailand is currently the world's largest exporter and China has become the fourth largest exporter in the 1980s. Both Pakistan and Burma are small but consistent net rice exporters. The United States is a very small rice producer in comparison with most of these countries, growing approximately 1 percent of total world output. Nevertheless, the United States devotes a great deal of its production to exports and supplies 15 to 20 percent of total world rice exports, making it the second largest exporter.[7]

A significant development among rice exporters in the 1980s has been the decline of U.S. exports and the subsequent rise in Thailand's position as the top export market share holder. U.S. rice exports declined by 15 percent between 1980 and 1986 while exports from Thailand increased by 31 percent (see fig. 2.6, p. 28). Most analysts agree that U.S. rice

[7]Italy is the only other developed country among the top rice exporting countries. The Italians produce less than one-half of 1 percent of total world rice production but currently are the fifth largest exporters.

Figure 2.5: World Rice Production and Consumption, 1960-86



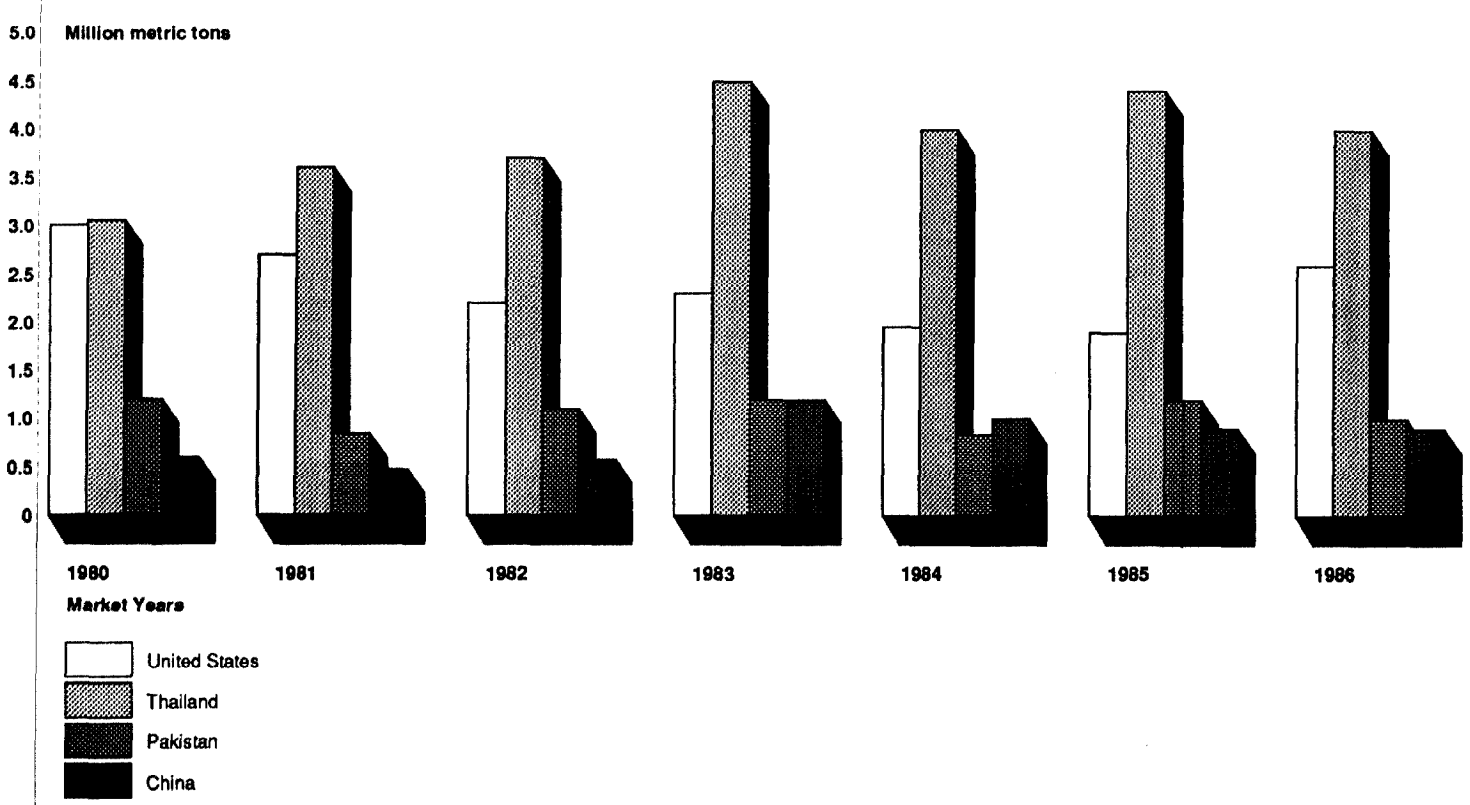
Source: Economic Research Service/USDA.

exports declined because of a combination of factors, including unfavorable exchange rates, poor weather conditions, and noncompetitive prices created by the adverse effects of existing farm legislation.[8] Even though U.S. rice prices were relatively low in comparison to past years, they were still twice as high as prices charged by other rice exporting countries. The U.S. loan program kept U.S. prices propped up at the loan level, thus preventing any adjustments to meet world competition. Thailand, on the other hand, adopted aggressive exporting policies and has achieved its marketing success without extensive use of production or export subsidies.

The rice import market has also gone through some important changes over the last 25 years. Although rice trade grew only moderately during

[8]Furthermore, a significant portion of U.S. rice exports is noncash sales occurring under foreign food assistance or export credit programs such as Food for Peace (PL-480), the Commodity Credit Corporation Export Credit Guarantee Program (GSM-102), and CCC African relief exports. In 1982, noncash sales were only 13 percent of total U.S. rice exports; this figure grew to 56 percent in 1985, the highest percentage in 10 years. USDA estimates for 1986 and 1987 are lower, 34 percent and 46 percent, respectively.

Figure 2.6: Rice Exports in the 1980s: United States and Major Foreign Competitors



Source: Economic Research Service/USDA.

the 1960s, rapid import growth occurred in the 1970s. The Middle East (Iran and Saudi Arabia), Nigeria, Ivory Coast, and the EC all increased rice imports as consumption levels rose. Between 1980 and 1986, world rice imports declined 20 percent in response to slower world economic growth. Four significant U.S. markets have virtually disappeared—Indonesia, Iran, the Republic of Korea, and Nigeria. Brazil, Iran, Iraq, and Saudi Arabia—all modest importers in 1970—are now the top importing nations. Asian countries accounted for over 37 percent of U.S. exports in 1976 but only 11 percent in 1985. African countries accounted for less than 12 percent of U.S. exports in 1976 but over 28 percent in 1985. U.S. rice exports to the Middle East have also risen during the same time frame, from 23 percent to 33 percent of total U.S. exports. This represents a significant shift in market destinations for U.S. rice exports.

Despite rising world production and consumption, rice trade has always been a very small share of world rice production, averaging between 2 and 4 percent since 1960. This compares with 15 percent for coarse grains and 22 percent for wheat. As such, the international rice market is thinly stretched and very volatile—a handful of exporters are dependent upon many small-quantity importers and just a few large ones. Rice trade can also be severely and quickly affected by disruptions in normal rainfall patterns in the large Asian producing regions where irrigation plays a small role. Even small production increases in self-sufficient and marginal exporter countries could cause major disruptions and trading tensions in the international rice market.

Although U.S. market share plummeted to 17 percent in 1985, U.S. rice exports have steadily improved since 1986, largely the result of provisions in the Food Security Act of 1985 that made rice prices more competitive. In 1986, U.S. market share improved to 19 percent and in 1987, to 20 percent. According to USDA, P.L.-480, GSM-102 credits, and the Export Enhancement Program helped to maintain and even expand the U.S. market share. In 1987/88, world consumption will most likely exceed production because of poor harvests in South and Southeast Asia, reduced stocks, and tight supplies.

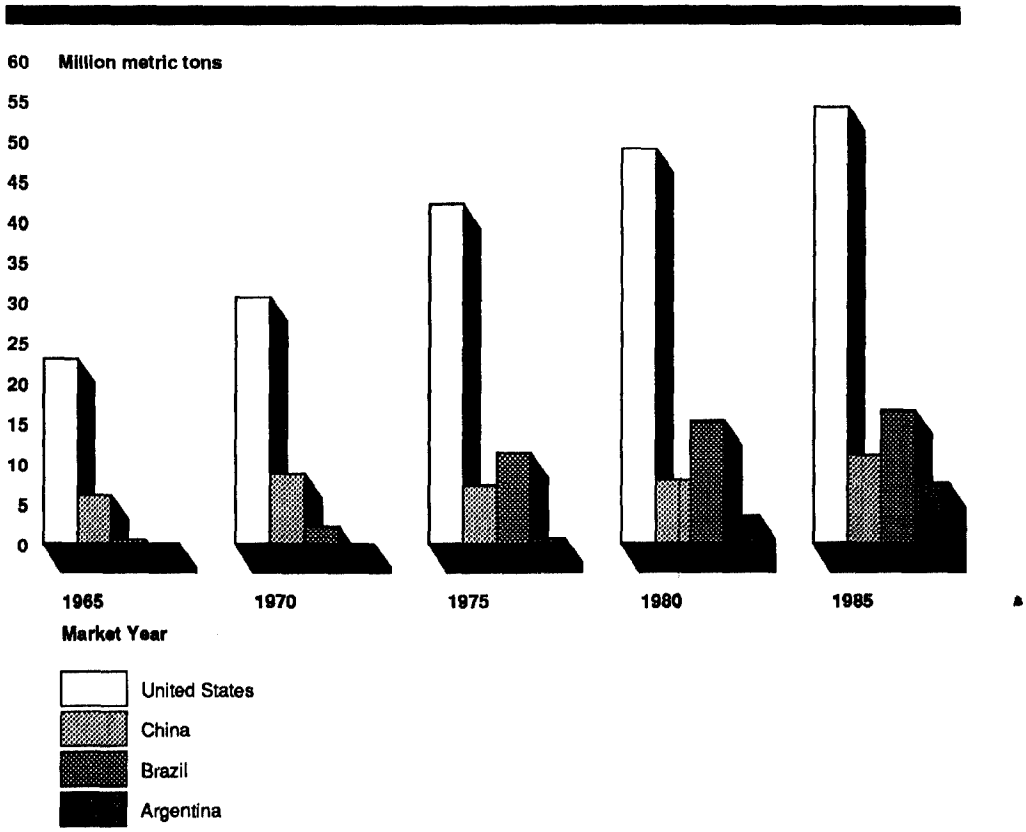
Soybean Production and Trading Patterns

Utilization of oilseeds, especially soybeans, grew rapidly during the 1960s and 1970s.[9] This increase in demand was due primarily to increased feeding requirements for the growing livestock and poultry sectors. However, some of the change can also be attributed to an increased use of vegetable oils in both food and industrial products. During the 1960s and 1970s, soybeans became the world's most important edible oil crop with respect to both meal and oil content of production. In 1983-84, world soybean production was nearly one-half of the total world oilseed production of 164 million metric tons.

[9]Other than soybeans, major oilseeds include palm, coconut, rapeseed, sunflower, and cottonseed. Most are used to produce vegetable oils used in cooking oils and margarine or protein meal used as a protein source in animal and poultry feeds.

As shown in figure 2.7, the United States has always been the largest single producer of soybeans and has held more than 70 percent of total world soybean trade since the mid-1970s. The United States exports primarily raw soybeans and lesser amounts of soybean oil and meal. Brazil and Argentina expanded their soybean production rapidly in the 1970s, but both have focused more on exporting meal and oil rather than raw beans. China also expanded soybean production until the 1970s and then slightly decreased output until expanding both production and exports again in the 1980s. Paraguay has also displayed both production and export growth in the 1980s; however, levels are very small in comparison with those of other major producers and exporters.

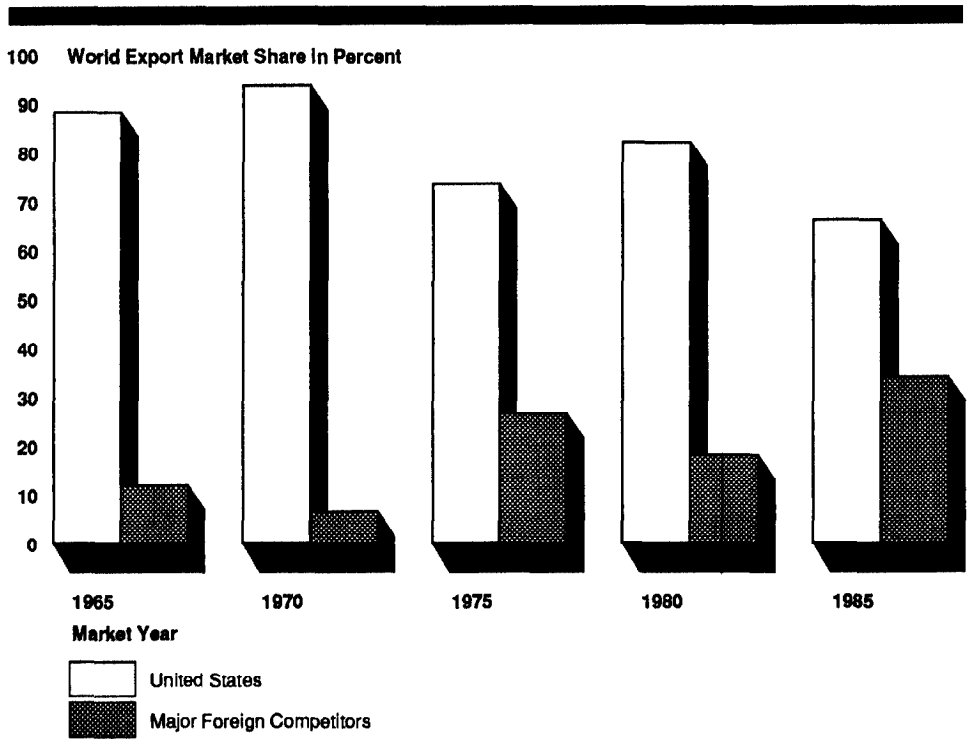
Figure 2.7: World Soybean Production: United States and Major Foreign Competitors, 1965-85



Source: Economic Research Service/USDA.

World soybean trade exploded in the 1970s, doubling in volume by the end of the decade. Despite record high soybean production in 1972/73, strong foreign demand combined with a sharp decline in world fishmeal production tightened protein meal supplies and caused soybean prices to rise rapidly. In response to tight U.S. domestic supplies (caused by less than optimum weather) and heavy foreign demand (due to crop failures in some producing countries and devaluation of the dollar, which made U.S. exports cheaper), the United States imposed an export embargo on soybeans and soybean meal, cake, and oil in June 1973.[10] Because of favorable prices, rapidly rising world demand, and favorable growing conditions, both Brazil and Argentina quickly expanded soybean production and exports. Chinese exports have also risen since 1984 because of rapid production gains and increased import demand in Japan and other Asian importing countries. Figure 2.8 shows soybean export volumes for the United States and major foreign competitors.

Figure 2.8: Soybean Export Volumes for the United States and Major Foreign Competitors, 1965-85



Major foreign competitors include China, Brazil, and Argentina.

Source: Economic Research Service/USDA.

[10]The embargo also included cottonseed and cottonseed meal, cake, and oil. From July 2, 1973, to October 1, 1973, the Office of Export Control of the U.S. Department of Commerce administered an export licensing system under which exports of soybeans were permitted on a contract-by-contract basis, after consideration of domestic needs.

The EC, Japan, Taiwan, South Korea, and the USSR have been the primary soybean and soybean product import markets. The EC has been the principal world import market for the last 20 years, constituting approximately 60 percent of total world imports. The EC countries have used soymeal as a feed for livestock and imported soybeans to support an expanding meal processing industry. The recent decline in soybean trade in the 1980s can be traced partly to recessionary conditions in the world economy in the early part of the decade. In addition, the EC import pattern has changed in the 1980s as soybean production has risen in response to high producer prices. Imports of meal for feed use have leveled off as domestic meal has risen as well.

Compared with grain production, soybean production and exports are less affected by government subsidies and importing restrictions. A few exceptions do exist, the most notable being the EC. The EC has stepped up its own production of soybeans and other oilseeds, particularly rapeseed and sunflower. Recent policies indicate a trend toward less reliance on soymeal as a major protein feed source because of the EC's increased ability to produce alternative oilseeds. EC minimum prices for oilseeds are currently three times higher than world prices, which cost the Community some $2.85 billion in 1986, up more than 50 percent in 1 year. Government programs also make up the difference between the world price and the much higher producer price that the crusher must pay to domestic oilseed producers. Thus, the EC oilseed program is designed to ensure that domestic seeds are processed and used in the EC. According to USDA, the subsidies to oilseed crushers have also been largely responsible for the EC remaining competitive in the world vegetable oil market and maintaining its market share.

In short, USDA commodity analysts have concluded that the soybean export market will most likely stay extremely competitive through the remainder of the 1980s. Production increases in the South American exporting countries—Brazil, Argentina, and Paraguay—combined with the increase in other oilseed production and usage in Europe and the USSR will most likely ensure a competitive international market. Similarly, most LDCs have not increased soybean imports since the 1981-83 world recession because of burdening foreign debts, higher soybean prices, and slower livestock production rates. As a result, U.S. soybean surpluses continued to grow to unprecedented levels in 1985 and 1986, constituting between 60 and 70 percent of world supply totals.

Recent Improvements in U.S. Agricultural Exports

In the past 2 years, U.S. agricultural exports have risen in volume and value by approximately 30 percent. USDA data indicate that for fiscal year 1987, aggregate U.S. bulk product exports rose in volume for the first time since 1980. Table 2.1 displays the changes in both volume and value for major U.S. food export bulk commodities since 1984 and presents USDA estimates for fiscal year 1988. Export volumes for wheat and coarse grains improved in 1987 and 1988, while rice, soybean, and soybean product exports have only seen modest change. However, 1987 export prices for all the commodities did not come close to recovering to levels of just a few years ago. As a result, the mild recovery in commodity prices offset the gain made in export volume in 1987; examining one without the other fails to provide an accurate picture of changes in U.S. agricultural exports. USDA forecast figures for 1988 show continued improvement in wheat and coarse grain export volumes and values. Export volume for rice is expected to slightly decline, while overall export value will improve slightly. In addition, USDA forecasts indicate that soybean and soybean product export volume and value (except for soybean oil) will remain close to 1987 levels.

Table 2.1: Export Volumes and Values of Major U.S. Bulk Food Commodity Exports: Fiscal Years 1984-88

	Volume (million metric tons)					Value (billions of dollars)				
Commodity	1984	1985	1986	1987	1988[a]	1984	1985	1986	1987	1988[a]
Wheat[b]	42.8	28.5	25.5	29.5	41.5	6.8	4.4	3.5	3.1	4.6
Coarse grains[c]	55.5	55.4	36.3	47.6	53.3	8.2	6.9	3.8	3.7	5.2
Rice	2.3	2.0	2.4	2.4	2.2	.9	.7	.6	.6	.7
Soybeans	19.3	16.6	20.1	21.3	20.9	5.7	3.9	4.2	4.2	5.1
Soybean oil	.8	.8	.6	.5	.9	.6	.6	.3	.2	.4
Soybean meal	4.9	4.5	5.5	6.6	6.2	1.2	.8	1.1	1.3	1.5

[a]USDA estimate.

[b]Includes wheat and wheat flour.

[c]Includes corn, oats, barley, sorghum, rye, and products.

Source: USDA, Economic Research Service, World Agriculture Situation and Outlook Report, WAS-48, June 1987 and USDA, World Agricultural Outlook Board, Outlook for U.S. Agricultural Exports, December 1988.

In one sense, this information signals a bright spot for U.S. agricultural exports in that export volumes and market shares for some bulk food commodities have risen after several years of annual declines. According to USDA data, gains in U.S. market share in 1987 appeared to have come at the expense of other foreign exporters—a reversal from the opposite trend between 1982 and 1985. To illustrate, USDA data show

that world coarse grain trade increased only slightly, by 2 million metric tons, compared with a U.S. coarse grain export volume increase of 11 mmts. In addition, USDA analysts have reported declining food and feed grain production and/or yields in 1988 for many countries, such as the Soviet Union, Thailand, and South Africa. Some countries have cut back production in response to policy changes, while others have experienced poor harvests because of weather.

On the other hand, close examination reveals that the turnaround in U.S. agricultural trade is a modest step toward regaining exports lost during the first half of the 1980s. Since the per unit prices of some commodities—such as wheat and corn—has declined, the value of grain exports continued to fall in 1987. At $7 billion, the value of wheat and coarse grain exports in 1987 was less than 50 percent of that recorded in 1984 (in current dollars) and the lowest since 1973.

