A Review of U.S. Competitiveness in Agricultural Trade

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A REVIEW OF U.S. COMPETITIVENESS IN AGRICULTURAL TRADE

A TECHNICAL MEMORANDUM

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Foreword

America's ability to compete in international agricultural markets has come into question during the past several years. Several factors have contributed to recent declines in the volume and value of U.S. agricultural exports. The global recession of the early 1980s, along with expanded production among the major exporting nations, accentuated competition for world markets. Many countries, especially those in the developing world, began to develop sophisticated domestic production capacities, and cut back on imports wherever possible. Technology transfer from the United States has become increasingly rapid.

This OTA technical memorandum reviews key factors that influence U.S. trade in agriculture. It is part of a larger OTA project that analyzes the effects of technological change on both international trade and the structure of the domestic economy. Despite basic structural changes in the economy of the United States in recent years, agriculture and food production remain important parts of this country's economic framework.

Agriculture's importance to U.S. trade grew during the 1970s, when an agricultural trade surplus helped to offset damaging trade losses in other areas. With the Nation's trade deficit reaching record levels, recent declines in the volume and value of agricultural exports pose formidable questions concerning the U.S. position in an increasingly complex system of international trade. We trust that Congress will find this OTA review an informative and useful tool in addressing these questions.

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NOTE: OTA appreciates and is grateful for the valuable assistance and thoughtful critiques provided by the reviewers. The reviewers do not, however, necessarily approve, disapprove, or endorse this report. OTA assumes full responsibility for the report and the accuracy of its contents.

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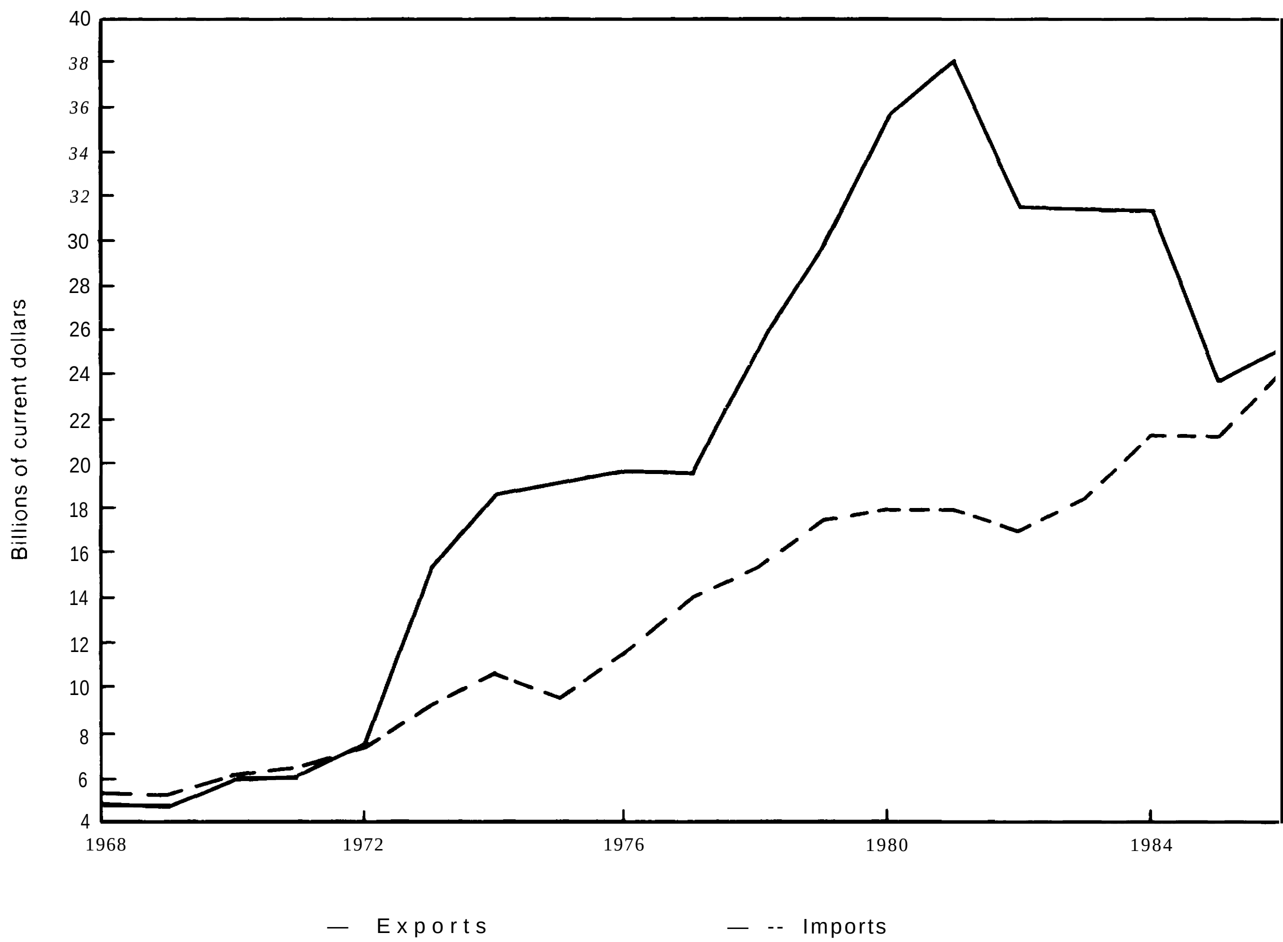
Introduction

Introduction

Are farmers in the United States losing their ability to compete in international markets? The question would have seemed absurd during the 1970s, when each year brought enormous increases in the value and volume of U.S. grain and oilseed exports. The U.S. share of burgeoning world markets seemed secure; agricultural exports were considered a bright spot in the United States' generally poor trade performance, In 1981, however, exports of wheat, corn, soybeans, and other key U.S. crops fell sharply, while slow but consistent growth in imports of a large variety of agricultural products continued unabated (see figure 1-1). U.S. farmers confronted the possibility that they might begin to face the kinds of trade 'problems that have plagued steel, automobiles, and other major U.S. production enterprises.

Despite numerous theories about "post industrial" societies, agriculture remains a crucial part of the U.S. economy. Declining agricultural exports confront this country with the prospect of losing an important counter to trade deficits in other areas. Agriculture is among the Nation's most capital- and research-intensive enterprises. It has become a "high-technology" enterprise which, combined with this country's vast wealth of resources, could remain a critical element in the U.S. trade balance.

Figure l-1 .—U.S. Trade in Food, Feeds, and Beverages



SOURCE U S Department o'Commerce Bureau of Economic Analys!s "'National Income and Product Accounts table 43, March 1986

This technical memorandum reviews the debate over the future competitiveness of U.S. agriculture—influences on world agricultural trade; trends in production, consumption, and trade of key commodities, including "high-value products"; and the cost competitiveness of U.S. agriculture.

The technical memorandum places special emphasis on the relationship between technology and the United States' competitive agricultural position. New technologies have led to increased yields in virtually every aspect of agriculture and food processing, and there is every indication that such progress will continue. However, the United States faces increasing technological competition from all parts of the world. The rapid pace of technology transfer suggests that unless domestic research and development efforts are continued and strengthened, foreign competitors may develop production capacities that match those of the United States.

FACTORS BEHIND THE DECLINE OF U.S. AGRICULTURAL EXPORTS

The export boom of the 1970s was made possible by a number of factors, including Third World economic growth, China's entry into world agricultural markets, and the Soviet Union's decision to import grain in order to increase livestock output. U.S. grain and oilseed producers expanded output rapidly, aided by a favorable exchange rate and by U.S. Government programs like agricultural price and income supports, liberal credit, and a favorable tax code. Other nations increased output to meet growing world demand, but U.S. producers captured a large share of this growth, using the United States' large stockpiles and enormous, underused areas of arable land to expand production. During the early 1970s, U.S. harvested wheat acreage rose by an amount greater than the total wheat acreage harvested by Canada, and between 1979 and 1981 the United States commanded 39 percent of the volume of all world trade in agriculture—up from 23 percent between 1969 and 1971.[1] In addition, the United States captured 71 percent of world volume trade in coarse grains in 1980, well over 10 times the share of the nearest competitor, Argentina (see table 2-16 of this technical memorandum).

Conditions changed after 1981, when global recession slowed rates of growth in demand. World corn and wheat production, for example, grew nearly 4 percent annually during the 1970s, but slowed to 3 percent per year between 1980 and 1985.[2] Approximately one-third of U.S. exports during the preceding decade were purchased by developing nations, who were forced to reduce imports after 1981, because their economies were weakened by the global recession. This problem was compounded by debt burdens. Moreover, many developed nations began to subsidize exports while imposing tariffs and quotas on imports. The "variable levy" of the European Economic Community (EEC), for example, has been cited as the single most important barrier to U.S. agricultural exports by the Office of the U.S. Trade Representative.[3] The EEC also began to subsidize food exports heavily, through the Common Agriculture Policy (CAP).

Other factors have worked against U.S. exporters. Many developing nations have cut back on imports, relying instead on the growth of domestic production capacity. Others have attempted to boost agricultural exports, in order to meet the crushing burden of foreign loans. In fact, both the U.S. Government and the World Bank have encouraged Latin American nations to increase exports as a method of raising revenue.

At the same time, production capacity in the developed world continued to climb, creating massive surpluses in key export commodities. As a result, prices fell sharply in the early 1980s; exporting nations struggled to maintain market

[1] U. S. Department of Agriculture, Economic Research Service, unpublished data.

[2] See table 2-11 of this technical memorandum.

[3] "Upcoming World Trade Talks: What's at Stake for U.S. Agriculture," *Congressional Research Service Review*, Washington, DC, vol. 7, No. 8, September 1986.

share. U.S. producers were hurt by the additional factor of an overvalued dollar. While the recent decline of the dollar may help U.S. producers to compete for Japanese and European markets, the dollar has not changed significantly with respect to Canadian and Australian currencies. Also, many Latin American nations tie their currencies directly to that of the United States.

Despite shrinking world markets, U.S. agricultural production continued to increase in the early 1980s. Profit margins for crop producers narrowed; for some producers, profits disappeared entirely. Government transfer payments, in the form of U.S. Department of Agriculture (USDA) price support loans and direct cash advances, rose sharply, compensating for some of the lost farm income. But the costs of these programs spiraled while stocks of wheat and feed grains—much of it owned by the government—accumulated. The price of maintaining U.S. exports, even at ***1985*** levels, has been high; the 1985 Farm Bill, which included plans for a 3-year, $52 billion series of programs to help U.S. farmers, will likely cost nearly ***$30*** billion for fiscal year 1986 alone and should top the initial ceiling after 1987, according to USDA.

A separate issue, and another potential factor behind the decline of agricultural competitiveness in the United States, is the comparatively low quality of U.S. grain. Recently, there has been a sharp increase in foreign complaints concerning the quality of U.S. grain stocks. This issue deserves comprehensive analysis, and OTA will soon commence a study that focuses on U.S. grain quality.

The Role of Technology Transfer

International trade in agriculture has also been affected by significant improvements in farm production technologies achieved over the past 15 years. Innovations in such areas as biotechnology, fertilizers, weed control, and animal reproduction and nutrition have led to spectacular gains, and this trend should continue. Table I-1 shows net gains in the productivity of wheat, corn, and soybean production. Similar kinds of efficiency improvements occurred and will continue to occur in dairy and livestock production.

While the United States once enjoyed an unchallenged lead in agricultural technology, foreign innovations have grown rapidly. The most significant development has been the upgrading of agricultural research capacity in developing countries, aided by technology transfer from the United States. The U.S. Government has encouraged this development, through a variety of bilateral and multilateral agreements designed to promote economic growth in developing nations and to coordinate scientific research. The establishment of International Agricultural Research Centers has also facilitated technology transfer to the developing world.

Other avenues of transfer exist. Much technological information is freely available in publications. Many foreign students study at U.S. schools. Perhaps most importantly, multinational corporations move technology to foreign subsidiaries with increasing speed, and sometimes—due to domestic regulations—introduce new technologies abroad before they are introduced in the United States.

Relative Costs of Production

The relative impact of new agricultural technology on production costs throughout the world is difficult to document, given the inconsistencies in international statistics, differing patterns of agricultural subsidies, enormous differences in patterns of land ownership and land values, and changing exchange rates. Still, the "green revolution" has clearly allowed countries such as India to increase production and change from net food importers to net food exporters. Many technologies permit significant increases in yields per acre, diminishing the comparative advantage of

Table I-l .—Projected Growth Rates in Crop Yields

	Actual 1970-84	Projected 1984-2000
Wheat . . . . ". . . . -----	1.5	1,2
Corn	2.1	1.2
Soybeans	0.2	1.2

SOURCE For past growth rates, see tables 24.2-7, and 2-8 of this report Projections come from U S Congress, Of fice of Technology Assessment Technology, *Public Policy, and the Changing Structure of American Agriculture* OTA-F-285 (Washington, DC U S Government Printing Off Ice, March 1986), table 3-4 Projections are for "most likely environment large U.S. land areas in a period of surplus production capacity. The surpluses do not, however, mean that technology has eliminated hunger; production increases trailed population growth in Third World nations least able to afford food imports.

Technical advances can allow foreign producers to grow many important crops below average U.S. costs. However, comparisons with average U.S. costs may be misleading. Unlike most manufactured products, U.S. farm production costs vary widely depending on region and farm size. While statistically precise statements cannot be made, it appears that a large percentage of U.S. farms are competitive with the most efficient producing areas in the world. These areas form the basis of U.S. strength in international agricultural markets. On the other hand, it appears that some U.S. farmers are operating at costs above world prices.

Of course, many foreign producers may also be operating with costs above world prices. For example, 1984 soybean yields in Argentina were 37 percent higher than those of the United States, and wheat yields in France were *250* percent higher. It is likely that this resulted from national programs designed to encourage exports, rather than from any advantage in resources or production technology.

U.S. Competitiveness in High-Value Agricultural Products

As total U.S. agricultural exports have declined, U.S. imports have grown at a slow but consistent rate, especially in a variety of "high-value" products (HVPS). HVPS include products that have been processed to some degree before export, as well as certain unprocessed commodities like horticultural crops. World trade value in HVPS now exceeds world trade value in bulk agricultural commodities. USDA estimates that the world high-value product market could rise by 9 to 12 percent per year until 1990, an increase of up to $2o billion.[4] Leading U.S. HVP exports include soybean meal, tobacco, cigarettes, cattle hides, and corn gluten feed.

While many European nations have moved aggressively to profit from the growth of HVP trade, the United States has not performed well in these markets. In fact, while the United States had captured 39 percent of world trade volume in agricultural products between 1979 and 1981, its relatively small share of high-value products meant that it held only an 18 percent share of the value of world agricultural trade. The U.S. share of the HVP market remained at about 10 percent during the 1970s; the United States has experienced a negative balance of trade in processed food since 1983.[5]

Many HVP export markets are highly volatile. Countries which at first import processed products often develop their own processing capabilities, and shift to imports of unprocessed products. In the 1970s, for example, the EEC was a major importer of soybean meal. As it developed its own processing capacity, its import emphasis shifted to raw soybeans, allowing it to reap the economic benefits associated with processing a raw commodity,

Questions for the Future

While it is likely that world demand for food exports will grow in the future, slow growth may occur for traditionally strong U.S. export commodities. For example, recent projections made by Resources For the Future (a Washington, DC, based research institute) point to vigorous growth in Third World economies and diets, but suggest that world demand for cereal grains will grow at about 2 percent per year for the remainder of the century—below the average rates of the past 5 years.[6] In addition, North American exports of cereals will command a shrinking share of total trade because of growing competition from other producers.[7]

The unfavorable conditions that faced U.S. producers in the early 1980s gave a number of other nations the opportunity to gain export market

[4]U.S. Department of Agriculture, Economic Research Service, "High Value Agricultural Exports: U.S. Opportunities in the 1980s," U.S. Department of Agriculture, Economic Research Service, *Foreign Agricultural Economic Report No.* **188,** Washington, DC, 1983.

[5]"Upcoming World Trade Talks," op. cit.

[6]See table 2-17 of this technical memorandum.

[7]See table 2-21 in this technical memorandum.

shares, which they will give up only reluctantly. In the case of the EEC, for example, expanded exports are a part of a larger strategy to protect European agriculture. Other nations have borrowed funds to make significant investments in such areas as land preparation, purchases of agricultural equipment, and construction of port facilities and roads. These activities encourage exports, which will likely be increased in order to repay the initial loan.

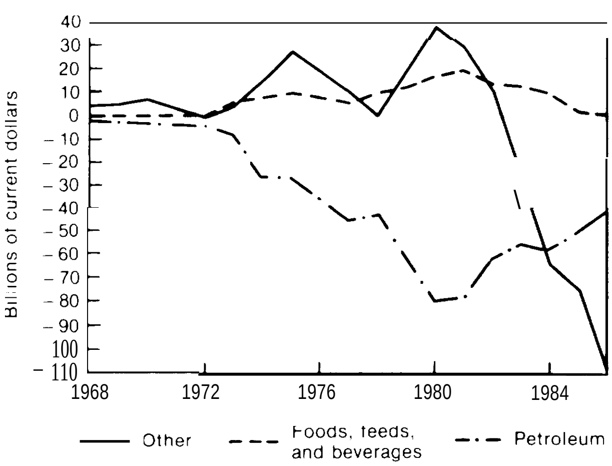
U.S. markets could be further eroded by developing nations that continue to absorb agricultural innovations and transfer them to local producers. Crop productivity in these nations may grow more rapidly, aided by U.S. technologies—many of which boost the productivity of both U.S. agricultural exports and those of our export competitors.

It is important to note that the measure of U.S. agriculture's international competitiveness may not necessarily be whether the peak market shares of the late 1970s can be regained. Rather, the focus for the future may revolve around whether U.S. producers can profit from their exports. If this does not occur, trade may actually decrease the total income available to U.S. farmers, which would tend to have a negative effect on the total number of agricultural jobs.

CONSEQUENCES FOR THE AMERICAN WORKPLACE

Why should the United States be concerned about balance of trade in agriculture and agricultural products? The most obvious answer is agriculture's historical contribution to net balance of trade. Figure I-2 illustrates the disastrous performance of U.S. merchandise trade during the past 5 years, a situation that would have been worse without the decline of petroleum prices. Agricultural exports constituted one of the few areas where the United States enjoyed positive trade balances that offset deficits occurring in other areas. However, USDA forecasts a U.S. agricultural trade surplus for ***1986*** of $7.5 billion, the lowest such level since ***1973.***

Figure 1-2. —U.S. Merchandise Trade Balance
(exports minus imports)



SOURCE U S Department of Commerce Bureau of Economic Analysis National Income and Product Accounts table 43 March 1986

Loss of agricultural exports translates into direct and indirect affects throughout the U.S. economy. Table I-2 summarizes how a decrease in agricultural trade could "ripple" through the economy, in comparison with trade in other areas. While agricultural trade could generate a significant amount of employment outside the farm sector, links to the rest of the economy may not be as great as those that result from trade in manufactured products. The table estimates that about 60 percent of the dollars gained or lost in livestock trade and 45 percent of the dollars gained or lost in other agricultural products occur in businesses outside the traditional farming sectors. By comparison, about ***60*** percent of the income lost from automobile imports would be lost by firms outside the automobile industry. [8]

Table I-3 suggests what kinds of jobs might be gained or lost through agricultural trade. It can be seen that the total number of jobs gained or lost through a given volume of trade in grain products or food processing is roughly equivalent

[8] U.S. Department of Commerce, Bureau of Economic Analysis, "1977 Input-Output Model," *Survey of Current Business*, vol. 64, No. 5, May 1964.

Table I-2.—If U.S. Trade in Agriculture and Other Products Increases (or Decreases) by a Dollar, Which Business Sectors Benefit From This Gain (or Suffer the Loss)?

$1 of trade in livestock and livestock products	
Other agricultural products	$0.21
Livestock and livestock products	$0.20
Food and kindred products	$0.09
Wholesale and retail trade	$0.08
Real estate and rental	$0.07
Transportation and warehousing	$0.03
Crude petroleum and natural gas	$0.03
Business services	$0.03
Agricultural, forestry, and fishery services	$0.03
Finance and insurance	$0.03
Other	$0.19
Total	$1.00
$1 of trade in “other agricultural products” (mostly grains)	
Other agricultural products	$0.55
Real estate and rental	$0.09
Wholesale and retail trade	$0.05
Crude petroleum and natural gas	$0.04
Chemicals and selected chemical products	$0.04
Business services	$0.03
Agricultural, forestry, and fishery services	$0.02
Transportation and warehousing	$0.02
Finance and insurance	$0.02
Electric, gas, water, and sanitary services	$0.02
Other	$0.12
Total	$1.00
$1 of trade in food and kindred products (mostly food processing)	
Food and kindred products	$0.35
Other agricultural products	$0.11
Wholesale and retail trade	$0.09
Livestock and livestock products	$0.05
Business services	$0.04
Real estate and rental	$0.04
Transportation and warehousing	$0.04
Crude petroleum and natural gas	$0.03
Electric, gas, water, and sanitary services	$0.02
Chemicals and selected chemical products	$0,02
Other	$0.22
Total	$1.00
$1 of trade in motor vehicles and equipment	
Motor vehicles and equipment	$0.39
Wholesale and retail trade	$0.07
Primary iron and steel manufacturing	$0.07
Screw machine products and stampings	$0.04
Business services	$0.04
Rubber and miscellaneous plastic products	$0.03
Transportation and warehousing	$0.03
Primary nonferrous metals manufacturing	$0.02
Other fabricated metal products	$0.02
Crude petroleum and natural gas	$0,02
Other	$0.27
Total	$1.00

SOURCE U S Department of Commerce, Bureau of Economic Analysis, “1977 Input Output Model,” *Survey of Current Business*, VOI 64, No 5, May 1984

with that of automobile manufacturing. All three enterprises could generate about 25 jobs per $1 million of output. Livestock products appear to be more labor-intensive, mainly because of the large number of individuals who classify themselves as “self -employed.” Of course, all of these estimates must be considered as approximations since statistics on agricultural employment, particularly on part-time and “self-employed” persons, are notoriously inaccurate.[9] And while more detailed analysis of-agricultural trade’s impact on the economy as a whole would be a valuable contribution, such depth is beyond the scope of this technical memorandum.

In looking to the future, however, it is also important to recognize that the labor productivity of agriculture and related businesses have been growing at rates significantly faster than the rest of the economy. The kinds of technical progress suggested in table 1-1 will also reduce the number of jobs generated per dollar of output. In fact, if the labor productivity of agricultural sectors grows at the average rate of the last 10 years, total agricultural employment per dollar of output will fall by 22 percent. These trends, however, may be misleading; labor productivity in the “food and feed grains” category grew 6.8 percent per year during the “boom years” of 1973 to 1979, but fell ***0,2*** percent per year between 1979 and 1984.[10]

[9] Figures were calculated using $1 million of demand for the commodit y indicated expressed in 1984 dol lars, Estimates of the way this demand translates into business output are made using the 1977 input-output table (see table I-2). Estimates of employment by occupation are made by using estimates of jobs per unit output in each industry prepared by the Bureau of Labor Statistics for the year **1982,** Conversions have been made using deflator series appropriate for each industry. The BLS series providing occupation by industry and standard BLS estimates of total national employment do not use the same definition of farmers, farm workers, and laborers, The estimates shown above are prepared by scaling jobs in these categories to make them consistent with employment data maintained in series published in the Monthly Labor Review,

[10] U.S. Department of Commerce, Bureau of Labor Statistics, unpublished data (“Employment Requirements’), Washington, DC, June **1985.**

Table 1-3—Jobs Produced by a Million Dollars' Worth of Exports (or Jobs Lost by a Million Dollars' Worth of Imports) in the Categories Indicated

$1 million of livestock and livestock products		**$1 million of other agricultural products**	
Self employed	13	Self employed	10
Farmers and farm workers	8	Farmers and farm workers	7
Clerical workers	3	Clerical workers	2
Laborers, except farm	2	Laborers, except farm	1
Managers, officials, proprietors	1	Managers, officials, proprietors	1
Salesworkers	1	Salesworkers	1
All other operatives	1	Other craft and related workers	1
Transport equipment operatives	1	All other operatives	1
Other craft and related workers	1	Transport equipment operatives	1
Mechanics, repairers, installers	1	Mechanics, repairers, installers	1
Other	4	Other	3
Total	36	Total	28
$1 million of food and kindred products		**$1 million motor vehicles and equipment**	
Self employed	5	Clerical workers	3
Clerical workers	3	Laborers, except farm	2
Laborers, except farm	3	All other operatives	2
Farmers and farmworkers	3	Metalworking operatives	2
All other operatives	2	Other craft and related workers	2
Transport equipment operatives	2	Assembler occupations	2
Managers, officials, proprietors	1	Managers, officials, proprietors	2
Salesworkers	1	Mechanics, repairers, installers	1
Other craft and related workers	1	Metalworking craft workers[a]	1
Mechanics, repairers, installers	1	Salesworkers	1
Other	5	Other	7
Total	27	Total	25

[a]Except mechanics

NOTES: Calculated using one million dollars of demand for the commodity indicated expressed in 1984 dollars. Estimates of the way this demand translates into business output are made using the 1977 input output table (see table I-2). Estimates of employment by occupation is made by using estimates of jobs per unit output in each industry prepared by the Bureau of Labor Statistics for the year 1982. Conversions have been made using deflator series appropriate for each industry. The BLS series providing occupation by industry and standard BLS estimates of total national employment do not use the same definition of farmers, farmworkers, and laborers. The estimates shown above are prepared by scaling jobs in these categories to make them consistent with employment data maintained in series published in the *Monthly Labor Review*. Estimates have been rounded to the nearest whole job. Including jobs that are both full and part time.

SOURCE: Office of Technology Assessment, 1986.

AREAS FOR POLICY ANALYSIS

It is clear that U.S. farmers are facing serious difficulties in international markets. What can be done, however, is subject to debate. While a comprehensive review of policy strategies is not the subject of this technical memorandum, OTA can outline broad areas where changes in policy might lead to improvements in U.S. agricultural competitiveness, and in the ability of U.S. producers to profit from their exports. These categories should be viewed not as specific alternatives, but *as* starting points for analysis.

Trade Negotiations

World competition for agricultural markets has begun to increase tensions between the United States and its allies, and may soon threaten programs designed to stimulate economic development in developing nations. Intensified competition in export subsidies, import tariffs, and other nontariff barriers cannot benefit international trade in agriculture. However, persuading nations to change their strategies regarding agricultural exports is a difficult task, since many policies are tied to domestic programs. Also, success in achieving an improved world position for U.S. agriculture may depend heavily on other areas of trade negotiations. Some possible strategies include:

- Using the General Agreement on Tariffs and Trade (GATT) to organize an international consensus network on issues related to agricultural trade. Goals might include the relaxation of domestic price supports, export subsidies, import quotas, and nontariff barriers

like variable levies, as well as the establishment of voluntary export restraints; in fact, trade ministers from the 92 nations that participate in GATT have placed agricultural trade as a priority item in the next round of GATT talks, scheduled to begin in 1987. This will, of course, require the United States to grant other concessions in programs that are particularly critical for products like peanuts, cotton, milk, and other dairy products. [11]
- Developing a consensus on reporting production costs and domestic policies. Negotiations about unfair trading practices are extremely difficult, given the complex nature of statistics on production costs and subsidies.
- Establishing binding, bilateral trade agreements with partners like the EEC, Japan, and Canada, and developing a bilateral mechanism for communication and dispute resolution.

Trade Promotion

A variety of techniques can be used to support U.S. agricultural exports. These range from direct subsidies to exporters through "marketing loans" to assistance available through consulates and agricultural attaches in U.S. embassies throughout the world. Many U.S. producers, especially those of high-value products, are not sophisticated in world trade, and need help both in identifying potential markets for their products and in satisfying the often complex procedures required by importing nations. USDA's Agricultural Information and Marketing Service (AIMS), which serves as a liaison between U.S. producers and potential importers of U.S. goods, represents one model for promoting U.S. exports. AIMS maintains a computer database that includes current information on such factors as domestic prices and product availability and foreign market potential.

Addressing the Third World Debt Problem

U.S. strategies for encouraging Third World nations—and Latin American countries in particular—to reduce their debt by expanding agricultural exports can have the effect of eroding U.S. exports both directly and indirectly, as can those for encouraging Japan to purchase more products from Third World producers. These nations then compete with U.S. producers for markets and drive international prices well below U.S. price support levels, placing tremendous economic pressures on U.S. farm programs. The United States has a clear interest in helping developing nations to expand their domestic economies in a way that would make them better markets for U.S. agricultural exports. Moreover, a policy that allows these nations to manage their debt problems without being forced to compete in tight world agricultural markets would assist all producers.

Research and Development

U.S. producers may find it increasingly difficult to benefit from agricultural research and development for long periods of time, due to the rapid diffusion of agricultural technology. This increases the need for government encouragement of research in agriculture and related biological sciences. Research spending on agriculture is high throughout the world; indeed, the fraction of nondefense research spent on agriculture in Japan, France, and several other nations exceeds that of the United States. [12] Many new technologies, particularly biotechnologies, raise unique problems that require a balance between the benefits of research, development, and fielding of new technologies on the one hand, and the interests of public health and safety on the other. A mechanism for dealing with these issues in a fair and expeditious way would facilitate agricultural research and development.

Given the growing importance of high-value agricultural products, it may also be necessary to increase research in areas not directly related to bulk cereal and soybean production, including technologies for value-added processing. [13] Technologies that could allow profitable production

[11] "Upcoming World Trade Talks," op.cit

[12] National Science Board, "Science Indicators 1982" (Washington, DC: U.S. Government Printing Office, 1983).

[13] U.S. Congress, Office of Technology Assessment, *Agricultural Postharvest Technology and Marketing Economics Research*, OTA-TM-F-21 (Washington, DC: U.S. Government Printing Office, April 1983).

of high-value crops in areas with relatively high production costs for bulk commodities would be particularly valuable.

In addition to emphasizing the role of agricultural research in the developed world, it is important to note that despite the transfer of technical innovations, many nations now produce less food per person than they did a generation ago. Per capita grain production in at least 13 African nations is at least ***20*** percent lower than it was ***30*** years ago; per capita production in Algeria and Mozambique fell by more than ***60*** percent during the same period. *[4] Research done by sophisticated agricultural programs has little impact on subsistence farmers working small plots of poor soil.

“U.S. Department of Agriculture, Economic Research Service, *World Indices of Agricultural and Food Production, 1 950-1984* (Washington, DC: 1985)

Modification of U.S. Domestic Farm Policies

While there is little doubt that domestic farm programs influence the competitiveness of U.S. products on world markets, there is little agreement about what changes in these programs, if any, could stimulate U.S. exports. There may be an unavoidable tension between the objective of domestic equity—maintaining the profitability of domestic farmers in different production cost categories—and the goal of creating a farm industry that could compete successfully in an international market free of foreign export subsidies. A program designed to achieve both objectives is likely to be expensive.

Of course, most agricultural exporters face similar dilemmas. Domestic programs designed to preserve traditional farm enterprises, both here and abroad, are viewed by other countries as unfair intervention in free trade. Given the many distortions in agricultural trade, there can be no easy resolution of this issue.

Chapter 1

Influences on International and U.S. Trade in Agriculture

Chapter 1

Influences on International and U.S. Trade in Agriculture

AGRICULTURAL TRADE AND THE WORLD RECESSION

For U.S. agriculture policy, the most important development in world agricultural trade in the early 1980s was a slowdown in the rapid rates of growth of key commodity markets that had characterized the preceding decade. International trade in coarse grains, wheat, soybeans, and soybean meal increased fairly steadily during the 1970s, but exhibited varying rates of decline in the early 1980s. The most serious reversal was in coarse grains—all grains but wheat and rice—which are used primarily for livestock feed. Coarse grain trade rose throughout the 1970s, and jumped abruptly in 1981 to 109 million metric tons (MT). Thereafter, exports for this commodity declined for three consecutive years, producing a 17-percent decrease by 1984. U.S. corn farmers, who dominate world coarse grain trade, were hit especially hard. U.S. corn export volume has declined every year since 1980, from 61,4 million MT to 46.3 million MT in 1985—a 24,5-percent decrease.