Moreover, most of the rebound in exports has come from increased volume. Despite tighter supplies, reduced stock levels, and increases in prices for grains and oilseeds, export values have not fully recovered. Although import demand has picked up in some countries, export volume increases are due largely to improvements in U.S. competitiveness. U.S. agricultural exports have benefited from the lower-valued U.S. dollar and increased use of the Export Enhancement Program (EEP), which has subsidized exports to foreign customers. According to USDA data, EEP sales accounted for 7 percent of the value of total U.S. agricultural exports in 1987 and almost one-half of the volume of wheat and flour exports. The EEP has played an even more prominent role in 1988, with nearly 70 percent of U.S. wheat exports coming under the program. In addition, aggregate increases in total U.S. food export values in 1987 were influenced more by high-value food exports (fresh fruits, vegetables, and dairy products) than traditional bulk commodities.

Whether these improvements in U.S. agricultural exports will be maintained remains uncertain. Some analysts argue that U.S. agricultural exports are (and will be) affected more directly by changes in world trade growth. Therefore, the longer-term direction of world agricultural supply, demand, and trade will likely be influenced by three important, interrelated factors affecting domestic crop production and usage in both exporting and importing countries.

First, future economic growth, particularly for the low- and middle-income LDCs, is paramount to higher levels of agricultural trade. Population growth in the LDCs will provide a steady growth base for food

demand, but income-derived demand—particularly for feedgrains, meats, and high value food products—will be a more dynamic element. Still, LDCs with rapid population growth rates may be more vulnerable to swift swings in world food supplies brought about by adverse weather conditions.

Second, world agricultural policy directions, particularly as they may act to restrict or stimulate world food trade, will play a critical role in the direction of future food production, consumption, and trade patterns. Some LDCs are providing greater incentives for agricultural production through policy changes. The reduction of food import barriers around the world and export incentives in excess capacity countries—a major topic in the current round of multilateral trade negotiations—could bring about a tremendous surge in new importing and exporting patterns. However, if such policies remain, agricultural trade—like world trade in general—may be constrained with export competitiveness based on expensive subsidy programs.

Third, the timing of successful commercialization of new agricultural technologies and the speed of the internationalization of these technologies could possibly change traditional food production, consumption, and trade patterns in the world. Agricultural production could become more efficient, output quality could change significantly, and new growing areas could become possible. Such changes have significant long-term implications for farmers around the world.

In the next three chapters, we examine these critical, long-term influences on agriculture—macroeconomic factors, government policies, and technology—by examining the dynamics involved in their past and present effects on food production, consumption, and trade.

The Impact of World Economic Conditions on World Agricultural Production and Trade

Global economic conditions can affect agricultural production and trade significantly. Strong economic growth, particularly in the developing countries, is normally accompanied by increased food demands as higher incomes lead to dietary improvements.[1] This increased demand requires either greater domestic agricultural production or larger food imports. On the other hand, stagnant economic growth slows overall food demand because of a combination of factors, including slow or negative personal income growth and higher levels of unemployment associated with slower rates of economic development. Furthermore, without strong economic growth in foreign countries, domestic exporting industries could suffer, causing countries to lose export earnings that are critical in purchasing agricultural imports. This is especially true for the developing countries and centrally planned economies; without foreign currency export earnings, foreign imports become extremely difficult and dependent upon loans or concessions.

The contrast between world economic conditions of the 1970s and those of the 1980s provides a key understanding of some critical causes behind the agricultural trade boom of the former period and bust in the latter. During the 1970s, the less developed countries contributed to a sharp rise in global food import needs. Increased food imports were financed through (1) increased foreign currency earnings from LDC exports to industrialized countries and (2) loans from foreign governments and international banking institutions. The rapid growth in world food demand greatly benefited U.S. farmers since they could quickly deliver large volumes at more competitive costs. Furthermore, because the prices of most agricultural commodities traded internationally are denominated in dollars, the declining dollar exchange rate during the 1970s lowered food prices for many countries in terms of local currencies. This situation encouraged imports by foreign countries, especially for U.S. commodities, thus contributing to an already rapidly expanding global economy and world trade flows.

In the 1980s, a reversal of these conditions occurred. A tightening of monetary policies and the resulting rise in interest rates contributed to lowered inflation, a very strong dollar in currency markets, a general global economic slowdown, and a heavy debt servicing burden for many LDCs and Eastern Europe, which had almost all of their debt in floating

[1]South Korea and Taiwan serve as two examples of the economic relationship between economic development and the emergence of markets for farm products. According to USDA, South Korea purchased some $2.1 billion worth of farm products in 1981, more than the value of all U.S. food aid provided to South Korea between 1955 and 1979. Similarly, Taiwan now imports 60 percent of all its cereals.

interest rate loans. These events dampened many world trade flows, including agriculture. In short, demand patterns have quickly changed in part because of changes in the world economic climate.

In light of these adverse economic conditions, many importing countries focused on increased agricultural production and self-sufficiency-oriented agricultural policies. A tightening of monetary restraint policies in most of the industrial countries contributed to rising real interest rates in the international currency markets and to a rapid appreciation in the real value of the U.S. dollar. Between 1980 and 1985, the real effective U.S. exchange rate rose almost 50 percent—more than twice the decline of the dollar that had occurred from 1973 to 1980. The rise not only affected the international price competitiveness of U.S. agricultural exports but also reduced debt-laden LDCs' capacity to finance imports, since most existing loans were short-term and denominated in dollars. Since 1985, the U.S. dollar has depreciated sharply against most major world currencies, especially the Japanese yen and the European currencies. This rapid decline is partially responsible for the subsequent volume increases in U.S. agricultural exports (particularly wheat and grains) in 1987-88. In short, the interdependence of trade with monetary policy and indebtedness has intensified in the 1980s.

Economic Events of the 1970s Brought About Rapid Growth in Food Production and Trade

The economic events of the 1970s produced shifts in economic power among groups of countries due to dramatic changes in international prices of major traded commodities, primarily oil.[2] Likewise, fundamental changes in international finance also occurred, the most notable being the collapse of the Bretton Woods fixed exchange rate system and a subsequent shift to a global floating exchange rate in 1973.[3] Despite these events, world trade flourished in the 1970s.

The growing interdependence of agriculture and macroeconomic conditions linked agriculture much more closely to powerful global economic forces. Two events, in particular, contributed to the rapid expansion of agricultural trade and production in the 1970s: (1) the abundance of international cash and credit and (2) the decline in the value of the U.S. dollar against most world currencies.[4]

Abundance of Cash and Credit Spurred Food Imports

When oil prices almost instantly quadrupled in 1973 at the time that the Organization of Petroleum Exporting Countries (OPEC) curtailed oil production, the entire international financial environment dramatically changed. Foreign exchange revenues moved from petroleum importing countries to low- and middle-income oil exporting countries. This influx of foreign exchange allowed OPEC countries to greatly expand their agricultural imports, starting the 1970s export boom in food and feed grains. The European industrialized countries and Japan—which were providing most of the redistributed revenue through higher oil import costs—had sufficient foreign exchange revenues to pay the costs of increased import bills while maintaining agricultural imports. The poorer, non-oil-producing LDCs, however, had to reduce both food and nonfood imports because of the increased demand put on their scarce

[2]Included among the other commodities experiencing dramatic price increases between 1973 and 1981 are bauxite and rubber (quadrupled in value), coffee and aluminum (tripled in value), and nickel and copper (doubled in value).

[3]From 1945 to 1973, exchange rates among countries were fixed in accordance with the international agreement reached at Bretton Woods, New Hampshire, in 1944. Under this system, the value of the dollar was defined in terms of gold and all other currencies were fixed in relation to the dollar. The exchange rate for each currency could fluctuate only 1 percent above or below the fixed value of the currency. Each country was expected to intervene in the foreign exchange market (buy or sell its own currency) if necessary to prevent wider fluctuations. Under the floating system, economic policies and performance in the United States and abroad ultimately determine exchange rates. Changes in monetary or fiscal policies can have a substantial effect on exchange rates. For instance, tight monetary and loose fiscal policy may lead to higher "real" interest rates (adjusted for inflation), capital inflows, and appreciation of the currency. Governments may also still intervene in foreign exchange markets by buying and selling foreign currencies to influence the exchange rate.

[4]As subsequently discussed in this chapter, these two events also triggered borrowing actions that spurred growth in LDC debt; these debts became a constraint to agricultural trade in the 1980s.

foreign exchange used in international trading transactions.[5] However, nonfood imports were reduced more. In the Soviet Union, a major oil producer, foreign currency revenues grew quickly, allowing policy changes designed to import more food for dietary improvements to be implemented.

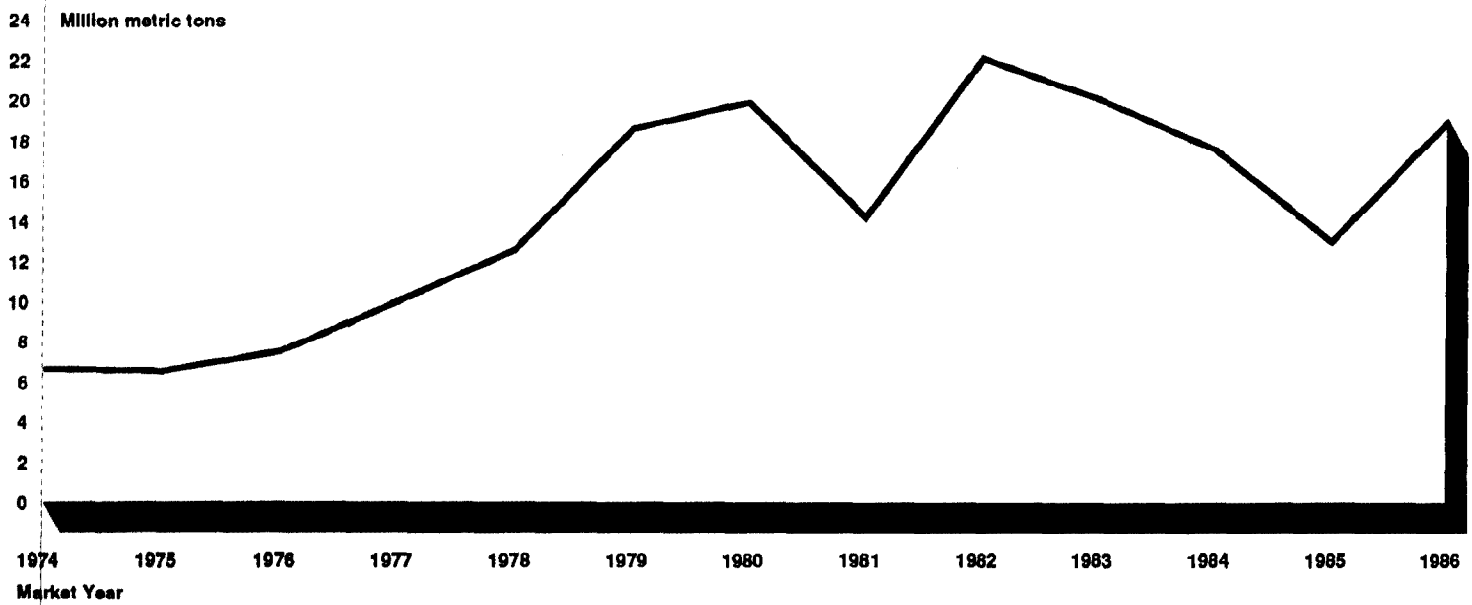
Despite the increase in oil prices, world economic growth quickly resumed. The resulting change in trade flows and expansionary monetary policies of most developed countries generated liquidity previously unavailable to the international financial system. The OPEC nations were able to absorb only a small portion of their new oil revenues and began recirculating some of these funds in the form of loans and investments abroad. The supply of loanable funds in Western banks and lending institutions increased, helping to ease the impact of rising oil prices on the industrialized countries. More importantly, this new liquidity—combined with decisions to expand money supplies in both the United States and other industrialized countries—made it easy for the emergence of massive lending programs to low- and middle-income LDCs. Therefore, these countries were able to sustain or increase imports of agricultural and industrial products, providing the main impetus for agricultural export growth in the 1970s.

From 1975 to 1980, developing countries provided the fastest growing markets for U.S. agricultural exports. Total agricultural commercial sales grew from 30 to 35 percent, with middle-income countries responsible for most of this growth. Two of the largest volume agricultural commodities experiencing growth in consumption during this period were wheat and coarse grains. Figure 3.1 shows LDC imports of U.S. coarse grains since 1974. The increase in U.S. export volumes was phenomenal during the period 1974 to 1980, rising from around 36 mmts to nearly 71 mmts. The U.S. share of the world market also grew from just over 50 percent to nearly 66 percent in 1979.

The U.S. share of wheat imported by the LDCs grew from 44 percent to 54 percent between 1970 and 1975. As shown in figure 3.2, LDC imports of U.S. wheat continued to grow in the latter half of the 1970s, except for a slight drop in 1978. (In 1980, the U.S. share still amounted to 50 percent.) Imports of U.S. wheat into the centrally planned economies grew similarly during the 1970s, going from a scant 6 percent in 1970 to 36 percent by 1980.

[5]At that time, available foreign exchange was being used to finance the rising costs of oil and fuel imports.

Figure 3.1: LDC Coarse Grain Imports From the United States, 1974-86



Source: USDA/Economic Research Service statistics.

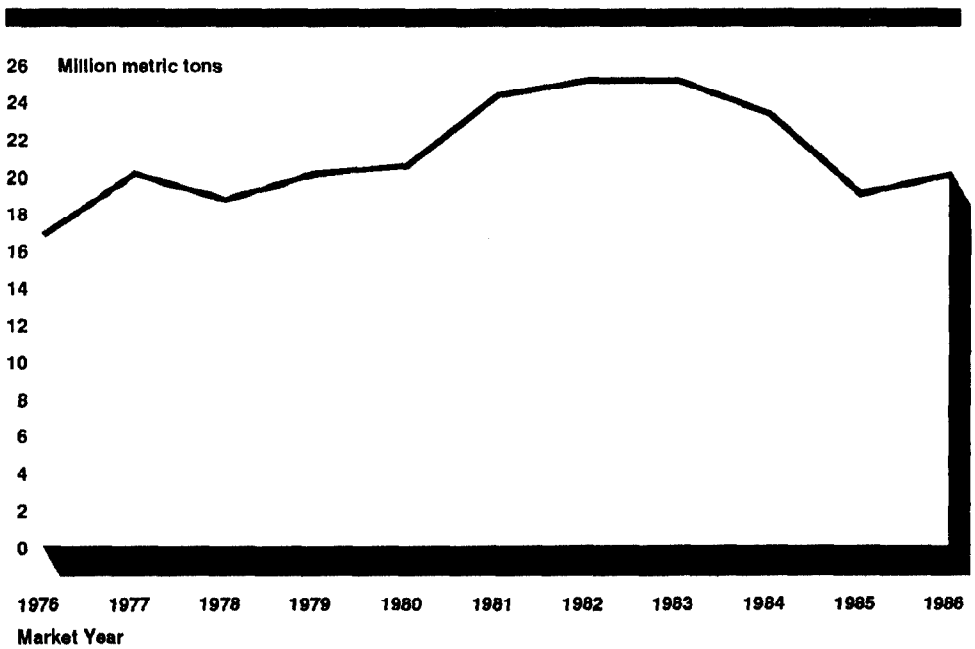
Depreciation of the Dollar Boosted U.S. Food Exports

The rapid growth in financial liquidity provided growth in financial resources that was abnormally high compared with historical levels since World War II.[6] It provided the developing nations with (1) a boost in demand for their exportable goods and services and (2) low real interest rates.[7] The dollar steadily depreciated against most of the major currencies throughout most of the 1970s. Very low real interest rates, especially in the United States, facilitated heavy borrowing by the LDCs and became an additional means to finance increased food imports. The negative real interest rates that existed throughout much of the 1970s

[6]Some economists have pointed out that the shift to a floating exchange rate system after 1973 also contributed to a rise in world financial liquidity by reducing the overall demand for foreign exchange reserves. See Mathew Shane and David Stallings, Financial Constraints to Trade and Growth, International Economics Division, Economic Research Service, USDA, Foreign Agricultural Economic Report No. 211, 1984.

[7]The sharp rise in oil prices clearly exceeded nominal market interest rates and produced rapid increases in export prices in practically all goods. The U.S. real rate of interest is derived by subtracting current inflation from nominal interest rates. The appropriate measure of real interest rates for debtor countries, such as many LDCs, is the interest rate adjusted for changes in an index of their export prices. If export prices rise faster than contracted interest rates on borrowed funds, the real rate is negative. See Shane and Stallings, Financial Constraints to Trade and Growth.

Figure 3.2: LDC Wheat Imports From the United States, 1976-86



Source: USDA/Economic Research Service statistics.

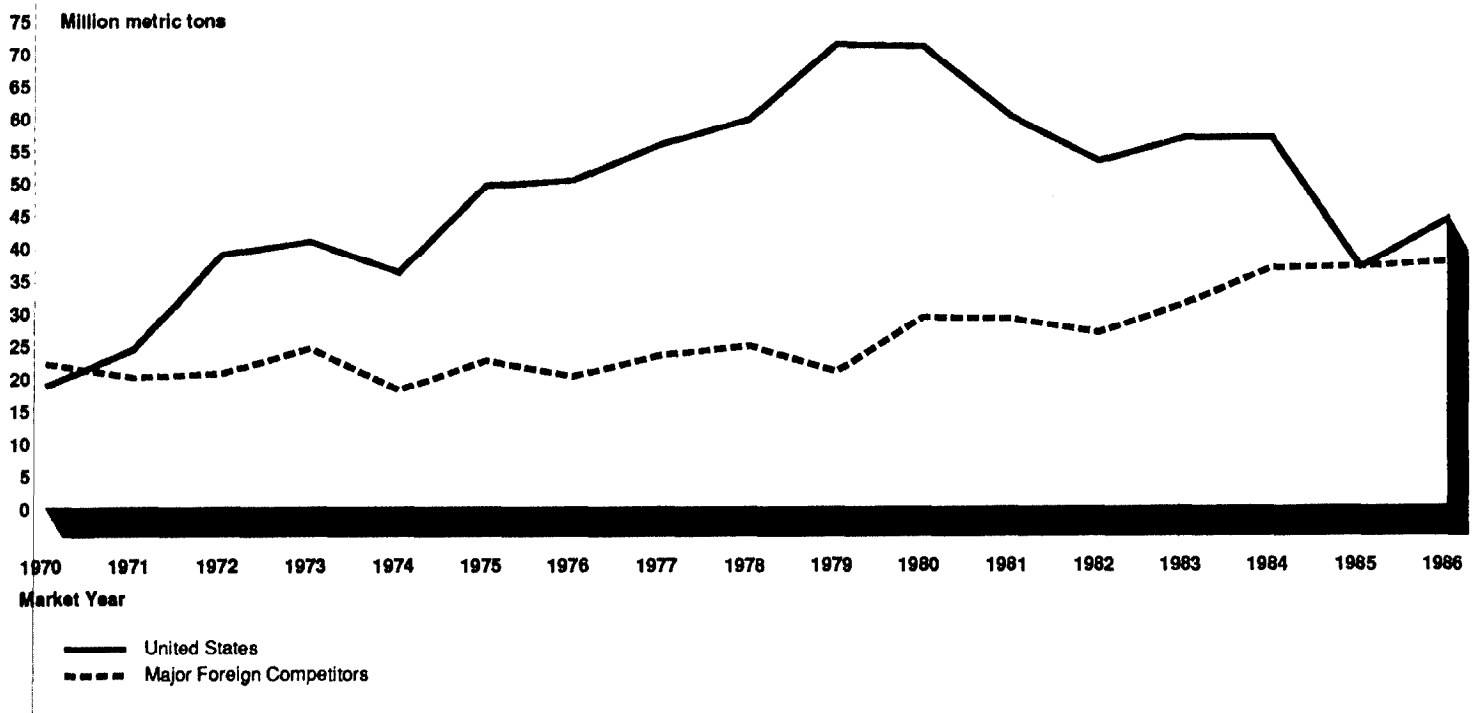
also made the question of debt repayment much easier to reconcile; however, the decision to finance food and other imports added increasingly to many LDCs' debt burdens. The reason for the negative real interest rates, in essence, was the fact that prices for LDC exports were rising faster than their contracted interest rates on borrowed funds.

Furthermore, since the United States is the world's largest agricultural exporter and most internationally traded commodities are denominated in dollars, the declining exchange rate lowered food prices in terms of foreign countries' local currencies. Lower prices encouraged imports by foreign countries and discouraged strong U.S. agricultural export competitors from expanding agricultural production.

As figure 3.3 shows, U.S. grain exports almost quadrupled between 1970 and 1980, from less than 20 mmts to over 70 mmts. The immediate impact of the oil price shock is seen on the trend line as evidenced by a sharp drop in exports between 1973 and 1974. However, after 1974, U.S. exports rose at an incredibly fast rate, the result of U.S. farmers' ability to quickly bring large amounts of land into production, superior agricultural infrastructure, and favorable agricultural investment policies. U.S. grain competitors, on the other hand, did not experience such

growth as a result of the low value of the dollar; moreover, many were experiencing increased domestic demand for grains as a result of economic growth.

Figure 3.3: Grain Exports of the United States Versus Major Foreign Competitors, 1970-86

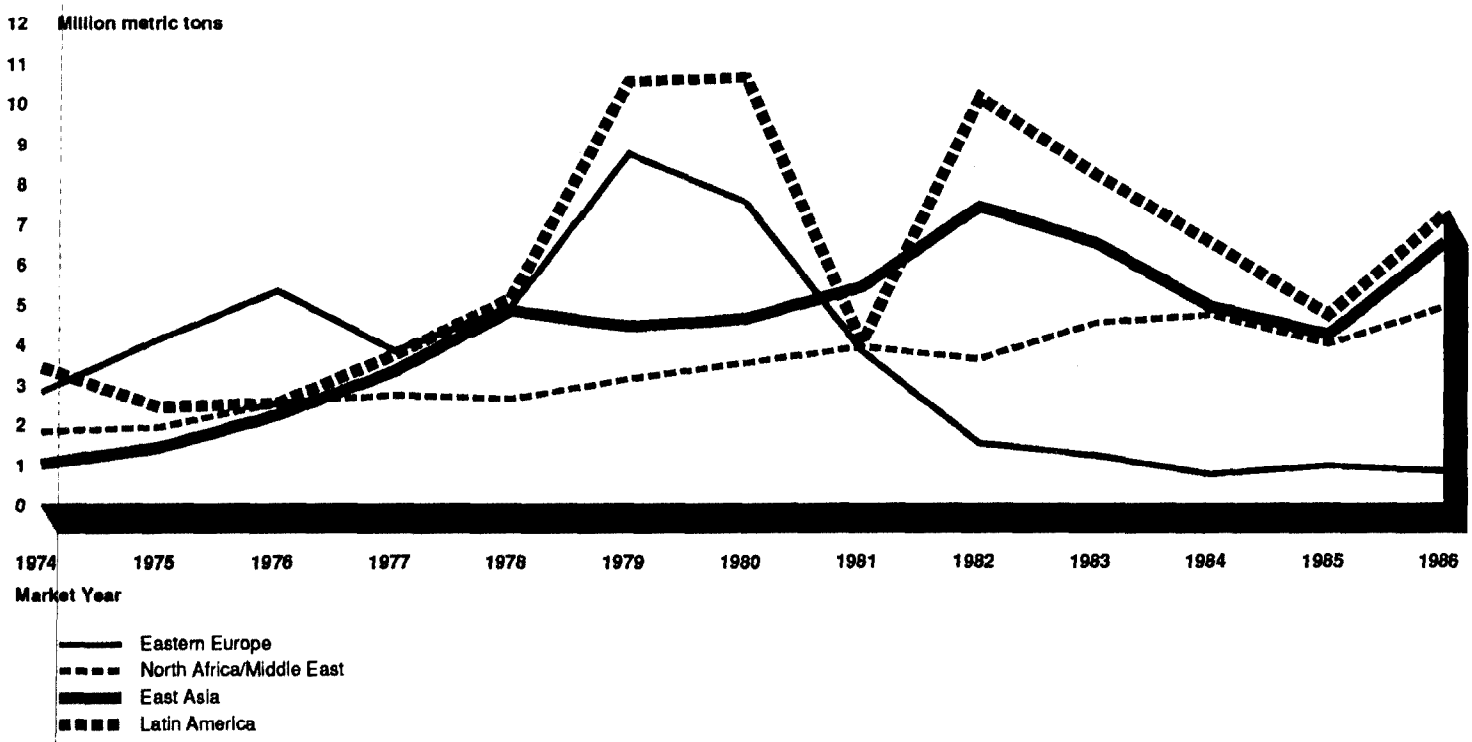


Major foreign competitors include France, Argentina, Australia, Canada, and China.

Source: USDA/Economic Research Service statistics.

Figure 3.4 shows the volume of U.S. grain imports into major world markets since 1974. Latin American imports of U.S. grain grew at an astounding rate, largely financed by increased oil revenues in Mexico and Venezuela and large purchases made with credit. Eastern European and Soviet imports of U.S. grain also rose significantly as livestock herds were increased to provide more meat in diets and grain imports were used to supplement feed grain production shortfalls. East Asian and North African/Middle Eastern imports also grew significantly, especially in the vastly improving economies of the East Asian countries. Dramatic declines in U.S. coarse grain imports occurred after 1980 as economic conditions worsened.

Figure 3.4: U.S. Coarse Grain Imports in Major Markets, 1974-86



Source: USDA/Economic Research Service statistics.

From this information, we can conclude that the tremendous growth in overall agricultural trade in the 1970s was facilitated by a world awash with cash and credit. The OPEC oil shock generated a new source of revenue for international financial and lending institutions. This made credit an easily obtainable option for LDCs as a means to finance food imports, allowing them to concentrate on developing nonagricultural exporting industries and general economic development—further adding to rising food consumption.

As world trade flourished, many countries used growing export earnings and/or low real interest loans to feed the growing dietary needs and changing demands of populations with rising per capita incomes. Agricultural production also expanded in many importing areas but did not keep pace with the rate of growth in consumption. The United States, with its comparative advantages in producing, transporting, storing, and marketing agricultural products, was in a natural position to increase

exports and its world market share. Increased production by many foreign exporters of wheat and coarse grains also was diverted to rising internal consumption.

Economic Events of the 1980s Have Diminished Agricultural Trade

Just as macroeconomic factors were important to agricultural trade growth in the 1970s, they were also dominant in bringing about an abrupt halt to trade expansion in the 1980s. The second oil price shock that occurred in 1979-80 produced a totally different policy response from the industrialized countries compared with the 1972-73 scenario. High inflation—the result of policy responses to the first oil shock—was no longer acceptable to the industrialized governments; hence, contractionary monetary policies were implemented by the United States and other Organization for Economic Cooperation and Development (OECD) countries to curtail it. This concerted effort to slow monetary growth sent a prominent shock to the international financial system by (1) slowing economic growth, (2) generating a sharp appreciation of the U.S. dollar, and (3) raising real interest rates.

Consequently, the LDCs—a major source of food export growth in the mid- and late seventies—were immediately faced with debt repayment problems due to a drop in their own exports and rising interest payments on short-term loans mainly denominated in dollars. World demand for food slowed or dropped in these and other areas, while agricultural policies and investments in major exporting countries—constructed on the premise of rapidly growing demand patterns of the late 1970s—continued to push production levels upward.

Partially because of the appreciating dollar, U.S. farm exports quickly became noncompetitive on the world market. The economic effects of the loss of export income were compounded by the increased need to support farmers who had lost markets and, since U.S. domestic agricultural production continued rising, to store excessive crop surpluses.

In addition to the high value of the dollar, the Agriculture and Food Act of 1981 set loan rates in the United States for the next 4 years that turned out to be far above market clearing levels.[8] High U.S. loan rates

[8]The nonrecourse loan is made to farmers by USDA's Commodity Credit Corporation using a quantity of the commodity produced as collateral at a given "loan rate" per unit of commodity. The farmer may elect to repay the loan plus accrued interest within a specified period of time or default on the loan, in which case the ownership of the commodity passes to the CCC, thereby satisfying the loan obligation. The latter action is taken if current market prices are at or below the established loan rate. As such, the loan rate serves as a floor or minimum price to the farmer for the commodity.

in 1982 and 1983 provided a real floor, not only for U.S. prices but also for the entire world market, at levels higher than the uncontrolled interplay of market forces would have dictated. These high prices ensured the profitability of efficient producers (i.e., Canada, Australia, Argentina) while allowing the EC to hold its export subsidies to relatively low levels.

Non-U.S. suppliers were allowed to increase production and export sales without fear of driving the price below the U.S.-based loan rate. The government held down U.S. production through acreage reduction requirements in 1982 and, when these proved insufficient, introduced payment-in-kind to further reduce production in 1983. Other countries, however, felt no similar constraints, and their production increased. As a result, U.S. export sales of wheat declined about 20 percent between 1981-82 and 1983-84, while stocks were increased by a like margin because of government defense of loan rates. Other suppliers increased international sales by slightly more than the U.S. contraction.

The Effect of Monetary Contraction on U.S. Agricultural Exports

Monetary contraction was the primary response of the industrialized nations to the oil price increases in 1979-80. The industrialized countries attempted to halt inflation, which set the stage for the world recession of 1981-83.

As incomes in both developing and industrialized countries grew more slowly (or declined in some instances), the overall demand for agricultural commodities also slowed considerably, especially the higher-priced U.S. commodities. In middle-income developing countries and the industrialized nations, demand for poultry and beef fell; this meant decreased needs for imported feed grains. The United States, being the largest feed grain exporter, suffered export declines and found itself with an immediate surplus production capacity in wheat and corn, since cropland had been expanded significantly in the 1970s.

The importance of the developing countries to U.S. exports is illustrated by the fact that in the mid-1980s, 93 of the developing countries made up approximately one-third of the U.S. export markets for agricultural commodities. These countries have the potential to increase or decrease total U.S. agricultural exports by almost 20 percent.[9] The drop-off of exports from developing countries removed a major source of both income growth and financing for increased food imports during the

[9]Shane and Stallings, Financial Constraints to Trade and Growth.

early 1980s. Those developing countries exporting agricultural goods did not fare well because of depressed world import demand and low world prices brought about by excess supplies. According to statistics compiled by the Food and Agriculture Organization of the United Nations, in LDCs as a whole, the dollar value of agricultural exports declined by 1.2 percent a year during 1980-84, after expanding almost 7 percent a year in the 1970s. In short, the purchasing power of agricultural exports from the developing countries either stagnated or deteriorated in the early 1980s, thus eroding an important source of world trade growth.

Table 3.1 shows agriculture export and import trends for selected LDC regions. Compared with the situation in the 1970s, all regions except Latin America and South Asia experienced declines in export growth rates between 1980 and 1984. Latin American countries (Mexico, Venezuela, Brazil, and Argentina, especially) pursued deliberate exporting policies because of debt servicing problems. South Asian exports grew as a result of dramatic turnarounds in both agricultural production and economic conditions in China and India. Except for the Asian regions, all areas experienced a dramatic drop in import levels in the 1980s compared with levels in the 1970s, partly the result of import restrictions, indebtedness, and global recession.

Table 3.1: Average Growth Rates in Exports and Imports for Selected Regions

Numbers are percentages

	Total exports		Total imports	
Region	**1971-80**	**1980-84**	**1971-80**	**1980-84**
Latin America	5.6	6.6	5.1	-4.7
Northwest Africa	12.2	−1.4	10.4	1.2
Near East	14.7	−9.7	15.1	7.5
East/ Southeast Asia	12.0	9.8	9.0	10.6
South Asia	−1.5	8.3	4.0	5.6
India	1.3	7.1	5.0	2.2
China	4.8	11.0	8.1	9.5

Source: Food and Agriculture Organization, The State of Food and Agriculture, 1985.

The sharpest decline in world output of goods and services between 1980 and 1985 took place in the oil exporting countries and in LDCs with debt servicing problems. The oil exporters experienced an annual average decrease in exports of 10 percent between 1981 and 1985. Developing countries with debt servicing problems had only modest growth in exports of 1.3 percent between 1981 and 1985, and their imports were

reduced by more than 5 percent a year. As a result, the positive economic growth rates that many LDCs experienced in the 1970s declined sharply in the early 1980s.

LDC Debt Servicing Effectively Slowed Food Imports and Forced Greater Self-Sufficiency

Debtor nations, many of them significant world agricultural importers and the best potential markets for U.S. agricultural exports, obtained U.S. dollar-denominated loans in increasing amounts during the 1970s and 1980s to finance imports and internal economic development. Most expected the loans would continue to depreciate in real value because of an expected continuation of U.S. inflation. When the opposite occurred—a huge rise in the value of the dollar—they found themselves faced with loan principals increasing in real value and rising real interest payments.

Many indebted developing countries have suffered a tremendous loss in purchasing power as substantial portions of their national budgets go toward debt repayments. LDC debt in 1987 totaled over $950 billion, with approximately $380 billion concentrated in Latin America.[10] Middle-income oil producing LDCs account for a substantial portion of the LDC debt. Major U.S. agricultural market countries accounted for two-thirds of the total LDC debt in 1984. A majority of these countries also held more than 40 percent of this debt in short-term and private categories that are most subject to swings in interest rates since they are normally written on variable interest terms.

A general rise in interest rates—the result of tightened monetary restraints—also occurred after 1980 and further complicated world agricultural trading patterns. Loans initiated in the 1979-81 period resulted in debt service obligations that most LDCs could not meet. As a result, unanticipated increases in real repayments on dollar-denominated loans occurred as the dollar continued to appreciate. This further eroded the LDCs' capacity to finance continuing levels of agricultural and nonagricultural imports.[11]

[10]Mexico, Brazil, Argentina, and Chile are major debtors in Latin America; India, the Philippines, South Korea, and Indonesia are major debtors in Asia; Yugoslavia, Poland, and Rumania are major debtors in Europe; and Egypt and Turkey are major debtors in North Africa and the Middle East.

[11]The Federal Reserve's tight monetary policy, combined with sharp increases in the federal budget deficit, produced historically high interest rates in the United States. This led to significant capital and investment flows into the United States as opposed to the sharp outflows of the 1970s. The LDCs, no doubt, suffered from this change.

The reduction of capital inflows from commercial sources since 1981 (after a period during the 1970s when funds were readily available in international markets) was another dimension of the debt problem. Between 1977 and 1981, most LDC debt was owed to private creditors; however, by 1984 the net borrowing from private creditors had declined to the lowest levels since 1973. Thus, a major source of LDC financing for food imports and economic development began to dissipate. The hard currency earnings of more and more of these countries were devoted to debt repayment—money that was used in the 1970s to import food and spur economic improvements. Many LDCs have been forced to aggressively export products to make debt payments, often selling at very low prices, which further depress world market prices. Some have turned to agriculture as a potential source for exports. Several factors have caused this turn (or return) to agriculture:

- growing political and social tensions resulting from high food prices, stagnant incomes, and widespread malnutrition;
- the need to quickly substitute for food imports that were using up scarce foreign exchange; and
- the fact that agriculture has been less affected by economic crises than other sectors, such as manufacturing and industry.

In short, agriculture seemed to be the most reliable source of growth, employment, and foreign exchange. Even so, the negative economic climate in many LDCs has forced many governments to curtail subsidies in agricultural development and reduce the role of government in marketing and pricing, and has forced a decline in overall agricultural investment.

Per capita incomes have suffered tremendously in some countries, falling by as much as 50 percent between 1981 and 1983 in oil exporting and debt-ridden LDCs. Such developments ultimately translate into reduced import requirements. Some middle-income debtor nations have been successful in pushing up exports as a means of tempering their debt crises, particularly the Asian countries. As a result, agricultural and nonagricultural imports in these countries have remained steady or actually grown during the 1980s and have contributed to a less gloomy picture for LDCs as a whole.

The Effect of Dollar Appreciation on U.S. Food Exports

The strong appreciation of the value of the dollar in relation to other world currencies also severely affected world agricultural trade. The dollar's strong and rapid growth hurt U.S. agricultural exports by raising prices in relation to export competitors. In short, appreciation of the dollar meant that foreign customers had to spend more of their currency to pay for U.S. agricultural imports.

The rise in the value of the dollar had a real, immediate impact on American farm exports. According to ERS, U.S. exports of wheat, corn, and soybeans were reduced by about $3 billion in 1981 and 1982 as a result of the strong dollar. This translated into a drop in export volume of 16 mmts—10 mmts in corn alone. The impact of the high dollar was more acute for soybean and corn exports because these markets are more sensitive to exchange rate fluctuations.

As figure 3.5 shows, foreign competitor production and exports picked up during the 1980s. Even though major importer demand slowed, import needs still existed and were filled more and more by U.S. competitors. Since 1983, combined foreign competitor exports of wheat and coarse grain have surpassed those of the United States. Between 1983 and 1986, increased U.S. production was steadily diverted into growing reserve stocks.

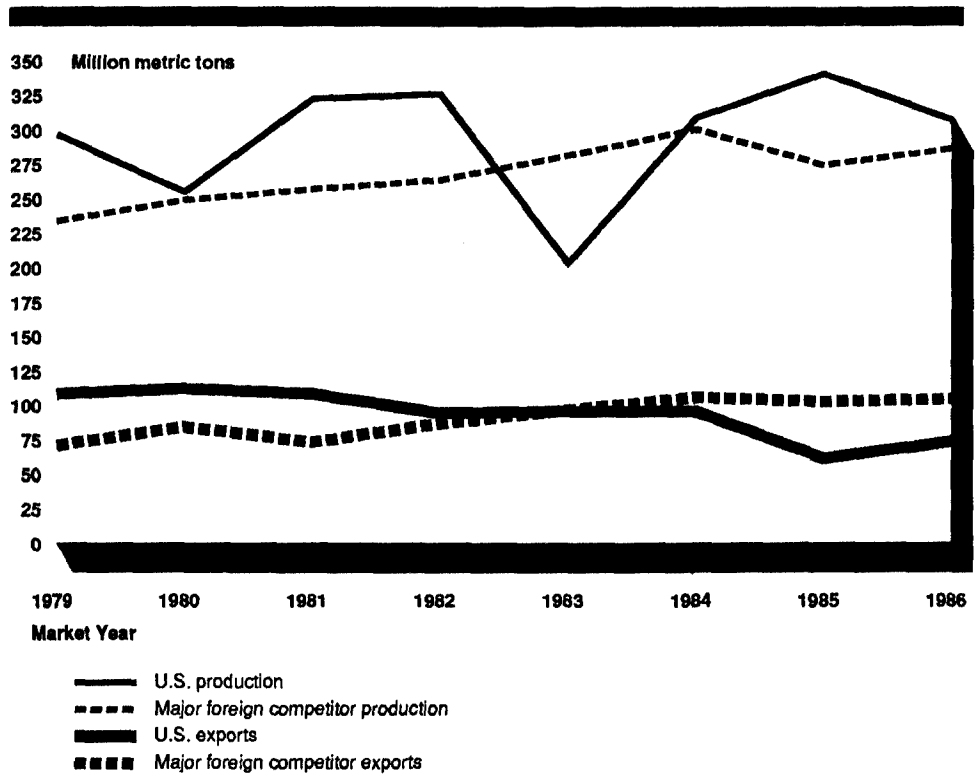
Impact of the Dollar Depreciation Since 1985 Has Produced Mixed Results

As the previous analysis of the 1970s and 1980s has demonstrated, the value of the U.S. dollar can have tremendous impact on the volume and value of U.S. trade.[12] After continually rising in value since 1978, the U.S. dollar has depreciated against most major world currencies since 1985. Measured in nominal terms against the Japanese yen and the German mark, for example, the dollar depreciated approximately 50 percent between the first quarter of 1985 and early 1988. This depreciation is benefiting U.S. exports, including agricultural commodities, since a dollar worth fewer units of foreign currency reduces the cost of these products to overseas buyers, without requiring similar declines in dollar prices.

While the decline in the value of the dollar has had an overall positive influence on U.S. agricultural exports, the impact has been slower and

[12]Analysis by USDA's Economic Research Service has suggested that for each 10 percent depreciation of the U.S. dollar compared with the currencies of major U.S. trading partners, the volume of wheat exports could increase by as much as 5 percent, corn exports by as much as 8 percent, and soybean exports by as much as 3 percent. The analysis assumes all other factors affecting trade remain constant.

Figure 3.5: Wheat and Coarse Grain Production and Trade: United States and Major Foreign Exporters, 1979-86



Includes wheat, corn, barley, sorghum, rye, oats, mixed grains

Major foreign competitors include Australia, Argentina, Canada, France.