The decline and stagnation of many world agricultural markets resulted from the global recession of the early 1980s. Characterized by slower growth in incomes, rapidly increasing interest rates, and—especially in developing countries—serious repayment problems on external debts, the recession constricted trade in a broad range of commodities and manufactured goods.

Generally, the change in a country's agricultural exports as a function of a given change in export price—the "elasticity of excess supply "—depends on "domestic demand and supply elasticities, the importance of trade, and effects of domestic agricultural programs on producer and consumer behavior."[1] Smaller export levels relate to domestic supply and use, while larger levels respond to price changes.

[1] "The U.S. Competitive Position in World Commodity Trade, " *Agricultural-Food Policy Review*, Economic Research Service, U.S. Department of Agriculture, Agricultural Economic Report No. 530, 1985, p. 104.

The United States appears to be more sensitive to declines in international agricultural trade than other exporting nations. Relative to Canada and Australia, the United States has experienced a proportionately greater decline in exports for both wheat and coarse grains during the early 1980s. However, because of large U.S. stocks, domestic supply and demand are more sensitive to price changes than in Canada or Australia; a decline in export price causes a relative reduction in supply and relative increase in demand. In recent years, U.S. Government stocks have absorbed much of the excess supply that has resulted when price support loans act as a floor on market prices. When export demand falls, U.S. commodity programs shift American grains into storage at the floor price instead of to exports, bringing about a decline in the U.S. market share.

As for developing nations, debt problems have prompted strong measures to reduce imports and expand exports in order to repay international lenders. Developing countries played a key role in the U.S. agricultural export boom of the 1970s, due to significant demographic and economic growth in those countries, and to the availability of large amounts of credit on favorable terms. The onset of the world debt crisis and recession at the end of the 1970s led developing countries to reduce agricultural imports more than nonagricultural imports; the exception was low-income Africa, where severe drought triggered large increases in food purchases and aid. U.S. Department of Agriculture (USDA) analysts have noted the importance of developing countries on U.S. agricultural exports:

> Because the 93 developing countries make up approximately one-third of the U.S. export market for agricultural commodities, their import performance (our export potential) is highly significant for U.S. agricultural export performance. These countries have the potential to increase or

decrease total U.S. agricultural exports by almost 20 percent. In addition, probable export losses are concentrated in countries most severely constrained by external finances. The degree to which such losses are realized depends heavily on the scope and types of response by the United States.[2]

[2]Matthew O. Shane and David Stallings, *Financial Constraints to Trade and Growth: The World Debt Crisis and Its Aftermath,* Economic Research Service, U.S. Department of Agriculture, Foreign Agricultural Econmic Report No. 211, 1984.

The opportunity to export commodities and manufactured goods to developed countries is crucial to resolving long-term debt and income problems in many developing nations. As a result, a rise in protectionism in the developed world—including the United States—could delay recovery of U.S. agricultural exports both directly and indirectly.

THE VALUE OF THE U.S. DOLLAR

An important and related feature of the world economic environment in the early 1980s was the strong and rapid growth in the value of the U.S. dollar, following a decade of sustained depreciation against other currencies. A relatively weak dollar served to boost U.S. exports, including farm products, during the 1970s. This was of particular importance for the soybean and corn trade, which grew rapidly over that period (see table l-l).

Between 1980 and 1984, however, the dollar appreciated by over 40 percent against most other currencies. American farmers, suffering from product price declines, faced the additional problem of export difficulties. Appreciation of the dollar meant that foreign customers had to expend more of their currency to pay for U.S. agricultural imports. Accordingly, American farmers were rendered less competitive: "U.S. exports of wheat, corn, and soybeans were reduced by about $3 billion in 1981 to 1982 as a result of the strengthening of the dollar. That decline translates into a volume of 16 million tons; corn exports alone were nearly 10 million tons less, " according to USDA. Furthermore, an economic model developed by USDA indicates that "a 20 percent rise in the value of the dollar will reduce farm ex-

Table 1-1 .—Agricultural Trade-Weighted Indices of the Foreign Exchange Value of the U.S. Dollar[a]

Year	Total	Soybeans	Wheat	Corn
	April 1971 = 100			
1970	102.10	102.40	101.29	102,38
1971	98.98	98.25	99.84	98.65
1972	91.19	88.21	94.29	89.80
1973	82.74	77.75	87.15	80.61
1974	79.12	74.53	82.07	77.01
1975	76.92	71.33	80.52	74.66
1976	77.97	73.33	80.66	76.89
1977	75.30	69.99	76,93	73,79
1978	70.02	63.28	72.76	67.10
1979	71.00	61.62	74.35	67.27
1980	72.24	64.28	76.39	68.59
1981	79.43	74.43	79.05	77.55
1982	86.80	83,52	85.37	86.84
1983	90.64	88.23	91.73	91.80
1984	97.17	95.34	98.69	98.19
1985	101.27	98.39	104.74	101.48

AdjU~t@ by the Consumer Price Index of the countries involved

SOURCE J. Longmire and A Morey, Strong *Dollar Dampens Demand for U S Farm Exports,* Economic Research Service, U S Department of Agriculture, Foreign Agricultural Economic Report No 193, 1983 ports by 16 percent. "[3] As table 1-1 shows, the reversal in the dollar's value in the early 1980s was considerably more acute for soybeans and corn than for wheat.

The stronger dollar affected U.S. exports in a number of ways. Because the dollar appreciated in comparison to the currencies of competing nations such as Canada, Australia, and Argentina, export prices received by producers in those nations rose relative to U.S. prices. The dollar's rising value actually increased returns to producers in several other nations, enabling them to compete with the United States. In addition, a considerable portion of the debt incurred by developing countries in the 1970s was denominated, or payable, in American dollars. As the dollar appreciated in value, more of the debtor nation's currency was required to repay interest and principal, which constrained their ability to pay for imports from the United States, and encouraged purchases from other suppliers.

Estimated impacts of a 10-percent appreciation in the value of the dollar appear in table 1-2. The projected changes do not match real developments within the given parameters, since factors other than exchange rates affect prices, exports, and stock levels. Nevertheless, the estimates show the potential magnitude of an appreciation of the dollar, other things being equal.

Markets for corn and soybeans are more sensitive to exchange rate fluctuations, but all three commodities are affected. The price that U.S. farmers receive for their commodities declines because a strong dollar reduces U.S. exports. In the cases of both corn and wheat, the predicted price

[3] J. Longmire and A. Morey, *Strong Dollar Dampens Demand for U. S, Farm Exports*, Economic Research Service, U.S. Department of Agriculture, Foreign Agricultural Economic Report No. 193, 1983.

Table I-2.—Simulated Impacts of a 10-Percent Appreciation in the Value of the Dollar

	Percent change		
Commodity	U.S. price	U.S. exports	U.S. stocks
Wheat	–5.6	– 1.9	4.8
Corn	–6.2	–2.5	6.4
Soybeans	–5.9	–3.1	5.8

SOURCE "The U.S Competitive Position in World Commodity Trade," *Agricultural-Food Policy Review Commodity* Program *Perspectives* Economic Research Service, U S Department of Agriculture, Agricultural Economic Report No. 530, 1985

declines would amount to 20 cents per bushel for 1984. By comparison, target prices for wheat increased 25 cents per bushel between 1983 and 1984, and by 16 cents per bushel for corn between 1982 and 1983. The price-decreasing effect of a lo-percent appreciation of the dollar would tend to offset the price enhancement offered by USDA commodity programs. Actual increases in the 1982 exchange value of the dollar were 11.4 percent for corn and 7.6 percent for wheat. Also, a 5.6-percent decrease in the price of soybeans would have reduced the 1982 seasonal average price by 34 cents per bushel.

Generally, reductions in exports and prices result in substantial increases in U, S. Government stocks. As world prices fall below the government price support loan rate, farmers participating in the price support programs tend to forfeit commodities they have offered to the government as collateral for the loan. Wheat stocks averaged 1.356 billion bushels between 1981 and 1983; an increase of 4.8 percent, which would result from a 10-percent dollar appreciation, would lead to an increase of 65 million bushels—roughly the amount of wheat produced in either Oregon or Illinois in 1982. At 1982 stock levels, the increase for corn would equal 169 million bushels, the equivalent of the 1982 crop in North Carolina, and 17 million bushels for soybeans, or the amount of the 1982 crop in Virginia.

U.S. AGRICULTURAL POLICIES

Falling export demand for U.S. grains and oilseeds in the early 1980s, combined with a simultaneous increase in U.S. production, drove U.S. prices down to the price support loan rates for wheat, feed grains, and soybeans, as set by Congress and USDA. In effect, this loan rate forms a floor under domestic prices. A farmer can expect to receive the minimum price, even if he or she is not participating in the price support programs. Because of the major role of the United States as a producer, stockholder, and exporter in the wheat, corn, and soybean markets, the U.S. Government price support loan rate can also form an artificial floor for the world price. Producers in competing nations may be signaled by this artificially high price—driven higher by the appreciating dollar—to increase production, since they may be able to undersell the United States. Importers may purchase less from the United States than they would have at a lower price. All of these interactions serve to reduce the U.S. market share.

Income supports, provided to farmers participating in USDA wheat and feed grain programs, have also affected U.S. exports. In the late 1970s, market prices for wheat and feed grains did not fall to the loan rate, but did decrease below the "target prices" established for each commodity. As a result, participating farmers qualified for direct "deficiency" payments, equal to the difference between the official target price and the lower market price. If market prices fall to the loan rate, participating farmers receive the difference between the loan and target prices. During the late 1970s, some participating farmers were able to receive these payments without having to idle land; in fact, acreage planted in program "bases," or the acreage on a farm that is eligible for program enrollment, expanded dramatically at that time. The availability of deficiency payments, along with tax and credit policies and low real rates of interest, stimulated grain production in the late 1970s. This resulted in lower U.S. and world prices, which, in turn, boosted world exports. In effect, by subsidizing production, U.S. commodity policy subsidized exports to high levels through 1981, contributing to the subsequent decline.

POLICIES OF OTHER NATIONS

Policies of other nations directly affect every major international market in which U.S. producers participate. Recent policies of U.S. competitors have brought about a decrease in American agricultural export volume, value, and market share.

Table 1-3 lists those agricultural policies of foreign competitors that have an impact on international trade in wheat, corn and other feed grains, and soybeans, all of which are major U.S. export commodities. Macroeconomic policies that affect the agricultural export performance of these other countries, such as currency devaluations, are not included.

The agricultural policies of the European Economic Community (EEC) have the most adverse effects on U.S. interests in wheat and feed grain markets. EEC policies that insulate their wheat and feed grain producers from world market fluctuations have stimulated production, and restitutions paid to facilitate exportation of the resulting surplus crops cut directly into U.S. markets. The Community's policies for soybeans have the effect of encouraging imports to the EEC from this country, but Community subsidies tend to erode U.S. markets for higher-valued soybean meal and oil.

Policies of Brazil, and more recently those of Argentina, which encourage rapid development of soybean processing industries, have also had a pronounced impact on the U.S. market share for soybean products. Brazil now leads the United States in soybean meal exports, and Brazil and Argentina combined surpass America in exports of soybean oil. Ironically, importation of American technology has played a key role in the development of the South American soybean industry (see ch. 4).

Table 1.3.—Price Support and Export Policies of Major U.S. Wheat, Corn and Feed Grains, and Soybeans and Products

Commodity: Country	Policy and effect
Wheat:	
Canada	Canadian Wheat Board stabilizes wheat prices; Western Grain Stabilization Program stabilizes farm incomes. Little impact on producer price levels. Credit offered to importers.
Australia	Reforms in Australian Wheat Board policies will reduce insulation of producers from world prices and increase price variability, Little impact on producer price level. Subsidized credit sales of wheat for export to some markets (mainly China and Egypt).
Argentina	Sales through National Grain Board and private companies. Export taxes, official exchange rate regulations act to discourage production of wheat for export, Long-term agreements with China, Iran, Algeria, Iraq. Government "does not hesitate to undercut U.S. price. " (USDA Agr. Info Bull. 467)
France	High CAP domestic support prices combines with variable levy to insulate producers from world price changes. Exports subsidized by restitutions to producers.
Corn and feed grains:	
Argentina	Export taxes similar to those for wheat discourage production of corn and sorghum for export.
South Africa	Government Maize Board offers price stabilization, sets minimum support price which provides some insulation from world prices.
Thailand	Export controls for corn removed in 1981, but no direct incentives or restrictions for corn exports. Bilateral agreements with Taiwan and other countries,
France	High domestic price supports and variable levies support domestic prices; restitutions to producers and subsidized exports of corn and barley.
Australia	Marketing boards handle sales of barley and sorghum, stabilize but do not support producer prices. Long-term agreements with Egypt, China, Japan, and U.S.S.R. Subsidized credit sales of wheat for exports to some markets (mainly China and Egypt).
Canada	Marketing of barley and sorghum through national boards, stabilizing but not supporting producer prices. Long-term agreements with Brazil, China, U. S. S. R., and East Germany for wheat and feed grains.
Soybeans and products:	
Brazil	Wide array of policies (tariffs, quotas, licenses, price ceilings, currency adjustments, and subsidies); designed to increase exports of soybean oil and meal; discourage export of unprocessed soybeans, Policies also used to assure adequate domestic supplies and expand domestic crushing capacity, Differential export taxes are now the main instrument for encouraging export products, and bean exports are expected to increase.
Argentina	National Grain Board restricts oilseed and product exports to protect domestic prices; preferential taxes to encourage exports of processed soybean products instead of beans; but export taxes discourage product ion of beans for export.
EEC	Exports of soybean meal and oil aided by "production aids" that support domestic prices above world price; crushers receive payments to compensate for higher domestic bean prices (however, most soybeans are imported).

SOURCES "World Agricultural Markets and U S Farm Policy" and "The U S. Competitive Position in World Commodity Trade, " *Agricultural-Food Policy Review: Commodity Program Perspectives,* Economic Research Service, U.S Department of Agriculture, Agricultural Economic Report No 530, 1985, and "Background for 1985 Farm Legislation, " Economic Research Service, U S Department of Agriculture, Agricultural Information Bulletins No 467 (wheat), 471 (corn), and 472 (soybeans), 1985

GOVERNMENT SUPPORT FOR AGRICULTURE

USDA analysts have attempted to quantify the overall importance of a broad range of policies that support agriculture in other nations. Table 1-4 shows the magnitude of direct government expenditures for agriculture from 1978 to 1980 in 10 selected countries. In absolute terms, Japan and the United States maintain a comfortable lead. It is important to note that government expenditures for agriculture in the United States have increased sharply since that time, from under $4 billion to

Table 1-4.–Direct Government Assistance to Agriculture, Selected Countries, 1978-80

Country	Total assistance (million $)	Percent of agriculture GDP (percent)	Per capita agricultural population ($ per capita)
Belgium	518	57	4,655
West Germany	1,147	28	1,942
United States	8,507	12	1,775
France	2,546	23	1,260
Japan	15,888	38	1,083
Canada	1,231	14	1,005
Australia	529	7	630
Mexico	2,620	21	106
Argentina	301	3	82
Brazil	1,925	8	53

SOURCE: "The U.S. Competitive Position in World Commodity Trade," *Agricultural-Food Policy Review: Commodity Program Perspectives,* Economic Research Service, U.S. Department of Agriculture, Agricultural Economic Report No. 530, 19S5

more than $15 billion. Agricultural support levels in the EEC have also increased substantially; more recent figures for other countries are not available. Furthermore, these estimates do not reflect the effects of certain government policies, such as dairy price supports and import quotas, which effectively raise consumer prices.

Expenditures as a proportion of agricultural gross domestic product (GDP) reveal a different picture. In this category, the United States ranks seventh among the 10 countries; government expenditures constitute 12 percent of the U.S. agricultural GDP. This is well below Belgium at 57 percent, Japan at 38 percent, West Germany at 28 percent, France at 23 percent, and even Mexico at 21 percent. Canada and the United States ranked about the same, at 14 and 12 percent, respectively. Three competitors ranked lower: Brazil at 8 percent, Australia at 7 percent, and Argentina at 3 percent.

However, when government expenditures for agriculture are divided by the agricultural population of these countries, the United States again ranks fairly high—third, behind Belgium and West Germany. France and Canada fall somewhat below the United States; Australia, Argentina, and Brazil rank far behind.

Absolute and per capita levels of expenditures for agriculture may be interpreted as indicators of overall commitment to agriculture. By these measures, the United States ranked high from 1978 to 1980, and may increase its position as a result of the rise in farm program outlays that has occurred since 1981. In a Congressional Budget Office analysis of government support for U.S. business, agriculture ranked highest among industries in terms of support expenditures as a percentage of the sector's "value added, " or percentage of the gross national product.[4]

Government agriculture expenditures in relation to agricultural GDP reflect with greater accuracy the extent to which national agriculture sectors depend on their governments for support. By this measure, the United States ranks below many countries, but above several other competitors. In recent years, high farm program costs throughout the world—particularly in the EEC—have made farmers more dependent on government expenditures for their livelihood.

[4] U.S. Congress, Congressional Budget Office, *Federal Support of U.S. Business* (Washington, DC: U.S. Government Printing Office, 1984).

Chapter 2

World Trends in Agricultural Production and Trade

Chapter 2

World Trends in Agricultural Production and Trade

This chapter reviews changes that have occurred in the production and trade of key agricultural commodities since ***1970,*** and summarizes projected world trends in production, consumption, and trade of cereal grains and oilseeds. Developments that affect the U.S. market position for wheat, corn, and soybeans are emphasized.

CROP PRODUCTION TRENDS

World crop production trends are affected by changes in both harvested area and yield. This section describes trends in harvested area, yield, and production for wheat, corn, and soybeans. Because substitutes exist for each crop in world markets, the section also reviews regional trends and forecasts for the general categories of cereal grains and oilseeds. In general, comparisons will be made between the United States on the one hand, and the principal producers and exporters of a particular crop on the other; the base period of 1969-71 is used to reflect levels of world production and trade prior to the export boom of the 1970s. Also, statistics relating to the European Economic Community (EEC) do not include figures from Spain and Portugal, the two most recent additions to the EEC.

Harvested Area

Harvested area of wheat, corn, and soybeans increased throughout the world during the 1970s. For all three crops, the United States possessed the largest harvested area among major exporters at the beginning of the period, and was able to expand that area significantly.

For wheat, U.S. harvested area increased substantially between 1969-71 and 1982-84, adding approximately 9.1 million hectares—an area close to that of Canada and Australia, the two leading producer-competitors (see table 2-1). Nevertheless, Canada and Australia did expand at impressive rates, and the U.S. figure has increased only slightly since 1974 to 1976, Argentina's harvested wheat area, a fraction of that of the United States, also rose substantially. Brazil and France enjoyed modest growth.

In harvested corn acreage, U.S. expansion dominated that of major competitors, especially Argentina (see table 2-2). Brazil was also able to expand its already large acreage. The enormous proportional growth in Thailand has allowed that country to compete actively with the United States in certain Third World markets.

The 10 million hectare increase in U.S. soybean acreage between 1969-71 and 1982-84 exceeded

Table 2.1 .—Wheat: Harvested Area, Selected Countries, 1969.84

	1969-71	1974-76	1979-81	1982-84	Percent change 1969-71 to 1982-84
	(1 ,000 ha)				
Canada ., ., ...	7,669	9,888	11,148	13,130	71
United States.	18,669	27,760	27,412	27,823	49
Argentina ., ...	4,402	5,311	6,169	6,773	54
Brazil	1,857	2,981	2,920	2,148	16
France ... ., ., ...	3,892	4,099	4,391	4,921	26
Australia	7,695	8,606	11,144	12,214	59

SOURCE *FAO Production Yearbook* Food and Agriculture Organization of the United Nat Ions vols 36 and 381982 and 1984 Rome Italy

Table 2-2.—Corn: Harvested Area, Selected Countries, 1969-84

	1969-71	1974-76	1979-81	1982-84	Percent change 1969-71 to 1982-84
			(1,000 ha)		
United States	23,749	27,591	29,548	26,441	11
Argentina	3,880	3,107	2,828	3,055	–21
Brazil	10,021	10,882	11,348	11,855	18
Thailand	771	1,180	1,424	1,511	96

SOURCE *FAO Production Yearbook,* Food and Agriculture Organization of the United Nations, vols 36 and 38, 1982 and 1984, Rome, Italy

the total harvested area of 1982-84 for Brazil, the next largest competitor (see table 2-3). The greatest proportional increase, however—74 percent—was achieved by Argentina, making it competitive with the United States. Much of this increase occurred between 1979-81 and 1982-84, during which time U.S. production actually declined. In contrast, Brazil's harvested soybean area fell by 20 percent over the 15-year period.

In the more inclusive category of cereal grains, harvested area grew at an average annual worldwide rate of 0.65 percent per year during the period 1969-71 to 1979-81 (see table 2-4). Annual expansion rates were well above average in Oceania, at 3.2 percent, and North America, at 1.75 percent. Area increases were also high in Sub-Saharan Africa and East Asia, while declines occurred in non-EEC Western Europe and Eastern Europe.

Projections of worldwide cereal grain trends in harvested areas, prepared by Resources For the Future and by Economic Perspectives, Inc. (RFF-EPI) indicate a 0.27 per year expansion for the period 1979-81 to 2000, only 42 percent of the 1970s rate (see table 2-4). Relatively rapid ex-

Table 2-3.—Soybeans: Harvested Area, Selected Countries, 1969-84

	1969-71	1974-76	1979-81	1982-84	Percent change 1969-71 to 1982-84
			(1,000 ha)		
United States	17,036	20,822	27,160	26,717	57
Argentina	1,314	375	1,665	2,281	74
Brazil	10,976	5,795	8,347	8,525	–22
U.S.S.R.	860	801	843	830	– 3

SOURCE: *FAO Production Yearbook,* Food and Agriculture Organization of the United NatIons, vols. 36 and 38, 1982 and 1984, Rome, Italy.

Table 2-4. —Rates of Change in Harvested Area of Cereal Grains, Cereal Yields and Production, By Region, 1969.71 to 1979-81 and Projected, 2000

Region	Area		Yield		Production	
	1969-71 to 1979-81	1979-81 to 2000	1969-71 to 1979-81	1979-81 to 2000	1969-71 to 1979-81	1979-81 2000
North Africa-Middle East	0.06	0.18	2.04	2.17	2.10	2.35
Sub-Saharan	1.17	0.70	0.93	1.00	2.10	1.70
EEC	0.09	–0.14	2.39	1.26	2.30	1.12
Other Western Europe	–0.17	–0.10	1.76	2.56	1.58	2.46
U.S.S.R.	0.53	0.05	–0.20	2.26	0.33	2.31
East Europe	–0.43	0.08	2.75	1.08	2.31	1.16
South Asia	0.42	0.14	1.94	1.97	2.37	2.11
East Asia	1.12	1.28	1.47	1.21	2.60	2.51
Asia (planned)	0.21	–0.22	3.44	1.85	3.65	1.63
Oceania	3.20	2.10	0.78	1.16	4.00	3.29
Latin America	0.73	0.49	2.18	1.98	2.92	2.48
North America	1.75	0.24	1.71	1.11	3.50	1.35
World	0.65	0.27	1.94	1.56	2.6	1.83

SOURCE: *Meeting Future Needs for United States Food, Fiber and forest Products,* Resources For the Future, Washington, DC, 1984 pansion is forecast for East Asia and Oceania. The North American rate falls below the world average.

Average worldwide rates of harvested oilseed area grew by 2.21 percent between 1969-71 and 1979-81. However, this overall picture has resulted from substantial increases in particular areas—over 4 percent per year in Oceania, Latin America, North America, the EEC, and other Western European nations (see table 2-5).

The RFF-EPI projections through the year 2000 reveal a significantly different pattern. Expansion of oilseed area slows to approximately one-third of the 1970's rate, or 0.80 percent per year, Nevertheless, expansion should continue to be an important source of increased production in many regions, since RFF-EPI predicts that rates of yield increase will decline as well.

Yields

Expansion of harvested acreage often leads to a trade-off in yield, because marginal land is brought into production. Although actual yields may decline, a slowdown in the rate of yield increase is more common. The performance of U.S. competitors varied by both crop and country between the early 1970s and early 1980s.

The expansion of Canada's wheat area, though variable, was not accompanied by a significant change in Canadian yields, which remain below those of the United States (see table 2-6). Expansion of harvested acreage in Australia and Brazil

Table 2-5.— Rates of Change in Harvested Area of Oilseeds, Oilseed Yields and Production, By Region, 1969-71 to 1979-81 and Projected, 2000

Region	Area		Yield		Product ion	
	1969-71 to 1979-81	1979-81 to 2000	1969-71 to 1979-81	1979-81 to 2000	'1969-71 to 1979-81	1979-81 2000
North Africa-Middle East. ...	–0.50	1.23	1.84	0.18	1.33	1,41
Sub-Saharan	–0.99	0.47	–0.05	0.70	-1.04	0.22
EEC	4.04	2.35	2.74	0.91	6.89	3.28
Other Western European ...	9.06	1.69	– 1.91	2.56	6.98	4,30
U.S.S.R.	–0.25	0.30	0.74	2.66	0.49	2.97
East Europe	2.37	2.56	1.14	1,26	3.53	3.85
South Asia	0.63	0.43	0.39	1,19	1,02	1,63
East Asia	1.07	0.69	1,46	2.47	2.54	3,18
Asia (planned)	1.23	1,64	1,30	1.38	2.54	3.04
Oceania	7.53	1,08	2.34	1.37	10.04	2.47
Latin America	6.95	1.00	4.02	0.90	11.26	1.91
North America	4.18	0.69	1.33	1.08	5.57	1.79
World	2.21	0.80	2.02	1.33	4,27	2,13

SOURCE Meet/rig *Future Needs for United States* Food, *Fiber and Forest Products,* Resources For the Future, Washington DC, 1984

Table 2-6.—Wheat Yields, Selected Countries, 1969-84

	1969-71	1974-76	1980	1981	1982	1983	1984
	Kilograms per hectare						
Canada	1,813	1,819	1,738	1,996	2,143	1,941	1,611
United States	2,144	1,980	2,249	2,323	2,386	2,651	2,608
Argentina	1,334	1,603	1,549	1,297	2,049	1,788	2,124
Brazil	939	879	865	1,151	646	1,190	1,054
France	3,626	4,078	5,169	4,809	5,236	5,127	6,454
Australia	1,171	1,362	962	1,377	770	1,709	1,521
	Percent of U.S. yields						
Canada	85	92	77	86	90	73	62
United States	100	100	100	100	100	100	100
Argentina	62	81	69	56	86	67	81
Brazil	44	44	38	50	27	45	40
France	169	206	230	207	219	193	247
Australia	55	69	43	59	32	64	58

SOURCE *FAO Production Yearbook* Food and Agriculture Organization of the United Natlons, VOIS 38 and 38, 1982 and 1984 Rome, Italy has led to yields that are more variable than those of the United States. Argentine wheat yields constitute more than three-quarters of the U.S. total. Interestingly, France has retained its yield advantage over the United States, even while expanding its harvested area by about one-quarter over the 1969-71 figure.

Changes in Argentine and Brazilian corn yields in relation to 1970's U.S. yields were not significant. Argentine yields hover at around one-half of the U.S. level, and Brazilian yields at around one-quarter (see table 2-7). Thailand's corn yields have declined slightly, relative to the United States.

The United States' two major competitors in world soybean trade, Argentina and Brazil, have closed much of the yield gap that existed in 1969 to 1971 (see table 2-8), a development largely attributable to the transfer of U.S. soybean varieties and pesticides to these countries (see ch. 4). In fact, 1984 Argentine soybean yields surpassed those of the United States by nearly 40 percent. The expected introduction of biotechnology to the United States in the late 1990s may increase yields. However, whether technologies will first be applied in other countries, even though such innovations may come from the United States, remains to be seen (see ch. 4).

Projections of average U.S. wheat, corn, and soybean yields through the year 2000, taken from a recent OTA study, * appear in table 2-9. These projections represent the "most likely environment" through 2000, and assume real growth in U.S. research and extension expenditures of 2 percent per year, as well as the continuation of past trends in the development and adoption of technology. Yields and production would increase with larger research and extension service expenditures.

The OTA projections indicate that average U.S. wheat yields in 2000 may be 25 percent higher than 1982 yields. Over the same period, corn yields may increase by 21 percent, and soybean

'U.S. Congress, Office of Technology Assessment, Technology, *Public Policy, and the Changing Structure of American Agriculture*, OTA-F-285 (Washington, DC: U.S. Government printing Office, March 1986),

Table 2-7.–Corn Yields, Selected Countries, 1969-84

	1969-71	1974-76	1978	1979	1980	1981	1982	1983	1984
	Kilograms per hectare								
United States	5,164	6,166	6,342	6,883	5,711	6,891	7,108	5,090	6,692
Argentina	2,247	2,516	3,612	3,107	2,570	3,801	3,028	3,030	3,141
Brazil	1,365	1,543	1,220	1,442	1,779	1,836	1,731	1,745	1,735
Thailand	2,567	2,271	2,014	2,187	2,245	2,354	2,299	2,267	2,500
	Percent of U.S. yield								
Argentina	44	41	57	45	45	55	43	60	47
Brazil	26	25	19	21	31	27	24	34	26
Thailand	50	37	32	32	39	34	32	45	37

SOURCE *FAO Production Yearbook,* Food and Agriculture Organization of the United Nations, vols 36 and 38, 1982 and 1984, Rome, Italy

Table 2-8.–Soybean Yields, Selected Countries, 1969-84

	1969-71	1974-76	1980	1981	1982	1983	1984
	Kilograms per hectare						
United States	1,830	1,766	1,776	2,027	2,121	1,759	1,893
Argentina	1,178	1,491	1,724	2,005	2,090	1,754	2,601
Brazil	862	1,668	1,727	1,765	1,565	1,792	1,650
U.S.S.R.	606	674	615	568	715	665	699
	Percent of U.S. yields						
Argentina	64	84	97	99	99	100	137
Brazil	47	94	97	87	74	102	87
U.S.S.R.	33	38	35	28	34	38	37

SOURCE *FAO Production Yearbook,* Food and Agriculture Organization of the United Nations, vols. 36 and 38, 1982 and 1984, Rome, Italy

Table 2-9—OTA Projections of Crop Yields, Crop Production, and Average Annual Growth Rates for Yields and Production

Crop	Yield		Product ion	
	Actual 1982	Projected[a] 2000	Actual 1984	Projected[a] 2000
	bushels/acre		billion	bushels
Wheat	36	45	2.6	3.5
Corn	113	139	7,7	9.3
Soybeans	30	37	1,9	3.2

Crop	Projected average annual rate of growth through 2000		Percent of production growth due to yield growth
	Yield	Production	
	percent		percent
Wheat	1.2	1.9	68
Corn	1.2	1.2	100
Soybeans	1.2	3.4	35

[a]Projections for "most likely environment" 'assumes to year 2000 (a) a real rate of growth i n research and extension expen di tures of 2 percent per year and (b) the continuation of all other forces that have shaped past development and adoption of technology

SOURCE U S Congress, Office of Technology Assessment, Technology, *Public* Policy, *and the Changing Structure of American Agriculture* OTA-F-285 (Washington, DC: U S Government Printing Off Ice March 1986)

yields by 23 percent. Combined production of the three crops in 2000 is expected to increase by nearly one-third over 1984 levels. Average annual rates of yield increase projected for wheat and corn —1.2 percent per year—fall below the RFF-EP1 world rate for cereal grains over a comparable period. Recently, the United States has lagged behind many regions of the world in terms of annual growth in yields, since actual U.S. yields are relatively high.