Source: USDA/Economic Research Service statistics.

not as dramatic as many had expected. Several reasons can help explain the sluggish response of U.S. agricultural exports to the dollar's depreciation. To begin with, the dollar has not dropped as dramatically against the currencies of all importers and export competitors.[13] Against the Canadian and Australian dollars and the Thai baht—major exporting competitors—the U.S. dollar has only marginally declined. Furthermore, with the dollar appreciating more than 100 percent between the first quarter of 1985 and April 1987 against the currencies of some Latin American countries—such as Argentina, Brazil, and Mexico—their food exports have become very price competitive in the world market. Lastly, currency movements will have limited impact on agricultural trading

[13]When considered against the currencies of all U.S. agricultural importing countries and export competing countries, the dollar depreciated less than 20 percent between the first quarter of 1985 and April 1987 (adjusted for inflation).

patterns of countries that tend to buffer producers and consumers from changes in world prices. For example, the EC has continually altered its export subsidies to farmers to insulate them from exchange rate variations. When the dollar rose in value, export subsidies were reduced; when the dollar began depreciating, the export subsidies were subsequently raised. This has provided EC farmers with relatively stable domestic prices and isolated them from normal market pressures.

Constraints Remain on Agricultural Trade

Perhaps the two most dominant economic factors constraining growth in global agricultural trade since the mid-1980s have been (1) sluggish world and regional economic growth and (2) continued external debt problems in many developing countries. World real economic growth declined from 2.8 percent in 1986 to 2.7 percent in 1987. Estimates for 1988 show a modest but sluggish recovery to near 3 percent. This is still far below the 4.2 percent real rate of growth experienced worldwide in the 1976-79 period. Economic growth in the developing countries is projected to rise slightly from 2.4 percent in 1987 to between 3 and 3.5 percent in 1988, but again, this is far below the 5.8 percent growth registered for these countries during 1976-79.

LDC exporting and importing trends between 1963 and 1984 highlight the impact that strong economic growth in the developing countries can have on agricultural trade.[14] Those developing countries with higher incomes increased their agricultural imports at a much faster rate than those developing countries with low incomes. Higher incomes and population growth in the LDCs usually create food demand that eventually outpaces growth in domestic agricultural production of food and feed grains. The higher-income developing countries are largely responsible for converting the developing world from a net exporter to a net importer of coarse grains since the 1970s. Until the lower and middle-income LDCs begin experiencing economic growth and higher incomes, agricultural imports into these areas will remain constrained.

Debt servicing remains a significant problem for many of the developing countries. USDA reports that 25 percent of export earnings of all developing countries went for debt servicing payments between 1983-86; moreover, the debt-dependent major borrowers spent 50 percent of their

[14]See Gary Vocke, "Economic Growth, Agricultural Trade, and Development Assistance," Economic Research Service, USDA, Agriculture Information Bulletin Number 509, March 1987.

export income on debt repayment.[15] At the same time, export commodity prices fell by more than 20 percent between 1981 and 1988. Faced with lost export earnings and rising repayment rates, many of the developing countries have restricted imports, including food and feedstuffs. Furthermore, many LDCs have reduced domestic investment, further inhibiting economic growth rates near those achieved in the 1970s.

Some improvements are occurring in 1988, but it will be difficult for world agricultural trade to rebound completely with many countries facing stagnant economies, trade imbalances, budget deficits, high debt burdens, and declining national investment. Without sustainable economic growth in the developing countries, higher incomes leading to increased food demand will be slow in occurring. Similarly, if LDC export growth is hampered by sluggish world economic conditions (or protectionist market barriers), these countries will encounter difficulties affording new credit and generating the revenues necessary to pay for increased food imports because most of their export earnings will be servicing large debt payments.

[15]See Mathew Shane and David Stallings, "Debt Crisis in Developing Countries Hurts U.S. Agriculture," Economic Research Service, USDA, Agriculture Information Bulletin Number 546, July 1988.

The Impact of Agricultural Policies on World Production and Trade

World economic and financial conditions have not acted alone in changing agricultural supply and demand conditions; governmental policies have also played a prominent role in shifting global agricultural production and trading patterns. In many developed countries, agricultural policies have emerged, aimed at supporting and protecting farmers through subsidy programs that generally insulate domestic prices from the supply and demand functions of the world market.[1] These policies, acting as incentives to farmers, help to explain the continuing increases in agricultural production and subsequent large competitive export volumes of many developed countries.

Conversely, many developing countries have pursued policies that have inhibited maximum farm production, stilted the efficient use of agricultural resources, limited investment needed to adopt new technologies, and acted as financial disincentives for farmers. According to the World Bank, this discrimination stems largely from (1) development strategies that promote domestic industries behind high trade barriers, (2) inadequate adjustments in real exchange rates that adversely affect agricultural exports, and (3) sectoral policies that keep domestic farm prices below their world prices despite various subsidy programs. Such policies have often resulted in the need for many developing countries to spend scarce foreign exchange earnings for food imports. Still others have pursued self-sufficiency goals despite noneconomic pricing and input subsidy programs. However, some of the developing countries are reversing their disincentives to agricultural production. For instance, China and Brazil have successfully altered their governmental policies since the late 1970s to the extent that they have become net exporters of specific commodities. Largely because of adverse world economic conditions in the early 1980s, other developing countries have also begun agricultural development reform policies designed to improve agricultural production efficiency.

The major developed countries have increasingly recognized that domestic farm policies in many countries have been a principal cause of the global surplus existing for some of the major bulk agricultural commodities. For example, in September 1986, the Uruguay Round of multilateral trade negotiations were launched under the auspices of the General

[1]The United States, the European Community, and Japan are often cited as the primary examples. Some developed countries that are large agricultural producers and exporters—such as Canada and Australia—have distinguished themselves as "fair traders" and pressed for the elimination or reduction of agricultural subsidies.

Agreement on Tariffs and Trade. To bring stability to the world agricultural market, participants are calling for greater liberalization of agricultural trade through such measures as reductions in import barriers and relaxation of direct and indirect subsidies used in agricultural production and trade.

Different Policies Have Different Market Effects

Domestic policy actions influencing a country's agricultural supply/demand levels or its agricultural trade policy ultimately affect the world market. While this is especially true for large volume producers, exporters, and importers of specific commodities, even in today's constricted and extremely competitive international market, changes in just a few importers and exporters can be significant. To illustrate, Japanese policies emphasize the need for stable food supplies and self-sufficiency. To do so, the Japanese restrict rice imports and thus allow the domestic rice price to rise well above the world price. These actions assist in depressing world rice prices by artificially reducing the world market demand level below that dictated by normal economic conditions.

The general response to increased demand levels and rising commodity prices of the 1970s was to take actions that would encourage agricultural output. Policy actions included raising price guarantees to farmers, subsidizing public credit, and expanding agricultural input investments. In the developed countries, agricultural production grew to meet increased world demand and began to produce sustainable surpluses in the early 1980s. In the developing countries, productive capacity improved but in some cases still could not keep pace with even faster-rising food demands. Thus, while some developing countries were capable of moving toward greater food self-sufficiency, the bulk remained dependent on food imports.

In the early 1980s, global food demand weakened in response to a slowing world economic expansion. Many industrialized countries' agricultural policies, by providing an umbrella of high domestic prices, not only encouraged uneconomic production but also created incentives to raise output further, irrespective of market demand. These policies have resulted in a buildup of massive commodity surpluses and their disposal on the international market using aggressive export subsidy programs at even further cost to taxpayers. Many developing countries, caught in a situation of overwhelming indebtedness, find their own trade earnings (especially for agricultural exports—a major source of export earnings) faltering because of weakened demand, depressed prices, and protectionism on world markets. Thus, with their ability to finance imports

constrained, some developing countries have refocused domestic policies toward greater agricultural production capacity and efficiency. These new policy directions, combined with slowed demand, also helped create a world agricultural commodity trade market burdened with oversupply.

Agricultural Policies and Their Consequences for Production and World Trade

Objectives of Agricultural Policies

The types of agricultural policies used can have numerous consequences for a country's domestic economy, its trading partners, and international markets. The objectives of agricultural policy vary in accordance with a country's specific national priorities. To illustrate, some countries might pursue income-oriented objectives designed to maintain or stabilize farmer income parity with nonagricultural sectors of the economy. Others might pursue agricultural policy objectives designed to boost the country's economic growth to address balance-of-payment problems or high debt levels. Still other countries might pursue agricultural objectives solely designed to ensure adequate food supplies for its citizens.

While the policies and objectives vary from country to country, the developing countries as a whole—which rely heavily upon agriculture for employment and exports—have generally pursued agricultural policies that have failed to develop, utilize, and maximize comparative advantages in agricultural productivity. In many instances, developing countries have taxed agricultural commodities, thereby encouraging food imports while discouraging agricultural exports. Conversely, many of the developed and industrialized countries—where agriculture generally is a much smaller sector of the total economy—have pursued agricultural policies that have overdeveloped and subsidized the farm sector, leading to excess commodity supplies. Thus, many industrialized countries have inhibited food imports (at the expense of those developing countries that export agricultural products) and encouraged large food exports (contributing to global oversupply and depressed prices). According to the World Bank, the net result is that most of the world's

food exports are grown in the industrialized countries, where the costs of production are high, and consumed in the developing countries, where production costs are actually lower.

Different Approaches Used to Obtain Agricultural Policy Objectives: Developed Versus Developing Countries

Agricultural policies in many developed, industrialized countries are primarily designed to ensure a satisfactory and equitable standard of living for farmers. Underlying this primary objective are numerous secondary ones, including the provision of a secure and sufficient food supply for consumers at reasonable prices. As some analysts have noted, these are often goals pursued for political rather than economic reasons. The basic problem faced by many of the industrialized countries is how to counteract excessive production while maintaining farm incomes at politically acceptable levels. Currently, the U.S. government pays farmers not to grow grain, while European Community farmers are paid prices in excess of the world price despite overproduction. Japanese rice farmers receive 8 to 10 times the world price; they grow enough for surplus to be sold as animal feed at one-half the going world price. The EC protects its farmers with its Common Agricultural Policy that imposes tariffs and import levies. Moreover, the CAP export grants refunds designed to permit disposal of excess production at world prices while producer prices remain high. The resulting stock accumulation overhangs world markets, contributing to depressed commodity prices. Ironically, the United States has simultaneously imposed acreage reductions on specific crops with intentions of slowing the rate of stock accumulations and raising world market prices. Besides spurring overproduction, high levels of import protection, and extremely fierce export competition, these policies have culminated in an uncoordinated and highly inefficient world agricultural trading system.

Industrialized countries with substantially developed agricultural sectors often include trade measures as part of their domestic agricultural policies. In order to maintain farmer incomes, a variety of policy tools are employed, including production quotas, input controls, and government intervention prices. The net result of these various measures is an income shift from consumers and taxpayers to farmers and landowners. Farmers are not growing crops in response to consumer demand as much as they are to producer incentives created by governmental intervention in agricultural production and trade.

More important, however, are the effects on the international marketplace. Some developed countries aggressively use exporting and protection-oriented policies at the expense of the developing countries. Net

food commodity exporters have generally pursued policies designed to increase exports, which ultimately enhances the value of agricultural output and helps achieve farm income objectives. Common measures include export subsidies, deficiency payments or two-price systems designed to compensate farmers when world prices drop below those guaranteed domestically, and production controls designed to limit supplies and thereby raise prices. Most of these measures have substantial costs that are borne by taxpayers and/or consumers within the country. The effect on international trade can vary depending upon the specific measure. For instance, the income support measures can serve as production incentives, boosting exportable supplies and depressing world prices. Conversely, acreage reduction programs can have the opposite effect on world prices due to the subsequent drop in production.

Many developing countries pursue food self-sufficiency goals but, ironically, also pursue policies that tax farmers, subsidize consumers, and increase dependence on imported food. Historically, developing countries have discriminated against agriculture by promoting domestic industrialization and manufacturing. This has accelerated the transfer of resources out of agriculture—where many developing countries had a natural comparative advantage—and into manufacturing and industry by reducing the profitability of agricultural production. Perhaps the biggest problem confronting agricultural production in developing countries is the lack of adequate prices for farmers. This problem is often aggravated in developing countries by (1) the existence of marketing boards that can monopolize selling, buying, and distribution of farm commodities; (2) consumer subsidies that shift costs back to the farmers in the form of lower prices; and (3) inefficient and noneconomical farm input subsidy programs that primarily benefit larger, wealthier farmers. Even where incentives exist, small farmers in developing countries face problems getting credit to invest in agriculture.

As labor and capital move out of the agricultural sector, technological progress—such as better irrigation methods, improved seed varieties, and new farm management techniques—slows. The World Bank has noted how public policy changes in such developing countries as China, Chile, Turkey, Bangladesh, and even parts of Africa have successfully reversed agricultural production declines. In the 1980s, with encouragement from the World Bank, some developing countries have attempted to reverse discriminatory policies against agriculture to promote a better climate for food production.

Some developed and developing countries rely on import control measures—such as tariffs, levies, and quotas—to protect domestic farmers from import penetration, to increase the value of domestic agricultural output to meet farm income objectives, and to enhance food security objectives. However, they carry subsequent ramifications for the domestic economy and international agricultural trade. For example, farmers benefit from the resulting higher domestic commodity prices at the expense of consumers and/or taxpayers, who bear the burden of the higher prices. Further, import control measures restrict world trade by limiting consumer access to imported supplies. The net result is a depressing effect on world market prices for the protected commodity despite the fact that domestic prices remain stable.

Agricultural Policies Have Contributed to the Changing Structure of the World Market

Public policies have played a pertinent role in transforming some countries into major world exporters of specific raw food commodities over the last 25 years. For instance, starting in the 1970s, the EC became a major grain exporter and a net exporter of sugar, beef, and dairy products primarily because of its CAP, not major changes in comparative advantages. Government policies have also contributed to successful agricultural export sectors in Brazil (soymeal and oil) and Australia (wheat), and—to a lesser extent—in Thailand (rice) and Canada (wheat) as well. Other countries have moved to a net surplus status for certain commodities, such as wheat in India and corn for China. Some countries are marginal or occasional exporters of selected crops with some potential for more export growth, such as wheat in Turkey and Saudi Arabia.

While some disputes exist over the scope, duration, and impact of agricultural production growth changes in the developing countries, it is generally agreed that public policies have been instrumental in affecting both the level and rate of agricultural production, whether positively or negatively.[2] Indeed, the developing countries have maintained higher production growth rates in the 1980s than either the developed or non-

[2]Dennis Avery, an Agricultural Research Specialist at the State Department, has promoted the crop production successes and the potential for even further farming productivity gains in the developing countries (see Dennis Avery, "Potential For Expanding World Food Production By Region and Country," U.S. State Department, Bureau of Intelligence and Research, Report 1182-AR, October 15, 1985). Other analysts, while noting the validity of recent LDC food production gains, point out that Avery's isolated examples mask the reality of overall supply/demand imbalances in the majority of the LDCs (see Earl D. Kellogg, "Agricultural Development in Developing Countries and Changes in U.S. Agricultural Exports," in Assistance to Developing Country Agriculture and U.S. Agricultural Exports, Consortium for International Cooperation in Higher Education, March 1987).

Asian centrally planned economies. However, much of this can be attributed to significant improvements in crop production in some of the larger, dominating developing countries, such as India and China.

A review of the research efforts conducted by analysts at such institutions as the World Bank, the Food and Agriculture Organization (FAO) of the United Nations, USDA's Economic Research Service, and the Organization for Economic Cooperation and Development reveals a consensus that policy distortions dominate global agricultural development and trade. As a result, a paradoxical situation exists. Many developed countries have agricultural surpluses and yet they subsidize farm production; many developing countries lack sufficient agricultural supplies and yet they subsidize consumption of agricultural products. Although a more open, free agricultural trading system—devoid of such market distorting incentives as production and consumption subsidies—is desired, it may be unreasonable to expect such a system to rapidly appear.

To illustrate the significant role that agricultural policies in countries around the world have had in affecting global agricultural production and trade over the last three decades, we have constructed three country/policy categories to emphasize their differing impacts on world agricultural production and trade: (1) food importing developing countries with discriminatory agricultural policies; (2) countries that have improved self-sufficiency or emerged as potential exporters of certain food commodities because of agricultural policy shifts; and (3) existing major food and feed grain exporters whose agricultural policies are rooted in protectionism.[3] For each, we present a brief policy overview, give examples of existing policy types, briefly discuss a country that serves as a case study, and highlight the resulting effects of these policy approaches on world agricultural production and trade.

Food Importing LDCs With Agricultural Policies Inhibiting Domestic Production

Despite efforts to reduce their dependency on food imports, many developing countries have pursued agricultural policies that have actually inhibited the development of their agricultural sectors. Government intervention is common to agriculture in developing countries, including production, consumption, distribution, marketing, and inputs. While the intentions of the governments are to improve the agricultural sector through public sector organization and assistance, inefficiencies often result that add unnecessary confusion and expense for farmers. Pricing, taxation, and industrial protectionist policies have for the most part

[3]These categories are not exhaustive nor meant to be inclusive of all country situations.

worked against the development of a strong agricultural base in many developing countries.

Types of policies. Many LDC governments often follow discriminatory farm output pricing policies. In some countries, prices are kept purposely low to address the food demands of large, poor, and undernourished populations. Some developing countries even subsidize consumer food prices despite the fact that such policies reduce incomes to farmers, most of whom are poorer than the urban consumers. In some developing countries, government policies result in farmers receiving far less than world prices for their crops, and yet these same countries may be using scarce foreign exchange to buy imported food. Prices to farmers may be even further reduced by taxation or charges by quasi-governmental marketing or distribution agencies. Farmers in developing countries share one common incentive with farmers worldwide—they will respond to higher prices by raising production. With low rates of return, there is little incentive for farmers to expand production or become any more efficient.

Moreover, many developing countries have directed revenue raising measures at their agricultural sectors. Some countries impose explicit or implicit taxes on agriculture—through input taxation, export taxes, and overvalued currencies—which can further reduce incentives for investment in the agricultural sector. In some cases, developing countries have imposed export taxes on specific agricultural crops with perceived export market strength to (1) direct agricultural production toward other, less abundant food crops or (2) promote agroindustries over the export of raw crops. However, this stifles further investments needed for technological improvements and gives competitors time to improve their own production capacities.

Furthermore, many developing countries have pursued policies emphasizing domestic manufacturing and industrialization over agriculture. Thus, industrial import substitutes have been made more expensive relative to agricultural import substitutes. On the other hand, in some developing countries industrial development has been in a more favorable position due to preferential treatment. Indirectly, imported industrial inputs used in the agricultural sector—such as tools, machinery, power, and fertilizer—are also more expensive and raise agricultural costs.

Argentina. As the previous discussion has emphasized, it is a common characteristic among many developing countries going through early

stages of economic development to construct discriminatory agricultural policies. Argentina serves as a primary example of a developing country that followed such a path. With ideal farming conditions, crop yields and production volumes of coarse grains and soybeans have increased over the last 20 years. However, the potential exists for crop outputs to be significantly higher if government policies adverse to the agricultural sector were eliminated or relaxed.[4]

Since World War II, the Argentine government has favored a traditional course of development that emphasized industry over agriculture. At times, agriculture has been reemphasized, but the resulting discontinuity in policy directions has resulted in underutilized grain production and export potential. Many government leaders believed that Argentina's agricultural exports were facing a long period of declining real prices on the world market and that what the economy needed was more industrial development.

To finance this industrial development, agriculture was taxed to support newly formed industries making import substitutes. Policy makers did not believe that this would result in large farm output losses. By the same token, it was believed that increasing agricultural prices or devaluing the currency would produce higher inflation and budget deficits, thereby hurting poor urban consumers without significantly boosting output. Given that agriculture accounted for as much as 70 percent of all exports, the export taxes were viewed as one of the easiest means to raise revenue.

Thus, the terms of trade were deliberately turned against agriculture in the form of tariffs, import restrictions on industrial goods (inputs), export taxes, and exchange controls that led to an overvalued currency. Input costs for agriculture were high, since value-added taxes and import barriers protecting industrial sectors of the economy raised the costs (and slowed the use) of tractors, chemicals, seeds, and fertilizers. Many farmers shifted production away from crops toward cattle because of the lower input costs and fewer livestock sector restrictions. The fact that export taxes have been lower for processed agricultural products also helps to explain expansion of the domestic soybean crushing industry.

[4]The International Food Policy Research Institute has concluded that if agricultural prices in Argentina between 1950 and 1972 had been 10 percent higher than they actually were, total agricultural output would have gradually increased to an annual level approximately 9 percent higher than was the case. This analysis was largely based upon additional capital and technology improvements that would have occurred under more favorable conditions.

Since 1976, Argentina has relaxed or eliminated some of the worst agricultural production disincentives, such as high export taxes and an overvalued exchange rate. Still, many economic and political conditions remain that serve as barriers to faster rates of agricultural sector development.

Since the mid-1980s, the Argentine government has placed more emphasis on agricultural exports, viewing them as a means available to raise foreign exchange needed to overcome the country's sizable debt problem. As shown in table 4.1, the domestic soybean industry expanded substantially in the 1980s, with soymeal exports reaching new highs. The Argentine government has strongly encouraged increased wheat and corn production since the mid-1980s. Between 1982 and 1984, record wheat exports were made, spurred largely by the U.S. grain embargo against the Soviet Union. However, poor weather in the 1985 crop year adversely affected wheat production and export levels, and 1986 levels were low in comparison with those in the 1982-84 period.

Despite production gains, many problems still face Argentina's agricultural sector. The political and economic instability of the country has forced farmers to adopt "low-risk cultivation practices" at the expense of long-term input investments. Use of fertilizers has not appreciably increased because of their high prices, largely due to import barriers. However, the recent policy shifts indicate that the Argentine government is focusing more on agriculture as a means of income generation than as a tax source. The fact that farmers are growing more crops to meet more favorable pricing and exporting conditions once again reveals the impact of government policy on production and trade.

Table 4.1: Soybean Production and Exports in Argentina, 1979-88

Million metric tons

Year	Soybean production	Soybean exports	Soybean meal production	Soybean meal exports
1979	3,700	2,776	499	260
1980	3,600	2,726	561	277
1981	3,500	2,190	838	591
1982	4,150	2,151	1,500	1,209
1983	4,200	1,338	1,924	1,765
1984	7,000	3,132	2,893	2,663
1985	6,750	2,954	2,739	2,600
1986	7,300	2,566	3,455	3,250
1987	7,000	1,292	3,920	3,600
1988[a]	9,900	2,400	5,645	5,175

[a]USDA June 1988 estimate.

Source: Foreign Agricultural Service, USDA, World Oilseed Situation and Market Highlights, June 1988, p. 23 (FOP 6-88).

The impact on world agricultural production and trade. Inefficiencies in the global agricultural production and trading system stem in part from many developing countries pursuing policies that distort their own agricultural capabilities. Rather than capitalizing upon land, labor, and resources that could be used to produce a portion of a country's food needs, many developing countries have chosen to meet food demand by importing, thereby transferring production incentives to other countries. In most cases, imports have come from the more developed, industrialized countries where agricultural production costs may actually be higher. In short, some developing countries have bypassed natural comparative advantages for agricultural production of certain crops in favor of industrial development. This has forced them either to use scarce foreign exchange to purchase food imports or to rely on concessional aid. Agricultural sectors have suffered from a lack of adequate investment in infrastructure, research and development, and extension services. Because of debt and stagnant economic growth, many developing countries have been forced to turn their attention back to the development of their agricultural sectors, but it may take years for past neglect to be overcome.

Nevertheless, agricultural policy reforms offer the potential for improvements in agricultural production. This is evident in the case of Argentina's soybean/soymeal production, which has benefited from

relaxation in export taxation measures and government support programs. The potential exists for even further changes in world production and trading patterns given that many developing countries are struggling to improve their domestic farm sectors for reasons relating to food security or balance-of-payment problems.

Countries That Have Improved Crop Production Because of Agricultural Policy Shifts

Over the last 25 years, several countries have moved from a net import status for specific food commodities to near or actual self-sufficiency and/or a net export status. Food grain production in India, China, France, and the United Kingdom in the latter part of the 1970s and early 1980s serves as good examples. Other countries have managed to implement agricultural and economic reforms that have contributed to higher agricultural production of major food crops. Some have experienced production levels surpassing domestic consumption needs, necessitating the search for external markets. In some cases, policies that inhibited agricultural investment and reduced production incentives were dropped or significantly reformed. No generalizations can be made about the desired policy reform path; the nature, design, and timing of the policies are largely determined by an individual country's circumstances. However, as concluded by World Bank analysts, farmers in both industrial and developing countries respond strongly to prices; therefore, the amount and types of crops they grow can be heavily influenced by the existing policy environment. For many developing countries, increased agricultural production can be a means of earning foreign exchange and reducing heavy external debt burdens that plague economic growth and development.

Types of policy changes. Many countries that have spurred agricultural production have removed incentive barriers and offered effective support mechanisms for agricultural development. Although general economic policies have tremendous ramifications for the agricultural sector, price stability and effective investment in agricultural technology and related infrastructure also play key roles. In addition, changes in pricing policies have ensured that farmers continue to receive favorable prices so that land and labor do not move to other economic sectors. In the EC, production or export subsidies in conjunction with import restrictions have been implemented to encourage farmers to produce specific food commodities for food self-sufficiency in those commodities.

In some cases involving agricultural reform, governments increased the profitability of farming by allowing producer prices to rise. In some developing countries, this has been accomplished, to some extent, by

simply eliminating policies biased against agriculture—such as export taxes. In most developed countries, the agricultural sector has basically been protected by government intervention measures—such as price guarantees.

China. The performance of Chinese agriculture since 1978 is impressive by any measure, and its success is largely the result of conscious public policy decisions initiated in 1978. The scope of the reforms covers all aspects of agricultural production, pricing, and marketing. The resulting turnaround in Chinese agriculture has changed the international commodity markets for grains and soybeans. Despite being one of the world's largest wheat producers, China remains an importer of wheat; however, the reduction in import volume—until 1987/88—led to a more constricted world wheat market. In addition, China exported over 6 mmts of corn to foreign markets in 1985/86, and exports have remained between three and four mmts as of 1988. Soybean production and exports have grown consistently in the 1980s.

In 1978, the Chinese government pursued a major agricultural policy shift toward more market-oriented production. The principal goal of the policy was to produce incentives for farmers and to reduce bureaucratic planning intervention. Several reforms were implemented, including (1) farm price increases ranging from 25 to 40 percent, (2) individual management of land plots as opposed to the communal farming system, and (3) direct grain sales in rural markets.

The results of this policy change on agricultural production were phenomenal. Net agricultural production increased at an average annual rate of 7.7 percent during 1980-84, compared with a 3-percent growth rate between 1971-80. In 1984, grain production was 34 percent higher than in 1978, while oilseeds were 128 percent higher. As table 4.2 shows, the average annual percent change in production growth for most major crops vastly improved after the reforms.

Table 4.2: Changes in Chinese Agricultural Production Volume

Commodity	Average annual percent of change in production 1957-78	1978-84
Grain	2.1	4.9
Soybeans	−1.1	4.2
Cotton	1.3	18.7
Oil crops	1.0	14.6
Sugarcane	3.4	11.1
Sugar beets	2.8	20.5

Source: World Bank Development Report, 1986, p. 105.

These successes were primarily due to more efficient use of existing resources through better incentives. China's agricultural turnaround brought about a 45-percent decline in food imports between 1983 and 1985. The surge in agricultural output was so rapid that surplus grains and cotton began to appear. In 1985, the government implemented new policy changes designed to deliberately slow agricultural production growth to allow infrastructure development (roads, storage, etc.) to catch up and reduce budget subsidies.

A dual pricing system was dropped in favor of a single pricing system. Producers were forced to sell above contract volumes on the free market at prices determined by the market.[5] Judging from the drop in grain statistics for 1985, the policy shifts were significant in affecting crop output. Compared with figures for 1984, harvested area fell by 8 percent, yields dropped by 7 percent, and production volume fell by 14 percent. The pricing and production shifts illustrate the difficulties involved in changing from an economic system run administratively to one in which market forces play an important role.

The Chinese agricultural policy today apparently is to maintain an agricultural trade surplus. However, pressing problems are emerging for the agricultural sector, including a transition away from parts of the existing government marketing system, inadequate transportation and storage, and a reduction in the availability of quality farmland. In 1986, the Chinese government responded to the apparent drop in grain production by raising the floor price, or the price paid for above-contract amounts, and by increasing the income of grain farmers through local subsidies. The change resulted in an immediate 35-percent increase in

[5]For grain, the government did not completely cut off its above-quota purchase option; it agreed to intervene and buy extra amounts of grain if the market price fell below the old quota price.

price for these sales. In addition, the government reinstated subsidized fertilizer sales for farmers signing grain contracts.

With rising wheat imports and lower corn and sorghum production, the Chinese government launched a major drive to boost overall grain production in the 1986/87 crop year. In some regions during 1987, contract prices were raised or paid in advance, and supplies of chemical fertilizers and diesel oil were increased and, in some cases, reserved exclusively for grain growers. It is possible that a new land law may go into effect to try to coerce farmers into devoting more land to grain production. Prices for cash crops (fish, fruits, tea, etc.) are being cut, and government investment in agriculture is expected to increase by 40 percent.

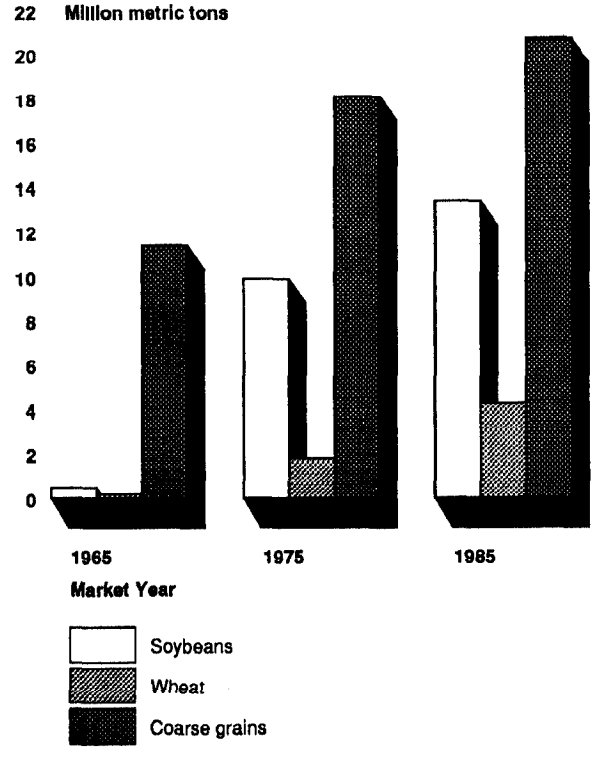
Brazil. Brazil possesses enormous agricultural resource potential, raising the possibility that it will be a very competitive coarse grain and soybean exporter. Its emergence as the largest international soybean meal exporter and fourth largest soybean oil exporter is largely attributed to conscious public policy decisions. In the 1960s and 1970s, the agricultural sector was developed by pumping large amounts of international and domestic credit into agricultural production. Government support measures have had a tremendous impact on the production of wheat, corn, soybeans, and rice. Debt problems stemming from expensive oil imports and a depressed world economy have affected Brazil's export competitiveness.

Although much of the tremendous acceleration in Brazilian agricultural production can be traced to successful efforts in expanding cropland, other government policy-induced measures, such as price supports and farm credit availability, have also contributed significantly to the development and support of a solid farm base. Research and extension service, mechanization, and fertilizer and pesticide usage were pushed by the government during the 1970s. Funding for expanding the use of modern farm inputs came from the Brazilian government, the World Bank, and the Inter-American Development Bank. Capital was put into important agricultural areas, such as the fertilizer, chemical, and hydroelectric industries. At the same time, farmers made input purchases subsidized by government low-interest-rate loans.

Unlike many other developing countries, Brazil has also invested heavily in the development of an infrastructure (roads, railways, deepened ports, and storage facilities) that is conducive to increased agricultural production and exportation. These improvements, in conjunction with

an extensive marketing system, have benefited Brazilian crop production and exports. The Brazilian government has also adopted a price support system to boost crop production. In addition, the government also provides export incentives, such as subsidized credit and tax exemptions, although these have been reduced because of financial hardships exacerbated by existing debt servicing problems. The net result of all these policy changes can be seen in the production patterns for soybeans, wheat, and coarse grains, as displayed in figure 4.1.

Figure 4.1: Brazilian Production Patterns for Wheat, Coarse Grains, and Soybeans



Source: USDA/Economic Research Service.

Trade and production impact of increased self-sufficiency. Some international agricultural trade economists have argued that the biggest problem facing U.S. agriculture is limited world market growth. In short, in terms of U.S. agricultural export interests, the export market is affected by what happens to utilization and what happens to domestic production in the importing countries. Rather than being the direct

product of foreign crop failures or competitor pricing, U.S. agricultural exports, some analysts argue, are more directly affected by changes in world trade growth. Some net food importers have moved closer to self-sufficiency or achieved it. Accordingly, the export market for certain bulk food commodities has declined in comparison with that in the 1970s, when U.S. farmers found the world market a convenient escape valve for overproduction. As such, domestic production and use in importing countries is an important indicator of export market changes.

Since 1975, the developing countries have become a dominant factor in world grain trade growth. Collectively, they were responsible for the greatest growth in agricultural exports from the mid-1970s until 1981. Since 1982, aggregate LDC agricultural imports have increased while those of the developed countries have declined. However, since the 1970s, some of the developing countries have moved toward greater self-sufficiency for specific crops. The Chinese and Indian grain markets have basically been lost to internal production growth. The same can be said of the EC, whose wheat production has grown consistently since the mid-1970s. Production progress has also been made in the Soviet Union and Eastern Europe, leaving their import levels largely dependent upon Soviet crop shortfalls. In short, because of increasing domestic production capabilities in many former large importing regions, those developing countries with higher levels of economic growth have become crucial to world grain exports.

Increased production of grains in many producing countries created global surpluses that contributed to increased export competition. In some instances, self-sufficient producers were able to export surplus crops, adding to competitive pressures among the larger exporting countries, such as the United States, the EC, Australia, and Argentina. Congressional Research Service (CRS) analysts who have reviewed USDA information are skeptical that many of these new exporters will emerge as strong competitors in the world marketplace, given their agricultural resource limitations.[6] One poor harvest in these marginal exporting countries or slight shifts in domestic consumer demand could result in a return to food imports. In addition, if world prices drop for certain food commodities, incentives to produce for exportation may subside.[7]

[6]Congressional Research Service, U.S. Trade Competitiveness in Corn, Wheat, Soybeans, and Rice, October 1986.

[7]USDA's Foreign Agricultural Service reports that U.S. exports of wheat, corn, and feed grains should be up by significant margins in 1987/88 because of poor harvests in many producing countries, declined crop output in some competitor countries, and increased regional food demand patterns, especially in the Pacific Rim countries.

Nevertheless, the emergence of strong production patterns in many of the developing countries combined with the shrinking of traditional markets highlights the critical importance of areas like the Far East, North Africa, and the Middle East. It also signals that several countries around the world will play a critical role in future world market changes, depending upon their own domestic production and demand balances.

Existing Major Food and Feed Grain Exporters and the Role of Agricultural Policies

Agricultural policies in some nations that compete with the United States for agricultural exports contributed to the decline in U.S. export volume and world market share during the first half of the 1980s. These policies, in some instances, are designed to protect domestic farmers from pricing changes in the international marketplace. To a large extent, many of these policies have contributed to overproduction during a period of declining or stabilizing demand.

Types of policies. Government involvement in the agricultural industries of the major agricultural exporting countries is not new; indeed, commitments to agricultural production have led to an entangled web of intervention measures designed to protect and preserve domestic farming. A variety of direct governmental intervention policies has emerged over the last two decades. Minimum and maximum prices are set for commodities, direct government marketing agencies control buying and selling, import levies and export taxes are employed, and quotas and tariffs are used to protect domestic producers from outside competition.

For the most part, policies that attempt to shield farmers from changes in world prices without regard for supply and demand have a definite impact on production levels and, thus, international trade. Policies enacted in the United States and its major exporting competitors prior to the 1980s were designed to deal with the international market at that time—a market of steady and sometimes rapidly growing demand. Production levels have flourished because of increased agricultural investments and farmer income support programs that protect from normal supply/demand forces. This has increased reliance on external markets to support the higher production levels. In short, government policies have contributed to changing agricultural production and trading patterns.

The United States and the EC. Agricultural policies in both the United States and the European Community illustrate the impact that government intervention can have on crop production levels. U.S. farm policies

provide price and income support to grain, rice, cotton, peanut, dairy, sugar, and soybean producers. The EC farm policies provide support to an even larger assortment of agricultural products, including grains, dairy products, beef, sugar, oilseeds, olive oil, wine, fruits, and vegetables.

The basic price and income support mechanism for grains and cotton in the United States is a nonrecourse loan, functioning in conjunction with a target price established legislatively by the U.S. Congress. When market prices fall below loan rates, producers who participate in a commodity program may forfeit the commodity for which they have received a loan instead of repaying. Deficiency payments, equivalent to the difference between the target price and the market price or loan rate, whichever is higher, are payable on covered production. Compliance with program provisions such as acreage reduction is generally required in order to have access to nonrecourse loans and deficiency payments.

The basic mechanism used in the EC is high internal prices maintained through variable levies on imports that increase as world prices fall relative to internal EC prices. Export refunds are also used to compensate exporters for the difference between internal market prices and world prices. This basically permits disposal of surpluses at world prices, while EC producer prices remain high.

In the EC, grain producers and/or first handlers of grain (i.e., grain elevator operators) may deliver grain to a national intervention agency and receive the intervention price. Thus, the intervention price is similar to the U.S. loan rate in operating as a price floor. However, unlike U.S. commodity programs, EC variable levies on imports and subsidies on exports operate at the border between the nations of the EC and the rest of the world. In this way, prices are supported by raising the price of imported goods rather than by directly paying producers the difference between the internal prices and the price level desired by EC policymakers.

For imports, the EC sets a "target price" for grains relative to the part of the EC with the largest grain deficit. The threshold price is determined by subtracting transportation costs from the port at Rotterdam to the region with the largest deficit and associated margins and marketing costs from the target price. The amount of the variable levy (or import tax) is then set with reference to the difference between the threshold price and the lowest price on a delivered basis in Rotterdam.

Impact on international production and trade. In the EC, domestic price supports accompanied by variable levies and export restitutions have created an environment in which rapid production growth has occurred in spite of saturated demand levels and low international prices. As a result, the EC has emerged as a major grain exporter because of large production increases in the United Kingdom, France, and Germany. In the United States also, the price support system allowed production to grow far in excess of what could be absorbed by domestic consumption growth. In both cases, excess domestic supply has been forced onto the international markets without sufficient world demand.

The deficiency payment system, such as that used in the United States, has an even further effect on international trade. In the case of a country that is not self-sufficient in a commodity, the major trade effect is a production incentive that might induce a country to grow food uneconomically as opposed to importing it. For an exporting country, however, a deficiency payment system is equivalent to an export subsidy. Some exporting countries operate deficiency payment policies for commodities, the level of price below which a payment will be made (a guaranteed minimum price), linked to previous market prices. Payments are more sporadic under such systems, especially in Australia and Canada. Regardless, the deficiency payment allows exports to occur at a price lower than that received by the producer.

In the case of supply management programs, trade distortions occur because such programs are almost always accompanied by import restrictions and/or export subsidies. Domestic consumers do not benefit because they continue to pay the support price.

World Agricultural Production and Trading Policies and the Uruguay Round of Multilateral Trading Negotiations

From their inception, international trade rules relating to agriculture have been adjusted to fit domestic programs of various countries, especially the United States. Under current GATT rules, which have evolved since their establishment in 1947, agricultural trade has received special treatment. In deference to the policies of many governments that have supported farm prices and incomes, GATT rules have permitted a wide range of nontariff barriers in agricultural trade. These commonly are in the form of import quotas and export subsidies that are not generally permitted for trade in manufactured products.[8] The absence of any internationally agreed-upon rules for agricultural trade has contributed to a multitude of domestic agricultural production and export subsidies as well as harsh agricultural import barriers.

The current Uruguay Round of the multilateral trade negotiations, begun in September 1986, is seriously considering major reforms in the international agricultural trading system.[9] This consideration is largely the result of an emerging consensus among major developed countries that domestic farm policies in many countries around the world have been a principal cause of overproduction for some of the basic agricultural commodities. The United States, the European Community, and the Cairns Group have presented formal proposals addressing means to resolve global overproduction and to promote greater farm trade liberalization.[10] The U.S. and Cairns Group proposals emphasize long-term frameworks aimed more at the root causes of the decline in agricultural trade that has occurred in recent years, namely, the domestic support programs and barriers to market access established by governments worldwide. Conversely, the EC proposal calls for gradual reductions in agricultural support but also emphasizes a short-term framework for immediately addressing imbalances in agricultural supply and demand in the dairy, grain, and sugar sectors.

[8]In 1955, GATT members agreed to a formal breach of the prohibition against import quotas by permitting the United States import quotas needed to sustain domestic farm supports. Thereafter, other GATT members devised various restrictions on agricultural imports not specifically covered by GATT trading rules. An agreement was reached in the 1979 Tokyo Round that legitimized export subsidies for agricultural products, so long as an "equitable market" share was maintained.