For the broad category of cereal grains, substantial percentage yield increases occurred in most regions of the world in the 1970s, mainly because of improved varieties and management practices (see table 2-4). Worldwide yields grew at an annual rate of 1.9 percent. Substantial increases occurred in North Africa and the Middle East, the EEC, Eastern Europe, centrally planned economies in Asia—especially that of China—and Latin America. Cereal yields in those regions rose by over 2 percent per year between 1969-71 and 1979-81, compared to a 1.7 percent rate in North America. The slight average annual decline in yields experienced by the Soviet Union, —0.20 percent, represents the only average negative trend over the period.

RFF-EPI projections indicate a continued increase in world cereal yields, but at a slower rate than that of the 1970s (see table 2-4). Marked declines are projected for the EEC, Eastern Europe, and Asian nations with centrally planned economies; North America may also experience a considerable drop, The Soviet Union, however, is expected to increase its average annual yield, from a decline of 0.20 percent to a 2.26 percent growth.

Yields of oilseed crops also grew rapidly during the 1970s (see table 2-5), at a worldwide rate of about 2 percent per year. Unlike wheat yields, substantial increases in certain regions set the pace: the EEC, Oceania, and Latin America all enjoyed annual growth in oilseed yields of over **2.3** percent, compared to a 1.3 percent average rise in North America, Annual yields fell in Western European countries not affiliated with the Community, and in Sub-Saharan Africa. A sharp decline in 'the average annual growth rate for world oilseed yields is foreseen by RFF-EPI, from 2.02 to 1.33 percent. Slower growth is forecast for North Africa and the Middle East, the EEC, Oceania, and especially for Latin America. In contrast, other Western European countries, the U. S. S. R., Sub-Saharan Africa, East Asia, and South Asia may enjoy significant increases.

Production

World production of wheat, corn, and soybeans increased appreciably over the past 15 years. Between 1970-72 and 1980-82, world wheat production increased by 37 percent, corn production grew 50 percent, and soybean output nearly doubled (see table 2-10). U.S. production of corn and wheat more than kept pace over this period, with wheat production rising by 75 percent and corn production by 50 percent. For soybeans, 75 percent U.S. production growth lagged somewhat behind world trends. As a result, U.S. farmers increased their share of expanding world wheat and corn production during this time.

Although U.S. production share for soybeans decreased, it remains comparatively large. In recent years, this country has accounted for 13 to 16 percent of world wheat production and over 45 percent of corn production—excluding 1983, when drought and government land idling programs cut the domestic corn crop in half. As for soybean production, the United States' share stands at approximately 60 percent (see table 2-11).

Traditional U.S. competitors in world grain and oilseed trade increased their crop production as well, and new competitors emerged for certain crops. For example, international corn production has increased by 40 percent since 1970 (see table 2-10). Corn exports by other countries have increased as well, but at a slower rate. Thailand, the fourth largest producer, is the only competitor to have achieved steady gains in production; its corn output has doubled since 1970, mainly due to increases in planted area. Thailand still

Table 2-10.—World and U.S. Production of Corn, Wheat, and Soybeans, Selected Periods

	Wheat		Corn		Soybeans	
	World	U.S..	World	Us.	World	Us.
			(million bushels)			
1970 -72	12,348	1,506	11,195	5,125	1,641	1,145
1980 -82	16,784	2,644	16,770	7,664	3,194	1,992
1983-85 [a]	18,483	2,480	16,821	6,905	3,283	1,799
			(percent increase)			
1970-72 to 1980 -82	36	76	50	50	95	74
1970-72 to 1983-85	50	65	50	35	100	57

[a] 1984 preliminary, 1985 projected

SOURCE' "Background for 1985 Farm Legislation,' Economic Research Service, U S Department of Agriculture, Agricultural Information Bulletins No 467 (wheat), 471 (corn), and 472 (soybeans), 1985

Table 2.11.–World Production and U.S. Share for Wheat, Corn, and Soybeans, 1970-85[a]

	Wheat		Corn		Soybeans	
Year	World (million bushels)	U.S. share (percent)	World (million bushels)	U.S. share (percent)	World (million bushels)	U.S. share (percent)
1970	11,530	12	10,291	40	1,627	69
1971	12,893	13	11,736	48	1,734	68
1972	12,621	12	11,558	48	1,807	70
1973	12,705	12	12,574	45	2,292	68
1974	13,235	13	11,362	41	2,007	61
1975	13,099	16	12,818	46	2,409	64
1976	15,484	14	13,917	45	2,183	59
1977	14,113	15	14,295	46	2,651	67
1978	16,417	11	15,326	47	2,843	66
1979	15,597	14	16,613	48	3,443	66
1980	16,274	15	15,893	42	2,969	60
1981	16,476	17	17,204	47	3,164	63
1982	17,604	16	17,216	48	3,438	64
1983	18,037	13	13,624	31	3,042	54
1984	18,912	14	18,003	43	3,391	55
1985	18,513	13	18,930	47	3,457	61

[a] 1984 preliminary, 1985, projected

SOURCE "Background for 1985 Farm Legislation," Economic Research Service, U S Department of Agriculture, Agricultural Information Bulletins No 467 (wheat) 471 (corn), and 472 (soybeans), 1985 claims a small share of world production, about 10 percent, but this Asian nation has become an important factor in world corn trade.

Furthermore, worldwide soybean production and exports have changed dramatically since 1970 (see table 2-10). Production has tripled in Brazil, and has increased tenfold in Argentina. Brazil enjoyed a sharp rise in soybean exports during the mid-1970s, but has since fallen off. The Argentine export boom ensued in the late 1970s; it, too, suffered a severe downturn in the early **1980s.**

Increases in harvested area and yields resulted in increased international production for both cereal grains and oilseeds during the 1970s (see tables 2-4 and 2-5). Cereal grain production rose at an average annual rate of 2.6 percent, led by Oceania at 4 percent, the planned economies of Asia at **3.65** percent, and North America at **3.5** percent. The U. S. S. R., at **0.33** percent, trailed all other regions.

Greater growth rates were achieved in oilseed production. World production rose by over 4 percent per year, with notably high growth rates in Latin America, Oceania, all of Western Europe, and North America. The U.S.S.R. increased oilseed production at a slower rate than all regions except Sub-Saharan Africa, which experienced a decline.

Extensive v. Intensive Agricultural Production

The relative importance of area expansion as opposed to yields varies by both region and crop (see tables **2-12** and **2-13).** While technology can play an important role in land expansion, especially with respect to land clearing and preparation for irrigation, it is more directly associated with trends in yields. The more a country relies on high yields, or "intensive" cultural practices, to increase production, the greater its dependence on agricultural technology.

World cereal grain production rose at an average rate of **2.6** percent per year between **1969-71** and 1979-81 (see table 2-4). one-quarter of this increase resulted from expansion of harvested area, and the remaining three-quarters from yield improvements. Production increases in Oceania, North America, and Sub-Saharan Africa were more dependent on increasing land area, accounting for **80, 50,** and **56** percent of average annual production expansion, respectively. The U.S.S.R. also depended on expansion of harvested area to increase production, but the Soviets experienced a trade-off in yields during the 1970s. Had the U.S.S.R, matched the world average annual growth rate in cereal yields of 1.94 percent, its total production would have increased by 2.47 percent per

Table 2.12.—Sources of Change in Cereal Grain Production, by Region, 1969-71 to 1979-81 and Projected to 2000: Average Annual Changes in Area and Yield as a Percent of Change in Production

Region	Area		Yield	
	1969-71 to 1979-81	1979-81 to 2000	1969-71 to 1979-81	1979-81 to 2000
North Africa-Middle East	3	8	97	92
Sub-Saharan	56	41	44	59
EEC	–4	–13	104	113
Other Western European	–11	–4	111	104
U.S.S.R.	161	2	–61	98
Eastern Europe	–19	7	119	93
South Asia	18	7	82	93
East Asia	43	51	57	48
Asia (planned)	6	–13	94	113
Oceania	80	64	20	35
Latin America	25	20	75	80
North America	50	18	49	82
World	25	15	75	85

SOURCE *Meet/rig Future Needs for United States Food, Fiber and Forest Products,* Resources For the Future, Washington, DC 1984

Table 2.13.—Sources of Change in Oilseed Production, by Region, 1969.71 to 1979-81 and Projected to 2000: Average Annual Changes in Area and Yield as a Percent of Change in Production

Region	Area		Yield	
	1969-71 to 1979-81	1979-81 to 2000	1969-71 to 1979-81	1979-81 to 2000
North Africa-Middle East	–38	87	138	13
Sub-Saharan	95	–214	5	318
EEC	59	72	40	28
Other Western European	130	39	–27	60
U.S.S.R.	–51	10	151	90
East Europe	67	66	32	33
South Asia	62	26	38	73
East Asia	42	22	57	78
Asia (planned)	48	54	51	45
Oceania	75	44	23	55
Latin America	62	52	36	47
North America	75	39	24	60
World	52	38	47	62

SOURCE" Meet/rig *Future Needs for United States Food, Fiberand Forest Products,* Resources For the Future, Washington, DC, 1984

year instead of 0.33 percent; this might have had a profound impact on world cereal trade. The opposite pattern is noted in the EEC, other Western European countries, and Eastern Europe. In these regions, agricultural production became more intensive: yield increases more than compensated for a decline inland area, raising average production as a whole.

The effects of extensive and intensive agricultural production as a source of growth will shift dramatically for cereal crops over the next 15 years, according to the RFF-EPI projections. Approximately 15 percent of the anticipated annual growth in world cereal production will result from increased area, as opposed to 25 percent in the 1970s; 85 percent is expected to come from higher yields, a reflection of high marginal returns to nonland inputs and advances in technology. Area expansion is forecast to play a lesser role in average annual production growth than during the 1970s in every region except East Asia and North Africa and the Middle East. In two important cereal regions, the EEC and the Asian centrally planned nations, projected declines in harvested area could reduce overall production growth rates by 13 percent unless yields increase. Growth in cereal production rates will also depend on more intensive agricultural practices in the crucial regions of North America and Oceania.

The United States' unique ability to increase crop production rapidly aids its international competitiveness in agriculture. Several factors contribute to this responsiveness: a considerable stock of arable land that suits world standards for intensive cropping, even though a sizable portion is marginal from a domestic perspective; maintenance of large carryover stocks of wheat and feed grains; and the technical capacity of U.S. farmers to expand plantings while increasing yields. U.S. farmers served the growing export markets of the 1970s and early 1980s, and can do so in the future.

Expansion of U.S. production capacity in the 1970s actually fostered trade, helping to keep world grain and oilseed prices in check after depletion of stocks triggered abrupt price increases from **1972** to 1975. Increased production also allowed U.S. farmers to increase their share in some markets, at least temporarily. In addition, the responsiveness of U.S. agriculture was an important factor in controlling inflation of domestic food prices, which had reached a rate of 14 percent in 1973-74 and which accounted for over one-half of the overall 1973 increase in the consumer price index,[2] Despite reductions in U.S. stocks of wheat and corn—as well as increases in domestic exports of

'Andrew Schmitz, "United States Competitiveness in Agricultural Trade, " contractor report prepared for the Office of Technology Assessment, 1985, these crops—between 1971 and 1975, stock levels were still ample by 1975. In the case of wheat, they were excessive.

To the extent that agricultural production can insulate the U.S. economy from abrupt increases in food prices and overall inflation, it has a positive effect on disposable income and thus can indirectly aid other sectors of the economy. Agriculture also enhances competitiveness in other sectors by its moderating influence on cost-of-living adjustments (COLAS) in wages. However, a trade-off exists, which has been dramatically evident since 1981: overproduction may result in lower farm incomes and increased costs for domestic farm programs.

As the export market contracted and became more competitive after 1981, the robust expansion of the preceding decade exposed U.S. agriculture to serious adjustment problems. In the price regime of the 1970s, grain and oilseed production were profitable enterprises for more U.S. farmers, in a wider range of production areas, than has been the case since 1981. The increased importance of feed grain—primarily corn—and soybean exports, which are more sensitive to income changes than wheat, has added to the instability. By the early 1980s, area planted for wheat, corn, and soybeans in the United States had reached record levels. Yields were also exceptional in 1981 and 1982, and international production remained high as well. As a result, enormous stocks of wheat and corn accumulated in this country (see table 2-14). Wheat stocks at the end of 1982 constituted 63 percent of total consumption—exports plus domestic consumption—and corn stocks had reached the highest level in 20 years. Corn stocks did drop substantially between 1982 and 1983, the result of a national production control program, as well as a severe drought; however, stocks doubled between 1983 and 1984.

Table 2-14.—U.S. Ending Stocks and Stock-to-Use Ratios for Wheat, Corn, and Soybeans, 1970-84

	Wheat		Corn		Soybeans	
Year	Ending stocks (million bushels)	Stocks-to-use (percent)	Ending stocks (million bushels)	Stocks-to-use (percent)	Ending stocks (million bushels)	Stocks-to-use (percent)
1970	823	55	'666	15	99	8
1971	983	66	1,127	22	72	6
1972	597	30	708	12	60	5
1973	340	17	484	8	171	12
1974	435	26	361	8	188	16
1975	666	35	400	7	245	16
1976	1,113	65	886	15	103	7
1977	1,178	59	1,111	18	161	9
1978	924	46	1,304	18	176	9
1979	902	42	1,617	21	358	17
1980	989	43	1,034	14	313	17
1981	1,159	44	2,174	31	254	13
1982	1,515	63	3,119	43	345	18
1983	1,399	55	723	11	176	10
1984	1,425	55	1,379	20	316	18

SOURCE "Background for 1985 Farm Legislation," Economic Research Service, U S Department of Agriculture, Agricultural Information Bulletins No 467 (wheat), 471 (corn), and 472 (soybeans), 1985

U.S. MARKET SHARES

Although the United States continues to dominate world trade in wheat, corn, and soybeans, the U.S. share of world markets for these crops has fluctuated over the past 15 years (see table 2-15). For example, the U.S. share of world wheat exports increased sharply between 1971 and 1973, from 33 to a record 53 percent. Since then, the export share has ranged from **30** to **48** percent of the world total. A declining market share since 1981 has presented serious problems for U.S.

Table 2-15.—World Exports and U.S. Market Share for Wheat, Corn, and Soybeans, 1970.85[a]

	Wheat[b]		Corn[c]		Soybeans	
Year	World (million bushels)	U.S. share (percent)	World (million bushels)	U.S. share (percent)	World (million bushels)	U.S. share (percent)
1970	2,021	37	1,236	41	462	94
1971	1,911	33	1,374	57	474	88
1972	2,462	48	1,752	71	567	85
1973	2,315	53	2,106	58	664	81
1974	2,363	43	1,823	63	572	74
1975	2,451	48	2,386	72	706	79
1976	2,326	41	2,386	71	703	80
1977	2,675	42	2,602	75	820	85
1978	2,646	45	2,799	76	906	82
1979	3,160	44	3,086	79	1,071	82
1980	3,458	44	3,295	72	903	80
1981	3,722	48	2,831	70	1,085	86
1982	3,625	42	2,634	71	1,045	87
1983	3,747	38	2,617	71	960	77
1984	3,899	36	2,837	65	918	65
1985	3.238	30	2,620	55	974	80

[a]1985 preliminary.
[b]Wheat excludes intra-EEC trade
[c]Corn includes intra-EEC trade

SOURCE' "Background for 1965 Farm Legislation," Economic Research Service, U.S Department of Agriculture, Agricultural Information Bulletins No 467 (wheat), 471 (corn), and 472 (soybeans), 196S

wheat producers, but it is important to note that pronounced declines were experienced in 1974 and 1976, when conditions were generally favorable for U.S. exports. In other words, the U.S. market share for wheat has been unstable, to some extent. Still, the effects of a decline in both market share and prices have been painful for U.S. producers over the last several years.

The United States has also dominated world corn exports, and has increased its share since the mid-1970s; again, however, this trend has varied, ranging from 41 to 79 percent since **1970.** Markedly large annual changes occurred between 1970 and 1973, and relatively large decreases have occurred since 183. The fact that corn is one of numerous livestock feed sources traded in international markets complicates matters; other coarse grains, such as sorghum, feed wheat, grain byproducts, manioc, and citrus pulp, compete with corn. In this larger context, the United States has suffered considerably in recent years. Argentina's exports of corn and sorghum have made that country a major competitor in the world coarse grain market. The U.S. share of coarse grain exports declined from **72** percent in 1979-80 to just under 60 percent in 1981-82, where it remained through 1984-85, while Argentina's share doubled over the same period (see table 2-16). An overall decline in world markets for both corn and coarse grains has made the U.S. farmer's loss in market share all the more difficult.

In soybeans, the United States has dominated an international market that increased enormously during the 1970s, but has since leveled off (see table 2-15), The U.S. share typically exceeds 80 percent of world exports. Still, there have been a number of interludes during which U.S. market share shifted up or down, notably 1970-71, 1973-74, 1976-77, 1980-81, and each year since 1982.

Although the United States ships wheat, corn, and soybeans to dozens of countries, the import levels of several key countries or groups of countries present major sources of instability for U.S. exports. Soybean purchases by centrally planned and developing countries, and by the EEC, have been a major source of variability. Corn purchases by the EEC, the U. S. S. R., and China have a profound effect on U.S. corn exports. The U.S.S.R. and China are also the most important sources of variability in world wheat trade. In recent years, China has increased wheat production and has reduced imports from the United States.[3]

[3]*FA0 Trade Yearbook*, Food and Agriculture Organization of the United Nations, vols. 32-38, 1970 to 1984, Rome, Italy.

Table 2-16.—World Coarse Grain Exports, 1979.86 Crop Years

Country or region	1979-80	1980-81	1981-82	1982-83	1983-84	1984-85	1985-86a
				Million metric tons			
United States	71,4	69.6	58.4	54.0	55.8	55.5	45.9
Canada	3,8	5.5	7.2	7.1	5.5	3.3	5.8
Australia	4.1	2.3	3.1	1	5.5	7.1	6.0
Argentina	5,3	14.2	10.3	11.6	10.9	10.6	11.9
South Africa	3,5	4.1	4.7	2.3	0.1	0.5	1.0
Thailand	2.2	2.4	3.5	2.3	3.4	3.5	3.8
Other	9.1	10.7	9.4	11.6	10.8	21,0	17,9
World total	99.4	108.8	96.6	89.9	92	101,5	92.3
				Percent of world total			
United States	72	64	60	60	61	55	50
Canada	4	5	7	8	6	3	6
Australia	4	2	3	1	6	7	7
Argentina	5	13	11	13	12	10	13
South Africa,	4	4	5	3	0	0	1
Thailand	2	2	4	3	4	3	4
Other	9	10	10	13	12	21	19
World total	100	100	100	100	100	100	100

SOURCE *Agricultural Statistics,* US Department of Agriculture Washington, DC 1986

Although the United States has experienced a pronounced decline from peak export years, U.S. shares of world wheat, corn, and soybean exports have not fallen so precipitously from long-term levels as to indicate a major shift in this country's international position. Significant annual changes in the U.S. market share—including some major losses—did occur before 1981. But these fluctuations in market share did not attract as much attention in the 1970s, due to expanding world markets and more favorable prices. U.S. exports of cereal and oilseed crops will probably increase over the long term, but world trends in production and consumption, and in imports and exports, suggest that U.S. market shares will continue to fluctuate from year to year.

THE LONG-TERM OUTLOOK FOR INTERNATIONAL TRADE

Based on anticipated trends in the food consumption and production of other regions, exports of cereals and oilseeds from North America are likely to increase over the long term, but at a slower average rate than experienced in the 1970s. Also, North American exports will play a more important role in the world food system. However, U.S. farmers will have to rely on world markets for their economic well-being to a greater degree than they do today, and will be exposed to greater risks as a result.

Table 2-17 shows regional production and consumption of cereal grains in 1978-80, and as projected for the year 2000 by RFF-EPI. Production is envisioned as increasing in all regions over the next 15 years, but consumption—a function of population, income trends, and evolving diets—is projected to outstrip production in every region but the EEC, Oceania, and North America. In 2000, Sub-Saharan Africa's cereal consumption exceeds production to a much greater extent than in the late 1970s; North Africa and the Middle East and South Asia will also be less able to meet consumption needs from domestic production. The entire Western European region should enjoy a considerably improved production-consumption balance,

Of the three surplus producing regions, Oceania is the most dependent on exports, with a production/consumption ratio of **2.67** in the late 1970s; a somewhat lower ratio is forecast for 2000. The EEC is projected to increase its exportable surplus

Table 2-17.—Production and Consumption of Cereal Grains, 1978-80 and Projected to 2000, by Region

	1978-80			2000		
	Production	Consumption (1,000 mt)	Ratio	Production	Consumption (1,000 mt)	Ratio
North Africa-Middle East	59,899	84,032	0.71	95,317	141,827	0.67
Sub-Saharan	53,939	58,324	0.92	78,897	108,187	0.73
EEC	121,940	123,115	0.99	153,330	133,337	1.15
Other Western European	32,708	42,358	0.77	49,446	57,747	0.86
U.S.S.R.	195,698	220,312	0.89	276,488	306,290	0.90
Eastern Europe	95,256	109,489	0.87	119,153	138,879	0.86
South Asia	180,675	182,754	0.99	277,446	291,288	0,95
East Asia	100,245	130,082	0.77	170,709	223,804	0.76
Asia (planned)	302,715	317,712	0.95	425,333	456,912	0.93
Oceania	22,444	8,398	2.67	41,749	16,413	2.54
Latin America	85,513	91,315	0.94	151,310	161,123	0.94
North America	322,625	199,753	1.62	450,546	253,917	1.77
World	1,573,647	1,567,644	1.00	2,289,724	2,289,724	1.00

SOURCE *Meeting Future Needs for United States Food, Fiber and Forest Products*, Resources For the FutureWashington, DC, 1984.

Table 2.18.—Production and Consumption of Oilseeds, 1978-80 and Projected to 2000, by Region

	1978-80			2000		
	Production	Consumption (1,000mt)	Ratio	Production	Consumption (1,000mt)	Ratio
North Africa-Middle East	3,417	4,811	0.71	4,679	10,065	0.46
Sub-Saharan	7,508	5,324	1.41	7,539	8,734	0.86
EEL	2,002	32,362	0,06	4,527	43,796	0.10
Other Western European	1,059	6,127	0.17	2,403	9,783	0.25
U.S.S.R	12,008	11,963	1.00	21,405	20,306	1.05
Eastern Europe	3,900	10,805	0.36	8,468	16,633	0.51
South Asia	13,997	11,256	1.24	19,172	17,046	1.12
East Asia	3,145	9,032	0.35	5,998	22,565	0.27
Asia (planned)	19,213	20,251	0.95	38,455	36,659	1.05
Oceania	460	408	1.13	793	1,989	0.40
Latin America	24,058	8,840	2.72	38,083	18,359	2.07
North America	67,119	32,870	2.04	97,695	43,282	2,26
World	157,796	154,049	1.02	249,217	249,217	1,00

SOURCE *Meeting Future Needs for United States* Food, Fiber and Forest Products, Resources For the Future, Washington, DC, 1984

by approximately 15 percent, suggesting that U.S. imports to the EEC will decrease while competition with the EEC in other cereal markets will grow more intense. The exportable surplus will also increase in North America, where production is expected to exceed consumption by 77 percent in **2000,** compared to **62** percent in the late 1970s.

Oilseed production is projected to increase in every region (see table 2-18) by 2000, although only 5 of the 12 regions should have an export surplus. Sub-Saharan Africa is likely to become a deficit region for oilseeds, with consumption topping production. Production/consumption ratios will also grow more precarious in North Africa and the Middle East, and in Oceania. The major surplus regions will continue to be North America and Latin America, both of which may produce more than twice the oilseed volumes that they consume. Latin America should lose its considerable dependency on exports to absorb production—nearly three times regional consumption in 1978 to 1980—because its level of consumption will increase sharply. However, North America, and the United States in particular, is forecast to grow more dependent on foreign markets.

World Trade in Wheat, Corn, and Soybeans

In absolute terms, world trade in these crops has increased dramatically since 1970. World wheat exports grew by 60 percent, corn exports by 111 percent, and soybean exports by 110 percent between 1970 and 1985 (see table 2-15), In terms of relative changes, however, world exports of the three crops rose as a proportion of world production throughout the **1970s,** but have decreased since that time. The corn market held the most pronounced change. World corn exports constituted about 12 percent of total production in the early 1970s; this figure climbed to a peak of 21 percent in **1980** and remained high, at 19 percent, in 1983. Since that time, corn exports have fallen to 14 percent of world production (see table 2-19). **The** corn market, which had approached wheat in terms of the proportion traded, has again fallen behind both wheat and soybeans in this category. In addition, the shift of international wheat trade toward commercial sales represents an important development of the past two decades,

Table 2-19.—World Exports as a Share of World Production, 1970.83 (percent)

	Wheat	Corn	Soybeans
1970	18	12	28
1971	15	12	27
1972	20	15	31
1973	18	17	29
1974	18	16	29
1975	19	19	29
1976	15	17	32
1977	19	18	31
1978	16	18	32
1979	20	19	31
1980	21	21	30
1981	23	16	34
1982	20	15	31
1983	21	19	32
1984	21	16	27
1985	18	14	28

SOURCE *Meeting Future Needs for United States Food, Fiber and Forest Products* Resources For the Future, Washington DC, 1984

Table 2-2o summarizes the flow of world trade in cereals and oilseeds, as implied by the regional production/consumption balances discussed in the preceding section. Cereals trade could double between 1980 and 2000, and oilseed trade may rise by about half. The RFF-EPI projections indicate that the volume of U.S. cereal grain exports could increase by about 58 percent, and oilseed exports by about 64 percent, compared to 1979-80.

Future patterns of trade implied by the RFF-EPI projections show a shift in world imports of cereal grains, away from Europe and the U.S.S.R. and toward regions where demand has been more variable, like Asia (see table 2-21). Increased cereal imports to Sub-Saharan Africa will largely be in the form of food aid and confessional sales. A similar shift in the flow of trade is anticipated for oilseeds. European regions, especially the EEC and Eastern Europe, will account for a smaller share of imports; North Africa and the Middle East, Sub-Saharan Africa, and in particular East Asia, are expected to grow as import markets. A change in import share toward developing countries may increase the variability of world trade in cereals, grains, and oilseeds. On the whole, production/consumption trends imply that U.S. producers will become more dependent on export markets, while exports will become less predictable in other regions. The burden of the increased risks associated with these developments will, in large measure, fall on the United States.

Table 2-20.—Trade Patterns Implied By Projected Balance of Production and Consumption of Cereal Grains and Oilseeds, 1978.80 and Projected for 2000, by Region[a](l,OOO MT)

Region	Cereal grains 1978-80	Cereal grains 2000	Oilseeds 1978-80	Oilseeds 2000
North Africa-Middle East . .	(24,133)	(46,510)	(1,394)	(5,386)
Sub-Saharan	(4,385)	(29,290)	2,184	(1,195)
EEC	(1,175)	19,993	(30,360)	(39,269)
Other Western European . .	(9,650)	(8,301)	(5,068)	(7,380)
U.S.S.R	(24,614)	(29,802)		1,099
Eastern Europe	(14,233)	(19,726)	(6,905)	(8,165)
South Asia	(2,079)	(13,842)	2,741	2,126
East Asia	(29,837)	(53,095)	(5,887)	(16,567)
Asia (planned)	(14,997)	(31,579)	(1,038)	1,796
Oceania.	14,046	25,336	52	(1,196)
Latin America.	(5,802)	(9,813)	15,218	19,724
North America	122,872	196,629	34,249	54,413
World	–130,905	–241,958	–50.652	–79,158

[a]Parenthesized values indicate amount by which consumption exceeds supply (implying imports).

SOURCE *Meeting Future Needs for United States Food, Fiber and Forest Products,* Resources For the FutureWashington, DC, 1984.

Table 2-21.— Projected Shifts In Shares of World Trade in Cereal Grains and Oilseeds, 1978.80 t0 2000, Percent of Imports (exports parenthesized)

Region	Cereal grains 1978-80	Cereal grains 2000	Oilseeds 1978-80	Oilseeds 2000
North Africa-Middle East . .	18	19		7
Sub-Saharan	3	12	(4)	2
EEC	1	(8)	60	50
Other Western European . .	7	3	10	
U.S.S.R	19	12	(o)	(1)
Eastern Europe	11	8	14	10
South Asia	2	6	(5)	(3)
East Asia	23	22	12	21
Asia (planned)				(2)
Oceania	(11)	(10)	(:)	
Latin America			(30)	(25)
North America	(94)	(81)	(68)	(69)

SOURCE *Meeting Future Needs for United States Food, Fiber and Forest Products,* Resources For the Future, Washington, DC, 1984

Chapter 3

Cost-Competitiveness of U.S. Agriculture

Chapter 3

Cost-Competitiveness of U.S. Agriculture

This chapter addresses the cost of producing crops in the United States and in other nations. Though such comparisons are fraught with difficulties, many U.S. producer areas are cost-competitive with similar areas in other countries. However, the United States does not appear to enjoy a large cost advantage over its major competitors in several key markets.

Also, the chapter focuses on an aspect of international competitiveness that has received relatively little attention: policy problems posed by the wide range of production costs associated with U.S. agriculture. As a result, many U.S. producers and farming areas may not perform at the level of better growing regions in other parts of the world.

INTERNATIONAL COMPARISONS OF PRODUCTION COSTS

Ideally, the competitive standing of U.S. agriculture could be gauged by comparing full production and marketing costs in the United States with those in competitor nations. But it may not be possible to obtain reliable and comparable production cost data for many other countries. A dearth of information is not unusual in international trade analysis; nevertheless, this handicaps evaluation of America's competitive standing in world agriculture.

Even if reliable on-farm cost data were available, they would reveal only the absolute advantage that the United States enjoys at the farm level in the production of specific crops. A complete treatment of absolute advantage would require comparison of costs associated with the marketing of farm goods, such as transportation—a major issue in the 1985 farm bill, raised by "cargo preference" provisions—and a range of important but indirect government expenditures, such as subsidies, research and development, education, and soil and water conservation. To examine the U.S. final comparative advantage as an agricultural exporter would require even more extensive analysis, which would determine whether land, labor, and capital devoted to the production of a specific crop might suit other agricultural products more effectively,

In 1985, U.S. Department of Agriculture (USDA) analysts attempted to duplicate U.S. on-farm "cost of production" (COP) budgets in other countries for key commodities. The USDA found, however, that the foreign data were not comparable. Several commodities and countries were examined: wheat—the U. S. S. R., Argentina, France, and People's Republic of China; rice—Thailand; soybeans—Brazil; and cotton—Pakistan. In a staff memorandum dated June 4, 1985, the USDA concluded that:

> In no country except the U.S. could [crop] budgets be developed using data collected by statistically reliable survey techniques and procedures. Sketchy budgets from other countries come from data collected from a few select farmers in the better producing areas. These budgets more nearly represent what extension farm management specialists at the universities [in the United States] put together using data provided by experiment station researchers and lead farmers.[1]

Even the limited number of crop budgets that were obtained from other countries did not compare to the USDA's COP data. Nor could analysts systematically isolate the impact of subsidies provided by various governments that affect input use or prices.

[1] "Foreign COP Data," unpublished staff paper prepared for the Economic Research Service, U.S. Department of Agriculture, June 1985.

Particular problems that USDA encountered in gathering data for individual countries demonstrate the overall difficulty involved in this process. In the appraisal of Soviet production costs for wheat, for example, USDA analysts note that:

> . . . the Soviet agricultural sector is characterized by extensive direct budgetary subsidies to farms, extremely lenient State credit policies, a complicated system of administered prices, no direct land rents, and other factors which not only make international cost of production analysis highly problematic, but also make meaningful internal Soviet cost-accounting an elusive goal , . . ***in no case were actual wheat cost of production data available*** [emphasis in original].[2]

Different but equally confounding problems arose in assessing wheat production costs in China:

> Much of the inputs are not purchased and carry an imputed value . . . the reported labor expense item is "standard labor days" valued at a uniform rate of 0.80 yuan per day for all years since 1956. The cost of labor certainly increased between 1956 and 1979, so this is a questionable measure of labor cost . . . Nothing is known about other critical components of total cost. Depreciation and return to collectively or individually owned assets are important but unknown. Estimation of many of these items would be very difficult . . . How do we estimate cost of land in an economy in which there is no market for land?[3]

Conversion of foreign currency values to U.S. dollars was necessary, in order to compare input costs and crop prices. However, some of these calculations were influenced by shifting exchange rates, government exchange rate policies, or financial conditions in certain nations. For instance, the dollar appreciated by 40 percent in value against the French franc over the 3 years for which wheat production cost data were obtained for selected farms in France—the exchange rate went from 5.43 francs per dollar in 1981 to 7.62 francs per dollar in 1982. "The strengthening dollar was a major contributor to the decline in French production costs, "[4] when those costs were denominated in U.S. dollars. Because Soviet rubles are not conversable, analysts resorted to the exchange rate set by the Soviet Government. The official exchange rate also had to be used to denominate Chinese costs and prices for wheat, which overvalued the yuan "to a significant but unknown extent.'" In Brazil, financial analysis was complicated by inflation rates of approximately 10 percent per month:

> Since the devaluation of the cruziero is linked to inflation, conversion of Brazilian estimates to U.S. dollars effectively deflates production costs , . . it is necessary to assume that a given input is used in a given month during the production cycle . . . adjustment is important because payment at harvest may be in cruzieros that have inflated [by] 100 percent since soil preparation costs were incurred. [b]

USDA analysts have recently evaluated variable production costs for major producing regions in the United States and competing nations from 1980 to 1982 (see table 3-l). In theory, a farmer will continue to produce an agricultural commodity, in the short term, for as long as variable production costs can be recouped. Over the long

'Ibid.
[2]Ibid.
[3]Ibid.
[4]Ibid.

'Ibid.
[6]Ibid.

Table 3-1 .—Average Variable Costs of Production for Wheat, Corn, and Soybeans, Selected Countries and Regions, 1980-82

Crop and region	1980-82 average	Percent of U.S. average
Wheat:		
U.S. average	1.56	100
Corn Belt/Lake States	1.65	106
North Plains	1.29	83
Central Plains	1.28	82
Canada (Saskatchewan)	1.28	82
Australia	2.06	132
Corn:		
U.S. average	1.22	100
Corn Belt/Lake States	1.13	93
Argentina (Pergamino)	0.87	71
Soybeans:		
U.S. average	1,97	100
Corn Belt/Lake States	1.46	74
Brazil (Southeast)	1.84	93
Argentina (Pergamino)	1.72	88

SOURCE: "The U S. Competitive Position in World Commodity Trade, " *Agricultural-Food Policy Review" Commodity Program Perspectives,* Economic Research Service, U.S. Department of Agriculture, Agricultural Economic Report No 530, 1985 term, production continues if the farmer can recover fixed costs—primarily associated with land—and earn acceptable returns to labor and management. At that point, fixed costs would begin to resemble variable costs. If prices fall below variable costs, farmers will tend to withdraw productive resources from that enterprise in the short term.

Many of these factors influence the data that USDA collected from other countries. It is not clear, for example, if the data presented for other countries represent average production costs for the nation or the region, or if they are costs for a "typical farm" or an exemplary one. Leaving these problems aside, however, it appears that compared to other countries and regions, the United States—as a whole—was not always the low-cost producer of wheat, corn, and soybeans. For the 1980-82 period, average variable production costs for wheat in the United States exceeded those of Saskatchewan, Canada, by 18 percent; for corn, the U.S. average exceeded that of Pergamino, Argentina, by 29 percent; and for soybeans, U.S. costs exceeded both those of Southeast Brazil by 7 percent, and Pergamino by 12 percent. When more productive U.S. growing areas—wheat in the two Plains regions, and soybeans in the Corn Belt—are compared individually against foreign regions, U.S. performance improves. In addition, U.S. production costs do fall below some competitors; Australian wheat production costs, for example, topped U.S. levels by almost one-third.

To reemphasize, these data do not provide a complete picture of U.S. cost-competitiveness relative to other countries. Nevertheless, the fact that most variable costs reported for other countries are comparable or below costs in the better U.S. growing regions suggests that this country does not enjoy a significant advantage in on-farm production costs.

TRENDS IN PRICES PAID AND RECEIVED BY FARMERS

International production costs and profits may be compared by examining national trends in prices received for crops and production input payments, and the relationship between these factors. Indexes of those prices are listed for the United States and four competitors in table 3-2. The indexes have been adjusted to a 1976 base year for international price relationships, Prices that farmers received for crops rose in all countries between 1976 and 1981. However, by the end of the 1970s, prices paid were rising even faster in every country but Canada. The ratio of prices received to prices paid suggests that Canadian producers enjoyed a more favorable price regime betweeen 1976 and 1981 than did their counterparts. Even in the hyperinflated Argentine economy, the 1982 ratio of prices received to prices paid was higher than in the United States. Interestingly, prices paid by farmers increased at roughly uniform rates in Canada, France, Australia, and the United States, although updated USDA data indicate that the prices-paid index for the United States rose to 173 in 1981, a higher level than that of the table. Still, this finding suggests that the United States has not been more vulnerable to cost increases than several major competitors.

U.S. Costs of Production

Discounting the problems of international comparisons, fairly reliable data for U.S. production costs reveal a wide range for most major crops. As a result, the use of a single "national average price" for a particular commodity can be misleading, particularly in the context of international trade. In terms of average costs, U.S. agriculture may be competitive for major traded commodities; however, many U.S. individual farm firms may not be able to compete.

Table 3-3 indicates the regional diversity of U.S. production costs for wheat, corn, and soybeans between 1980 and 1982. Wheat production costs in the Southern Plains topped the national aver-

Table 3“2.—Indexes of Prices Received by Farmers for Crops and and Prices Paid for Production Inputs, Selected Countries, 1976-82[a]

Country	1976	1977	1978	1979	1980	1981	1982
Canada							
Prices received.	131	124	130	154	181	190	NA
Prices paid	100	104	116	136	149	169	
Ratio	1.31	1.19	1.12	1.13	1.21	1.12	
Argentina							
Prices received.	100	244	634	1,303	2,283	4,814	16,947
Prices paid	100	238	624	1,482	2,903	5,947	19,429
Ratio	1.00	1.03	1.02	0.88	0.79	0.81	0.87
France							
Prices received.	118	120	126	136	143	157	NA
Prices paid	100	108	115	126	145	164	
Ratio	1.18	1.11	1.09	1.08	0.99	0.95	
Austra/ia							
Prices received.	110	110	108	120	146	169	162
Prices paid	100	112	124	132	147	169	188
Ratio	1.10	0.98	0.88	0.91	0.99	1.00	0.86
United States							
Prices received	107	105	110	122	131	141	127
Prices paid . :	100	105	115	132	146	159	162
Ratio	1.07	1.00	0,96	0.92	0.90	0.88	0.78

[a]Indexes constructed from FAO data, *1982 Production Yearbook*. prices paid indexes were adjusted to a base year of 1976. Prices received index was constructed based on the ratio between prices received and prices paid in 1976

SOURCE *FAO Production Yearbook,* Food and Agriculture Organization of the United Nations, vol. 36, 1982, Rome, Italy

age by over 35 percent 1980; a difference of 56 percent existed that year between the lowest cost region, the Central Plains, and the Southern Plains. Also, considerable annual fluctuation in production costs is evident within wheat producing regions, although the Central and Northern Plains maintain consistently low levels. In the case of corn, the Lake States and Corn Belt regions that dominate U.S. corn production were also the low-cost producers of the early 1980s. The other regions had above-average production costs in all 3 years, which were especially high in the Southeast and Southwest. For soybeans, both the Lake State/Corn Belt and Northern Plains regions hold low costs, and are fairly competitive. A wide gap exists between those two regions and the Delta and Southeast regions.

Several factors contribute to regional differences in cost of production: varying yields, attributable to climate and soil conditions; differences in the amount and cost of inputs like herbicides, insecticides, and fertilizer; and fluctuations in interest rates on loans for land, equipment, and operating expenses.

In addition to differences in production costs between regions, such variation exists within small areas as well. Regional aggregation tends to obscure these developments.

A high cost of production does not always relate to a misallocation of productive resources. In some cases, low financial returns for a particular crop are actually higher than they would be for other enterprises, especially when government subsidies are taken into account. In certain regions, notably the Southeast, Delta, and Corn Belt, wheat and soybean production costs might be affected by double-cropping, in which case wheat returns alone may not accurately measure the economics of a particular farming enterprise. Furthermore, prices received by farmers may vary. In some cases, higher prices result from higher production costs.

These qualifications may reduce the nationwide range of wheat production costs, but actual variation remains wide. Some regions are more efficient than others in wheat production, and are more vulnerable to price changes as a result.

Table 3-3.—Average Variable Cost of Production for Wheat, Corn and Soybeans, U.S. and Selected Regions, 1980-82

	Dollars per bushel			Percent difference from U.S. average		
	1980	1981	1982	1980	'1 981	1982
Wheat (HRW)[a]						
Central Plains	1.06	1.54	1,25	–20	–9	–16
Northern Plains	1.44	1.20	1.23	9	–29	–17
Southern Plains	1.79	2.12	1.95	36	25	31
Southwest	1.43	1.48	1.69	8	–12	13
U.S. average	1,32	1.69	1.49	0	0	0
Wheat (SRW)[b]						
Lake States/Corn Belt	1.50	1.68	1.78	–10	–7	–9
Northeast	2.09	2.39	2.26	26	33	15
Southeast	2,02	1.93	2.11	22	7	8
U.S. average	1,66	1,80	1,96	0	0	0
Corn						
Lake States/Corn Belt	1.18	1.12	1.09	–9	–7	–6
Northeast	1.49	1.36	1.32	16	13	14
Northern Plains	1.36	1.23	1.26	5	3	9
Southeast	2.33	1.94	1.47	81	62	27
Southwest	1,54	1.44	1.60	19	20	38
U.S. average	1,29	1,20	1.16	0	0	0
Soybeans						
Delta	3.77	3.46	2.66	83	72	45
Lake States/Corn Belt	1.42	1.51	1.46	–31	–25	–20
Northern Plains . .	1.56	1.28	1.36	–24	–36	–26
Southeast	4,63	3,39	2.90	125	69	58
U.S. average ., ...	2,06	2.01	1,83	0	0	0

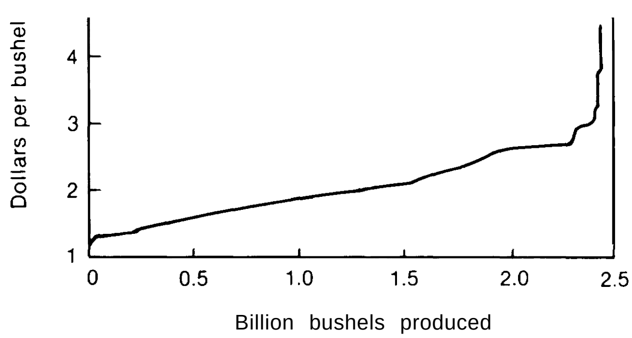
[a](HRW) - hard red winter.
[b](SRW) = soft red winter

SOURCE "The U S Competitive Position in World Commodity Trade, " *Agricultural-Food Policy Review Commodity Program Perspectives,* Economic Research Service, U S Department of Agriculture, Agricultural Economic Report No 530, 1985

Moreover, depending on international production costs, certain U.S. regions may be more competitive than others in world markets.

A different perspective on the range of U.S. wheat production costs is presented in figure 3-I and table **3-4,** which show how much of the 1981 U.S. wheat crop was produced at a given variable cost. USDA analysts constructed the graph using the average variable cost of production and the amount of production for wheat in each State, arranging the States from lowest to highest cost of production. Significant variations in costs of production exist within individual States, but were not captured by the graph. Variable costs account for only those items required for production and harvesting; depreciation, taxes, interest on long-term debts, and land charges were not included.

Figure 3-l.—Wheat Produced at Less Than the Specified Variable Cost Per Bushel, 1981



SOURCE "Commodity Price and Income Support Policies in Perspective, " *Agricultural-Food Policy Review Commodity* Program *Perspectives,* Economic Research Service, U S Department of Agriculture, Agricultural Economic Report No 530, 1985

USDA estimates that the national average variable cost for wheat production in 1981 was $2.04 per bushel. Variable costs were below this level for more than half of all wheat produced in the United States (see table 3-4). About 1 billion bushels, approximately **40** percent of the crop, were produced at a cost that was above the national average. Significantly, for about 97 percent of the 1981 wheat crop, variable costs were below the government price support, or loan level,

Table 3-4.— Percent of Wheat Crop Produced at Less Than Specified Variable Cost of Production, 1974 and 1981

	Percent produced	
Cost less than	1974	1981
$0.75/bu	10	0
$1 .00/bu	29	0
$1 .25/bu	45	1
$1.50/bu	60	16
$1.75/bu	72	34
$2.00/bu	79	53
$2.25/bu	86	66
$2.50/bu	90	77
$2.75/bu	92	94
$3.00/bu	94	97
$3.25/bu	95	99
$3.50/bu	96	99
$3.75/bu	97	99
$4.00/bu	98	100
$4.50/bu	98	100

SOURCE:"Commodlty Price and Income Support Policies in Perspective," *Agricultural-food Policy Review: Commodity Program Perspectives,* Economic Research Service, U.S. Department of Agriculture, Agricultural Economic Report No. 530, 1985

set at $3.20 per bushel. As a result, in 1981, "producers who had a variable cost of less than $3.20 would have found it to their advantage to plant their maximum acreage, assuming opportunities on other crops were not as profitable."[7]

A similar relationship existed between the government loan rate and variable costs for corn production in 1981. The national average variable cost was $l.45 per bushel; roughly two-thirds of the U.S. corn crop had variable costs below $1.50 (see table 3-5). The government loan rate of $2.40 for corn exceeded variable costs for 98 percent of total corn production that year (see figure 3-2).

High market prices encouraged added production of wheat and corn for much of the 1970s. By 1981, however, government price supports that topped variable production costs provided an incentive to retain large wheat production acreage. As noted earlier, direct income support payments to farmers, via the target price mechanism, offered an additional impetus to expand wheat and feed grain production.

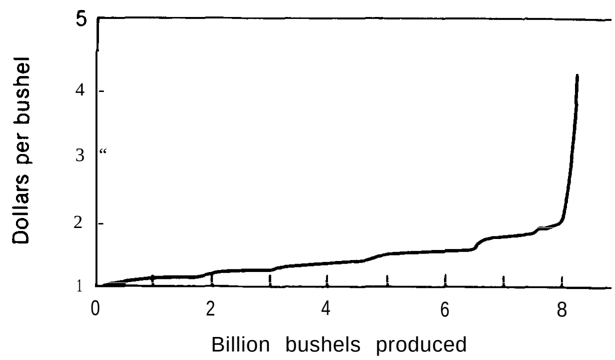
These levels of government protection are significant, because while downward adjustments in

Table 3.5.—Percent of Corn Crop Produced at Less Than Specified Variable Cost of Production, 1974 and 1981

	Percent produced	
Cost less than	1974	1981
$1.00/bu	33	0
$1,25/bu	62	28
$1.50/bu	79	66
$1.75/bu	87	80
$2.00/bu	93	96
$2.25/bu	95	98
$2.50/bu	96	98
$2.75/bu	97	99
$3.00/bu	98	99
$3.25/bu	98	100

SOURCE: "Commodity Price and Income Support Policies in Perspective, " *Agricultural-Food Policy Review: Commodity Program Perspectives,* Economic Research Service, U S Department of Agriculture, Agricultural Economic Report No. 530, 1985.

Figure 3-2.—Corn Produced at Less Than the Specified Variable Cost Per Bushel, 1981



SOURCE: "Commodity Price and Income Support Policies in Perspective," *Agricultural-Food Policy Review: Commodity Program Perspectives,* Economic Research Service, US. Department of Agriculture, Agricultural Economic Report No, 530, 1985,

price support levels for wheat and feed grains tend to make the United States more competitive in world markets, the impact on high-cost U.S. producers–and on those in other countries—would be significant. For example, if the 1981 loan rate for wheat had been set at $2.50, in order to stimulate wheat exports and retain U.S. market share, variable costs would have exceeded the loan rate for approximately one-quarter of domestic wheat production. This evidence, together with that which will be presented in the next section, indicates that enterprises and regions that earned acceptable returns under the higher commodity prices of the **1970s** could do so in the 1980s only by virtue of U.S. Government price and income

[7]"Commodity Price and Income Support Policies in Perspective, " *Agricultural-Food Policy Review: Commodity Program Perspectives,* Economic Research Service, U.S. Department of Agriculture, Agricultural Economic Report No. 530, 1985.

supports. Even with those government supports, cash flow problems associated with high variable production costs would have been more acutely felt were it not for the convention among farm lenders, including the Farmers Home Administration, of financing farm operation and ownership based on solid assets, such as land, rather than on the basis of cash flow.

REGIONAL PRODUCTION COSTS AND AGRICULTURAL STRUCTURE

The continued concentration of ownership and control of agricultural land and resources, and the *role* of government in this process, has long been a feature of agriculture policy debates. The fate of small and medium-size "family farms" has been of special concern to many policy makers. In assessing international competitiveness, however, it may be just as important to examine differences between high-, medium-, and low-cost producers. Grouping farm enterprises according to production costs would resemble conventional classifications based on annual gross sales or acreage; production costs often decrease as enterprise size grows, The term "enterprise" refers to the resources devoted to production of a particular crop, and is, in many respects, synonymous with the term "farm. "

A recent OTA study described the complex relationships among enterprise size, dynamics of farm expansion, geographic location, and production costs for major crops. [8] Table 3-6 lists characteristics for representative corn, wheat, and soybean enterprises of three different sizes in four different production areas. The enterprises are arrayed on the basis of unit cost of production, from lowest to highest. The unit cost ranges were grouped in intervals of roughly 10 percent.

Clearly, production costs vary for each crop, even in traditionally "fertile" areas. Corn production costs for the representative enterprises ranged from $1.67 to $3.21 per bushel. For wheat, the range was $2.05 to $3.91 per bushel, and for soybeans, $3.32 to $6.02 per bushel. The difference between the lowest and highest cost enterprises exceeded 90 percent for corn and wheat, and 80 percent for soybeans. These cost ranges are consistent with nationwide variations in unit production costs for major crops, discussed earlier in this chapter.

For each crop, the highest production costs tend to be concentrated in one of the four areas studied: south central Nebraska for corn, central North Dakota for wheat, and the Mississippi Delta for soybeans. At the low-cost end of the spectrum, western Kansas seems to enjoy a comfortable absolute advantage in wheat production. Regional competition is evident in the case of corn and—to a lesser degree—soybeans in the low-cost ranges. Soybean competition appears keenest in the middle range; a measure of competition is also observed in that range for wheat and corn.

As would be expected, what constitutes a "very large" enterprise size in one major producing area may differ from an enterprise of similar size in another. Enterprise sizes in the respective areas are grouped by percentile distribution—based on planted acreage, "very large" enterprises were in the 90th percentile, "large" enterprises in the 70th and 80th percentiles, and "moderate" enterprises the 40th to 60th percentiles. However, in addition to acreage, unit production costs distinguish enterprise size. A 1,283-acre wheat enterprise is "very large" by central North Dakota standards, but its per bushel cost of production might be 85 percent higher than a "very large" enterprise of 3,9o9 acres in western Kansas, 37 percent higher than a "moderate" enterprise of 753 acres in eastern Washington, 24 percent higher than a "moderate" enterprise of 421 acres in northeast Montana, and 16 percent higher than a "very large" enterprise of 2,388 acres in eastern Washington.

Even more interesting from a national perspective is the diversity of enterprise sizes in the lower and middle ranges of production costs. At the same time, unit production costs for corn and soybeans are similar in enterprises of different sizes

*U, S. Congress, Office of Technology Assessment, *Technology, Public Policy, and the Changing Structure of American Agriculture,* OTA-F-285 (Washington, DC: U S. Government Printing Office, March 1986)

Table 3-6.—Production Costs, Farm Size, and Yields for Corn, Wheat, and Soybean Enterprises in Selected Crop Production Areas, 1983

Crop: Total cost	Production area	Farm size	Acreage	Economies of size rating	Yield (bu/acre)
Corn:					
$1.67/bu	North central Iowa	VL	576	4	119.0
$1.67/bu	East central Illinois	VL	1,113	4	130.3
$1.67/bu	Central Indiana	L	NA	4	125.3
$1.69/bu	Central Indiana	VL	903	4	125,6
$1.75/bu	East central Illinois	L	NA	1	128.6
$1.75/bu	North central Iowa	M	170	2	113.0
$1.77/bu	Central Indiana	M	271	2	122.4
$1.80/bu	North central Iowa	L	NA	1	117.4
$1.991bu	East central Illinois	M	246	0	123.1
$2.83/bu	South central Nebraska	VL	1,715	4	118.6
$3.03/bu	South central Nebraska	L	NA	2	112.6
$3.21/bu	South central Nebraska	M	266	0	106,2
Wheat					
$2.05/bu	Western Kansas	VL	3,909	4	33.1
$2.30/bu	Western Kansas	L	NA	3	33.1
$2.41/bu	Western Kansas	M	774	2	33.2
$2.76/bu	East Washington	M	753	1	47.8
$2.771bu	Northeast Montana	VL	577	4	31,3
$2.94/bu	Northeast Montana	L	NA	0	29.9
$3.05/bu	Northeast Montana	M	421	0	29.2
$3.26/bu	East Washington	VL	2,388	2	39,9
$3.60/bu	Central North Dakota..	L	NA	4	30.8
$3.79/bu	Central North Dakota.	VL	1,283	3	31.7
$3.86/bu	East Washington	L	NA	2	39.9
$3.91/bu	Central North Dakota.	M	338	0	29.7
Soybeans:					
$3.32/bu	North central Iowa	VL	707	3	36.8
$3.38/bu	East central Illinois..	L	NA	4	38.2
$3.44/bu	North central Iowa	L	NA	3	36,6
$3.56/bu	East central Illinois..	VL	684	2	38.2
$3.58/bu	North central Iowa	M	210	1	36,6
$3.59/bu	Western Ohio	L	NA	4	34.8
$3.64/bu	East central Illinois.	M	270	0	37.4
$3.66/bu	Western Ohio	M	244	1	34.4
$4.27/bu	Western Ohio	VL	897	2	35.6
$5.171bu	Mississippi Delta	M	795	2	23.6
$5.20/bu	Mississippi Delta	VL	1,262	3	25.0
$6.02/bu	Mississippi Delta	L	NA	0	23.6

NOTE: Cost of production excludes land charges Relative farm size within a given area VL (very large), L (large), and M (moderate) Economies of size rating 4 clear advantage for enterprise rize relative to other sizes within production area, O = no advantage

SOURCE US Congress, Office of Technology Assessment, *Technology, Pub/lc Policy, and the Changing Structure of American Agriculture* OTA F-285 (Washington DC US Government Printing Office, March 1986)

across various regions. For example, the unit production cost of corn on a l,113-acre corn enterprise in east central Illinois falls within 10 percent of the cost for a 170-acre operation in north central Iowa or a 271-acre enterprise in central Indiana. Costs at 250-acre soybean enterprises in western Ohio resemble those at 700-acre soybean operations in east central Illinois. Furthermore, for every crop, ''large'' and “very large''enterprises in some regions appear to be less efficient than medium-size farms in others,

Within a particular region, incentives may exist to expand enterprise size, which would lower unit production costs. Expanding enterprise size may also increase total income, even with little change in unit costs. In contrast, “diseconomies” of scale—rising production costs—tend to discourage expansion. On the whole, regional variation in production costs will remain, due to differences in yields and input costs such as fertilizer, pesticides, and land preparation.

The “economies of size” rating indicates the extent to which a clear advantage exists for one enterprise size versus another within a particular region. The rating was derived from four indicators: production costs, utilization of harvesting equipment, and two measures of changing concentration of production—static for 1982, and dynamic for the period 1978-82. A "4" denotes a "clear advantage"; a "O" implies "no advantage. " Table 3-6 reveals an interesting pattern for corn, wheat, and soybeans: enterprises and regions with lower costs of production tend to have higher ratings for internal economies of size. This relationship seems most compelling for corn, since the enterprises in the lowest range of production costs exhibit exceptionally strong economies of size; for wheat and soybeans, the pattern is more ambiguous.

This complex system of regional production costs and economies of scale raises important policy questions for international competitiveness. A U.S. strategy that calls for downward flexibility in commodity prices, achieved in part by lowering government price support levels, could have important effects on the pace of resource concentration within agriculture, which would differ among crops and regions because of varying cost structures and economies of size. Program participants would still be eligible to receive the higher target price level for wheat and feed grains; in this case, the relationship between target prices and variable costs may be more relevant. However, acreage reduction requirements and limits on government deficiency payments would affect benefits for program participants, influencing their decision to participate.

For example, if 1983 wheat prices had fallen below $3.60 per bushel in central North Dakota—in fact, the national average market price that year was $3.55 per bushel, and direct payments to program participants averaged 50 cents per bushel—large enterprises would have been unable to recoup variable costs below this price. Although they exhibited a clear advantage in internal economies of scale, large enterprises would have lost money by expanding in this price regime. In addition, very large and moderate-size enterprises with even higher unit production costs would have no incentive to expand in that region, since they would be unable to cover variable expenses even by remaining the same size. The same could be said for large farms in eastern Washington.

Other enterprises represented in table **3-6,** whose production costs are well below **$3.60** per bushel, would earn returns in excess of their variable costs. Nor would that price affect the dynamics of resource concentration for these areas. Some wheat enterprises might even increase acreage, so as to lower average production costs. Moreover, where unit costs did not differ widely among enterprise sizes, expansion might occur if farmers desired to increase income.

Similar observations apply to the corn and soybean enterprises in table **3-6.** All other factors being equal, a low corn price—below **$2.83** per bushel—would affect irrigated corn operations in Nebraska most severely. Likewise, soybean enterprises in the Mississippi Delta would be sensitive to a low-price environment. In lower cost areas, production patterns and resource concentration would not be affected.

If relatively low market prices prevailed for several years, shifts might occur in the geographic location of production, away from high-cost areas and toward those with lower costs. Within high-cost regions, movement toward different types of farming enterprises—such as other crops or livestock—could occur.

The sharp downslide in agricultural exports since 1981 has raised concerns about whether U.S. farmers can compete in international markets. However, emphasis on this dimension of the problem alone diverts attention from the competition that U.S. farmers face from one another. U.S. enterprises and farms of different sizes compete within regions, and enterprises and farms of all sizes in one region may compete with those those of another.

Few policy debates have focused on this particular type of competition, which may affect the U.S. international agricultural position. Commodity policies designed to favor "moderate" over "very large" enterprises, for example, could have serious effects when viewed across several regions. And downward flexibility of market prices, considered by many analysts to be a prerequisite for a more competitive U.S. agricultural sector, could create new and complex situations between and within regions. Omnibus farm legislation, enacted in **1985,** does aim to increase U.S. competitiveness through lower price support loan rates for major crops, In order to assess the full regional and structural effects of this policy, more thorough analysis of USDA information on farm and enterprise characteristics and production costs is needed.

This discussion is based on limited data. However, current information does suggest that greater market orientation in government commodity programs could improve the competitiveness of the United States in world markets, but could also slow the concentration of resources in high-cost production areas, which may alter the geography of crop production.

Chapter 4

Technology Transfer and the Competitiveness of U.S. Agriculture

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New technologies have bolstered the remarkable gains in agricultural productivity that the United States has enjoyed since World War II. To a large degree, technology is the foundation of the U.S. position as the world's leading exporter of agricultural products. In recent years, however, poor export performance has led to questions about whether the United States can maintain its edge in agricultural science and technology. This chapter examines the international transfer of agricultural technology, emphasizing the transfer of U.S. technology to other countries, including competitors.

In general, although this country continues to dominate the field of agricultural technology, other nations have begun to close the gap. Technology transfer from the United States has played an important role in this process, and should continue to do so in the future. Over the next decade, the United States' strategic advantage in agricultural technology may be reduced. Of course, the introduction of crop biotechnologies into commercial use will enhance the U.S. advantage over other nations; however, because international diffusion of biotechnology can occur rapidly, U.S. farmers may enjoy cost advantages for a shorter period of time than has been the case with technological innovation in the past.

'Unless otherwise noted, the material in this chapter is drawn from an OTA contract report entitled "The Potential for Transfer of U ,S. Agricultural Technology, " by Robert E.Evenson, Jonathan Putnam, and *Carl Pray, 1985.*

AGRICULTURAL TECHNOLOGY TRANSFER

In general, transfer of agricultural production technologies is more difficult than that of other manufacturing technologies. This process is affected by economic conditions and policies in the receiving nation, natural resources, and climate. Agriculture's biological nature often negates the possibility of "direct transfer" to another country or region without adjusting for local growing conditions; for example, plant varieties must be adapted to specific soil types. As a result, "adaptive transfer" *is more* common. Diffusion of scientific findings or techniques—''pretechnology science transfer' '—represents another important process. This may lead to new inventions in other countries, or may support efforts to "adapt" technologies. Also, the transfer of technical and scientific capacity among nations, as in the training of foreign graduate students in the United States, constitutes a significant channel for the transfer of agricultural technology.

Patent Information

Patent registration data provide imperfect but useful information about invention activity, and about the direction and pace of technology transfer between countries. One drawback of patent data is that inventors may not wish to disclose trade secrets in patent documents, tending to underestimate the actual number of inventions. International comparisons of patent data present other difficulties. For example, about 90 percent of all patent applications are granted in France, compared to **35** percent in West Germany; a greater degree of innovation maybe needed in West Germany to gain patent protection. Evaluation of patents awarded in a broad range of countries reduces this problem. Finally, certain agricultural inventions—chemicals and chemical processes, for example—are excluded from patent protection in such major agricultural nations as India, Under these circumstances, a foreign technology that can be imported constitutes an inexpensive alternative. In this situation, however, foreign firms may be reluctant to transfer technology, and fewer incentives exist to import and adapt foreign innovations.

Three sources of agricultural patent information demonstrate trends in the international diffusion of technology, as described below.

U.S. Crop Variety Patents

The Plant Variety Protection Act of 1970 led to a marked increase in the number of crop varieties registered for patent protection in the United States. With the exception of patents for such widely grown forage grasses as fescue, bluegrass, and perennial ryegrass, foreign firms have not been particularly active in this area. In contrast, private U.S. firms have acquired many patents for an array of minor crops, as well as for major export crops like field corn, cotton, wheat, and soybeans (see table 4-1). Although the private sector has dominated corn breeding over the years, the growing number of private patents for wheat and soybean varieties suggests a significant shift in the locus of inventive activity. The public sector—U. S. Government, other national governments, and international research and development institutions—has traditionally dominated the invention and transfer of soybean and wheat varieties. Now, many U.S. companies with foreign subsidiaries, or with joint ventures for research and marketing, are positioned to play a major role in this process. Also, in addition to its impact on U.S. markets, the increase in private sector patents may affect avenues and rates of international germplasm transfer for export crops.