[9]An agriculture negotiating group has been established, with membership open to any GATT member. Two phases of negotiations are to occur. The first phase will be used to identify major problems, submit data, and forward proposals for solutions; the second phase will be used to reach agreement on strengthening GATT rules, decide what multilateral commitments are to be undertaken, and exchange concessions. No consensus has emerged on a scheduled completion date.

[10]The Cairns Group was formed in 1986 to represent the interests of "fair-trader" agricultural exporters; its 13 members include Australia, Argentina, Brazil, Canada, Chile, Columbia, Hungary, Indonesia, Malaysia, New Zealand, the Philippines, Thailand, and Uruguay. Combined, these countries comprise about 25 percent of global farm exports, compared with 31 percent for the EC and 14 percent for the United States.

Approaches Presented to Resolve Agricultural Trading Problems

The U.S. proposal calls for, first, agreement on a measure of the aggregate support that countries provide to their agricultural producers. In addition, the United States is emphasizing an overall schedule of reductions for all levels of agricultural supports (domestic subsidies, export subsidies, and import barriers) that distort agricultural trade and complete abolishment of these supports within a 10-year time frame. Second, the United States has suggested that specific policy changes be identified by each country to meet its overall commitment of scheduled support reductions, with these changes agreed to by other contracting parties.

The EC has also put forward a two-stage proposal. The first stage encompasses short-term measures to bring about emergency relief to several badly affected markets, namely cereals, sugar, and dairy products. The second phase proposes a progressive and substantial decline in government support for farmers.

The Cairns Group proposal calls for the establishment of a long-term framework of revised and strengthened rules for agriculture, the removal of distorting policy measures, and immediate actions for early relief from severe policy distortions affecting agricultural trade. The proposal also argues for the use of a producer subsidy equivalent (PSE) measure to lower aggregate support to agriculture, with the eventual goal of reducing and eliminating trade distorting policies. The group's long-term proposal stresses the abolition of any market access restrictions not explicitly sanctioned by GATT, the prohibition of subsidies and government support measures that negatively affect trade, and the creation of consultation, surveillance, and dispute settlement mechanisms.

All three proposals highlight a growing consensus that agricultural production levels and trading patterns are being severely affected by domestic farm policies. Market access barriers, production levels divorced from market demand levels, and heavily subsidized export programs are contributing to tensions among trading partners.

The Impact of Agricultural Research and Technology on World Agricultural Production

Scientific and technical advances in agriculture have increased productivity levels throughout the world. These advances are the result of mechanization; improved methods of planting, cultivation, and farm management; the use of fertilizers, pesticides, and herbicides; expanded irrigation; and plant breeding practices that have resulted in hardier, high-yielding crop varieties. While the United States has led in the development and application of these advances, many are directly or indirectly transferrable to other parts of the world. Many developing countries have dramatically improved agricultural production by adopting, refining, and using them. For example, the introduction of high-yielding rice strains has revolutionized rice production in such Asian countries as China, Indonesia, and the Philippines; in all three countries, rice production has more than doubled since 1960. As better farming techniques are transferred to developing countries, the agricultural technology "gap" between them and developed countries has the potential to narrow over time. Still, the pace of this transfer or adoption remains uncertain, since cost considerations and government policies in the recipient countries play important roles.

As world population has grown, the need to feed more people has brought under cultivation most of the world's arable land. Many agricultural experts agree that in the future, most increases in worldwide grain production will be based on higher yields from existing acreage rather than land expansion. Indeed, most current technology, such as fertilization and high-yielding seed strains, is aimed at getting more and better crops from land already in production. While these existing technologies have greatly enhanced crop qualities and yields, even more effective advances are on the horizon as researchers strive to produce better plants through genetic manipulation. Some of these new technologies are focusing attention on means to reduce the cost of production.

Man's ability to grow more food at lower cost and under more adverse conditions can help eliminate widespread famine and hunger. But the United States has already suffered export declines, partly because some food importing customers are supplying more of their own needs. These losses could increase if technology enables more nations to feed themselves. More importantly, as foreign exporting nations around the world improve and expand their own agricultural technologies—including the newer biotechnological research advancements—competitive pressures will increase on the United States to improve production cost efficiencies. Countries with the most efficient farmers (i.e., those capable of producing larger and improved quality output with less input costs) will

be the most effective export competitors, especially if agricultural subsidies are reduced or eliminated through multilateral trade negotiations. Unless the United States continues to support efforts to increase production cost efficiencies through continued research and development support, similar efforts by major competitors could affect U.S. agricultural dominance of certain export crops.

Despite the promise for further improvements in agricultural productivity resulting from new biotechnological techniques, barriers still hinder the successful commercialization of biotechnology-related products. First, many technical scientific barriers still remain, especially for crop improvement methods in biotechnology. Although many significant breakthroughs have occurred, some applications appear to be more than a decade away from commercial usage. Incomplete knowledge of basic processes involving plants, microorganisms, and microbial ecology poses a formidable barrier. Second, regulatory uncertainty also poses a formidable barrier to commercialization. The novelty of the new techniques and the lack of experience with their known environmental consequences have produced a strict regulatory process for private companies in the United States. Third, questions and disputes about international intellectual property rights are also hindering research and commercialization efforts, leading many U.S. firms to protect their technologies by following trade secrecy.

Brief History of Agricultural Technological Progress

Crop yields are affected by many factors ranging from weather to amounts and types of fertilizer application. Agricultural technology advances, including better fertilizers, better cropping methods, improved seed and plant varieties, and mechanization changes, have contributed significantly to increased crop output.To fully appreciate the impact that farm technology has had on production trends, consider the following statistics. Three quarters of the 2.6-percent average annual increase in world grain production between 1970 and 1980 was due to yield improvements as opposed to land expansion. Yield increases were especially evident in the EC, other Western European nations, and Eastern Europe. Recent studies conducted by Resources for the Future indicate that 85 percent of the increases in cereal grain production over the next 15 years will come from increased yields as opposed to land expansion. In fact, according to RFF, land expansion is "forecast to play a lesser role in average annual production growth than during the 1970s in every region except East Asia, North Africa, and the Middle East."

The first two technological revolutions disproportionately favored agricultural improvements in North America, Western Europe, and Oceania. The first was the rise in mechanization that occurred during the first four decades of this century in the developed countries and that is still going on in the developing countries. The second was the creation and widespread use of pesticides, fertilizers, and other farm chemicals after the end of World War II. These two farming revolution periods affected mainly the developed countries, perhaps 40 percent of the world's arable land, and one-fourth of its population. Most of the agricultural technology improvements utilized during the 1970s emphasized increased crop output.

Many of the productivity gains made in the developing countries since the 1960s have come through adoption of irrigation practices, more fertilizer and pesticide application, multiple cropping techniques, and the use of high-yielding plant varieties. While the gains in LDCs have been impressive, the transfer of these technologies to many developing areas is hampered by deficiencies in science and technology, infrastructure, and educational processes needed to apply the technology to food production.

The third and current revolution, commonly referred to as the "genetic revolution," revolves around improved plant genetics advanced through new biotechnological processes.[1] Its impact, some scientists argue, is far more worldwide than the previous two revolutions.

The United States has been and remains the world leader in agricultural research and development (R&D). To a large extent, it was agricultural technology originating in the United States that was responsible for farm productivity improvements throughout the developing world. This transfer is expected to continue to play an important role in the agricultural development of other nations. The introduction of the newer biotechnological advances will initially enhance the U.S. advantage over

[1]These newer biotechnological processes can be distinguished from the "classical" genetic selection and/or breeding techniques used for centuries and further developed in the early 1900s. Today, biotechnology is generally considered to be a component of high technology. Agricultural biotechnology, specifically, involves sophisticated research techniques focusing on the cellular and subcellular levels of plants, animals, and microorganisms. Two powerful molecular genetic techniques common to this approach are recombinant deoxyribonucleic acid (DNA) and cell fusion technologies.

other nations, including many competitors. Nevertheless, this new technology, like others preceding it, is transferable and could provide American farmers with a limited time of cost advantage opportunities.[2]

Plant genetics, the science of improving plant varieties through cross-breeding and other gene-induced measures, has greatly improved world agricultural production. New plant varieties, combined with improved land and cropping techniques, such as irrigation and drainage improvements and crop rotation, have led to greater food production in many countries. Rapidly accelerating production levels have allowed a few countries to move closer to self-sufficiency or to a new exporter status, sometimes in direct competition with major crops grown in the United States.

Agricultural Technology Transfer in the Past

The so-called "Green Revolution" that began in many developing nations in the 1960s and continued through the 1970s refers to the dramatic gains in crop productivity that came from replacing traditional, domestic wheat and coarse grain varieties with new, short-stemmed, high-yielding varieties; increasing chemical input usage; and improving farm management techniques. Some of the new plant varieties and seeds were the result of cooperative ventures between research foundations in the United States and foreign countries. For example, the venture between the Rockefeller Foundation and Mexico, resulting in what is now called the International Maize and Wheat Improvement Center helped to produce the very successful semi-dwarf wheat varieties for Latin American countries. Similarly, the International Rice Research Institute in the Philippines has been instrumental in developing new high-yielding rice varieties now planted on 55 percent of the world's rice lands. Many of these new varieties were introduced into Asia in the mid-1960s and have produced remarkable results in China, India, Pakistan, Indonesia, and the Philippines.

Many of the new grain and rice varieties that these international agricultural research centers developed proved successful in several developing nations. Adoption rates often reached 30 to 40 percent of the total area of a country within 3 or 4 years. The rapid adoption was aided by

[2]There is an open debate within the U.S. agricultural community as to how long it will take for these newer plant and animal technologies to spread to other parts of the world. Western Europe and Japan are already actively involved in biotechnology research. For the developing nations to adopt this newer technology, however, may require substantial R&D, extension service, and agricultural infrastructure improvements. Climatological parameters and existing resource endowments also play a large role.

the use of government programs that often involved distributing the new seeds and the necessary fertilizer and chemicals. For instance, India and Pakistan began importing new wheat seeds from Mexico for commercial planting in 1965, and Turkey did the same in 1967. With the use of increased irrigation and fertilization, these semi-dwarf varieties have helped increase yields to two and three times those of native varieties. Now, most of the major wheat growing areas of the developing world have shifted to the newer semi-dwarf variety and have enjoyed much higher production output as a result.[3]

Agricultural Technology Has Expanded Food Production

Worldwide major crop production of grains and oilseeds has steadily risen over the last 25 years. Many factors are responsible for this constant upward productivity trend. Favorable weather conditions, abundant and fertile land, and plentiful water supplies are important to good harvests and yields. Indeed, in some years, exceptionally good growing conditions have contributed largely to record crop outputs. However, improvements in fertilizer and chemical technology, conventional plant breeding techniques, mechanical technology, and tillage practices also have contributed significantly to rising crop yields.

Plant breeding techniques, leading to better plant varieties, have greatly improved world agricultural production. Some new seed varieties produce best when accompanied by increased fertilization and pesticides. At the same time, fertilizer usage has increased in many world areas, especially in middle- and low-income countries. As a result, crop yields have been rising with the spread of higher-yielding varieties combined with greater use of fertilizer, herbicides, insecticides, and expanded irrigation.

Introducing new agricultural methods into the developing countries is not a simple task. Efforts are often frustrated by climatic differences and adverse government policies. Where technological improvements have not been accompanied by supportive government policies, production improvements have lagged. For those countries lacking adequate farming organizational structures (e.g., distribution, educational support, and transportation), adaptation of new farm technologies has always been slower.

[3]The high-yielding wheat varieties were developed in Mexico by American scientist Norman Borlaug, who crossed American and Central American varieties of wheat with Japanese lines.

The Agricultural Technology Gap May Be Narrowing

Historically, the United States has enjoyed three major advantages over the rest of the world when it comes to agricultural production. First, the United States has a very favorable agroclimate suitable to a wide variety of crop types. Second, the overall economic system of the United States has advanced investment and efficiency into our agricultural production. Third, the United States has been at the forefront in the development of new agricultural technologies, allowing vast improvements in yields and productive capacity and efficiencies over those of other nations. While most analysts conclude that the United States still retains its comparative advantage in most major crop production, some believe it has declined, leaving U.S. farmers faced with increased competition in the near future.

The agricultural technology gap between the United States and many other parts of the world, while still present, is narrowing, according to reports issued by analysts at Yale University's Economic Growth Center, the Office of Technology Assessment (OTA), the State Department, and USDA. For instance, in examining agricultural research and development measured in terms of (1) number of personnel and (2) dollars spent in public sector agricultural research, OTA has drawn the following conclusions from the 1959-80 period: (1) the developing countries are expanding agricultural R&D at the greatest rate (Latin America has experienced a six-fold increase while Asian commitments have expanded seven-fold), and (2) U.S. competitors have increased spending on public sector agricultural R&D at greater rates than the United States. In addition, Yale University researchers have concluded that since the mid-seventies, the expansion of developing countries' agricultural research capacity, as well as the capacity of some of our export competitors, has contributed to improvements in foreign agricultural production and comparative advantage.

Many countries are actively pursuing the adoption of new agricultural technologies. For example, Canada and Brazil are among the biggest importers of agricultural technologies, particularly crop patents. Furthermore, indirect adaptive transfer of agricultural technologies has been greatly enhanced through the development of agricultural research systems in both the LDCs and U.S. competitors. Studies have indicated that the 13 International Agricultural Research Centers (IARC) have greatly facilitated the indirect transfer of new plant and seed varieties into the LDCs, leading to crop productivity improvements for virtually all grains. In short, while the United States remains the dominant force in agricultural technology research and development, significant improvements are occurring worldwide either through adaptation of U.S.-based

farm technology or through development efforts funded by international agricultural research institutes or multinational corporations. As such, the potential exists for the United States to lose traditional lead times on the adoption of new agricultural crop growing techniques, more so in the next 10 to 15 years. Nevertheless, U.S. research centers and private firms remain leaders in the development of new agricultural biotechnologies, which, if the leadership is maintained, could lead to comparative advantage gains in the next century.

Agriculture's New Technological Direction

Throughout the remainder of this century and beyond, world agriculture will be offered a new variety of biological and informational technologies that could revolutionize both crop and animal production. The effects of past agricultural technologies have been to raise agricultural productivity through yield increasing measures. New agricultural biotechnologies also lend themselves to continued yield improvements; however, agricultural scientists are calling for greater efforts focused more on cost-saving technological innovations given the world's existing crop production capacity.

Some researchers suggest that food dependence is being shifted from natural resource-based agriculture (i.e., land for production) to science-based agriculture emphasizing output quality, cost reductions, and yield advantages. This change may be necessary in some areas simply because of the limited amount of arable land left available for food production. In short, for farmers to be competitive in the near future, some experts believe they will have to increase their efficiency of production with reduced emphasis on the sheer quantities they can produce. According to some agricultural scientists, the goal of the new wave of technology is to produce "precision" agriculture—increased yields, improved plant traits, reduced labor and production costs, and the evolution of quality, dependable food commodities.

Biotechnology offers vast potential for improving crop production efficiency, thereby lowering the cost and increasing the quality of food.[4] By combining knowledge from biology, genetics, physiology, and biochemistry, biotechnology offers new techniques for manipulating the genes of plants, animals, and microorganisms. Genetic engineering techniques are

[4]It is not entirely clear, however, that biotechnology will be low-cost. Experience with the more advanced biotechnology research in genetically engineered pharmaceutical products suggests that recovering research costs may dictate the need for high product prices.

the key to many applications of biotechnology. Put simply, biotechnology involves inserting, changing, or deleting the genetic information within a host organism to give it new characteristics or variation in biological traits. In short, man is manipulating a naturally occurring process to produce new organism varieties with desired traits.

These new biotechnological techniques offer advantages in speed, precision, and reliability over traditional plant and animal breeding methods. The bulk of this technology remains in research and development phases in controlled laboratory settings or field test sites. Controversy abounds over environmental soundness and safety, causing field testing delays until regulatory measures are either met or clarified. Some analysts argue that the rapid push for the scientific development of new biotechnology methods has dwarfed more practical considerations of the economic and marketing feasibility of its commercialization. The performance of the new technologies in the marketplace is important to their successful commercialization. The new products must offer an advantage over existing ones by improving farmers' profit margins through increased yields or reduced production costs.

How Biotechnology Is Affecting Agricultural Crop Production

Although the most immediate impacts of the newest agricultural biotechnologies will be experienced with animal production,[5] by the end of the century new technical advances could allow some crops to be genetically altered for greater disease and pest resistance, growth in harsh environments, and self-production of fertilizer and herbicide.[6] Traditional plant breeding techniques have been applied to agriculture in the past to achieve remarkable developments, but agricultural scientists have made even further progress in understanding gene functions and structures critical to new plant development and improvements. However, the exact timing of successful commercialization of new techniques and products is open to considerable debate given the uncertainties surrounding continued scientific breakthroughs, research investment levels, regulatory delays, and consumer acceptance.

[5]Agricultural scientists now believe that many new animal technological improvements, such as genetically engineered porcine growth hormones (PGH) and recombinant DNA techniques, can elevate animal growth rates, feed efficiencies, and ratio of muscle to fat. Fatty tissue growth, for instance, is depressed by PGH and nutrients are redirected to muscle growth, resulting in leaner meat.

[6]Herbicides are chemicals used to kill weeds that compete with crop plants.

Of the various biotechnological methods that are being used in crop improvement—cell culture selection, plant breeding, and genetic engineering—plant genetic engineering is the least established but the most likely to have a major impact. Through these techniques, researchers introduce deoxyribonucleic acid from one living organism into another, thus allowing the traits of one plant to be induced in another. Crops can be modified to increase protein content, to resist diseases and insects, to grow under more adverse conditions, and to be less dependent on nitrogen from fertilizers as opposed to nitrogen-fixing bacteria. In general, more emphasis is being given to research and development of plants that can cope with environmental problems that limit crop production and output.

To date, agricultural biotechnology that focuses on crop production has emphasized three related but different approaches: (1) the genetic engineering of plants, (2) the genetic engineering of microorganisms associated with plants, and (3) genetic engineering for crop protection. Genetic engineering of plants alters the basic genetic structure of plants so that they possess new characteristics that will improve the efficiency of crop production. Genetic engineering of microorganisms seeks to enhance the abilities of certain microorganisms that protect plants from such things as bacterial and fungal infections or environmental stresses such as soil acidity or salinity. Conversely, this approach also attempts to inhibit the harmful effects of other microorganisms that can cause plant disease.[7] Genetic engineering for crop protection involves protecting plants from pests, viruses, nematodes, and weeds using biological control methods instead of relying solely on chemical insecticides, herbicides, and other pesticides. Plant genes that naturally repel insects or disrupt their reproductive cycles can be identified and genetically transferred to other host plants.

The Promises of New Agricultural Biotechnological Methods

Genetic engineering of plants. Agricultural scientists have made several important breakthroughs using plant genetic engineering techniques that have the potential for rapidly increasing crop production efficiency. For example, herbicide resistance traits have been successfully transferred to increase weed control effectiveness. Glyphosate (commercially sold as "Roundup") is considered to be an effective herbicide;

[7]Certain bacteria and fungi known as pathogens are among the primary causes of plant disease. Once started, certain diseases can spread rapidly, as was the case with the Irish potato famine in the mid-1800s.

however, it indiscriminately kills crops as well as weeds, thus effectively limiting its usage prior to plant germination. Through genetic engineering, scientists have altered such plants as cotton, soybeans, and tomatoes to make them resistant to glyphosate. Field testing and commercialization are expected soon; product developers are already predicting significant input cost reductions for farmers that use the new plant types.[8]

In another application of plant genetic engineering, sulfur-rich protein genes have been successfully transferred to both tomato and tobacco plants. Soybeans, a major source for oils and fats used in cooking and meal used in livestock and poultry feed, are deficient in these protein genes. However, if scientists can successfully transfer these protein genes through genetic engineering methods, then the role of soybeans as a major food protein source could be enhanced. The resulting protein-rich soybean output could have tremendous marketing advantages over traditional soybean crop output.

Other genetic engineering research is underway that offers great potential for improving crop production efficiency. Agricultural scientists are already experimenting with alleopaths—plants that produce chemicals affecting the growth of other plants. If genetic transfer methods are successful, farmers might be able to grow certain crops that fight weeds with natural, biological means in addition to chemical herbicides.

Plant growth and development may also be improved through research focusing on naturally occurring chemicals that affect plant growth. As a result of research, scientists have learned that flowering, dormancy, and fruit ripening all appear to come under the control of a relatively few plant hormones or growth regulating substances within the plants. By identifying inhibitors and substitutes for these substances, agricultural chemists have already produced commercially available products that can control ripening, induce flowering, and produce more compact growth. The impact on the more efficient delivery and marketing of agricultural food products could be immense as more is learned about ways to regulate and control plant growth and development.