Foreign Patents Granted by the United States for Agricultural Technology

Foreign firms that plan to transfer or produce technologies in the United States—directly, through subsidiaries, or via joint ventures—are likely to seek U.S. patent protection. U.S. patent office data indicate that foreign entities obtained between 24 and 52 percent of all patents in each of seven agricultural technology fields and in postharvest technology (PHT) between 1980 and 1984 (see table 4-2). Foreign patent activity is greatest in threshing equipment, fertilizers, and biotechnology, which claimed shares of 46, 44, and 52 percent of all patents, respectively. This suggests that these areas have the highest potential for technology transfer to the United States. The proportion of U.S. patents granted to foreign firms increased from the 1975-79 period to 1980-84 in five technology fields—planters and diggers, harvesters, threshers, animal husbandry, and fertilizers.

In contrast, the proportion of patents received for these technology fields by the U.S. Government did not change significantly between 1975-79 and 1980-84. Nor did the percentage of patents granted to U.S. citizens rise or fall dramatically, except for a decline in the field of planter and digging machinery and an increase in threshing equipment. In fact, the actual number of patent applications increased over the decade in only three other technology fields—harvesting equipment, biotechnology, and PHT,

International Patents for Agricultural Technology

One way to gauge the potential for technology transfer is to examine international patent activity. Foreign patents protect property rights for products that firms plan to market or license in other nations. International patent data for 7 nations and 13 technology fields between 1978 and 1984 indicate that the United States is a leading exporter of agricultural and postharvest technology. During that period, for example, U.S. inventors were granted 6,555 patents for agricultural chemical technologies other than fertilizers. One-half of these patents were granted in this country, and one-half in the six other nations examined—the United Kingdom, France, West Germany, Japan, Canada, and Brazil. In other words, U.S. inventors obtained a foreign agricultural chemicals patent abroad for every one they received domestically.

U.S. inventors show an even greater degree of international patent activity in biotechnology fields. Inventors in the United States obtained 115 U.S. patents for mutation and genetic engineeer-

Table 4-l.— Plant Patents in the United States, 1970-84

Variety	Total 1970-90	Total 1981-84	The Netherlands 1970-90	The Netherlands 1981-84	United Kingdom 1970-90	United Kingdom 1981-84	Other 1970-90	Other 1981-84	Public 1970-90	Public 1981-84
Agrotriticum	4	0	0	0	0	0	0	0	0	0
Alfalfa	11	17	0	0	0	0	0	1	7	0
Aster, china	10	1	0	0	0	0	0	0	0	0
Barley	14	7	0	1		0	0	0	2	0
Beans, field	3	9	0	0	0	0	0	0	2	2
Beans, garden	80	26	2	9	0	0	0	0	0	0
Beans, lima	5	3	0	0	0	0	0	0	0	0
Bentgrass	1	1	0	0	0	1	0	0	1	0
Bluegrass	11	14	5	4	0	0	0	1	0	1
Broccoli	1	2	0	0	0	0	0	0	0	0
Buckwheat	0	1	0	0	0	0	0	0	0	0
Cauliflower	6	6	3	6	0	0	0	0	0	0
Celery	0	3	0	0	0	0	0	0	0	0
Clover, all	3	3	0	0	0	0	0	0	2	
Corn, field	5	17	0	0	0	0	0	0	0	0
Corn, pop	1	2	0	0	0	0	0	0	0	0
Corn, sweet	3	0	0	0	0	0	0	0	0	0
Cotton	82	33	0	0	0	0	0	0	0	0
Cowpea	2	3	0	0	0	0	0	0	2	1
Eggplant	1	1	0	0	0	0	0	0	0	0
Fescue, all	12	26	5	9	1	3	0	1	5	1
Lettuce	43	6	0	0	1	0	0	0	0	0
Marigold	21	8	0	3	0	0	0	0	0	0
Muskmelon	6		0	0	0	0	0	0	2	
Nasturtium	9	;	0	0	0	0	0	0	0	0
Oat	12	4	0	0	0	0	0	0	7	1
Onion	10	12	0	0	0	0	0	0	0	4
Orchardgrass	2	1	1	1	0	0	0	0	0	0
Pea, garden	92	52	0	2	0	1	0	0	0	0
Peanut	8	2	0	0	0	0	0	0	2	0
Pepper	0	3	0	0	0	0	0	0	0	0
Pumpkin	4	1	0	0	0	0	0	0	0	0
Radish	1	3	0	0	0	0	0	0	0	0
Rice	9	3	0	0	0	0	0	0	0	0
Rye	2	0	0	0	0	0	0	0	1	0
Ryegrass, annual and other	4	8	1	2	3	0	0	0	0	1
Ryegrass, perennial	13	21	4	8	1	0	1	2	1	0
Safflower	5	0	0	0	0	0	0	0	0	0
Sainfoin	2	0	0	0	0	0	0	0	1	0
Soybeans	170	139	0	0	0	0	0	0	27	16
Squash	5	2	0	0	0	0	0	0	1	
Sunflower	1	5	0	0	0	0	0	0	0	0
Sweetpea	6	0	0	0	0	0	0	0	0	0
Tobacco	11	5	0	0	0	0	0	0	0	0
Tomato	0	13	0	0	0	0	0	0	0	2
Trefoil Birdsfoot	1	1	0	0	0	0	0	0	1	1
Triticale	0	3	0	0	0	0	0	0	0	0
Turnip	0	1	0	0	0	0	0	0	0	0
Vetch, common	0	4	0	0	0	0	0	0	0	4
Watermelon	6	7	0	0	0	0	0	0	1	0
Wheat, common	84	39	0	0	0	0	0	0	27	9
Wheat, Durum and other	5	4	0	0	0	0	0	0	0	0
Zinnia	3	0	0	0	0	0	0	0	0	0
Others (minor grasses and flowers)	14	11	1	1	0	1	0	0	3	2
Totals	—	—	22	45	7	6	1	5	107	50

SOURCE Robert E Evenson, Jonathan Putnam, and Carl Pray, "The Potential for Transfer of US Agricultural Technology" contract report prepared for the Office of Technology Assessment, 1985

Table 4-2.—U.S. Patents Granted in Agricultural Technology Fields

	Earthworking equipment	Planters, diggers	Harvesting equipment	Threshing equipment	Animal husbandry	Fertilizers	Biotechnology	Postharvest technology
Patents granted								
1975-79	554	128	339	83	807	1,251	493	2,866
1980-84	451	120	418	96	786	1,085	527	2,340
Ratio, 1980-84/1975-79	0.82	0.94	1.23	1.16	0.97	0.87	1.06	0.82
Percent U.S. corporation								
1975 -79	38	25	50	55	24	58	40	52
1980-84	36	33	48	35	24	52	42	49
Percent U.S. Government								
1975 -79	00	02	00	00	01	01	03	03
1980-84	01	02	00	01	01	02	02	01
Percent US individual								
1975 -79	27	36	26	12	58	03	03	12
1980-84	30	28	24	18	51	02	04	13
Percent foreign origin								
1975-79	35	35	24	32	17	38	54	32
1980-84	34	38	28	46	24	44	52	27

SOURCE: Robert E. Evenson, Jonathan Putnam, and Carl Pray, "The Potential for Transferor US Agricultural Technology," contract report prepared for the Office of Technology Assessment, 1985

ing technologies, as opposed to 350 in this field in the six other countries. U.S. inventors received 183 patents in Japan for mutation and genetic engineering, more than at home.

Table 4-3 shows that the United States is a net exporter to these other nations in each of the 13 technology fields, and is a net exporter to most of the countries individually. U.S. patent activity abroad is most pronounced in the biotechnology fields, agricultural chemistry, and postharvest technologies.

Table 4-4 indicates what types of technology are most readily transferred among these seven countries. It shows the ratio of the total number of patents granted in a field in all countries to the patents granted in origin countries in the same field. For example, the seven countries granted 23,814 patents in agricultural chemistry, which was the largest number in any field; 13,397 of these were obtained by inventors in their own country. The ratio of total-to-origin patents was 1.78; a total of 78 agricultural chemical patents were received in the six foreign nations for every 100 received in the home nation. Once again, biotechnology and agricultural chemicals represented the fields with the greatest relative degree of transfer. For mutation and genetic engineering technologies, slightly more international patenting activity occurred than patenting activity within countries of origin, for a ratio of 2.12.

Further analysis of international patent data for these countries reveals that:

- The United States imports a significant amount of agricultural chemistry and fertilizer technology from West Germany.
- Canada and Brazil stand out as substantial net importers of agricultural technology. The Canadians produce a great many inventions, but import even more from the United States. The Brazilians patent relatively few inventions while maintaining significant imports, primarily from the United States.
- In most fields, U.S. patents are outnumbered by those of Japan, which:

  > . . . is overall a net exporter although it imports in several fields [and] outproduces the two traditional invention economies, France and the U. K., in all fields except agricultural chemicals. Japan is also an exporter of some biotechnology and will probably become a large exporter in the future.

- Biotechnology inventions that enter the United States could become a significant factor in the growth of domestic agricultural productivity. Because this country represents a large, relatively affluent market, in which the adoption of new technologies proceeds rapidly, it tends to attract emerging biotechnology. All other things being equal, lower production costs that result from biotechnology will benefit U.S. farmers, and domestic and foreign consumers.

Table 4-3.—Indices of International Trade in 13 Agricultural Technology Fields, 1978-84: Trade Index for Patents by Country; U.S. Trade Index for Patenting Activity With United States

	Earthworking —planting	Harvesting machinery	Animal husbandry	Fertilizer	Agricultural chemistry	Mutation genetic engineering	Biotechnology: Micro-organism tissue culture	Biotechnology: Enzyme	Biotechnology: Apparatus	Postharvest: Meat dairy	Postharvest: Fruit	Postharvest: Grain	Postharvest: Food preservation
Trade index[a]													
United States	0.24	0.25	0.09	0.36	0.54	2.69	0.74	0.62	1.05	0.671	0.373	0.620	0.401
United Kingdom	0.26	-0.18	0.11	-0.27	0.60	1.42	0.97	1.04	1.38	0.39	1.58	0.613	0.563
France	0.38	0.27	0.04	0.07	0.82	-1.61	0.73	1.23	0.98	0.135	0.215	0.704	0.140
West Germany	0.34	0.09	0.22	0.35	0.86	0.232	0.38	0.08	0.23	0.352	0.245	0.288	0.215
Japan	2.22	3.23	0.07	0.00	0.29	0.413	0.09	0.05	0.11	0.110	0.186	0.015	0.007
Canada	1.64	-1.53	1.56	-1.46	-6.84	-0.15	7.30	6.54	7.33	2.91	0.90	3.86	3.75
Brazil	0.31	-0.48	0.66	-2.90	19.10	41.0	6.00	5.75	2.04	5.10	1.39	2.47	
United States trade[b]													
United Kingdom	0.025	0.016	0.029	0.046	0.067	0.513	0.149	0.077	0.129	0.115	0.109	0.109	0.069
France	0.015	0.032	0.044	0.041	0.045	0.252	0.072	0.051	0.122	0.062	0.109	0.099	0.029
West Germany	0.019	0.026	-0.016	0.03	0.074	0.261	0.052	0.000	0.035	0.013	0.036	0.037	0.012
Japan	-0.019	-0.01	0.016	0.061	0.220	1.356	0.201	0.179	0.248	0.178	0.081	0.051	0.067
Canada	0.187	0.144	0.074	0.137	0.126	0.104	0.195	0.195	0.241	0.220	0.054	0.241	0.160
Brazil	0.051	0.041	0.021	0.101	0.159	0.286	0.072	0.051	0.059	0.082	0.190	0.081	0.060

[a]Trade index = (patents granted abroad to foreign inventors / patents granted at home to foreign inventors) / patents granted at home to national inventors

[b]U.S. trade = (patents obtained by U.S. inventors in country / patents obtained by country's inventors in U.S.) / U.S. patents granted to U.S. inventors

SOURCE: Robert E. Evenson, Jonathan Putnam, and Carl Pray, "The Potential for Transfer of U.S. Agricultural Technology," contract report prepared for the Office of Technology Assessment, 1985.

Table 4-4.—Total Origin Patents and Patents Granted in 13 Agricultura Technology Fields, 1978-84

	Earthworking —planting	Harvesting machinery	Animal husbandry	Fertilizer	Agricultural chemistry	Mutation genetic engineering	Biotechnology: Micro-organism tissue culture	Biotechnology: Enzyme	Biotechnology: Apparatus	Postharvest: Meat dairy	Postharvest: Fruit	Postharvest: Grain	Postharvest: Food preservation
Total origin patents	2.393	1.570	1.388	1.774	13.397	565	894	1.098	1.412	3.967	468	2.006	6.608
Total granted patents	3.563	2.190	1.907	2.696	23.814	1.200	1.691	1.770	2.321	6.481	716	3.002	8.176
Transfer index[a]	1.49	1.39	1.37	1.52	1.78	2.12	1.89	1.62	1.64	1.63	1.53	1.50	1.24

[a]Ratio of total patents granted in all countries to origin patents.

SOURCE: Robert E. Evenson, Jonathan Putnam, and Carl Pray, "The Potential for Transfer of U.S. Agricultural Technology," contract report prepared for the Office of Technology Assessment, 1985.

Indirect Transfer of Agricultural Technology

Because of its biological basis, agriculture—more than most production processes—reacts to local conditions. As a result, direct international transfer of agricultural technologies is not a common occurrence. For example, foreign use of wheat germplasm developed in the United States demands a high degree of adaptation. Even within the United States, technologies that have proven successful in some areas require a measure of adaptation to agro-climatic conditions in others. As a result, a considerable amount of international technology transfer takes on the form of scientific information, knowledge, and techniques. This section addresses the process of scientific transfer, for agricultural and postharvest technology.

Patent Citations

Patent applications in the United States contain "citations" of scientific literature, which help to distinguish an invention proposed for patent protection. Patent citations capture the process of adaptive technology transfer, providing "a kind of pedigree of the intellectual or technical parentage" for an invention.

Table 4-5 provides the number and origins of patent citations in eight agricultural and postharvest technology (PHT) fields for two periods, 1975-79 and 1980-84. Over the 10-year timeframe, the percentage of citations of foreign literature increased in every field:

> In the early period, 29.1 percent of all patents were granted to foreigners (foreign patents of U.S. ownership are not included), while 17.5 percent of all cites were to foreign patents. In the second period, 32.2 percent of all patents were granted to foreigners while 23.6 percent of all cites were to foreigners. Thus the citation data are consistent with a growing foreign role in U.S. [agriculture and postharvest] invention and with the recognition that foreign invention is a growing part of the intellectual structure of [those] inventions.

Scientific Publications

As noted earlier, many inventions relevant to agriculture and postharvest technology are not patented. However, another way to evaluate adaptive transfer of agricultural science and technology, and the United States' standing in that process, is to examine scientific publications in these fields. Among 24 major agricultural nations and in 10 "traditional" agricultural technology fields, the United States ranked first in scientific publications between 1978 and 1982; U.S. publications totaled 289,061 over this period. The United Kingdom, with **100,135** publications, and India, with **89,750** publications, placed second and third. Significantly, India ranked second in the areas of plant breeding, plant pathology, crop science, and soil science.

Between the two periods examined, 1973-77 and 1978-82, the United States maintained its standing among these countries, although the total number of U.S. publications dropped by 22 percent in animal nutrition and by 3 percent in plant breeding. Publications grew significantly in four scientific fields between the timeframes: veterinary medicine, 59 percent; soil science, **40** percent; entomology /hematology, 39 percent; and animal breeding, 31 percent (see table 4-6).

The United States gained in the 24-nation share of publications in **6** of the 10 fields—animal breeding, weed science, plant breeding, plant pathology, crop science, and soil science—lost share in 3—animal nutrition, entomology /hematology, and veterinary medicine, and held steady in dairy science (see table 46). India is the only other country to demonstrate significant gains in terms of world literature share in the agricultural sciences.

Comparing U.S. distribution of publications by field with that of other countries provides another indication of technology transfer. Statistical correlation shows that the structure of U.S. literature resembles that of 12 other countries, assuming a correlation coefficient greater than **0.900:** Canada, Australia, the United Kingdom, France, West Germany, The Netherlands, Switzerland, East Germany, Mexico, Argentina, Japan, and Israel, The diffusion of technology, and of scientific knowledge and methods in particular, appears to occur most easily between the United States and these nations. Correlations are also close with New Zealand, Poland, and Egypt.

Table 4-5.– U.S. Patents Granted in Agricultural Technology Fields

	Earth working Equipment	Planters, diggers	Harvesting equlpment	Threshing equipment	Animal husbandry	Fertlllzers	Biotechnology	Postharvest technololgy
Patents granted								
1975-79	554	128	339	83	807	1,251	493	2,866
1980-84	451	120	418	96	786	1,085	527	2340
Ratio, 1980-84/1975-79	0.82	0.94	1 23	1 16	097	087	106	082
Percent foreign orlgln								
1975-79	35	35	24	32	17	38	54	32
1980-84	34	38	28	46	24	44	52	27
Cltatlons/patent								
1975-79	952	1701	571	1319	1567	753	1264	708
1980.84	1162	2045	746	1354	1683	943	1311	968
Percent foreign cttes (Indirect)								
1975-79	17	10	20	08	03	20	15	13
1980-84	14	09	21	11	06	20	18	17
Percent foreign cites (direct)								
1975-79	12	12	05	03	01	05	02	05
1980-84	15	18	10	05	03	11	03	08

SOURCE Robert E Evenson Jonathan Putnam and Carl Prav The Potential for Transfer of U S Agricultural Technology contract report prepared for the Office of Technology Assessment 1985

Table 4-6.—Total Publications in 24 Countries for 10 Applied Agricultural Science Fields and U.S. Share, 1973-77 and 1978-82

Scientific field	Total publications 1978-82	U.S. share	Total publications 1973-77	U S share	Ratio 1978-82/1973-77
Animal breeding	39,680	+ 0.216	30,435	0.182	1.31
Animal nutrition	30,616	– 0.240	39,164	0.255	078
Crop science	47,424	+0.189	41,722	0.160	1,14
Dairy science	43,440	0.163	35,882	0.163	1 18
Entomology /hematology	46,113	–0.194	33,126	0.233	139
Plant breeding	48,786	+0, 178	50,204	0.161	097
Plant pathology	29,260	+o.168	28,030	0137	1,04
Soil science	50,658	+ 0.203	36,096	0,167	1.40
Veterinary medicine	191,965	– 0154	121,319	0.189	1 59
Weed science	19,492	+ 0.328	141361	0,303	109

+ Gain in share since 1973-77
– Loss in share since 197377

SOURCE Robert E Evenson Jonathan Putnam and Carl Pray The Potent (al for Transfer of U S Agricultural Technology contract report prepared for the office of Technology Assessment 1985

The Role of International Agricultural Research Centers (IARCS)

An important recent development in international agriculture is the formation of International Agricultural Research Centers (IARCS). Thirteen IARCs now conduct a variety of agricultural research and development projects, specializing in productivity gains in tropical agriculture. The two most renowned centers, the International Maize and Wheat Improvement Center in Mexico (CIMMYT) and the International Rice Research Institute in the Philippines, played central roles in the development and dissemination of high yielding varieties of wheat and rice—the cornerstone of the "green revolution. " For these and other agricultural commodities, IARCS train large numbers of scientists of less developed countries (LDCS), disseminate genetic materials like new seed varieties, and release scientific information. "The IARCS function partly as a transfer station between work in the research centers in the developed countries and the LDCS. "

A recent study examined the effects of IARC activities on crop productivity for 10 crops in 25 developing countries,[2] and concluded that "IARC programs contributed positively to crop productivity improvement in maize, millets, sorghum,

[2]Robert E Evenson, The IARCS Evidence of Impact on National Research Extension and Productivity, study paper prepared for the Consultative Group of the World Bank, Washington, DC 1986

wheat, rice, beans, groundnuts, cassava and potatoes. " Moreover, the study reinforced the notion that growing conditions influence technology transfer for most crops:

> The IARC impact was higher in countries with gee-climatic conditions similar to those of the IARC host location. For cassava and rice little impact beyond the host countries was measured, showing less transfer potential. Only wheat showed high transferability outside the similar regions.[3]

Agricultural Research Capacity

Investment and personnel devoted to agricultural research indicate the dynamics of a nation's agricultural sector (see table 4-7). Between 1959 and 1980, worldwide expenditures for public agricultural research programs increased significantly, by 360 percent after inflation. The number of scientist-years committed to agricultural research more than tripled during the same period. Dramatic growth occurred during the first decade of this period; worldwide, research expenditures and personnel rose more rapidly between 1959 and 1970 than between 1970 and 1980.

Striking differences exist between different parts of the world in spending and employment patterns for agricultural research over the 20-year period. All regions spent more and employed more people in 1980 than they had in 1970 or 1959, but changes occurred in regional shares of worldwide investment and personnel. Eastern Europe and the Soviet Union together fell from about 28 percent of world expenditures in 1959 to 20 percent in 1980, and from 38 percent of world personnel to 35 percent. North America and Oceania dropped from 37 percent of world expenditures to 23 percent, and their personnel share declined from 18 to 9 percent. Western Europe and Asia gained significantly in percentage share. Africa held steady, although its proportion of research personnel did rise slightly. The largest expansion of research capacities occurred in developing countries:

> Research spending increased by a multiple of 5.8 in developing countries in Latin America, 6.9

[3]Ibid.

Table 4-7.—Agricultural Research Expenditures and Scientist-Years, by Region, 1959-80

Region/subregion	Expenditures (000s constant 1980 U.S.$) 1959	1970	1980	Manpower (scientist-years) 1959	1970	1980
Western Europe	274,984	918,634	1,480,588	6,251	12,547	19,540
Northern Europe	94,718	230,135	409,527	1,818	4,409	8,027
Central Europe	141,054	563,334	871,233	2,888	5,721	8,827
Southern Europe	39,212	125,165	208,828	1,545	2,417	2,636
Eastern Europe and U.S.S.R,	568,284	1,282,212	1,492,783	17,701	43,709	51,614
Eastern Europe	195,896	436,094	553,400	5,701	16,009	20,220
U.S.S.R.	372,388	846,118	939,383	12,000	27,700	31,394
North America and Oceania	760,466	1,485,043	1,722,390	8,449	11,688	13,607
North America	668,889	1,221,006	1,335,584	6,690	8,575	10,305
Oceania	91,577	264,037	386,806	1,759	3,113	3,302
Latin America	79,556	216,018	462,631	1,425	4,880	8,534
Temperate South America	31,088	57,119	80,247	364	1,022	1,527
Tropical South America	34,792	128,958	269,443	570	2,698	4,840
Caribbean and Central America	13,676	29,941	112,941	491	1,160	2,167
Africa	119,149	251,572	424,757	1,919	3,849	8,088
North Africa	20,789	49,703	62,037	590	1,122	2,340
West Africa	44,333	91,899	205,737	412	952	2,466
East Africa	12,740	49,218	75,156	221	684	1,632
Southern Africa	41,287	60,752	81,827	696	1,091	1,650
Asia	261,114	1,205,116	1,797,094	11,418	31,837	46,656
West Asia	24,427	70,676	125,465	457	1,606	2,239
South Asia	32,024	72,573	100,931	1,433	2,569	5,691
Southeast Asia	141,469	521,971	734,694	7,837	13,720	17,262
China	54,166	502,491	643,555	1,250	12,250	17,272
World total	2,063,553	5,358,595	7,390,043	47,163	108,510	138,039

SOURCE Robert E. Evenson, Jonathan Putnam, and Carl Pray, "The Potential for Transfer of U S Agricultural Technology, " contract report prepared for the Office of Technology Assessment, 1985 in Asia and 3.6 in Africa. Scientist man-year multiples were 6.0 in Latin America, 4.1 in Asia and 4.2 in Africa. This is in contrast to spending and personnel multiples for public sector agricultural research in the U.S. of 1.9 and 1.4 respectively. The major competitors, Canada, Australia, Argentina and Brazil, had spending multiples of 2.4, 4.0, 2.1 and 1.4, respectively.

Further analysis of world expenditures and personnel devoted to agricultural research shows that between 1959 and 1980, research expenditures in developing countries grew at a faster pace than agricultural extension expenditures as a percentage of the value of agricultural products. As a result, the intensity of research and extension are now approximately equal in developing countries. This reorientation signifies a more sophisticated and balanced capability for adaptive research within the developing world than that which existed two decades ago.

Capacity Transfer: Foreign Students Trained in the United States

One of the most significant avenues for transfer of technology, and of scientific knowledge and technique in particular, has been the training of scientists from developing countries in the United States and other developed nations. Table 4-8 indicates the total number of U.S. doctoral degrees awarded in agricultural and related fields between 1960-64 and 1975-79; during this period, over 7,500 such degrees were awarded to foreign students. In most fields, foreign students represent a growing share of degree recipients-over 40 percent in agronomy, which includes crop breeding and soil science, veterinary medicine, agricultural engineering, agricultural economics, and general agriculture. In contrast, in the related and important field of genetics, the percentage of foreign Ph.D. recipients over this period fell from 48 percent in 1960-64 to 25 percent in 1975-79. In the 1975-79 interval, approximately 16 percent of foreign students with temporary visas planned to remain in the United States for postdoctoral studies. The majority of these planned to obtain employment in either education or government.

TECHNOLOGY TRANSFER AND MAJOR EXPORT CROPS

Important differences exist in the avenues of international technology transfer for three major U.S. export crops: corn, wheat, and soybeans. In some cases, as with hybrid corn seed, indirect technology transfer takes place through multinational companies. For other crops and technologies, such as soybean varieties, direct transfer from the United States to other countries has occurred via public research entities or international research centers. For all three crops, an accelerated pace of agricultural technology transfer has resulted from worldwide improvements in public and private research capacity over the past few decades, especially in the developing world. Moreover, the international exchange of scientific knowledge and trained scientists are important routes for the diffusion of technology that affects corn, wheat, and soybean productivity.

Technology transfer brings many benefits to agricultural production and trade. U.S. farmers gain from certain technology imports, although transfer generally flows toward agricultural producers in other nations—including international competitors. Because technology transfer tends to lower the price of crops throughout the world, it facilitates consumption. In a number of cases, U.S.-based multinational firms have the lead in a particular technology, and can profit through technology exports, or through production and sales via subsidiaries or joint ventures in other countries. U.S. farmers may benefit from such transactions indirectly, since many U.S. firms reinvest profits in domestic research and development. Finally, agricultural technology transfer that boosts income in other countries may translate into increased trade with the United States.

Table 4-8.—Total Number of Ph.D. Degrees Awarded in 20 Fields Associated With Agriculture and Home Economics and the Proportion of Degrees Awarded to Non-U.S. Citizens With a Temporary Visa[a]

	1960-64		1965-69		1970-74		1975-79	
Fields	Total	Percent foreign	Total	Percent foreign	Total	Percent foreign	Total	Percent foreign
Agronomy, including soils and soil science	711	28.0	873	36.8	1,150	38.1	1,060	43.5
Horticulture	237	27.8	334	33.5	321	34.9	321	34.0
Forestry	66	9.1	172	15.1	249	19.3	304	26.1
Entomology	444	25.2	651	21.8	823	20.8	685	25.1
Phylopathology	385	30.4	561	29.6	468	29.3	410	31.9
Physiology-plant	96	27.1	262	29.4	287	25,5	183	28.4
Physiology-plant and animal[b]	160	13.1	—				—	
Animal husbandry, animal science, and nutrition	573	15.7	649	27.6	651	26.5	667	28.4
Veterinary medicine	96	26.0	184	23.9	196	37.3	152	44.1
Physiology-animal	163	8.6	509	14.3	732	12.8	590	12.6
Agricultural engineering	97	21.6	181	19.9	309	31.1	235	45.5
Agricultural economics[d]	—	—	92	30.4	794	33.4	742	42,7
Food science and technology	—	—	—		373	30.8	510	35.1
Agriculture and food chemistry	160	40.0	223	27.4	160	20.6	42	33.3
Fish and wildlife	65	13.8	90	7.8	204	10.3	255	11.4
Agriculture (general and other)	116	27.6	314	33.1	519	31.3	383	40.2
Nutrition and/or dietetics[c]	—	—	—	—		·	283	7
(Other) home economics		22.7	150	21.3	133	16.5	269	
Subtotal	(3,497)	(23.6)	(5,035)	(28.0)	(7,274)	(27.9)	(7,887)	?
Biochemistry	696	17.8	1,099	19.4	1,140	15.5	1,019	?
Genetics	296	48.0	418	35.2	444	30.5	372	25.3
Totals	4,489	23.3	6,662	26.5	8,858	26.4	8,478	29.4

[a]Foreign is defined as a Ph D recipient of a US university who has a temporary visa
bin fiscal year 1962, "Physiology" was broken out into "Animal Physiology" and "Plant Physiology"
c"Animal Science" was added as a field in fiscal year 1973 Field was changed to 'Animal science and Animal Nutrition" In fiscal year 1977
dAdded as a field in fiscal year 1969.
e"Nutrition" dropped as afield in fiscal year 1960 "Nutrition and/or Dietetics" added as a field in fiscal year 19

SOURCE Robert E Evenson, Jonathan Putnam, and Carl Pray, "The Potential for Transfer of US Agricultural Technology," contract report prepared for the Off Ice of Technology Assessment, 1985

International Transfer of Corn Technology

As much as any other U.S. crop, technological change has altered postwar corn production. Conventional plant breeding, more frequent and more efficient use of nitrogen fertilizer, and assorted "production management technologies" should continue to increase corn yields through the end of the century. Even greater potential for increasing corn yields may lie in biotechnologies that will enter commercial markets by the mid-1990s. Plant growth regulators for corn could have the largest impact of any biotechnology, followed by photosynthetic enhancement, breeding techniques like cell and tissue culture, and biological nitrogen fixation. Developments in pesticide and fertilizer technologies will play important roles as well.

How rapidly and by what routes might these technologies be transferred to other nations, eluding U.S. competitors? As befits the U.S. position as the world's top producer and trader of corn, this country generally leads in corn technology. In particular, U.S. companies figure critically in the development and dissemination of chemicals and biotechnology. U.S. and multinational firms either operate subsidiaries or participate in joint ventures in every major corn producing nation:

> Pioneer Overseas Corporation, Cargill, and DeKalb/Pfizer have subsidiaries or joint ventures in all of our major competing countries. These subsidiaries or joint ventures all have some research capacity. Northrup-King and Funk Seeds have subsidiaries in all of these areas except Thailand where Funk is just starting a research program. All of the major seed companies are active in Europe.

Moreover, U.S. companies play a crucial role in the development of hybrid corn seed. Most corn produced in the United States comes from hybrid seed developed by these firms, although inbred varieties that result from public sector research often serve as one of the hybrid parents. To the extent that productivity-boosting corn technology will center around seed, U.S. and European multinationals will be the main channels for direct and rapid transfer.

Genetic material, research methods, and basic knowledge may be transferred rapidly and directly by these companies. For example, a hybrid, high-yield corn seed that is rich in carbohydrates, resists certain diseases, or has other similar traits, could be transferred by a private U.S.-based multinational to Argentina, Europe, and South Africa, and could enter commercial use within a relatively short time—perhaps several years. These countries possess temperate climates similar to that of the United States, and offer large, accessible, and lucrative markets. Furthermore, governments often encourage and assist such transfer, particularly those of developing countries like Argentina and Brazil.

Hybrid corn seed developed for temperate climates would probably need to undergo biological adaptation before entering such tropical countries as Brazil and Thailand. As a result, new knowledge in general, and new research methods in particular, are critical forms of genetic technology transfer to these nations. Moreover, the CIMMYT and State-sponsored research efforts play a more important role than private companies in transferring genetic material to the tropics.

Even if new corn hybrids are not transferred directly, many U.S. seed companies contribute to plant breeding programs in competing nations, which may lead to new, higher yielding, locally developed corn hybrids within the next few years. Programs of this type have already increased corn yields in Argentina and Brazil over the past decade. Transfers may occur in the reverse direction as well; germplasm collected in tropical countries has been an important and controversial source of genetic material for corn breeding programs in the United States.

In addition, multinational companies could facilitate the transfer of chemical technologies for corn production, and for pesticides and plant growth regulators in particular. These firms conduct most of the important research and development for corn pesticides and corn hormones. Two European chemical companies, Ciba-Geigy and Shell, market corn herbicides in the United States and maintain significant product development programs. These firms also “have extensive sales, production and research programs in Latin America and Asia. ” Similarly, U.S. companies that dominate corn herbicides and insecticides “have major sales programs in Europe and South America, They also have applied research and development programs in many countries. ”

Market characteristics and the security of property rights influence the pace at which U.S. companies introduce new agrichemicals to agricultural competitor nations; the cost of building a production plant or distribution network for a new product is weighed against the size of the market and the availability, cost, and efficacy of competing products. A number of large, lucrative markets for agrichemicals, such as Australia, Canada, and Europe, do possess mature chemical industries that can replicate new technologies. However, strong patent protection in these nations should allow U.S. firms to market new products rapidly. Patent protection is not as secure in other countries, but not all U.S. chemical companies perceive the risk of infringement in the same way. For example:

> Argentina has a patent system but has not signed the Paris convention on patents and so one company, which is very concerned about patent rights, stated their reluctance to introduce their newest chemicals there. Most other companies did not appear to have particular concerns about Argentina.

Similarly, Thailand’s new and as yet untested patenting system could affect transfer of agrichemicals: “One major American company will not expand into Thailand or introduce new products there because it feels that it recently had a new product stolen by a Thai company. ” However, “other companies are attracted to Thailand because the [pesticide] registration requirements are almost nonexistent and so companies can introduce a new product very quickly. ”

Relatively lax registration requirements are common in developing countries, which benefits companies in developed nations that produce and market chemicals and uses of chemicals that have been banned or restricted in their home country. Also, insecticides and disease control agents, or "fungicides," are not widely used for corn production in developing countries, and appear to be prime candidates for technology transfer. Broad spectrum herbicides represent another possibility for transfer to the developing world.

International Transfer of Wheat Technology

International competitiveness in wheat production has become a sensitive issue to the United States, in the wake of recent declines in the U.S. share of the world wheat market. International developments in wheat production technology have an important effect on this market. Conventional plant breeding programs, which formed the basis for the "green revolution" in wheat production during the past two decades, will continue to produce high-yield wheat varieties—perhaps the most important source of productivity improvement over the next 5 to 10 years. Improved management techniques, combined with new plant varieties, will facilitate the multiple-cropping of wheat and other crops, effectively extending wheat's already wide geographic range. Wheat growth regulators, which may enter the market within the next decade, should boost yields moderately, as may the development of hybrid wheats. The United States occupies an important position in the development and dissemination of these technologies.

In contrast with corn, the breeding and transfer of wheat germplasm is dominated by the public sector. Many programs are sponsored by national governments and by CIMMYT, which played a key role in the "green revolution. " In the United States, varieties developed by public research comprise more than 90 percent of all wheat acreage.

Direct regional and international transfer of wheat varieties is rare, due to varying growing conditions and, in some cases, different preferences for specific types of wheat. Even within the United States, for example, wheat varieties remain site-specific: soft white wheats are suited to some areas, and hard red winter wheats are suited to others. Moreover:

> . . . each country has to produce its own varieties using the characteristics of germplasm from around the world. If the country does not have local capacity to do research it cannot use the qualities in the germplasm like disease resistance or, in the future, biological nitrogen fixation.

Even where varieties are transferred to other regions, preferences and grading standards for specific types of wheat can cause delays. The "era" variety of wheat produced yield increases of up to 25 percent when released in Minnesota in 1970, but Canada did not adopt this crop until recent years because of stringent standards imposed by that country's wheat board. Release of a high yielding, rust-resistant wheat variety developed by CIMMYT was delayed in Australia because its red grain was unacceptable to Australian millers. Rather, Australian scientists employed the CIMMYT germplasm to develop a white-grained wheat, which spread rapidly; by 1978, about one-third of Australia's wheat area was planted with CIMMYT-based varieties. Argentine wheat production also benefited from CIMMYT research and plant materials; approximately 60 percent of Argentina's wheat acreage is planted with CIMMYT-based varieties.

As a result, although the transfer of wheat varieties and germplasm is indirect, promising biological traits may be utilized by experienced scientists. The rate of transfer depends on the nature of the individual trait. Concerning the process of transfer:

> Breeders from government institutions in the U.S. and other developed countries regularly exchange their genetic material. Breeders read about a new development in an academic journal, they write to the author for a sample of seeds and then try the seed under their conditions. They then incorporate the useful characteristics into their own commercial varieties.

Again, CIMMYT is a critical link in such exchanges. Other avenues of transfer include shipments of material from international wheat rust research nurseries, and through training programs that bring foreign scientists to the United States. Significantly, this country has also benefited from transfer of wheat germplasm and scientific information about wheat traits.

Apart from biotechnology breeding techniques, growth regulators may become the first form of biotechnology to be transferred among major wheat producing nations. Current research aimed at altering wheat's genetic proclivity to aluminum toxicity could lead to an important breakthrough for tropical wheat production, particularly in Brazil and other Latin American countries. In contrast, the international diffusion of other agrichemicals and of mechanical technologies holds a lower potential for increasing wheat yields, although wheat "fungicides' '—which are employed by European and North American farmers, and are developed and marketed by companies on both continents—may have an impact.

International Transfer of Soybean Technology

Through the turn of the century, conventional plant breeding should continue to be the main avenue for improving the productivity of soybean production throughout the world. In addition, higher yields, further improvements in the efficiency of biological nitrogen fixation, and more effective soybean pesticides are anticipated. On the other hand, emerging biotechnologies—with the possible exception of tissue cultures—and the advent of hybrid soybeans are not likely to have a direct impact on productivity in this century. Public research remains the fountainhead of soybean breeding, although private companies have developed and marketed their own varieties since the late 1970s.

Historically, international transfer of soybean varieties has been a salient feature of global production. The United States dominates production and trade today, but this country imported its first soybeans from China. Over the past two decades, soybean varieties developed in the U.S. public sector formed the foundation of the soybean industry of our closest competitor, Brazil, and played a key role in establishing the Argentine soybean industry, In contrast to the adaptive and indirect international transfers of corn and wheat varieties, "some soybean varieties . . . developed by . . . land grant universities in the Southern United States were grown commercially with no modification in Argentina and Brazil. " The Brazilian soybean boom of the 1970s also benefited from private sector transfers of soybean milling and marketing technology, via U.S.-based multinational corporations. Brazil now exports large amounts of soybean meal and oil, and has displaced some U.S. markets in Europe and Japan. Within the past several years, the Brazilian research system has matured, and now develops its own varieties—used in Argentina, Uraguay, and Paraguay, along with U.S. varieties. Still, about 80 percent of Argentina's soybean acreage is planted with U.S.-produced varieties, and the United States regularly exchanges soybean types with Canada.

Future improvements in soybean varieties, or desirable soybean characteristics, may be transferred or adapted directly and rapidly from the United States to Brazil. Varieties or traits adapted to the tropics will then be transferred to other Latin American countries, and perhaps to Africa and Asia. Important transfers could occur in the opposite direction, but this has not yet occurred.

In addition, transfer of soybean pesticides is a potential source of short-term productivity improvements to competitors. And, as is the case with corn and wheat, plant growth regulators combine considerable potential for productivity gains and technology transfer. However, this technology is not expected to be available to the marketplace until the end of the century.

INTERNATIONAL TRANSFER OF EMERGING AGRICULTURAL TECHNOLOGIES

An OTA document published in 1986[4] identified technologies likely to be introduced to U.S. agriculture over the next 20 years. OTA contractors used that information to assess the potential for transfer of these technologies to other nations, as discussed below,

[4] U.S. Congress, Office of Technology Assessment, *Technology, Public Policy, and the Changing Structure of American Agriculture*, OTA-F-285 (Washington, DC. U.S. Government Printing Office, March 1986).

The technologies were grouped into 44 separate fields, and rated for their potential to increase productivity, for the ease and direction of transfer, for impacts on competitors and importers, and for other characteristics. The ratings were assigned based on a variety of factors, including patent information, research and development activity, and technology transfer data. Sources included interviews with U.S. companies, publications, technology characteristics—a number of which are in the form of scientific knowledge, not specific products—and contractors' experiences. This qualitative rating scheme does not attempt to specify the pace of transferor adoption; as noted above, the actual transfer and adoption in recipient countries depends on such considerations as costs and government policies.

Table 4-9 lists the technology fields that have at least a medium (M) potential for producing productivity gains over the next 20 years and at least a medium (M) potential for transfer to other countries. Of the 44 fields examined, 29 received such a rating. The table also identifies leading research nations for each field; the United States is among the top four for all technologies. Eleven agricultural technology fields received a rating of "M+" or greater for the potential for transfer from the United States: entomology-nematology; general, wheat, and soybean pesticides; regulation of animal growth and development; environment and animal behavior; meat PHT; mutations and genetic engineering; micro-organisms/tissue culture technologies; enzymes; and biotechnolog y equipment and apparatus. Of the 12 crop technologies,

Table 4-9.—Technology Fields With At Least Medium Productivity and Transfer Potential

Leading field	Leading centers	Transfer potential: General	Transfer potential: From U.S.
Crop Technologies:			
1. Plant Breeding	U. S., India, U. S. S. R., U.K.	L	L-M
2. Entomology -hematology	U. S., U. K., India, U.S.S.R.	M +	M +
3. Pesticides-general	U. S., W. Germany, Japan, France	H –	H –
Corn	U. S., IARC, U. S. S. R., Argen.	L –	M
Wheat	U. S., IARC, India, U.S.S.R.	M –	M +
Soybeans	U. S., Brazil, Argentina, India	M –	M +
Rice	IARC, India, Japan, U.S.	M –	L
4. Genetic engineering	Japan, U. S., U. K., W. Germany	H –	M
5. Enhance photosynthesis		M	M
6. Plant growth regulation	U. S., Japan	M	M
7. Plant disease control	U. S., U. K., India, U.S.S.R.	M –	M
8. Biological N Fix.		M	M
Animal technologies:			
1. Animal husbandry	U. S., W. Germany, France, U.K.	L-M	M
2. Animal breeding	U. S., U. K., India, W, Germany	M	M
3. Regulating animal growth and development		M	M +
4. Animal disease control	U. S., U. K., India, W. Germany	M	M
5. Animal reproduction	U. S., U. K., W. Germany, Austral	M	M
6. Environment and animal behavior		M +	M +
General mechanical and managerial technologies:			
1. Communication/information	U.S.	M	M
2. Monitor/control plant	U.S.	M	
3. Monitor/control animals	U.S.	M	
Postharvest (PHT) and biotechnologies:			
1. General PHT	Japan, U. S., W. Germany, France		M
2. Meat PHT	Japan, U. S., W. Germany, France	M +	M +
3. Fruit PHT	France, U. S., Japan, W. Germany	M	M
4. Grain PHT	U. S., W. Germany, Japan, U. K., France	M	M
5. Mutations and genetic engineering	Japan, U. S., U. K., W. Germany	H	H
6. Micro-organisms/tissue culture	Japan, U. S., W. Germany, France	H –	H –
7. Enzymes	Japan, U. S., W. Germany, France	M +	H
8. Biotechnology equipment	Japan, U. S., W. Germany, France	M +	H

NOTE Number of technology fields examined 44 Fields this table 29, Number of fields Where transfer from U.S is at least M + 11

SOURCE Robert E. Evenson, Jonathan Putnam, and Carl Pray, "The Potential for Transfer of U S Agricultural Technology," contract report prepared for the Office of Technology Assessment, 1985.

only 2—plant breeding and rice pesticides—were assigned less than a medium (M) potential for transfer from the United States to other countries, It is important to note, however, that most products associated with conventional plant breeding are not directly transferable, except in the case of soybeans.

OTA contractors rated the potential impact of the transfer of these technologies to U.S. export competitors on a similar scheme, although the results do not appear in tabIe 4-9. Ten of the technology fields shown in the table have at least medium (M) potential to increase productivity in competitor nations. In this respect, crop technologies were the most sensitive: they comprised **8** of the 10 fields with medium (M) or greater potential productivity impacts for U.S. competitors.

CONCLUSIONS

Compared to many other industries—manufacturing, for example—technology transfer in agriculture proceeds at a slow rate, in part because of its varied biological nature, and in part because much agricultural production remains the province of millions of small-scale farmers slow to adopt new technologies, Over the past two to three decades, however, the pace of international transfer of agricultural technology has increased. Developing countries have improved their capabilities in conventional agricultural science; at the same time, developed countries, such as West Germany, France, and Japan, have established sophisticated, competitive agricultural input industries. Substantial public investments have been made in agricultural research and extension activities. It is not surprising that the United States, a leader in most aspects of agricultural technology, occupies a central role in technology transfer through direct trade, scientific research and training, and agricultural development programs.

Between now and the end of the century, the rest of the world—including export competitors—will match the United States in many aspects of agricultural technology and development, and will absorb a wide range of innovations and knowledge more easily and rapidly. It is unlikely that the United States will lose its preeminence in all aspects of agricultural science and technology, or even in most. Still, many emerging agricultural technologies in the United States appear to be transferable to other countries via private companies and public agencies, including important biotechnologies that may provide the next spurt in productivity for plant and animal agriculture. As a result, U.S. farmers may not enjoy the fruits of early adoption of new technology for as long as they have in the past; their absolute advantage in the production of many agricultural goods, which is rooted in technology, could diminish over the next ***10*** years, depending on how much emphasis the United States places on agricultural research.

Chapter 5

U.S. Trade in High-Value Agricultural Products

Chapter 5

U.S. Trade in High-Value Agricultural Products

World trade in low value-per-unit commodities, such as grains and oilseeds, doubled during the 1970s; the United States capitalized on this trend by increasing corn, wheat, and soybean exports, However, the rapid rise in trade of processed and high-value agricultural products (HVPS) represents another significant trend. In fact, the value of HVP trade now surpasses that of the lower value bulk commodities. The United States has not performed impressively within this dynamic arena of world agriculture. In 1980, the United States retained roughly the same 10 percent share of world trade in HVPS that it had held in **1970.** Other countries, particularly those of the European Economic Community (EEC), have taken greater advantage of the growing HVP market (see table 5-I for a listing of the major HVP exporters, their commodities, and their markets).

Increasing affluence and efforts to upgrade diets fueled the expansion of HVP trade in the 1970s. Despite the global recession of the early 1980s, world trade in HVPS continues to be strong, while a slowdown has occurred in trade of low-value products. In theory, the United States could benefit from an expansion of HVP exports. According to one U.S. Department of Agriculture (USDA) analysis, the world HVP market may grow by $15 billion per year in the 1990s, and "expanding the U.S. share of the world market in high value products by just 5 percentage points—a rise from 10 to 15 percent—could give the country up to a million new jobs, add $5o billion to the gross national product (GNP), and increase government revenues by $10 billion per year by the early 1990s. "[1] In addition, world HVP markets appear to be less erratic, and may provide a more stable and diversified source of earnings for U.S. agriculture. [2]

Can the United States expand its share of the HVP trade, as some policymakers propose? What are the barriers to such expansion? Which high-value products and markets show the greatest promise? This chapter attempts to answer these questions by reviewing overall trends in world and U.S. HVP trade, and by examining recent trends for leading U.S. high-value products that accounted for over $8 billion in ***1985*** export sales. The evidence suggests that opportunities exist for expanded U, S. trade in a number of HVP markets, but that significant, sustained expansion will not come easily.

[1]Kathryn L. Lipton and Patrick O'Brien, "Expanding the U.S. Share of High-Value Agricultural Exports," *National Food Review*, summer 1985.
[2]Ibid.

FACTORS INFLUENCING HVP TRADE[3]

The Significance of HVP Exports

In this chapter, the term "high-value products" refers to certain unprocessed commodities—genera] y horticultural crops—and to semiprocessed and highly processed products, which involve capital- or labor-intensive production relative to raw agricultural commodities. HVPS have higher unit values than do such agricultural commodities as grain or soybeans. In comparison with raw agricultural commodities, export of HVPS is associated with high levels of employment, gross economic output, personal income, and government tax revenues, It is clear that when the United States exports highly processed products, it reaps

[3]Unless otherwise noted, the material in this section of chapter 5 was drawn from two sources: Michael Dwyer, et al., "Value-Added U.S. Agricultural Exports, 1967- 1981: An Analysis of the Distribution and Structure of Exports by Commodity and Regional Destination, " U.S. Department of Agriculture, Foreign Agriculture Service, staff paper, 1983; and U.S. Department of Agriculture, Economic Research Service, "High-Value Agricultural Exports: U S. Opportunities in the 1 980s, " Foreign Agricultural Economic Report No 188, 1983

Table 5.1.— Major HVP Exporters: Leading Commodities and Major Markets, 1980

Exporter	Leading commodities	Value (1980, $ billions)	Major markets
EEC-9 . . . .".	Dairy products	$53.5	EEC (internal trade)
	Meats	(total)	Middle East
	Beverages	$19.9	Western Europe
	Fruits and vegetables	(extra-EEC)	U.S.S.R.
	Grain products		Japan
	Sugar products		
United States	Vegetable oils and meals	$11.4	EEC-9
	Tobacco and cigarettes		United States
	Meats and livestock products		Western Europe
	Fruits and vegetables		Far East
	Processed grains and feeds		Middle East
Brazil	Coffee	$ 5.8	EEC-9
	Soybean oil and meal		United States
	Cocoa		Western Europe
	Processed fruits		Far East
	Meats		Middle East
	Fresh fruits		
Spain	Fresh fruits, especially citrus	$ 3.3	EEC-9
	Vegetable oils		Middle East
	Beverages		United States
Australia	Meats and livestock products	$ 2.8	United States
	Dairy products		Japan
	Grain products		Middle East
	Fruits and vegetables		
New Zealand	Meats and livestock products	$ 2.3	EEC-9
	Dairy products		United States
			Middle East
			Japan
Canada.	Meats	$ 1.9	United States
	Beverages		EEC-9
	Fresh vegetables		Japan
Argentina. ., ...	Meats	$ 1.8	EEC-9
	Fruits and vegetables		Middle East
	Vegetable oils		Western Europe
			United States
			Japan
Mexico	Coffee	$ 1,05	United States
	Fresh vegetables		EEC-9
	Preserved fruit		
Greece	Fresh fruit	$ 1.04	EEC-9
	Dried fruit		Middle East
	Preserved vegetables		

SOURCE: U S Department of Agriculture, Economic Research Service, "High Value Agricultural Exports" U S Opportunities in the 1980s, Foreign Agricultural Economic Report No 188, 1983

the benefits of added employment, economic output, and government revenue that are associated with processing.[4]

Higher unit prices of HVPS, relative to bulk commodities, imply that modest increases in HVP export volume would have a greater economic effect than would corn, wheat, or other bulk commodities. Also, this price structure makes HVP prices less likely to have an unfavorable relationship with the overall inflation rate. While average nominal prices for U.S. farm exports during the 1970s doubled, they failed to keep pace with inflation; postinflation prices for "low-value" agricultural products actually declined by 1 to 2 percent per year during the 1970s. In contrast, HVP prices showed an inflation-adjusted annual increase of 2 to 3 percent over that period. Since 1980, LVP trade prices have fallen in current as well as real terms, further widening the imbalance between LVP volume-dominated growth and HVP price-dominated gains.[5]

[4]Lipton and O'Brien, op. cit.

[5]Ibid.

In terms of volume, the United States attained a **39** percent share of world agricultural trade between 1979 and 1981, compared to a 23 percent share between 1969 and 1971. In terms of value, however, the average 14 percent share for the earlier period rose to only 18 percent from 1979 to 1981,[6] due to the predominance of low-value products in U.S. exports. Furthermore, the average value of world agricultural exports rose from $520 to $530 per ton between 1979 and 1984, while falling prices for raw commodities over the same period caused the average price of U.S. agricultural exports to decline by almost 12 percent—from $260 to $230 per ton. As a result, the United States accounted for one-third of world agricultural trade volume by 1984, and 13 percent of trade value. Both figures are below the 1979 to 1981 average.[7]

Another advantage of HVP exports is the relatively steady growth of HVP markets over the past decade. Even during the world recession of the early 1980s, growth of HVP trade did not decrease as severely as trade in raw commodities. As a result, the bulk-dominated agricultural trade of the United States has been subject to substantial year-to-year swings in value; the value of U.S. trade fluctuated 14 percent between 1979 and 1981, compared to an average 8 percent fluctuation in HVP-dominated world trade. The instability of international agricultural trade has become more pronounced than that of the 1960s, when average annual world market prices fluctuated by 5 percent, and U.S. prices by 9 percent.

International trade in HVPS holds other benefits as well. Saturation in some domestic markets could make the export market more attractive for some U.S. processors. Processing industries can adjust production more easily than farmers; exporting processed goods may hold fewer risks for U.S. agricultural trade. Also, many agricultural processing activities, particularly those up to the semiprocessed stage, occur close to the site of raw commodity production. In the future, rising energy costs may encourage even greater onsite processing, in order to reduce product weight prior to shipment, Since many farm communities are associated with processing industries, these areas could benefit from an expansion of HVP trade.

Barriers to Expanding U.S. Trade in HVPS

Although international HVP trade may appear attractive, it will be difficult for the United States to sustain a rapid expansion in many HVP markets. Many of the macroeconomic forces working against U.S. trade in raw agricultural commodities, including both the relative strength of the U.S. dollar in the early 1980s and debt repayment problems in developing countries, have dampened near-term prospects in HVP markets as well.

Another set of barriers concerns the role of food processing industries in international economic development, especially within the Third World. As was the case in the United States, food processing industries are important in the early phases of industrial growth, Many developing and middle-income countries seek to expand or protect their own processing sectors, to generate employment and to achieve a greater measure of food security. In fact, developing countries may have stronger incentives to establish their own processing industries than to import HVPS. This trend is encouraged through import barriers in South Korea, Taiwan, Hong Kong, Western Europe, and Brazil, and more recently in the Middle East and in newly industrializing and oil exporting countries. National goals of self-reliance in food supply may create a market for raw or semiprocessed U.S. exports, but not necessarily for highly processed products. Some developing countries discourage food imports, viewing them as luxury goods that siphon scarce foreign exchange away from more important investments.

These long-term trends give an ephemeral character to international markets for processed agricultural products. As demand may change over time, expansion of U.S. exports of high-value products may not have lasting effects. Soybean meal is a case in point. In conjunction with its nascent poultry industry in the 1970s, the EEC was a major importer of soybean meal. While the EEC

[6] U.S. Department of Agriculture, Economic Research Service, unpublished data.

[7] Lipton and O'Brien, op. cit.

remains a large regional consumer, it has developed a domestic processing capacity. Current growth markets for soybean meal lie in the industrializing countries of the Far East and Latin America, but these markets will change as production capacity develops. Other commodities likely to be affected by similar trends include unrefined vegetable oils and fresh meats, particularly poultry. In some cases, U.S. environmental controls encourage processing overseas. Leather tanning, for example, produces toxic chromium wastes that are strictly regulated in this country.

Import barriers are especially formidable in the EEC, which would otherwise represent a logical market for U.S. HVPS. The EEC'S Common Agricultural Policy (CAP) imposes tariffs and levies that "severely restrict many U.S. food exports, including most meat, dairy products, poultry, flour, baked goods, lard, sugar, and many fruits and vegetables."[8] Food and agricultural products are traded within the EEC without price penalties, giving these countries "a decisive price advantage over U.S. products. Food from Mediterranean and developing countries outside the EEC also frequently benefit from preferential tariff treatment."[9] Since the United States imposes fewer tariffs or levies on food imports, this country possesses few direct bargaining chips in HVP trade negotiations; efforts to liberalize EEC-U. S. trade in HVPS would probably invite European demands to liberalize many other U.S. import policies.

Despite the EEC import barriers and the Community's favorable balance of HVP trade with the United States, heavy EEC imports of raw and semiprocessed agricultural commodities have given the United States a positive agricultural trade balance with Europe. A similar situation exists in Japan. Although the Japanese make widespread use of both quotas and insect / disease quarantines to prevent entry of a number of U.S. HVPs—especially fruits and vegetables—Japan stands as another large importer of overall U.S. agricultural products.

Another force that negates the potential for U.S. HVP exports is the subsidizing of HVP processing and exports by such competitors as the EEC and Brazil. Among the principle HVP traders, the EEC maintains the most complete range of export support policies for the broadest spectrum of products. Within the Community, variable levies maintain price competitiveness, while export subsidies are designed to remove HVP surpluses that result from high price supports. EEC actions have contributed to the U.S. withdrawal from the Middle Eastern whole-broiler trade, the erosion of the U.S. share of world wheat flour markets, and the reduction the U.S. presence in markets for oilseed meals and oils, processed fruit, vegetables, and cereal products. Brazil, the third largest HVP exporter—after the EEC and the United States—subsidizes the processing and export of soybean products, poultry, and orange juice; Brazilian policies have crippled U.S. performance in several world markets.

Attributes of certain HVPS, such as perishability, pose other trade barriers. High perishability of particular fruits, vegetables, and meats may raise freight costs significantly, as with the case of U.S. vegetables in the Far East. In this market, stiff competition is posed by nearby producers and by Australia and New Zealand, as these nations can airfreight their produce. Because of its proximity to the United States, Canada has represented the traditional market for U.S. produce, but saturation of Canadian markets suggests a need for more aggressive U.S. efforts in the Far East. Technological advances in packaging and food preservation may enhance export competitiveness for perishable U.S. products.

Many of the difficulties that the United States encounters in HVP markets are attributable to a lack of acumen or interest in international trade on the part of domestic companies. Also, U. S.-based multinational companies may choose to penetrate foreign markets through acquisition or development of foreign production and distribution facilities, instead of through exports. Eventually, foreign subsidiaries or joint ventures with foreign firms actually may benefit from import barriers, as well as from low-cost overseas labor and materials. As U.S. companies increase the number of their overseas ventures, however, benefits to this country become more difficult to as-

[8] Harold A. McNitt, "U.S. Food Exports to the United Kingdom: Opportunities and Obstacles, " *National Food Review*, summer 1985.
[9] Ibid.

sess, depending on the extent of profit repatriation.

While U.S. grain and soybean production has been geared to world markets for decades—due largely to government programs and subsidies—U.S. HVP producers must acclimate themselves to international trade. In contrast to EEC firms, whose food manufacturing and marketing operations are oriented toward export, U.S. HVP producers primarily serve homogeneous domestic markets, placing these firms at a marketing disadvantage. High-value products demand careful attention to labeling, health certification, advertising, packaging, and other service activities that involve additional costs. Many aspects of the current U.S. transportation system center around bulk commodities; costs of refrigeration, security, and other transport modifications will need to be factored into the HVP export decision as well. In addition to tailoring U.S. products to foreign market niches, U.S. exporters must give more consideration to smaller HVP markets, rather than to larger markets for bulk commodities.

World and U.S. Trends in HVPS

In recent years, world trade in semiprocessed agricultural products has not grown as quickly as trade in highly processed goods. In contrast with global trends, the United States' HVP exports are dominated by semiprocessed products. Of a total of $11 billion in U.S. HVP exports in **1980,** over one-half, or $6.1 billion, were semiprocessed goods; 28 percent, or $3,1 billion, were highly processed; and 17 percent, or $2.2 billion, were unprocessed products. By contrast, highly processed products dominated the $19.9 billion of 1980 EEC exports in HVPS—59 percent, or $11.7 billion, were highly processed; 35 percent, or $7 billion, were semiprocessed; and ***6*** percent, or $1.3 billion, were unprocessed.'[10]

Along with fresh fruits, semiprocessed oilseed meals were the fastest growing U.S. HVP exports during the 1970s. Other semiprocessed items among the top U.S. HVP exports have included cattle hides, corn gluten feed, beef, tallow, wheat flour, soybean oil, and brown rice. Further processing for leather goods, high-quality greases, pastas, bakery products, and fully refined and hydrogenated oils has generally occurred overseas with foreign government support. Also, of the top U.S. semiprocessed export items, several—such as cattle hides, corn gluten feed, and tallow—are byproducts of primary industries.

In certain cases, U.S. market characteristics have encouraged the export of highly processed goods. The low U.S. demand for dark poultry, for example, coupled with subsidized competition from the EEC and Brazil in the whole-broiler trade, has resulted in increased exports of cut chicken pieces to the Far East and the Caribbean. This contrasts with beef, since retail beef cuts are taken after export, from subprimal boxed beef. The United States exports only a small fraction of its fully processed meat. Still, while value gains from processing are negligible, weight reduction remains an important concern, and processing operations may take place within the United States; transportation costs have encouraged pre-export tobacco stemming, almond shelling, and rice milling. For reasons of technical capability, the parboiling of rice also occurs in the United States. Finally, perishable high-value products, like vegetables, have created the need to export larger processed product shares relative to HVPS, like fresh fruit.

International HVP Markets

Historically, international trade in HVPS has been carried out among both developed and fast-growing, middle-income countries. The United States and the EEC are the leading importers of HVPS, followed by Japan and Canada. Although the relatively high value of the U.S. dollar between 1981 and 1985 stimulated growth in U.S. HVP imports, the general trend over the past decade has been one of slow growth in U. S., EEC, and Canadian markets; newly industrializing nations have assumed greater importance as growth markets. Over the next 10 to 15 years, developed and middle income countries are likely to remain large importers, but—with the exception of Japan—these nations should continue to be slow-growth markets for the United States. Market saturation in the developed regions and emphasis on local processing in the middle income

[10]Lipton and O'Brien, op. cit.

areas is expected to decrease overall growth in HVP trade.

Currently, the Middle East and the Pacific Rim represent the fastest-growing regional HVP importers, and the United Arab Emirates, Singapore, and Hong Kong are the largest per capita importers. During the 1970s, dramatic expansion of HVP imports occurred in the OPEC countries, where growth in population and income was complimented by a preference for Western food. Annual HVP imports rose by 30 percent, particularly for meats, vegetable oils, and beverages. Debt problems and falling OPEC oil revenues have reduced overall imports in the 1980s; declining expatriate labor forces have closed some HVP markets altogether. Japan, Hong Kong, Singapore, Malaysia, and Taiwan stand out as prospective markets in the Pacific Rim, with exceptional growth potential in meats and fresh fruits. Japan's HVP imports, for example, have grown at an average rate of 20 percent per year since 1970, mainly for meats, coffees, and fresh fruits.

In fact, the fastest growing markets for the majority of top U.S. HVP export items lie in the Far East. The movement of U.S. agricultural attaches from Europe to the Far East reflects the importance of that region to future U.S. success in HVP and overall agricultural trade. As noted previously, long-term U.S. export success will depend on aggressive marketing efforts. Competition from established Far Eastern producers is growing, and the potential emergence of China as a major HVP exporter may diminish U.S. opportunities in the Pacific Rim.

Marketing Programs

An effective marketing program for HVPS could include two basic elements: product promotion, and trade servicing. U.S. promotional efforts for HVPS have decreased over the last 10 years. While foreign exporters typically spend 1 to 5 percent of HVP trade value on promotion, U.S. promotional expenditures have decreased from 0.4 percent of HVP export value in 1970 to 0.2 percent in 1980.[11]

In 1985, USDA established a Processed Products Division, devoted to statistics and market analysis for processed products. In addition, the agency has increased its trade servicing activities through the development of its Agricultural Information and Marketing Service (AIMS). AIMS serves as a liaison between domestic producers and foreign importers of agricultural products, particularly for HVPS. The AIMS database includes current information on domestic prices and product availability, as well as foreign market information provided by overseas attaches. Program managers have reported significant increases in sales of HVPS by U.S firms that participate in AIMS.