Genetic engineering of microorganisms. Microorganisms that live in conjunction with plants offer another route for agricultural scientists to improve crop production through genetic engineering. For instance,

[8]One estimate shows California tomato growers saving $100 per acre in weed control costs if Roundup were to be used on glyphosate-resistant tomato plants.

researchers have identified bacteria commonly found on plants that contain a protein that initiates ice crystal formation at subfreezing temperatures. By removing the gene from the bacteria that make this protein, scientists can then transfer the genetically altered bacteria to plants to prevent frost damage. This process has already been successfully applied to fruit crops in field tests, demonstrating the potential for saving fruit harvests from unexpected freezes and perhaps expanding fruit and vegetable production to colder climate areas.[9]

Genetic engineering technology has been used in research settings to detect plants infected with viruses so that they can be replaced quickly to stop the spread to other plants. In tests, scientists have also successfully "inoculated" tomatoes and certain orchard crops against particular diseases by injecting mild strains of the viruses into the plants. Further experimental research is warranted, but preliminary tests indicate that some of these resistance traits can be transferred to seeds and thus transmitted through conventional breeding methods.

Agricultural scientists are also experimenting with microorganisms that can be used in plant nitrogen fixation. If successful techniques are discovered, it could significantly lower farmer production costs by reducing the need for petrochemical inputs used in producing nitrogen-enhanced fertilizers. Plants need nitrogen for healthy growth but are unable to absorb nitrogen gas directly from the atmosphere. "Fixation" involves the production of nitrogen compounds that can subsequently be applied to plants. Certain soil bacteria and algae use natural methods to produce nitrogen compounds as well; industrial processes can also be used for production. Scientists know that a particular bacterium—Rhizobium—is well suited for nitrogen fixation and associates well with soybeans, peas, peanuts, and other legumes. The goal is to improve upon this natural process and genetically transfer it to other plants.

Genetic engineering for crop protection. Advances in genetic engineering are being used to develop and improve biological pest control methods. For example, research indicates promise for the genetic transfer of genes that produce substances that repel insects so that crops are able to produce their own natural insect repellents. Some plants contain these natural substances, but more research is needed to understand how they can be manufactured in other plant systems.

[9]The process is not without controversy, however, as courts have been asked to intervene to block testing until more is known about the potential environmental impact.

A genetically altered bacterium has been successfully tested for corn by one company in the United States. A corn-root colonizing bacterium (Pseudomonas florescence) has been genetically changed to naturally produce an endotoxin that serves as an effective insecticide against certain pests, such as the black cutworm. Preliminary testing proved successful in transferring this bacterium to corn crops either by coating seeds before planting or spraying on corn plants while in the field. The protection offered by the bacterium remains viable for only 8 to 14 weeks in the field; it then dissipates and appears to have no long-term effects. Nevertheless, further research and development in this area could lead to potential successes that could effectively (1) safeguard growers from heavy crop losses due to insect and pest damage, (2) improve harvested output quality, and (3) improve crop production potential for world areas where insects and pests continue to impede agricultural expansion.

Commercial Availability of New Technological Products

Many scientists in the agricultural research community believe that the new plant agricultural biotechnologies will not start having significant impact on productivity for at least 10 years. The consensus among a panel of leading physical and biological scientists, engineers, economists, extension specialists, agribusiness representatives, and experienced farmers convened by OTA in 1985 was that approximately 27 new animal technologies could be available for commercial introduction by 1990 and 30 additional ones by the year 2000. In plant technologies, about 50 new technologies are expected for commercial use by 1990, and another 40 more by the year 2000. Thus, by the start of the next century, the prospects for substantial changes in agricultural productivity appear to be very positive. Given the present research and investment patterns, it is most likely that private companies will play a critical role in developing and marketing the new biotechnologies.

International Transfer and Development of Emerging Agricultural Technologies May Affect Export Competition

The United States remains a world leader in the development of emerging agricultural biotechnologies. A 1984 study by the Department of Commerce affirmed this conclusion by comparing the United States with Japan and five Western European countries—West Germany, United Kingdom, Switzerland, Sweden, and France. However, agricultural research is also being conducted in many competitor countries and by international agricultural research centers. The United Kingdom and Australia, in particular, have advanced plant biotechnology research; biotechnology programs are receiving special support in West Germany, Switzerland, Sweden, France, and Japan as well.

Some reports indicate that European research has been increasing at a greater rate than in the United States, especially for genetic engineering. In addition, Japan is starting to put increased emphasis on biotechnology research. Japan's unusual degree of cooperation among related industries, research universities, and the government presents U.S. and European biotechnology firms with formidable competition. Japan's Ministry of International Trade and Industry has created a consortium of 14 major corporations to collaborate on biotechnology. Because of Japan's increased spending on basic biotechnology research, some think that it could be the world leader in biotechnology during the 1990s.

Few systematic data are readily available on the international transfer of agricultural technology. In one study we found, researchers at Yale University assessed the international transfer potential for the new emerging plant and animal technologies being developed in the United States.[10] These technologies were rated for ease of transfer, based on examination of "data-based" information such as (1) U.S. and international patent information; (2) research and development activities, expenditures, and training; (3) quantitative assessments of scientific publications; and (4) case studies. Interviews with U.S. companies engaged in food and agricultural science research were also conducted. Table 5.1 summarizes their findings for crop technologies and biotechnologies, including the potential productivity impact of the transfer of these technologies to importers and U.S. export competitors.

[10]Robert E. Evenson, Jonathan Putnam, and Carl Pray, The Potential for Transfer of U.S. Agricultural Technology. Yale University, OTA contract report, 1985.

Table 5.1: Transfer Potential of U.S. Plant Technology Fields

Technology Field	Leading R&D centers[a]	Transfer potential from U.S.[b]	Productivity impact	
			Exporters	Importers
Traditional crop production technologies				
Plant breeding	U.S.,India,USSR, U.K.	L-M	M+	M-
Entomology-nematology	U.S.,U.K.,India,USSR	M+	M	M
Fertilizers	U.S.,Japan,W.Germany,U.K.	H	L	M
Pesticides-general	U.S.,W.Germany,Japan,France	H-	L	M
Corn	U.S.,IARC,USSR,Argentina	M	M+	M+
Wheat	U.S.,IARC,USSR,India	M+	M	L
Soybeans	U.S.,Brazil,Argentina,India	M+	H	M
Rice	IARC,India,Japan,U.S.	L	M	M
Biotechnology crop production technologies				
Genetic engineering	Japan,U.S.,U.K.,W.Germany	M	M	H
Plant growth regulation	U.S.,Japan	M	M	H
Plant disease control	U.S.,U.K.,India,USSR	M	L	M
Enhanced photosynthesis	N/A[c]	M	L	M
Biological nitro fixation	N/A	M	L	L+
General biotechnologies				
Mutations and genetic engineering	Japan,U.S.,U.K.,W.Germany	H	L	H
Microorganisms/ tissue culture	Japan,U.S.,W.Germany,France	H-	L	H
Enzymes	Japan,U.S.,W.Germany,France	H	L	H
Biotech equipment	Japan,U.S.,W.Germany,France	H	L	H

[a]IARC, International Agricultural Research Centers.

[b]L, low; M, medium; H, high. A plus or negative sign further indicates relative strength attached to the rating.

[c]Not available.

Source: Robert Evenson, Jonathan Putnam, and Carl Pray, The Potential for Transfer of U.S. Agricultural Technology. Yale University, OTA contract report, 1985.

As the table illustrates, the advancements from improvements in traditional crop production technologies are assumed to have a relatively lower rate of transfer abroad (with some exceptions) than the newer biotechnologies. The productivity impact of the new biotechnologies is also rated higher because of their highly transferable characteristics.[11] However, the impact will largely depend on host country R&D capacity, since in many cases it is the biotechnology method as opposed to the crop variety that is highly transferable.

[11]It appears that the potential for technology transfer would have a lessened impact on many of the U.S. export competitors—such as Canada, Argentina, Brazil, and Thailand—because of their limited research capacities.

As pointed out by an official at USDA, the OTA study does not appear to consider the physical transferability of technologies or economic factors affecting successful adoption. These factors, as opposed to the legal barriers or research capacity of host countries, may be just as relevant in predicting broad-based adoption of new plant varieties and growing techniques.

Technology Transfer Affecting Selected Export Crops

Agricultural technology comes in many forms: a new plant type, a new machine, improved cropping techniques, or a chemical. According to OTA, the agricultural technology affecting corn, wheat, and soybeans is highly transferable through a variety of direct and indirect means, while the transferability potential for rice is much lower.[12] The international exchange of knowledge and the number of trained scientists are important determinants of how rapidly technology dissemination involving these crops occurs. Using these indicators, OTA researchers concluded in 1986 that many of the emerging agricultural technologies—including import biotechnologies—appear to be transferable to other countries.

In some instances, the transfer is indirect vis-a-vis multinational companies (as is the case with hybrid corn seed). In other cases, the transfer is more direct by way of public research entities or international agricultural research centers (as with soybeans). Although the United States does import some farm technologies, the bulk of this country's transfer is to other producers around the world, including competitors. U.S. multinational firms are heavily involved in farm technology development and its sale abroad. Some argue that this transfer ultimately benefits U.S. farm interests, since U.S.-based firms reinvest some of these profits in domestic research and development.[13]

The pace at which U.S. companies introduce new agrichemicals into agricultural competitor nations is often influenced by market characteristics and the extent of patent protection enforcement. Since many of the developing countries have less stringent registration requirements, they serve as an attractive market for many of the agricultural research

[12]These conclusions are drawn from OTA, A Review of U.S. Competitiveness in Agricultural Trade. See pp. 59-63 of this report for a more in-depth discussion of technology transfer involving specific export crops.

[13]It should be noted that public sector research laid the foundation for hybrid corn and the private sector breeding programs still rely heavily on these varieties. Semi-dwarf wheat was also developed by the public sector and has been widely adopted. Wheat varieties developed by public research comprise more than 90 percent of all wheat acreage in the United States.

industries. This is especially true for insecticides and fungicides (disease control chemicals), which are less widely used for specific crop production within some developing countries.

New Technologies and International Export Competition

The research capacity to undertake the development of sophisticated agricultural biotechnologies is currently concentrated in a few leading countries and a relatively small number of large private companies. The United States remains the dominant force behind most aspects of this new technology advancement. However, other developed countries—both importers and exporters—are pumping heavy investments into agricultural R&D. Some of these countries, such as West Germany, France, the United Kingdom, and Japan, have already established highly sophisticated and competitive agricultural input industries. OTA has concluded that when compared with past agricultural technologies, many of the newly emerging ones could be prone to quicker, direct international transfer. Some new technologies may be rapidly disseminated through government information and research exchanges as well as private sector marketing. Even though the developing countries may be slower in adopting newer agricultural technologies because of inadequate research capabilities, adverse public policies, and the difficulty involved in transmitting basic research to farmers, they, too, will likely benefit from production improvements. U.S. farmers may not enjoy the absolute comparative advantage they now have for many agricultural goods and products.

How much U.S. agricultural comparative advantage, largely rooted in technology, diminishes within the next 10 to 15 years may largely depend on how much emphasis the United States places on agricultural research. Already, research conducted by OTA has concluded that the United States is losing some of its comparative advantage in mechanical and chemical technologies to aggressive and dynamic firms in Europe and Japan. Two major technical studies have concluded that newly emerging agricultural technologies may have a greater proclivity for direct international transfer than older technologies. The United States faces very strong biotechnology development competition from Japan, Germany, and other European countries.

Investment and expenditures in biotechnology are difficult to track because of the absence of any widely accepted definition of what constitutes biotechnology research, and only in recent years have any attempts been made to analyze biotechnology research support. Consequently, caution must be exercised in assessing financial investment and

spending data related to biotechnology research and development. Federal and state agencies define biotechnology differently, often depending upon their different scientific and political perspectives as well as the overall mission of the agency. We did not attempt to evaluate the adequacy of biotechnology-related research funding; rather, we simply present statistics indicating the levels of funding in the past few years and the opinions of officials involved in this research as it relates to agriculture.

From existing data analyses, it appears that relatively small percentages of agricultural R&D funding in both the private and public sector go directly to biotechnology research. A 1985 Agricultural Research Institute survey concluded that 7.2 percent of the agricultural research conducted by private industry was on biotechnology.[14] Biotechnology research at USDA's Agricultural Research Service, the State Agricultural Experimental Stations, and veterinary colleges accounted for approximately 5 percent of total research funding at these institutions in fiscal year 1984.[15]

In a July 1988 report on U.S. investment in biotechnology, OTA found that total federal spending for all biotechnology research and development (i.e., for health, agriculture, industry, etc.) has not changed substantially in current dollars since 1985.[16] Spending for biotechnology research and development in 12 federal agencies totaled about $2.2 billion in 1985, $2.34 billion in 1986, and $2.61 billion in 1987. Biotechnology research and development funding for USDA's Cooperative State Research Service was reported to be $49 million in fiscal year 1987 (a 6.5-percent increase over fiscal year 1986) and $35 million for ARS (a 29.6-percent increase over fiscal year 1986). However, corporate research programs in biotechnology research and development have grown in the 1980s.

OTA's analysis also reported that 33 states are actively engaged in some form of biotechnology research and development, with total state

[14]A Survey of U.S. Agricultural Research by Private Industry, Agricultural Research Institute, July 1985. Areas ranked from highest to lowest percentages were as follows: pesticides, plant breeding, human food, biotechnology, and "other" (includes farm machinery and equipment, biologics, animal nutrition and feeds, plant nutrients, packaging materials, energy research, agricultural economics, natural fiber processing, and tobacco products and processing).

[15]Biotechnology: The U.S. Department of Agriculture's Biotechnology Research Efforts (GAO/RCED-86-39-BR, October 1985).

[16]New Developments in Biotechnology, U.S. Investment in Biotechnology, Office of Technology Assessment, July 1988.

investment estimated at $147 million in fiscal year 1987. In addition, OTA identified 403 U.S. companies dedicated to biotechnology and 70 U.S. corporations with significant investments in biotechnology. U.S. private industry spending is estimated by OTA to be $1.5 billion to $2 billion annually; however, human health care biotechnology research dominates this private sector research and development (approximately 40 percent). OTA estimates that 75 percent of all private investment in U.S.-based biotechnology is in health care applications; agricultural applications have received an estimated 16 percent of the total investment. OTA's analysis found that only 11 percent of the dedicated biotechnology companies (businesses or ventures started specifically to commercialize biotechnology innovations) and 21 percent of the large corporations investing in research and development were primarily involved in animal health and agriculture biotechnology.

Agricultural research comprised less than 2 percent of the total federal research expenditures in 1985, far less than the 80 percent level in 1939. Only 5.2 percent of total federal research funds is allocated to USDA and only 1.4 percent of the USDA budget is used for research. This has led some observers to conclude that present agricultural research spending patterns might be too low given the potential to improve the future competitiveness and profitability of U.S. agriculture. This conclusion may be particularly true for plant applications of biotechnology, since OTA found the general information base for plant biotechnology to be far more limited than for animal sciences.

The need to enhance the competitiveness and profitability of U.S. farmers was echoed in a 1987 annual priority report presented to the Secretary of Agriculture by the Joint Council on Food and Agricultural Sciences.[17] Among the eight science and education priorities identified by the Joint Council, four deal directly with the development and expansion of new agricultural technologies: (1) expansion of biotechnology and its applications, (2) development and maintenance of scientific knowledge and expertise, (3) assessment of new and expanded uses for agricultural products, and (4) preservation of germplasm and genetically improved plants. In its recommendations, the Council called for the continued development of new technologies designed to lower production costs and enhance product quality, since they are critical to future increases in the U.S. share of the global agricultural market.

[17]Fiscal Year 1989 Priorities for Research, Extension and Higher Education, Joint Council on Food and Agricultural Sciences, June 1987. The Joint Council was established in 1977 to encourage and coordinate research, extension, and higher education activities in the food and agricultural sciences. Its role was reaffirmed in the Food Security Act of 1985.

Barriers to Commercialization

Although developments in agricultural biotechnology offer the potential for improvements in crop output and quality, several barriers to successful commercialization remain.[18] Experts agree that the sparse fundamental knowledge base pertaining to plant agricultural biotechnology is a barrier to the rate of commercial development. Some applications may remain a decade or more away from commercialization unless significant breakthroughs occur. However, some technical barriers viewed as formidable obstacles to development only a few years ago are now being cleared, particularly for DNA transformation, opening the possibility for efficient genetic engineering in several cereal crops, such as wheat, rice, and maize. Furthermore, analysts expect U.S. companies to experience profitable returns on investments in agricultural biotechnology.

Regulatory uncertainty also poses a formidable barrier to the commercialization of agricultural research; indeed, it may be the most serious obstacle. In numerous instances companies have complained of delays when attempting to move production of new crop techniques from laboratories to small-scale, experimental field sites. Private sector biotechnology companies argue that the regulatory delays forced upon them by the federal government affect the profitability of product development and slow the commercialization research agenda. OTA notes that biotechnology companies are concerned that the expensive and lengthy regulatory hurdles they now face could ultimately affect time-critical development efforts and corporate profits. Yet, because of the novelty of these techniques and the largely unknown consequences of exposing the environment to new microorganisms and genes, the federal government has delayed approving some new plant technologies because it has no agreed-upon regulatory mechanism to deal with field test applications.

Lastly, questions and disputes about international intellectual property rights also pose potential problems that could hinder efforts. The general lack of intellectual property protection for plant technologies in other countries erects a potential barrier given the international competitiveness of today's agricultural sectors. According to OTA, many U.S. companies have pursued trade secrecy as a short-term or more certain protection for their technology. Investment could possibly increase in agricultural biotechnology research if this risk was removed.

[18]These are discussed in New Developments in Biotechnology, U.S. Investment in Biotechnology—Special Report, Office of Technology Assessment, OTA-BA-360, July 1988.

Challenges for U.S. Agricultural Production and Trading Policies

International agricultural production and trade for the major bulk commodities have undergone dynamic changes in the last 25 years. The international food commodity markets of the 1980s are different in marked and perhaps permanent ways from the markets of the 1960s and 1970s. Increased global interdependence in farm production and trade has produced a complex set of issues relating to global food production, markets, and trade. A more complex trading environment exists due to increased worldwide crop output and to the availability of alternative supply sources—especially for wheat and coarse grains—and, in the case of soybeans, substitute products.

The primary reasons for the changed international agricultural environment in the 1980s are (1) the volatile fluctuations in world economic conditions, (2) the adoption of new sets of agricultural and trading policies by governments around the world, and (3) the use of improved farming technologies. While changes in these factors have always altered agricultural production and trade patterns, the changes have had more pronounced effects in the 1980s. More importantly, these factors have the potential to perpetuate long-term market uncertainties with regard to the supply and demand of major agriculturally traded commodities. Therefore, it is important that U.S. policies not be constructed in isolation from economic decisions, agricultural and trade policy actions, and farm-related technological developments in other countries around the world. U.S. agricultural policy must be flexible enough to respond to the interaction of these three factors or abrupt, isolated changes occurring in any one. In short, U.S. agricultural policies cannot address an international marketplace of the past; rather, policymakers must construct policies that recognize the dynamics of a competitive, internationally based agricultural trading system.

As the Congress begins to prepare for the upcoming 1990 farm bill, it faces the challenge of developing U.S. agricultural production and trading policies in an increasingly complex and uncertain world agricultural marketplace. These policies should emphasize (1) international agreements that curtail the market-distorting effects of domestic policies that subsidize farm production and exports, as well as those that present unfair importing restrictions; (2) innovative and timely approaches to economic development and financial assistance for the developing countries to help revitalize their own economic growth; and (3) open debate on the priority that should be afforded to agricultural science and technology to keep the United States competitive in agricultural production and exports in the years ahead.

Macroeconomic Conditions Have Intensified in Their Effects on Agricultural Production and Trade

The interdependence of global agricultural production and trade, world economic and monetary policies, and indebtedness has become more intensified over the last 25 years. These major macroeconomic forces that affect the future of world trade will by their very nature significantly affect the future of global agricultural trade and production. At least two major changes have occurred in the global economy that are responsible for introducing major volatility into the world trading system, including agriculture.

First, the extent of LDC debt—currently close to $1 trillion—continues to have a significant effect on world agricultural production and trade. As a result of their debt obligations, many important food importing developing countries are having to allocate their foreign exchange earnings to debt repayment rather than internal economic development and food imports. This debt burden severely impairs the purchasing power of the developing countries, in turn hurting U.S. farmers. More important, many developing countries have attempted to revitalize their own domestic food production capabilities in order to meet growing food demands brought about by population increases. Unable to import food in needed quantities because of economic difficulties, some are pursuing food self-sufficiency goals. This constricts an already intensely competitive export market for food and feed grains and, in some cases, may create the impetus for future agricultural export competitors to emerge.