Of course, without an increase in overall marketing funds, greater promotion of HVP exports may diminish the funding available to promote bulk commodities. Promoting HVPS also entails a shift in benefits; manufacturing and processing interests outside the farm sector generally receive 70 to 80 percent of the returns on HVP exports .12 Accordingly, increased support of HVP promotion should be measured against the concurrent interest in marketing bulk commodity exports.

[11]U.S. Department of Agriculture, "New Uses for Farm Products, " *Challenge Forum*, Oct. 11-12, 1984.
[12]Lipton and O'Brien, op. cit.

LEADING U.S. HVP EXPORT COMMODITIES'[3]

This section of the study examines leading high-value export commodities in the United States (see table *5-2).* Trends in world and U.S. trade, competitors, and policy issues are presented for each high-value product.

Oilseed Products

Background

Oilseed products include soybean meals and cakes used for livestock feeds, refined oils for industrial purposes, and further-processed refined and hydrogenated oils for cooking. The processing of soybeans and other oilseeds is a sizable U.S. industry, and exports grew in both volume and value during the **1970s** and early 1980s. Over the same time period, however, the U.S. share of the world market declined, the result of a slowdown in demand, increased competition, and the availability of substitute products. The U.S. Government and U.S. trade associations are now turning away from stagnating markets in the developed countries, and toward higher-income developing countries in Latin America, the Middle East, and South Asia.

Trends in the processed oilseed trade reflect the ephemeral nature of value-added product markets. Processed oilseed products are imported when countries wish to upgrade diets or expand livestock industries; when demand rises to a certain level, however, domestic processing facilities are developed. Imports shift toward new commodities.

During the 1970s, world vegetable oil prices doubled. With $8 billion in world exports in ***1980,*** trade in vegetable oils nearly matched that in beef.

Table 5-2.—U.S. Leading HVP Export Commodities, 1985

	Volume (MT thousands)	Value ($ millions)
'1, Tobacco	257	1,587.9
2. Cigarettes	47[a]	1.180.0
3. Cattle hides,	673[a]	1,035.0
4. Soybean meal	4,460	833.6
5. Rice	1,972	677,1
6. Soybean oil	752	558,0
7. Tallow	1,129	542.9
8 Beef	112	477.5
9 Corn gluten feed	3,383	458,8
10 Shelled almonds.	125	316,7
11 Poultry meat	234	257,0
12 Oranges	385	230.0
13 Wheat flour .,	727	155,1
14 Cottonseed oil ...	196	137.5
15, Apples	205	108.7
16, Grapefruit ., . .	199	86.7
17, Pork	43	73,1

	Unit dollars, 1985 (dollars/MT)
1, Cigarettes	25,1 06,4[a]
2, Tobacco	6,175,0
3. Beef	4,263.4
4. Shelled almonds. . .	2,533.6
5 Pork	1,700,0
6: Cattle hides, ...	1,538,2a
7, Poultry meat . . . .,	1,098,3
8. Soybean oil	742.0
9. Cottonseed oil	701.5
10. Oranges	597.4
11. Apples . . .., .	530,2
12. Tallow . .	480,9
13. Grapefruit	435,7
14, Rice	343.7
15, Wheat flour ., ...	213.3
16. Soybean meal	186,7
17. Corn gluten feed . .	135.6

[a]Figures are approximate Commodity Information provided by Foreign Agriculture Service. U S Department of Agriculture

SOURCE U S Department of Agriculture Foreign Agricultural Service, U S Agricultural Exports Oct 1980-Sept 1985 " August 1986

[3]The material in this section of chapter 5 is based on four sources. Comparisons of world and U.S. trade in various commodities between 1970 and 1984 were drawn from the Food and Agriculture Organization of the United Nations, *FAO Trade Yearbook,* vols. 32-38, Rome, Italy; comparisons of U. S. production and U.S. exports of various commodities were drawn from Food and Agriculture Organization of the United Nations, 1984 *FAO Trade Yearbook* and *1984 FAO Production Yearbook,* Food and Agriculture Organization of the United Nations, Rome, Italy, 1985; updated US export figures for 1985 were drawn from U.S Department of Agriculture, Foreign Agricultural Service, "U.S. Agricultural Exports Oct 1980 -Sept. 1985, " Washington, DC, August 1986, and information on the destination of U S. export commodities was drawn from U, S, Department of Commerce, Bureau of the Census, "U. S Exports: Schedule E Commodity Groupings, Commodity by Country, " FT-4 10 reports, Washington, DC, 1984.

World trade in soybean meal reached over $5.5 billion in 1980; growth in meal prices, coupled with volume increases during the 1970s, resulted in an almost sixfold increase in world trade value. Since 1980, the world level has hovered about $5 billion.

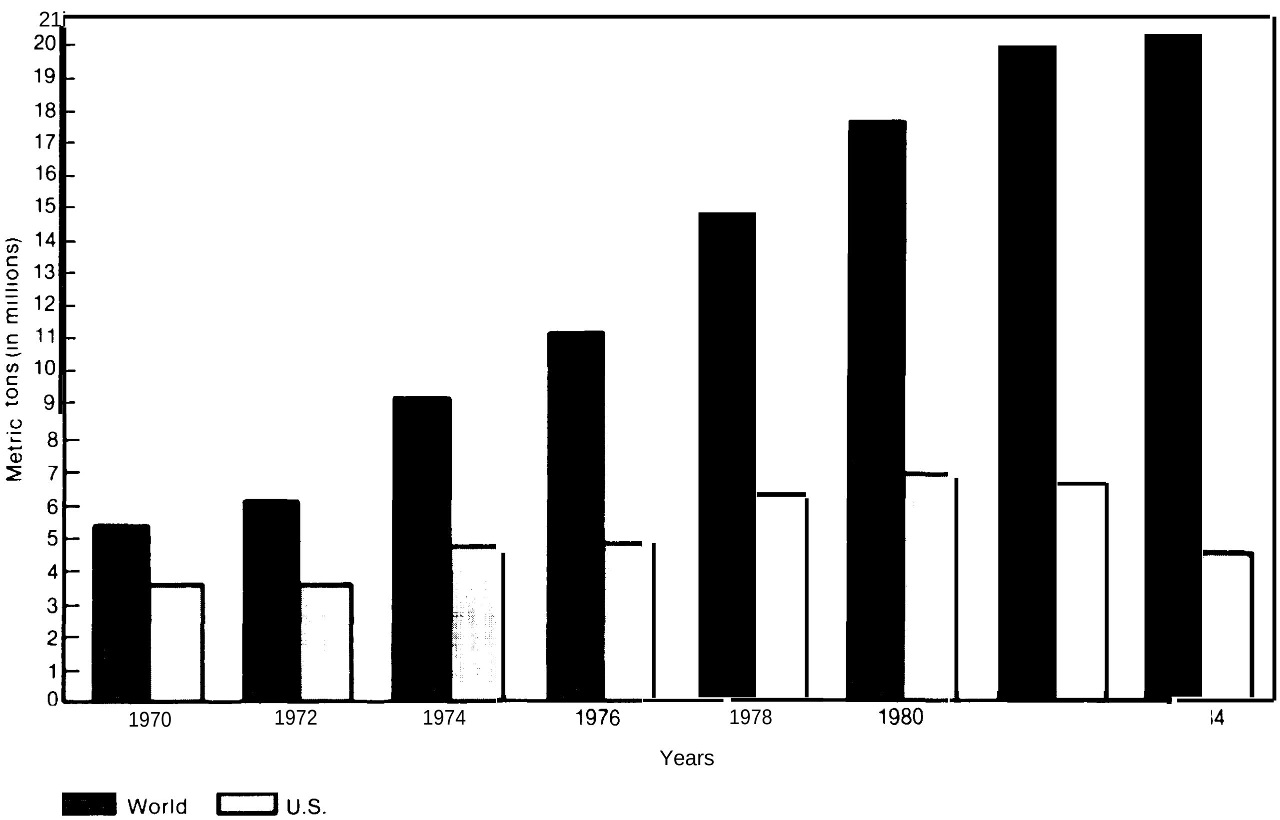
U.S. Trade

Although U.S. soybean oilcake, and meal exports fell from $1.65 billion in 1980 to $833 million in 1985, the United States remains second to Brazil as an international supplier of this commodity. The United States follows Malaysia in world vegetable oil exports; leading U.S. vegetable oil export commodities for 1985 include soybean oil at $558 million and sunflowerseed oil at $301 million. Sunflowerseed oil and linseed oil, while small in volume compared to other vegetable oils, have been the fastest growing U.S. oilseed export products in recent years.

In terms of volume, U.S. soybean cake and meal exports nearly doubled between **1970** and 1980 (see figure 5-l), but have since fallen by approximately **40** percent. Similarly, soybean oil exports rose by about one-third during the **1970s,** but have since fluctuated considerably while decreasing overall. However, even the actual U.S. increases of the 1970s did not match the rapid growth of world exports. Between 1970 and 1984, the U.S. world soybean meal volume market share fell from 68 to 21 percent, while the U.S. share of the soybean oil market decreased by 33 percent. Foreign processing, import barriers, and export subsidies combined to bring down the total value-added proportion of U.S. oilseed exports from 35 percent of all oilseed products in 1972 to 17 percent in 1981.

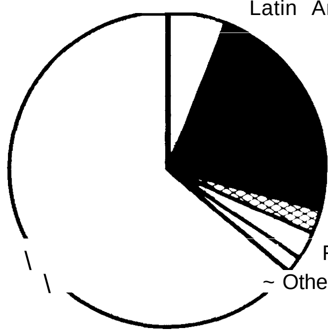
Western Europe stands as the world's largest importer of U.S. oilseed products, purchasing 64.3 percent of U.S. soybean meal exports in 1983 (see

Figure 5.1.—World and U.S. Soybean Meal Exports



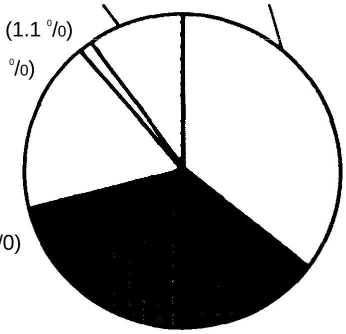
SOURCE *FAO Trade Yearbook,* Food and Agriculture Organization of the United Nations, Vols. 32-38, 1970-1984, Rome, Italy

Figure 5-2.— U.S. Soybean Meal Exports by Destination, 1983



SOURCE "U S Exports Schedule E. Commodity Groupings, Commodity by Country," Bureau of the Census, Department of Commerce, FT-410 reports, 1984

Figure 5-3.— U.S. Soybean Oil Exports by Destination, 1983



SOURCE. "U S Exports Schedule E Commodity Groupings, Commodity by Country," Bureau of the Census, Department of Commerce, FT-410 reports, 1984

figure 5-2). The Community, however, is not a growth market. Oil imports are regulated, and policies are directed toward increased importation of raw soybeans. For soybean meal, top U.S. export country markets in 1983 were The Netherlands, West Germany, Venezuela, Canada, Italy, the Philippines, Poland, and Iraq. In general, exports of value-added oilseed products to the developed world, such as the EEC, Canada, and Japan, are slowing, the result of reduced population and income growth. Eastern Europe and the U.S.S.R. represent potential markets, contingent on balance of trade and development considerations, and on political relations with the United States. China may develop into a large potential market as it modernizes its livestock industry, which would increase per capita vegetable oil consumption.

The fastest growth markets for U.S. oilseed products are likely to lie in the higher income industrializing countries of the Middle East, the Far East, and Latin America; currently, Latin America and South Asia dominate U.S. export markets (see figure 5-3). Many of these nations lack the capital, infrastructure, and technical capability to process oilseeds. Five countries—India, Pakistan, Iran, Morocco, and Turkey—accounted for 55 percent of world soybean oil import growth between 1976 and 1984,

Competitors

Brazil, the United States, and Argentina are the world's largest exporters of soybean meal, followed by The Netherlands and West Germany. Of course, Brazil's high-protein, pelletized form of meal is somewhat different than the U.S. product; nevertheless, the rapid decline in the U.S. processed oilseed market share during the 1970s can be attributed to aggressive competition from Argentina and Brazil in world meal and oil trade, and from Spain in the Mediterranean oil markets. Also, a dramatic increase in production of Malaysian palm oil has displaced some of the demand for soybean and cottonseed oil.

Issues

Several factors have slowed the growth of U.S. oilseed exports in recent years:

- As with most other high-value and value-added commodities, policies of other nations have been a major impediment. In fact, the U.S. soybean processing industry has filed two pending petitions under Section 301 of the Trade Act of 1974: one that charges Brazil, Argentina, Spain, Portugal, Malaysia, and Canada with subsidization of soybean crushing industries and soybean exports; and one that charges Argentina with imposing a differential soybean export tax.

- The premiums associated with U.S. products, especially oils, are prohibitive for some importing countries. Developing nations can buy cheaper palm oil, lard, or tallow from Asia.
- Demand slowed during the early 1980s, due to worldwide recession. Although this factor has abated, growth is not projected to reach the level of soybean meal demand seen in Europe during the 1970s, where infrastructure for livestock production and transport was already in place.

To date, U.S. promotional efforts have focused on exports of raw soybeans, rather than meals and oils. The ***$6.5*** million allocated annually to USDA has been directed primarily to trade servicing—support for current trade—and to technical assistance for foreign processing industries. Recently, however, domestic interest groups have become more active in promotion of processed products. For example, while its efforts have not yet been reflected in trade performance, the Export Processing Industy Coalition (EPIC), an industry-labor alliance, has articulated processors' concerns. EPIC hopes to double the size of Public Law 480 grant-in-aid programs, in order to include more semiprocessed and processed goods.

Tobacco and Cigarettes

Background

U.S. tobacco export volume has declined slightly in recent years, the result of a strong dollar through early 1985, relatively high U.S. prices, the availability of competitive overseas supplies, and stagnant world cigarette demand. Former growth markets for cigarettes in the developed countries have declined due to health concerns and large cigarette tax increases. Analysts expect greater export growth for cigarettes relative to leaf tobacco. American blended cigarettes are unique in taste and are considered status items overseas, particularly in newly industrializing countries.

A steady increase in world tobacco exports between 1964 and 1984 can be attributed to the rapid income and population growth in developing countries during this period. In 1984, world trade in tobacco stood at 1.4 million metric tons (MT) (see figure 5-4), and was valued at $4.2 billion. Future long-term trends in U.S. tobacco and cigarette exports are difficult to predict, and the degree of optimism varies among analysts. Still, the reduction of price supports for U.S. tobacco in 1985, along with the weakening of the U.S. dollar, is likely to increase the international competitiveness of U.S. tobacco in the near term.

U.S. Trade

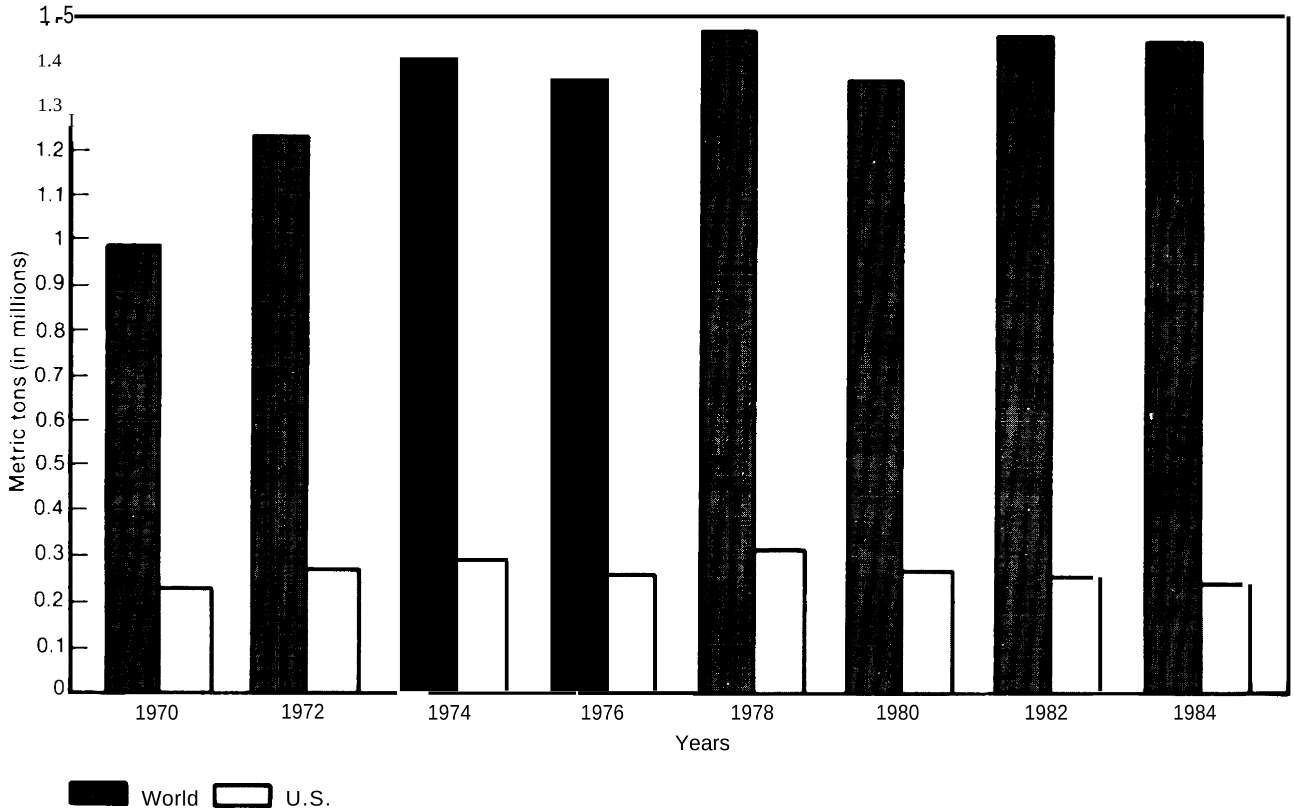
The United States is the world's leading tobacco exporter, shipping over 256,000 MT in 1985, valued at $1.59 billion. Flue-cured tobacco is the leading export commodity, valued at $1.06 billion and comprising two-thirds of 1985 exports. Burley tobacco, the next most-traded commodity, held a 21 percent export share. U.S. cigarette exports stood at 58.9 billion pieces, or approximately 47,000 MT, in 1985, for a value of $1.1 billion; in terms of unit value, cigarettes are easily the highest value commodity mentioned in this study (see table 5-2)–approximately four times the value of tobacco as a whole, the second highest item.

In contrast to tobacco production, six major firms dominate U.S. cigarette manufacturing, including the multinationals Phillip Morris and R.J. Reynolds. Since a large percentage of U.S. production occurs overseas, only 9 percent of domestically produced cigarettes were exported in 1983. In the same year, total exports of U.S. tobacco represented 36 percent of domestic production.

Although price increases drove the value of U.S. tobacco exports up by an average of 13 percent per year, export volume showed little change; at 256,000 MT, the 1985 volume was only 10 percent greater than the 234,000 total of 1970. Total world trade, on the other hand, grew from 986,000 MT in 1970 to 1.4 million MT in 1984, an increase of 43 percent. During this period, the U.S. share of the world market fell from 23 to 17 percent (see figure 5-4). Twenty years ago, the United States held a 30 percent share.

Since 1960, the use of cheaper foreign tobaccos in U.S. cigarettes has increased, particularly in flue-cured and burley tobacco. In 1982, imports

Figure 5-4.—World and U.S. Exports of Tobacco (unmanufactured)



SOURCE" *FAO Trade Yearbook*, Food and Agriculture Organization of the United Nations, Vols 32-38, 1970-1984, Rome, Italy

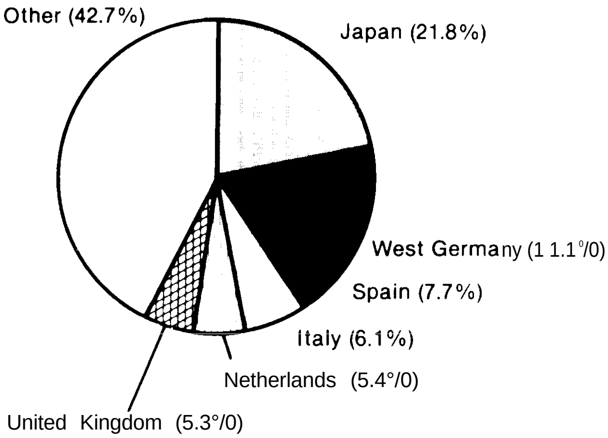
of flue-cured tobacco from Brazil, Zimbabwe, and Korea represented 18 percent of total U.S. flue-cured use. These escalated imports have complemented the established trend of importing air-cured "Oriental" tobaccos from Mediterranean areas like Greece and Turkey. In addition, longer filters, reduced cigarette circumference, and the increased use of sheet tobacco, stems, and puffed tobacco, have all contributed to a decline in the volume of tobacco per cigarette.

Although demand continues to fall, Western Europe remains the world's largest regional market for tobacco, followed by Japan. West Germany took 11 percent of U.S. tobacco exports in 1983, followed by Spain, Italy, The Netherlands, and the United Kingdom (see figure 5-5).

U.S. cigarettes have enjoyed faster export growth than tobacco. Increased cigarette consumption is directly related to rising incomes in developing countries. Between 1970 and 1980, average annual U.S. cigarette exports grew ***10*** percent in volume, and 20 percent in value; however, the United States' market share held relatively steady (see figure 5-6). Subsequently, exports fell; the United States held 17 percent of the world market in 1983,

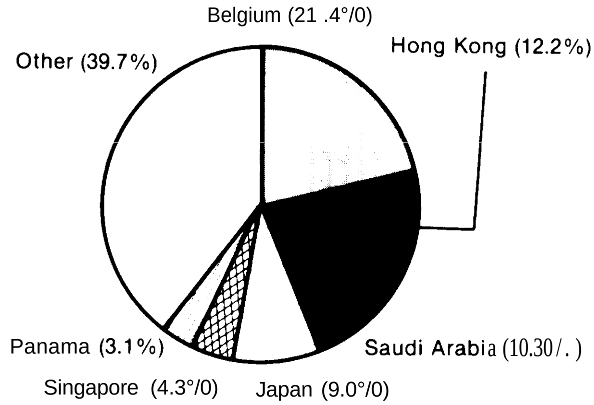
The fastest growing markets for cigarettes are the middle-income, oil-exporting, and newly industrializing countries of the Middle East, the Far East, and parts of Latin America. North Africa is also a growth region, and West Africa is expected to grow with future petroleum development. Belgium receives the largest shipments of U.S. cigarettes, but this nation is a transshipment point, not a major market. Hong Kong is the largest importer of U.S. cigarettes, followed by Saudi Arabia, Japan, Lebanon, and Singapore (see figure ***5-7).***

Figure 5-5.—U.S. Unmanufactured Tobacco Exports by Destination, 1983



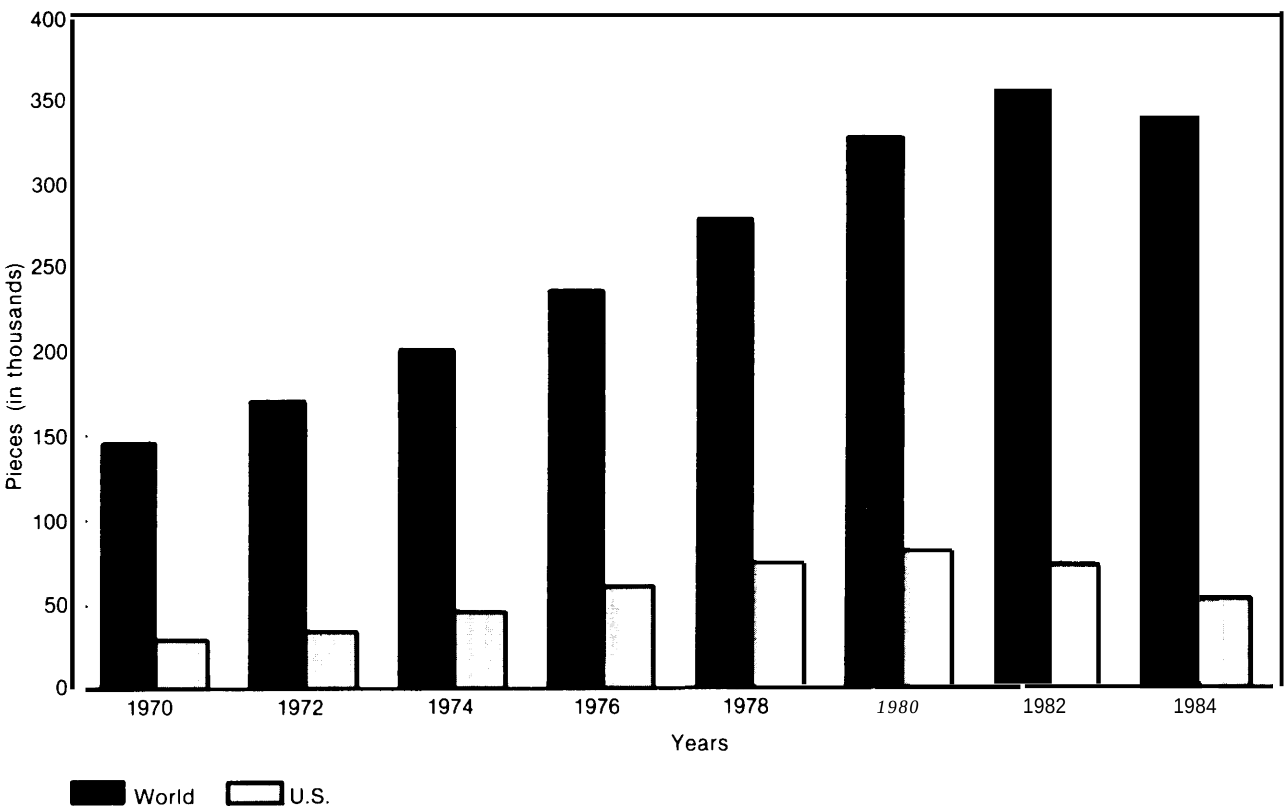
SOURCE: "U.S. Exports: Schedule E. Commodity Groupings, Commodity by Country, " Bureau of the Census, Department of Commerce, FT-410 reports, 1984.

Figure 5-7.—U.S. Cigarette Exports by Destination, 1983



SOURCE. "U. S Exports: Schedule E. Commodity Groupings, Commodity by Country, " Bureau of the Census, Department of Commerce, FT.41O reports", 1984.

Figure 5-6.—World and U.S. Exports of Cigarettes



SOURCE: *FAO Trade Yearbook,* Food and Agriculture Organization of the United Nations, Vols. 32-38, 1970-1984, Rome, Italy

Competitors

The United States is the world's largest exporter of tobacco, followed by Brazil, Italy, Greece, and Zimbabwe. Brazil, Zimbabwe, Malawi, Korea, Italy, and Greece are the top competitors with the United States in major markets. As U.S. exports fell during the last decade, quality improvements by foreign exporters allowed these countries to become increasingly competitive, and at lower prices. In the cigarette trade, the United States faces export competition from the United Kingdom and West Germany. Bulgaria supplies the U. S. S. R., and is expected to capture the growth markets of Eastern Europe.

Issues

Although the United States produces a high-quality tobacco, high U.S. prices have reduced the country's international competitiveness. Because tobacco exports constitute a large percentage of total production, domestic price supports for tobacco have both domestic and international ramifications. Since 1982, U.S. price support levels have been frozen in an attempt to make U.S. tobacco more competitive. The "no net cost" Tobacco Fund reduced the cost of farm sector supports by requiring contributions from tobacco manufacturers and exporters to supplement farmers' contributions. The Tobacco Program Improvements of 1985, attached to the 1985 Budget Reconciliation Act, have reduced price supports by 25 percent.[14] These lower price supports, combined with a declining U.S. dollar, should enhance U.S. competitiveness. In addition, the USDA's GSM-102 Export Credit Guarantee Program boosted exports, from ***$30.4*** million in 1983 to $82.5 million in 1984. Iraq, Egypt, and Jamaica participated in this program.

Finally, many countries maintain government control over tobacco and cigarette production, and collect major revenues from cigarette taxes. Promotional efforts by U.S. trade associations in these nations have focused on advertising campaigns, especially in the Far East.

[14] Dan Stevens, Foreign Agricultural Service, U.S. Department of Agriculture, personal communication, 1986.

Cattle Hides

Background

U.S. cattle hides are considered to be of superior quality to those of foreign producers. U.S. cattle hide exports have grown steadily in volume and spectacularly in value since 1970, and continued growth is expected. However, while cattle hides represent one of the most dependable U.S. value--added livestock exports, this country annually imports over three times their value in finished leather products.

The world market for hides and skins grew at an average of 10 percent per year between 1975 and 1982, reaching a record high of $4 billion in 1982. Although most U.S. value-added commodities are subject to foreign import restrictions designed to protect local industries, cattle hides are an exception. Importing nations generally convert these hides to fully processed leather goods.

U.S. Trade

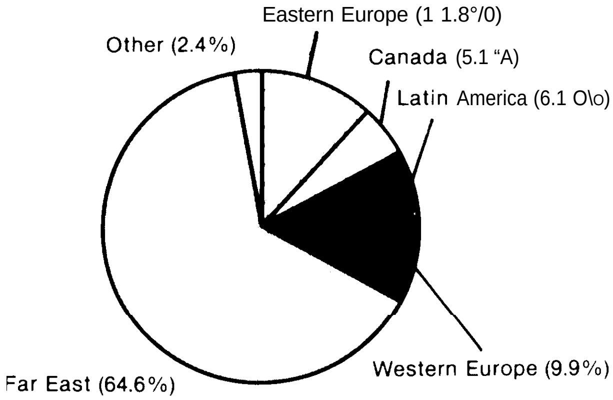
The United States is the world's leading exporter of hides and skins, followed by the EEC, Canada, Australia, New Zealand, and South Africa. The United States supplies over one-third of the world's hide and skin products, and—excluding inter-EEC trade, which is cloistered from the international market—approximately 60 percent of the world hide trade. Cattle hides, which brought the United States $1.035 billion in export revenue in 1985, constitute over 90 percent of all U.S. hides and skins exports, followed by calf skins and sheep skins.

Italy, Japan, and South Korea are the world's largest importers of hides and skins. The Far East and Eastern Europe represent the largest regional markets for U.S. cattle hides (see figure 5-8); Japan, Korea, and Taiwan accounted for over 60 percent of U.S. cattle hide exports in 1983. Other significant country markets include Romania, Mexico, Italy, Canada, Spain, West Germany, France, Czechoslovakia, Yugoslavia, the United Kingdom, and the U.S.S.R.

Competitors

Australia, New Zealand, and the EEC are the principal competitors in the hides trade, par-

Figure 5-8.—U.S. Cattle Hide Exports by Destination, 1983



SOURCE: "U.S. Exports: Schedule E. Commodity Groupings, Commodity by Country,"' Bureau of the Census, Department of Commerce, FT-41O reports, 1984.

ticularly in Far Eastern markets. Within competitive markets, submarkets for foreign range-fed hides and more expensive U.S. hides remain segmented.

Issues

In recent years, several developing countries that had been exporters of raw hides have become net importers, processing these into leather goods for export. Licenses, taxes, and quotas restricting hide exports have been complemented by rebates, grants, and subsidies that encourage processing and leather goods exports. Argentina, Uruguay, Paraguay, Brazil, Colombia, India, Pakistan, and Morocco have all implemented such policies.