Second, agricultural economists at USDA and FAO also point to the impact that currency exchange rate fluctuations and the increasing globalization of the world's financial markets have had on agricultural commodity trading. Exchange rate fluctuations have the ability to dramatically affect the market price of a commodity, adding further uncertainty to the world market. According to FAO, currency fluctuations characteristic of the 1980s have made agricultural exporters and importers more protectionist-oriented. Exporting nations do not want their domestic agricultural support policies to be undermined by wide swings in commodity prices brought on by exchange rate movements. Similarly, food importing countries may be encouraged to become more self-sufficient, at whatever the costs, as a result of uncertainties in food prices brought about by acute exchange rate movements.[1]

[1]Currency fluctuations can have other consequences for agricultural commodity production and trade. Agricultural investment and development are made with greater risk because of pricing uncertainties, international comparative advantages may be disrupted solely because of changes in competitiveness brought about by currency movements, and determining the currency to use in international food commodity agreements becomes problematical.

Addressing Ways to Increase Economic Growth in the LDCs

These major changes in the global economy present challenges to U.S. policymakers concerned with the future of U.S. agriculture. Among the most critical challenges for the United States is how to assist in bringing about a revitalization of low- and middle-income LDC economic growth. These countries represent a significant portion of the world's trading markets; yet, with stagnant economies since 1981, many developing countries have been forced to dramatically reduce imports of all goods and services. This import reduction has led to a constrained export market for many agricultural and nonagricultural goods. Until the conditions creating and perpetuating the depressed economic conditions in the developing countries are resolved, many U.S. export commodities (which have been exported traditionally in large volume to developing countries) and international trade in general will remain constrained.

The 1970s illustrate the positive impact of economic growth in the developing countries on agricultural trade in particular. Strong economic growth, particularly in the oil producing developing countries and many of the Asian economies, spurred an increase in world demand for imported food. High rates of economic growth led to higher food consumption rates; this translated into improved export opportunities for U.S. farmers. Economic growth in both the developed and developing countries increased aggregate world food demand. If economic growth and development improves in developing areas, they are expected to be significant importers of specific agricultural commodities, especially coarse grains. This means that future economic growth in the developing countries is taking on paramount importance in reviving world trade flows, particularly for agriculture.

During periods of slow or stagnant world economic growth, as has generally been the case in many areas of the world since 1982, agricultural trade normally slows as well. In the early 1980s, a global economic slowdown contributed to much slower rates of growth in agricultural imports for many world regions—including the developing countries. While the economies of most of the developed countries have recovered from the recessionary period of 1981-83, many developing countries have not. Their much slower rates of economic growth, combined with the pressure of servicing large external debts, have forced many of these countries to reduce their food import levels and thus contributed to a constricted world export market.

World Trade and the LDC Debt Crisis

Many developing countries continue to find themselves confronted with rising debt servicing requirements on the one hand and falling commodity prices for many of their exports on the other. Faced with overwhelming external debt burdens, many countries have taken drastic measures to attempt to finance payments to creditors. Strict domestic austerity measures have been used to curb consumption and imports while resources are being devoted to dollar-earning export sectors. Many of the debtor countries find themselves in a situation in which the debt load is equal to or greater than it was at the start of the debt crisis in 1982. Furthermore, instead of contributing to domestic economic growth and development, export earnings to a large extent are channeled to debt repayment programs. For example, according to one estimate, 30 percent of Latin America's export earnings in 1987 went toward debt repayment. Economic growth in some developing countries, as a result, is less than half of that experienced in the 1970s. Funding for modernization and expansion projects has been reduced, and the erosion of living standards induced by government economic policies has reduced import demands.

At the same time that the developing countries are looking for their exporting sectors to provide debt repayment revenues, they are encountering depressed prices for many world exports, decline of foreign investment capital (due to already existing debt burdens and unstable economies), high domestic inflation, slow growth in world markets, and mounting protectionism among the developed countries. In short, the debt-laden developing countries are importing less, attempting to export more, earning less revenues for their exports, and using the export earnings to pay off debts. Consequently, normal world trading patterns have been interrupted, especially for agricultural commodities.

With so many developing countries experiencing low economic growth and debt repayment schedules in many cases showing little improvement, the Third World debt situation is taking on paramount importance. The combination of restructuring existing loans, receiving infusions of new funds from commercial banks and multilateral lending institutions, instituting economic reforms under International Monetary Fund supervision, and benefiting from improvements in world economic growth was expected to lead the developing countries out from under the burden of external debt. After more than 5 years of painful adjustment with little visible improvement, these debt situations do not appear to be lending themselves to quick fixes or rapid turnarounds. New proposals and plans have recently surfaced that attempt to reduce the debt burden of the developing countries without causing commercial

banks to write off enormous losses or requiring huge amounts of new capital to spur economic growth. However, few signs of improvement have occurred, leading some international experts to conclude that a major first step in solving the LDC debt crisis is to stimulate economic growth in the debtor countries.

Enhanced LDC Economic Growth and U.S. Agricultural Interests

In addition to reduced capital inflow problems within the debt-ridden developing countries, increases in trade protection throughout the world have exacerbated LDC economic difficulties. Given the importance of the developing countries to the future of world trade, it is important for them to experience favorable conditions for their own trade and economic expansion.

At least one agricultural analyst has suggested that U.S. agricultural policy objectives—while not guiding foreign aid assistance—should be considered in overall U.S. economic development assistance and trading policies toward the developing countries. Helping to improve their overall economic growth could lead to stronger export markets for U.S. farm products and offers an additional policy approach to concessionary food aid programs and expensive export subsidy programs basically designed to relieve excess production problems in the United States and other developed food exporting nations. In fact, given the agricultural production and exporting capacity of the United States in food and feed grains, an expansion of the total world agricultural market—rather than forcing U.S. farmers to compete for an increasing share of a shrinking market—could lie in the long-term interest of U.S. agriculture. Such an approach recognizes that U.S. farmers are not producing for a fixed market and is consistent with beliefs underlying the U.S. position in current multilateral trading negotiations on agriculture (i.e., that the United States can successfully compete against other food exporting countries in a world market that is free of subsidies and import restrictions).

U.S. foreign assistance policies should be tailored to country-specific conditions and in such ways that will best promote the countries' own economic transformation and placement in the world trading system. For example, in many low-income developing countries, agriculture remains the primary source of employment, income, and general economic growth. Policy reforms in the developing countries that provide farmers with profits, new technology, and improved infrastructure are in the interests of the countries themselves. Such policies can be complementary to U.S. agricultural interests, even if they increase foreign production.

LDC markets were responsible for the greatest growth in agricultural exports from the mid-1970s until 1981. Developing countries whose agricultural sectors grew faster during this time frame tended to import more food generally and more food from the United States specifically. In some instances, these countries imported twice as much corn and four times as much soybeans per capita than developing countries with slow economic growth. Studies conducted by the World Bank and the International Food Policy Research Institute show that the growing farm sectors spurred employment (both farm and rural nonfarm), leading to higher incomes and greater consumption. As consumption outpaced existing food supplies, food import needs increased. Several studies have reportedly confirmed the positive relationship between increases in per capita food production and per capita food imports.[2] Some exceptions have occurred—such as India and China—but larger food import demands eventually may develop in these countries when more broad-based economic growth occurs and improvements are made in internal food marketing and distribution systems.

Furthermore, the United States and other developed countries could help the developing countries develop or improve the production of specific agricultural and nonagricultural commodities for which the LDC has a comparative advantage and the United States an importing need. This could help deter the developing countries from attempting to cultivate or expand production of other food commodities that can be produced more efficiently. By helping to ensure the production and exporting success of a limited number of food commodities, the United States can help secure markets for its much larger array of food products.[3]

Agricultural economists at ERS have suggested how such an approach to development assistance could work so that it benefits both the United States and the developing countries.[4] Industrial and agricultural sectors

[2]K.L. Bachman and L.A. Paulino, Rapid Food Production Growth in Selected Developing Countries: A Comparative Analysis of Underlying Trends, 1971-76, International Food Policy Research Institute, October 1979; J. Lee and Mathew Shane, "U.S. Agriculture Interests and Growth in Developing Economies: The Critical Linkage," USDA/Economic Research Service, June 1985; Robert Paarlberg, United States Agriculture and the Developing World: Partners or Competitors?, Curry Foundation, December 1986; and E.D. Kellogg, R. Kall, and P. Garcia, "The Effects of Agricultural Growth on Agricultural Imports in Developing Countries," American Journal of Agricultural Economics, 68 (1986):1347-52.

[3]Agricultural economists label this situation "complementary comparative advantage"; it is said to exist between two countries when each has a comparative advantage in the production and export of a commodity or commodities that the other wishes to import.

[4]These ideas are incorporated from a staff study written by Lon Cesal entitled "Agricultural Policy Distortions, Economic Development, and Growth in Agricultural Trade," International Economics Division, Economic Research Service, USDA.

of the LDC economy could be identified where comparative advantage or potential comparative advantage exists.

Highly technical assistance projects designed to increase production and/or exports could be incorporated into economic development. At the same time, long-term trade agreements between the United States and development assistance recipients could be developed to assure the recipient country of a stable supply of agricultural imports from the United States and to provide preferential treatment to the recipient country's exports into the United States.

Although such an approach is controversial because of a potential short-term negative impact on some U.S. economic sectors, some agricultural trade experts suggest that it actually provides long-term benefits to the United States. However, the United States should have an import need for the sector being assisted in the recipient country. Also, the aggregate effects of economic development that would occur from the assistance must be considered, not just the effects of a single country increasing exports of a single commodity.

LDC agricultural sector development and improvements can have numerous consequences for the United States as well as other major agricultural exporting countries. First, additional foreign crop production may lead to declining exports to specific countries and perhaps the eventual loss of specific markets, as has been the case with the U.S. rice market in Indonesia and the U.S. wheat market in India. Second, the composition of agricultural trade for different world regions may vary substantially since not all U.S. export crops are affected the same by increased foreign production. If production costs in the United States are low in comparison with those of other countries, if world markets remain large and diverse, and if end users are varied, then certain U.S. export crops can expect to do well on the world market.[5] Third, the extent of change in the world agricultural market will also be affected by whether the developing countries simply incorporate technical assistance/changes into their agricultural production or whether the incorporation of technology is accompanied by agricultural policy reforms. Agricultural technology can affect their farm profitability and competitiveness; moreover, policy reforms can revolutionize the entire agricultural sector

[5]Average production costs for principal U.S. export crops are not the world's lowest but are competitive against major exporting competitors. Corn and soybeans are produced at nearly as low a cost as the world's least-cost producers, and average U.S. wheat production costs are competitive with all other exporters except Argentina.

of a country and have an even more profound impact. As some agriculture trade analysts have argued, in the short run, the United States may lose food exports to agricultural reform-oriented developing countries. In the long run, food imports could once again increase as dietary preferences change and food demands increase.

In brief, economic development and growth are essential for the expansion of world trading markets, including agriculture. Without economic growth, food import markets can stagnate, leading to overproduction and global food surpluses that ultimately hurt agricultural exporting countries, such as the United States. Empirical evidence from the past demonstrates that as countries become more urbanized, more affluent, and more economically developed, they become dependent upon food imports.[6] For substantial improvements in world agricultural trade to occur, the developing countries will need to increase their economic growth and development. This can generate additional income that can be used to import more food to provide growing populations with better diets. The United States can promote economic development in the developing countries by cooperating with other developed countries to reduce trade restrictions and debt burdens and to restore investment capital flows to these areas.

Worldwide Agricultural Policy Changes Have Created Changed Markets

Agricultural policies in the developed and developing countries also have changed over the last two decades. Countries such as India, China, Pakistan, and Indonesia have constructed domestic policies that have effectively increased incentives resulting in near self-sufficiency and sometimes surpluses in basic commodities like wheat and rice. Although these countries may eventually evolve into importers of feed grains and other value-added agricultural commodities, they have effectively removed their dependence on imported basic food grains.

Other countries have imbedded protectionist agricultural policies that shield their domestic markets from foreign competition. These actions have also served to restrict growth in international agricultural trade, forcing consumers and taxpayers in countries that employ such policies

[6]See Robert Paarlberg, United States Agriculture and the Developing World: Partners or Competitors, Curry Foundation Report, 1986; John Lee and Matthew Shane, "United States Agricultural Interests and Growth in the Developing Economies: The Critical Linkage," Economic Research Service, USDA, June 1985; Suzanne Marie Marks and Mervin J. Yetley, "The Impact of Economic Development on Global Food Demand Patterns," World Agriculture Situation and Outlook Report, Economic Research Service, USDA, May 1988; Gary Vocke, "Trends for Grain Consumption, Production, and Trade in the Developing Countries," World Agriculture Situation and Outlook Report, Economic Research Service, USDA, June 1986.

to bear the brunt of the expense in the form of higher food prices or costly government subsidies to producers. Other countries offer subsidies to farmers designed to protect farm income levels, resulting in production being geared toward artificial prices exempt from the world market forces of supply and demand.

Many of these policies have distorted the equilibrium between world supply and demand, leading to overproduction of certain commodities, inefficient use of domestic resources in many countries, and burgeoning surpluses that depress world food prices. As major studies by the World Bank, OECD, and FAO indicate, traditional comparative advantages have become distorted. Yet, the policies responsible for these distortions—whether they be import barriers, farm production subsidies, or export assistance programs—exist due to fundamental social, political, and economic forces operating within the countries. Therefore, it is unlikely that these policies—and their resulting effects on agricultural production and trade—will subside quickly and perhaps not at all.

Addressing Policies That Distort World Agricultural Production and Trade

The biggest agricultural trade policy challenge immediately facing U.S. policymakers is the current Uruguay Round of the Multilateral Trade Negotiations. Agricultural policy reforms have been given a high priority for the first time in the history of these negotiations, emphasizing a recognition among major agricultural exporting countries that their own domestic farm subsidy programs have contributed to imbalances in food supply and demand and produced harmful effects on the world food trading system. Agreement on how and when to move to such a global world agricultural production and trading structure, however, is not imminent.

Should agreements be reached to reduce or eliminate agricultural subsidies and trading barriers through the MTN round, the international agricultural markets could undergo substantial change. Markets would potentially become more open, and exporting competition could be based more on production and marketing efficiencies and quality output. Elements of the farming sector in countries where production and exports currently are heavily subsidized undoubtedly would be affected in significant ways.

Many do not foresee quick resolution of the political and social forces acting to distort domestic agricultural production and trade, despite the energy and intensity of the MTN. This realization has helped forge a consensus among leading international trade analysts and organizations

that economic growth in the developing countries is a critical component in the revival of world trade flows for all goods and services. As a natural consequence of enhanced economic growth, LDC demand for many bulk food and feed commodities—grown in abundance in the United States—should rise, as was the case in the 1970s.[7] Most developing countries normally experience a concomitant rise in gross national product (GNP) and food imports as food consumption patterns change and consumption levels of large, growing populations outstrip domestic production capacity.

Adoption of New Agricultural Technologies Has Altered World Food Growing Capabilities

The introduction of new crop varieties, improved fertilizers, herbicides, and insecticides and the adoption of better farm management practices have resulted in a surge in agricultural production capacity in practically all areas of the world. Not only have farmers in the major food exporting countries of the developed world experienced yield improvements, but LDC farmers have also been able to capitalize on adoption and adaptation of improved farm technologies.

For some importing countries, the adoption of better technology has meant reduced food import needs. In some developing countries, improved capacity brought about by improved farm methods and better plant varieties has contributed to the establishment of agricultural commodity exports. In the major export producing countries, higher yields have contributed to the ability to meet growing world food needs without cropland expansion.

The changes that have occurred in agricultural production as a result of better farm technology emphasize its powerful impact on world production and trading patterns. Technology can be largely responsible for market changes because of its impact on crop volume alone. The new crop growing technologies that are emerging from public and private sector research around the world have the potential to allow food-deficient countries to further enhance their abilities to grow food for their own needs.

[7]With more food exporting countries in the 1980s, agricultural production efficiency and competitive pricing factors are even more important than they were in the 1970s.

Addressing the Impact of Emerging Agricultural Technologies

A new wave of agricultural biotechnology advancements emphasizing output that could result in lower costs and enhanced profitability and competitiveness is under development. Some of these new technologies, unlike previous chemical and mechanical developments, are designed not only to increase output but to do it more economically. This "precision" agriculture promises improved plant traits, reduced labor and production costs, and the evolution of quality, dependable food commodities. Farmers adopting these newer technologies could have tremendous advantages over other producers.

Evidence indicates that foreign food exporters and importers are also investing in the development of these new biotechnologies. Further, some agricultural scientists believe the ability to transfer these technologies may be easier than in the past. Therefore, even though the United States is a leader in the development of these new agricultural biotechnologies, other countries are quickly establishing similar research and development capabilities. Given that many private companies and international corporations are heavily involved in the research and development of these new products, the international transfer of the technology to major U.S. export competitors and even major food importers seeking ways to improve domestic production capabilities appears to be highly probable. Therefore, with substantial changes in future agricultural production patterns expected, the United States should focus on maintaining its competitive edge in the production of many different food commodities. As the United States considers its position in the agricultural biotechnology evolution, it will need to hold an open debate and address important decisions on the priority and funding levels necessary in agricultural science and technology to keep the United States competitive in agricultural production and trade. Despite the impressive advances made in new agricultural technological development, two issues remain unresolved and cloud successful commercialization around the world. First, controversy abounds over the environmental soundness and safety of many of the new crop technologies that alter plants and microorganisms associated with plant life.[8] Public concern exists about potential side effects from genetic manipulation or chemical applications. This concern centers on genetic modifications that may accidentally convert a harmless microbe into one capable of producing a toxin or attacking plants and animals in unintended ways. Some fear that without strict regulation, disclosure laws, and testing procedures, unknown environmental hazards could occur. On the other hand, private companies complain that rigid federal regulations governing the

[8]See Jack Doyle, Altered Harvest (New York: Viking Press, 1985).

testing and development of new biotechnologies can lead to critical delays that can affect profits and investment levels. Multinational companies have located research, development, and testing of some new farm technologies to other countries where environmental and safety standards are not as restrictive. Given these controversies, U.S. policymakers should continue to address the adequacy of the current standards in protecting public safety and welfare, and construct new or revised standards where necessary.

Second, some analysts argue that the push for the scientific development of new biotechnology methods has advanced without careful consideration of problems that are likely to be encountered in successful commercialization. Costs, distribution methods, potential shelf lives, and even educational programs on applications have yet to be adequately addressed. If these new technologies cannot successfully compete with existing ones in terms of cost versus output, there is little reason for farmers to jump to adopt them. In brief, the promise of new farm biotechnology must be affordable to work its wonders. Small, family farms could see their existence further threatened should the new crop growing and protection methods be adopted by large corporate farmers with better means to afford them.

Understanding International Market Forces

Since U.S. farmers grow a substantial portion of food and feed grain crops for export purposes, it is critical that U.S. agricultural policy recognize the changes that are occurring in international markets. Food demand patterns, foreign government policy changes, and world economic conditions can substantially affect agricultural trading levels. U.S. agricultural policy must be flexible enough to respond quickly to market changes brought about by these forces so that farmers are producing at levels commensurate with demand levels.

Due to the unpredictable influence of some factors on agricultural production and trade, such as weather and foreign exchange rates, some degree of market uncertainties remains a permanent part of international agriculture. U.S. farmers have benefited during periods of rapid global food demand growth or poor foreign harvests because of their ability to bring idle land and resources quickly into production for export purposes. Yet, with slower economic growth in traditional U.S. export markets, wide swings in currency exchange rates, and the creation of protectionist trade policies by other countries, U.S. farmers have been confronted with lower export sales and intense market competition.

Aside from these uncertainties that cause swings to occur in commodity production, prices, and trade, the international marketplace itself has changed. More agricultural producers and exporters exist for the United States to compete with in specific commodity sectors, such as wheat, rice, and soybeans. A few previously large-volume importers have become virtually self-sufficient in wheat and rice food production. The international marketplace, in short, may never resemble what it was like in previous decades. We conclude that agricultural trade for wheat, rice, and soybeans will remain intensely competitive during the next decade as improvements in productive capacities of foreign countries are brought about by changes in agricultural development policies and, more importantly, agricultural technology.[9]

[9]Rice production in Asia has been largely improved from high-yielding rice varieties introduced in the late 1960s and into the 1970s. Although technological advances specifically affecting rice are less transferable, research by the International Rice Research Institute in the Philippines, combined with labor intensive harvesting and production methods in many of the large Asian rice producing countries, should keep foreign rice exporters competitive with U.S. rice exporters.

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