Aside from USDA activities, there are no commercially sponsored promotional programs for U.S. cattle hide exports. Trade analysts believe that if exports are maintained at the current level of two-thirds of domestic production, sufficient hides will remain to satisfy domestic demand.

However, domestic leather industry trade associations support the upgrading of hides to semifinished and finished leather products. Increased foreign imports, especially of shoes, have accentuated declines in the tanning and shoemaking industries of the Northeast and Midwest. Negotiations are underway between the Leather Industry of America and the Footwear Industry of America on the one hand, and Japan, Korea, and Taiwan on the other, to decrease imports of further-processed leather products. Although a Section 201 Trade Act case filed by the Footwear Industry of America in early 1984-calling for restricted imports of shoes from Korea, Taiwan, and Brazil —was later rejected by the Reagan Administration, the Textile and Apparel Trade and Enforcement Act of 1986 (HR 1562) includes import quotas on footwear.

On the other hand, there are significant environmental costs associated with leather production. The net expenditure of increased leather production and tanning in the United States includes the cost of managing or eliminating toxic chromium wastes and other pollutants.

Rice

Background

U.S. rice exports increased in volume and value throughout the ***1970s,*** but have declined since 1981 except for a slight rise between 1983 and 1984. Although the United States maintains a top quality rice product, upgraded quality from competing nations has diminished overseas interest in paying the premiums associated with U.S. rice. Furthermore, decreasing oil revenues in oil-exporting markets have slowed the growth of global rice imports.

The four major rice commodities, in order of processing stage, include rough wild rice, brown rice, milled white rice, and parboiled rice. The parboiling process involves a sealing of nutrients, and can be applied to rough, brown, or milled rice. White rice is the end product of complete milling, If exports in parboiled, milled, and brown rice decrease in the future, increased attention may be given to "luxury" submarkets for instant and wild rice.

Recent domestic policy developments may brighten prospects for U.S. rice exports. The "marketing loan rate" system, introduced in the 1985 Farm Bill, allows U.S. rice farmers to repay government loans at international market prices, which are often substantially lower than domestic loan rates. As a result, farmers can sell rice at reduced prices in order to compete in international markets. USDA reports that this program has begun to improve U.S. export performance, but that such changes may not appear statistically until 1987.[15]

Due to an expansion of harvested area, coupled with the "green revolution" that has produced large yield increases, world rice production has nearly doubled since 1970. The global crop of 1984 amounted to approximately 470 million MT of rough rice, over 90 percent of which was produced in Asia. World rice exports constitute only 3 percent of total production. As only one-half of Asian acreage is irrigated, Asian production depends on the timing of the monsoon, and is subject to wide variations. This makes the international rice market highly volatile, which is aggravated by government controls on imports in many countries, and a by limited number of exporters.

U.S. Trade

Thailand and the United States supply about one-half of the world rice trade. In 1985, the United States exported 1.97 million MT of rice, valued at $677,1 million, down considerably from the 1981 peak level of over 3 million MT and over $1.5 million. This has resulted from noncompetitive U.S. prices, which—coupled with quality upgrading of the Thai commodity—have led to a loss in market share to Thailand. With labor-intensive Thai harvesting and production methods, rough rice can be produced at $75 per ton, well below the U.S. cost of production. Unlike Thai rice, however, the U.S. crop is irrigated, allowing for stable production; also, integration of U.S. harvesting, processing, and marketing permits more efficient quality control.

Parboiled and milled white rice have been the two major U.S. export items, with 42 and 37 percent of the 1983 export share, respectively. Brown rice follows with 10 to 19 percent, and rough wild rice constitutes about 2 percent. U.S. overseas sales of parboiled rice have made the largest gains of any rice commodity in the past 10 years, particularly in value.

Compared to 1.7 million MT of rice exports in 1970, the 1985 level represents an increase of 16 percent. Exports comprised about 34 percent of 1984 domestic production. World rice exports totaled 12.5 million MT in ***1984,*** compared to 8.8 million MT in 1970, for an increase of 42 percent; U.S. world market share fell slightly during this period, from 20 to 17 percent (see figure 5-9). In terms of value, this country has increased exports by 121 percent, from $306.2 million in 1970 to $677.1 million in 1985, despite the post-1981 decline. About 20 percent of U.S. exports consisted of food aid to developing countries; Public Law 480 grants accounted for approximately three-fourths of these shipments, and GSM 102 extended credit for the remainder.

The Middle East, Africa, and Western Europe are the largest markets for U.S. rice exports (see figure 5-10). Other growth markets may develop for U.S. specialty products, such as instant rice and wild rice mixtures. While the United States dominates production of these commodities, neither instant nor wild rice stands as a significant export item.

Competitors

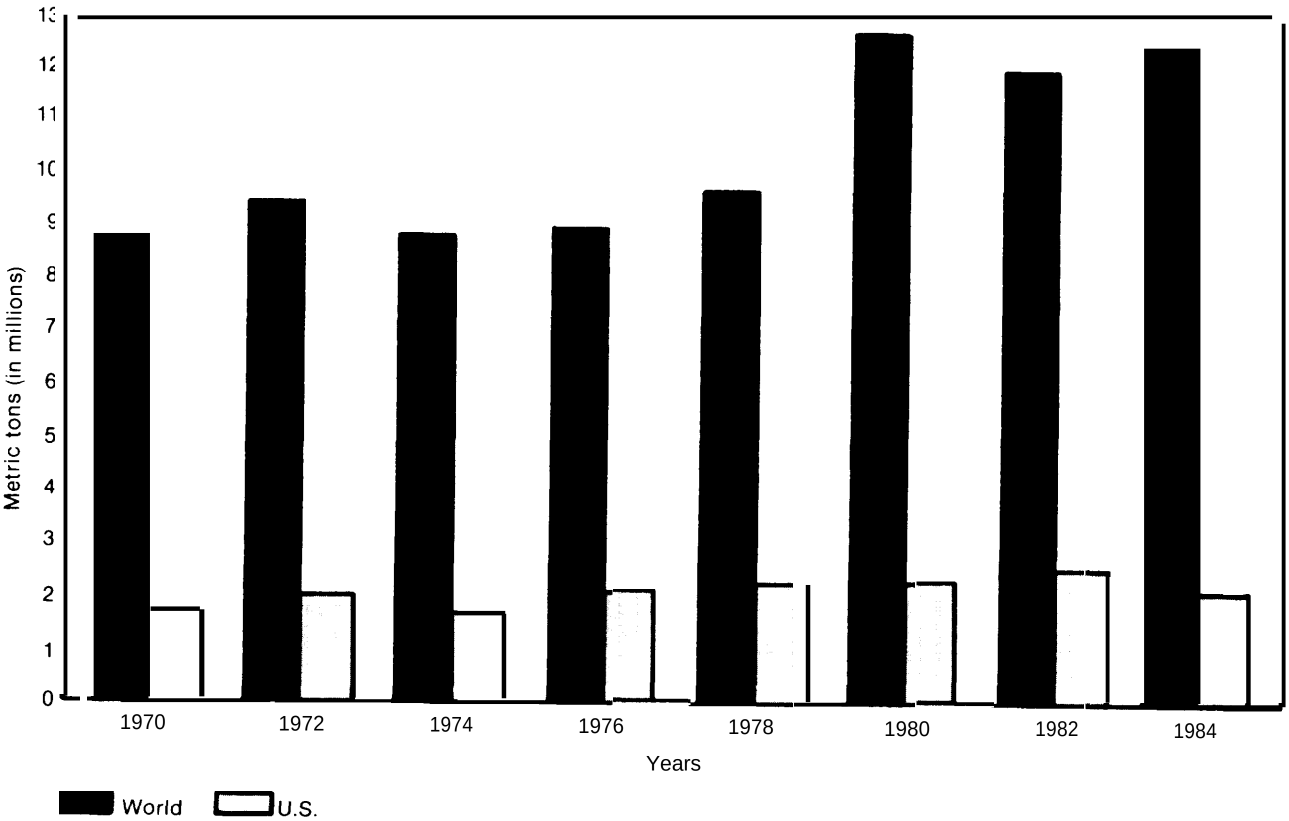
Thailand, the United States, Pakistan, China, and Burma supply three-quarters of the world rice trade. Thailand outcompetes the United States in most Asian markets, competes aggressively in Europe and the Middle East, and has captured most of the South American market, excluding U.S. aid to Peru and some exports to Bolivia.

Issues

High domestic producer prices have been the primary obstacle to U.S. export growth, and the principal cause of large domestic surpluses. Price support levels for rice, established in the 1981 Farm Bill, created a wide differential between domestic and international prices. The 1985 Farm Bill includes provisions that may reduce this problem, such as the new "marketing loan rate, " described previously. However, this program has received extensive criticism from competitors, particularly from Thailand.

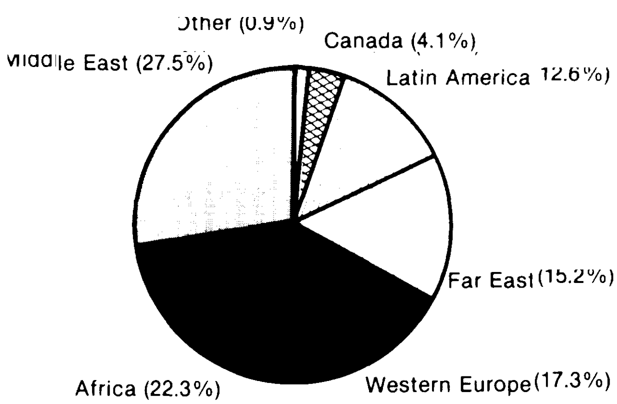
[15] U.S. Department of Agriculture, Economic Research Service, unpublished data.

Figure 5-9.—World and U.S. Rice Exports



SOURCE: *FAO Trade Yearbook,* Food and Agriculture Organization of the United Nations, Vols. 32-38, 1970-19S4, Rome, Italy.

Figure 5-10.—U.S. Rice Exports by Destination, 1983



SOURCE: "U.S. Exports. Schedule E. Commodity Groupings, Commodity by Country, " Bureau of the Census, Department of Commerce, FT-41O reports, 1984,

Corn Gluten Feed

Background

The rising world demand for meat products and meat processing has led to increased imports of coarse grains for feed. Highly processed feeds have enjoyed dramatic export growth in the last decade, under liberal trade conditions. Corn gluten feed, a byproduct of the wet milling process used to produce alcohol fuel, cornstarch, corn syrup, dextrose, and high-fructose syrup, is the most successful U.S. grain-derived export feed. Although the United States has no competitors in the world corn gluten feed market, this product faces competition from other types of high-protein feeds, The United States is the world's leading exporter of high protein feeds excluding soybean meal, receiving $909 million for sales in 1985. The most heavily exported U.S. processed feed commodities are corn gluten feed and meal, other corn products and byproducts, citrus pulp pellets, dried beet pulp, livestock feed preparations, alfalfa hay cubes, and poultry feeds. U.S. feedstuff exports have increased in volume and value over the last decade, and constituted approximately 13 percent of 1985 U.S. coarse grain exports.

The expansion of the EEC'S high-yield dairy industry during the 1970s, coupled with high EEC grain support prices, caused dairy producers to look overseas for inexpensive high-protein feeds. This development was synchronous with the growth of the U.S. high-fructose corn sweetener industry; corn gluten feed has entered duty-free into the EEC since the 1960s. However, shipments to the EEC are expected to decrease throughout the current decade, due to a recent decision to de-emphasize high-yield dairy production, and to a new EEC proposal to place a tariff quota on imported gluten feed.

Because corn gluten feed is a byproduct, some analysts argue that a plateau and possible slowdown in the high-fructose corn sweetener industry would cause an overall decline in wet milling, and a concurrent decrease in corn gluten feed production. Others believe that a plateau in the high-fructose industry will be offset by growth in other industries that require wet milling and produce corn gluten feed as a byproduct. The recent EPA ban on leaded gasoline is expected to foster growth in alcohol fuel use, which should lead to an increase in wet milling. In addition, production of corn syrup and cornstarch is expected to remain healthy. Finally, while high-fructose corn sweetener production has reached a natural peak, it has done so at a high level.

U.S. Trade

In 1985, the United States exported 3.4 million MT of corn gluten feed, valued at $458.8 million. Between 1972 and 1985, exports of corn gluten feed grew nearly 400 percent in volume, or an average annual rate of approximately 30 percent.

In 1983, the United States produced ***3,7*** million MT of corn gluten feed; exports, which stood at 3.5 million MT, represented over 90 percent of total production. Prices were strongest for this commodity between 1976 and 1981, when competitive bidding by the EEC increased its value. Since then, prices have plummeted as a result of reduced EEC demand and price declines in other feeds.

Most U.S. corn gluten feed exports go to the European Community; a small percentage goes to the Caribbean, U.S. producers have begun to seek new markets in Eastern Europe, the U. S. S. R., and the Far East, but no substantial sales to these areas have been made to date. There has also been discussion of sending corn gluten in the form of food aid, to encourage livestock production overseas. The benefits of such efforts should be weighed against potential setbacks to the U.S. livestock export industry.

Issues

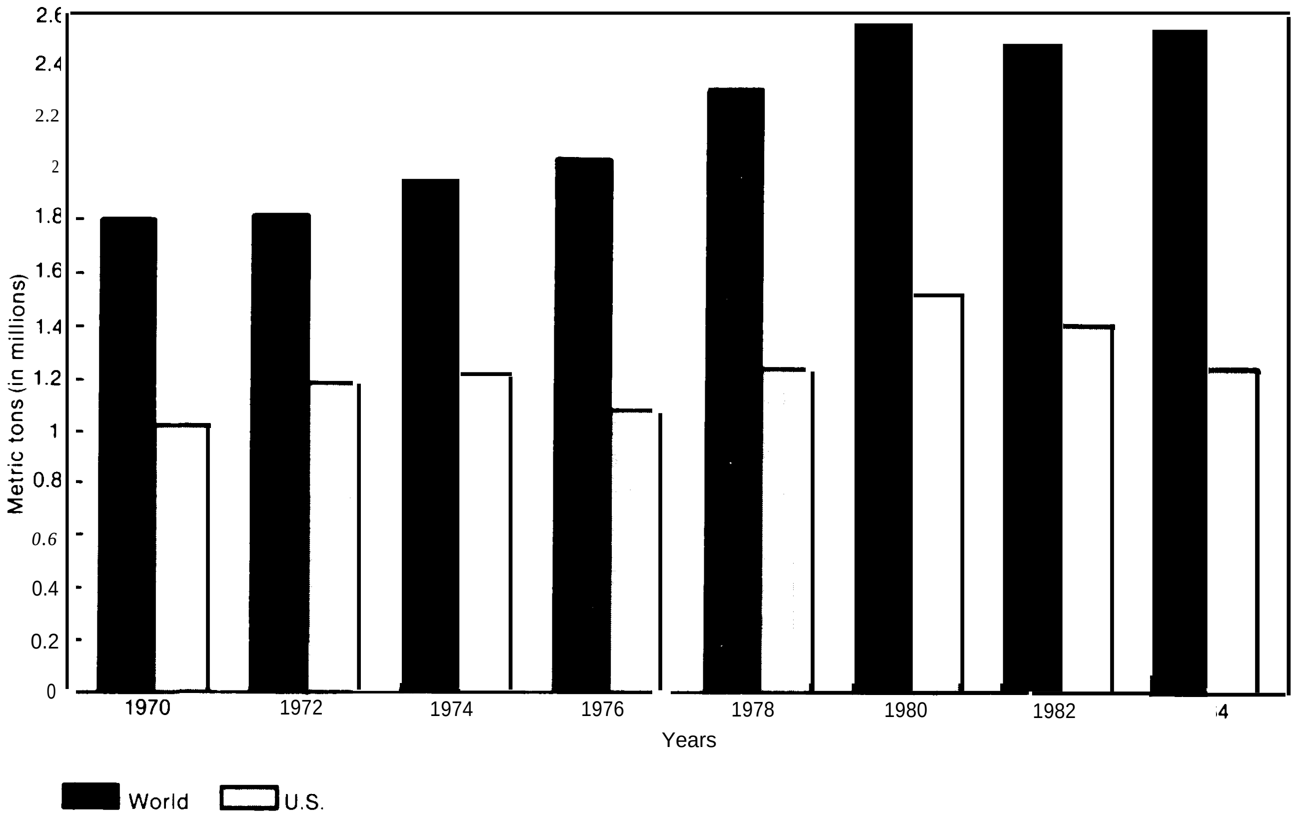
The EEC has recently proposed to cancel the no-tariff GATT agreement regarding corn gluten feed, requesting a "tariff -quota," or a restrictive tariff on annual imports of over ***3.4*** million metric tons. The quota and tariff-free status of corn gluten feed were agreed on under confessional terms during GATT negotiations during the 1960s. The EEC has not met with success in its proposal, and the situation is unlikely to change without major renegotiations.

Tallow

Background

The United States is the leading exporter of tallow, holding at least one-half of the world market share for the past 15 years, although the 1980s have witnessed slight declines (see figure 5-11). However, while U.S. exports have increased in volume with the growth of soap industries in the developing countries of Asia and the Middle East, tallow prices have plummeted. This is primarily a function of substitutability by vegetable oils and petroleum products. U.S. exporters must explore new agricultural and industrial uses for tallow and its derivatives to offset recent declines in export volume.

Figure 5-11.—World and U.S. Exports of Animal Fats (including oils, excluding lard)



SOURCE: *FAO Trade Yearbook*, Food and Agriculture Organization of the United Nations, Vols. 32-38, 1970-1984, Rome, Italy.

Supply of world tallow, a byproduct of beef and other meat industries, depends on trends in world meat production. Trade in animal fats and oils is vulnerable to competition from both natural and synthetic substitutes. Substitution of Malaysian palm oil for soap, and a gradual trend from tallow-based bar soaps to petroleum-based detergents, have combined to depress international tallow and oil prices. Average world prices for tallow, currently 10,5 to 12.5 cents per pound, are the lowest in 10 years.

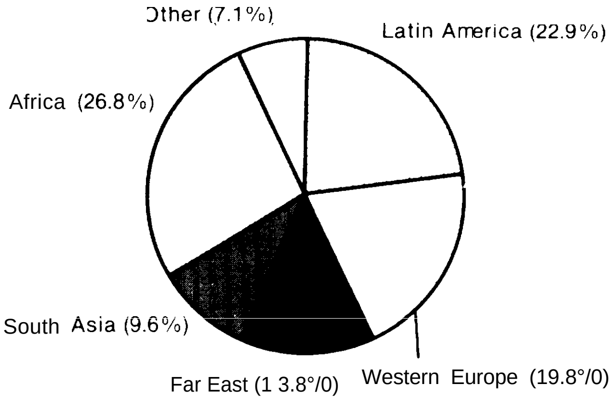
Huge stocks of palm oil, primarily from Malaysia, represent the driving force behind the international price drop. Competition from palm oil is strongest in the developing countries, where foreign exchange considerations encourage the importation of lower cost oils. Moreover, soybean oil competes with tallow in its use as an animal feed enhancer.

U.S. Trade

U.S. exports of tallow, the second most important U. S.- livestock export product after cattle hides, were valued at $542.9 million for 61 million MT in 1985. As noted above, volume increases during the 1970s were associated with expansion of soap industries in developing and newly industrialized countries. Limited overseas supplies have resulted in minimal import restrictions for tallow. Since 1980, however, U.S. volume exports have decreased.

The largest markets for U.S. exports of tallow are found in the newly industrialized countries; top country markets in 1983 included Egypt, Mexico, Pakistan, Korea, Japan, and Colombia. Other markets with high-volume imports include the U. S. S. R., India, Spain, Taiwan, Nigeria, West Germany, Algeria, and El Salvador. As a region,

Figure 5-12.—U.S. Inedible Tallow Exports by Destination, 1983



SOURCE "U S Exports Schedule E Commodity Groupings, Commodity by Country, ' Bureau of the Census, Department of Commerce, FT-41O reports, 1984

the Far East is the fastest growing market for U.S. feed tallow (see figure 5-12 for 1983 regional export shares),

Competitors

West Germany, Australia, and Canada follow the United States in the tallow trade, but these and other competitors hold relatively small world market shares,

Issues

Cattle hides and tallow have enjoyed free access to world markets, with some exceptions. There have been problems in India and Pakistan, where Muslim religious practices mandate the omission of lard from tallow; the EEC has imposed a 2-year quota on tallow, in retaliation for U.S. steel import quotas; and certain countries with fishmeal and other significant protein feed industries have restricted tallow imports.

Only a small amount of tallow is included in U.S. food aid. Programs in 40 countries are currently underway to reduce barriers to U.S. tallow exports, and to promote the diverse uses of tallow. As with cattle hides, the possibilities of further processing of tallow for export are being explored; further-processed products include refined greases and fatty acids. Though some fatty acids are exported from the United States, the majority of developed and newly industrialized countries already possess a domestic production capacity. Tallow as a detergent ingredient may be attractive to developing countries who wish to make the transition from bar to detergent soaps; China has shown some interest in this type of product. A research foundation supported by National Renderers Federation is currently testing new uses of tallow, including the development of emulsions which will reduce evaporation from seed crops and soil.

Beef

Background

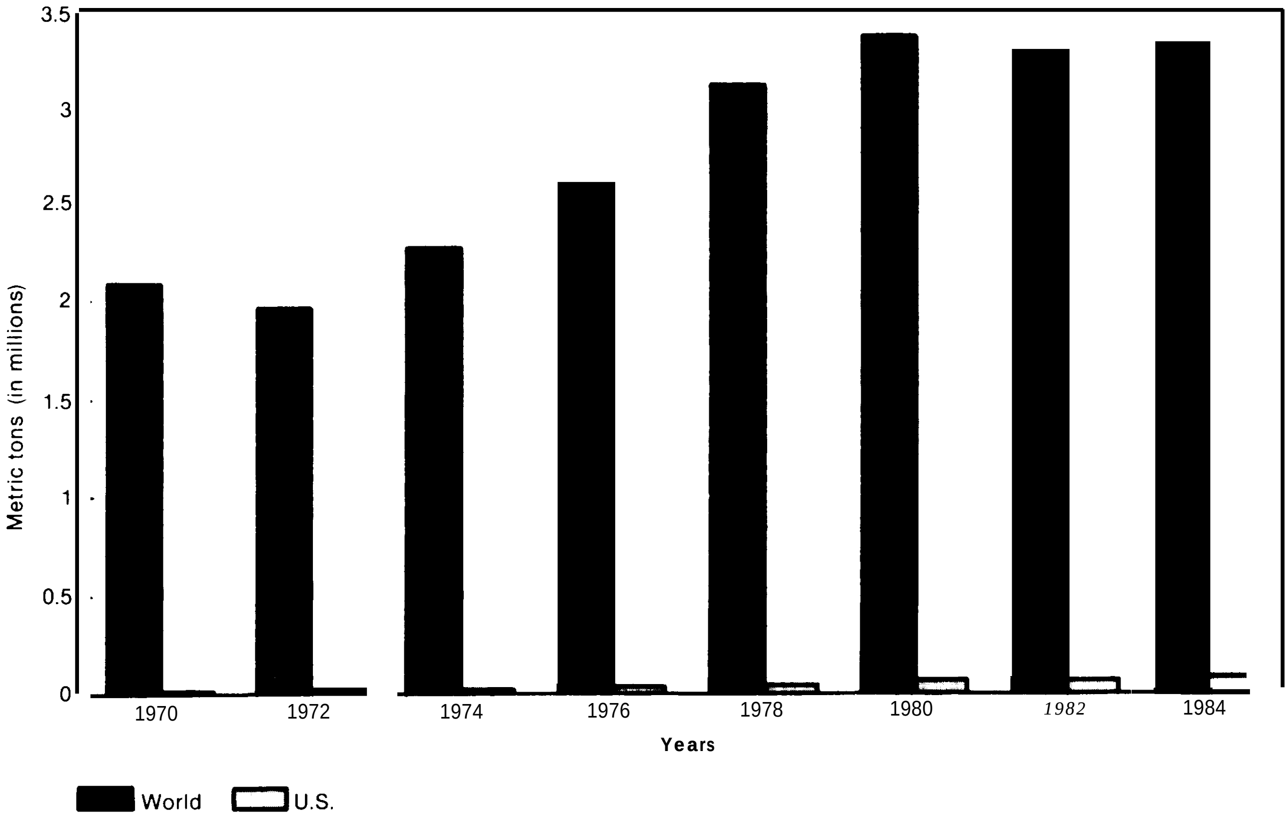
The United States produces a corn-fed, high-quality, marbled beef that is popular in the Far East, and is sought by hotel and restaurant industries in other regions. However, most countries prefer the range-fed, lean beef produced in Australia, New Zealand, the EEC, and South America; this product is gaining popularity in the United States as well. While U.S. exports of beef have risen dramatically over the last decade, the U.S. world market share has remained small. Declining growth in GNP in the developed countries has encouraged imports of poultry and leaner, less expensive beef.

World trade in red meats grew more slowly than that of poultry or feeds during the 1970s, and this trend is expected to continue due to the efficiency and mobility of poultry production. Beef packing is labor-intensive, relative to poultry, although both products are highly perishable.

U.S. Trade

The United States is the sixth largest exporter of beef, following the EEC, Australia, New Zealand, Argentina, and Brazil. In 1985, the United States exported 111,500 MT of beef and veal, valued at $477.5 million. Interestingly, while this country is the leading exporter of high-quality, high-priced, grain-fed beef, it remains the top importer of less-expensive range-fed beef. In ***1985,*** the United States imported $1.3 billion in foreign beef, three times the value of U.S. exports, although the trade balance for beef and veal has improved in recent years,

Figure 5-13.—World and U.S. Beef Exports



SOURCE: *FAO Trade Yearbook,* Food and Agriculture Organization of the United Nations, Vols. 32-38, 1970-1984, Rome, Italy,

In 1970, the United States exported 8,500 MT of beef, including veal, valued at $20 million (see figure 5-13), As evidenced by the 1985 figures, exports have risen dramatically. In terms of market share, U.S. exports constituted 2.9 percent of 1984 world beef trade, compared to 0.4 percent in 1970, representing a 625 percent gain in world market share.

The Far East is the most important regional market for U.S. beef exports, taking 74 percent of the total in 1983 (see figure 5-14). Fifty-seven percent of U.S. exports went to Japan alone in 1983, followed by France at 10 percent, and Canada at 7 percent.

Competitors

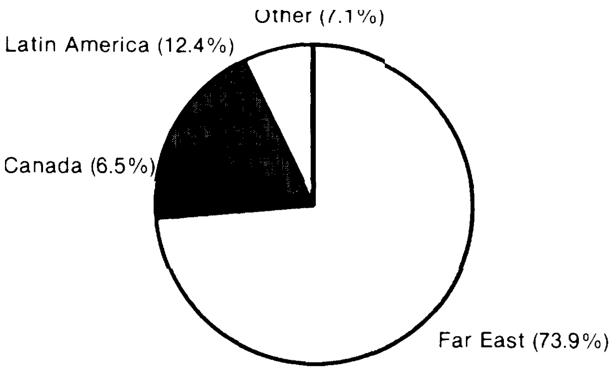
The world's major beef producers hold relatively small market shares, although Argentina and New Zealand have more than doubled their beef exports over the last 20 years, These countries, along with Australia and-Brazil, are the principal competitors in the major U.S. export markets.

Issues

Cordwooding—the export of lower value items, rather than more highly processed ones—is an important issue in beef trade. ” U.S. exports of feed grains, and even of high-value feeds, support livestock production and processing industries in other countries; the United States receives much smaller benefits in economic activity by exporting feed products than would be gained through greater exports of animal products, including beef. Unlike poultry, where successful U.S. exports are

[16]Kenneth C. Clayton and Gerald Schluter, "Cordwooding-Whatfs It Costing Us?" paper prepared for the Southern Regional Association Science Meetings, Knoxville, TN, 1982.

Figure 5-14.—U.S. Beef Exports by Destination, 1983



SOURCE "U S Exports Schedule E Commodity Groupings, Commodity by Country. " Bureau of the Census, Department of Commerce, FT-410 reports, 1984

typically in retail cut parts, most U.S. beef is exported at lower stages of processing. Both Japanese and Western European importers prefer to pay the added freight rates associated with unfinished cuts, so as to break the subprimal pieces into retail or "portion control" cuts domestically. Indeed, job protection and the capturing of the resultant value added is an issue for importing countries; beef value nearly doubles between the subprimal and retail stage. Several nations maintain **3.3** kilogram minimums on their imported cuts of beef, to maintain domestic jobs and to capture the economic benefits of retail meat-cutting.

Some nations without substantial beef industries, such as Saudi Arabia and several Caribbean countries, import larger shares of retail cuts. Retail cuts are also marketed to restaurants in Canada, Europe, and the Far East.

The EEC'S CAP for beef and veal involves price supports and subsidies, as well as import protection in the form of health and sanitation regulations. In Japan, prices are stabilized and beef imports are controlled through quotas established by the Livestock Industry Promotion Corp.; Japanese import quotas have expanded since 1978. The next round of formal beef trade negotiations between the United States and Japan are not scheduled to begin until 1988.

Pork

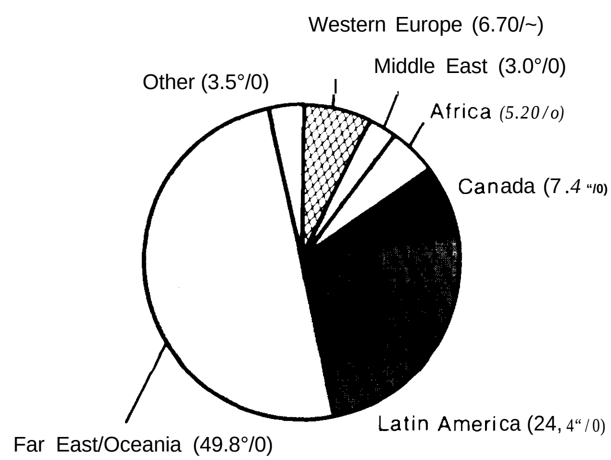
Of the ***6.7*** million MT of pork produced in the United States in 1984, exports represented less than 1 percent of total production. The potential for future growth appears to be weak; in ***1985,*** exports dropped even more, from ***60,100*** MT valued at 137.8 million to 42,600 MT valued at $73.1 million. Japan, Canada, and Mexico represent the top foreign markets for U.S. pork. The United States imported ***$847*** million in pork in 1985, over 10 times the value of exports.

Poultry

Background

The U S. export picture for poultry in the 1980s bears little similarity to that of the 1970s. In the past few years, the United States has lost much of its share of the Middle Eastern market for whole broilers, which had been the largest market for U.S. poultry exports as recently as 1981. Two factors have contributed to this development: competition from the EEC and Brazil, and increased poultry production in the Middle East. If U.S. overseas sales are to return to former levels, marketing efforts could be directed toward export of chicken parts to the Far East and the Caribbean, where transport advantages can be maintained over the EEC. In 1983, 50 percent of U.S. poultry exports were sent to the Far East, 28 percent to Japan alone (see figure 5-15). However, producers in Brazil, the EEC, and Asia are rapidly increasing shares in the parts trade.

Figure 5-15.—U.S. Poultry Meat Exports by Destination, 1983



SOURCE "U S Exports Schedule E Commodity Groupings, Commodity by Country, " Bureau of the Census, Department of Commerce, FT-410 reports, 1984

Poultry is the third most traded meat in the world, after beef and pork. In 1984, world trade in poultry stood at 1.57 million MT, valued at $1.94 billion. Four-fifths of the 1983 world poultry trade was supplied by five countries: France, Brazil, the United States, Hungary, and The Netherlands. Finally, although the value of the world beef trade is about four times that of poultry, the growth rate of poultry trade has outpaced that of any other meat.

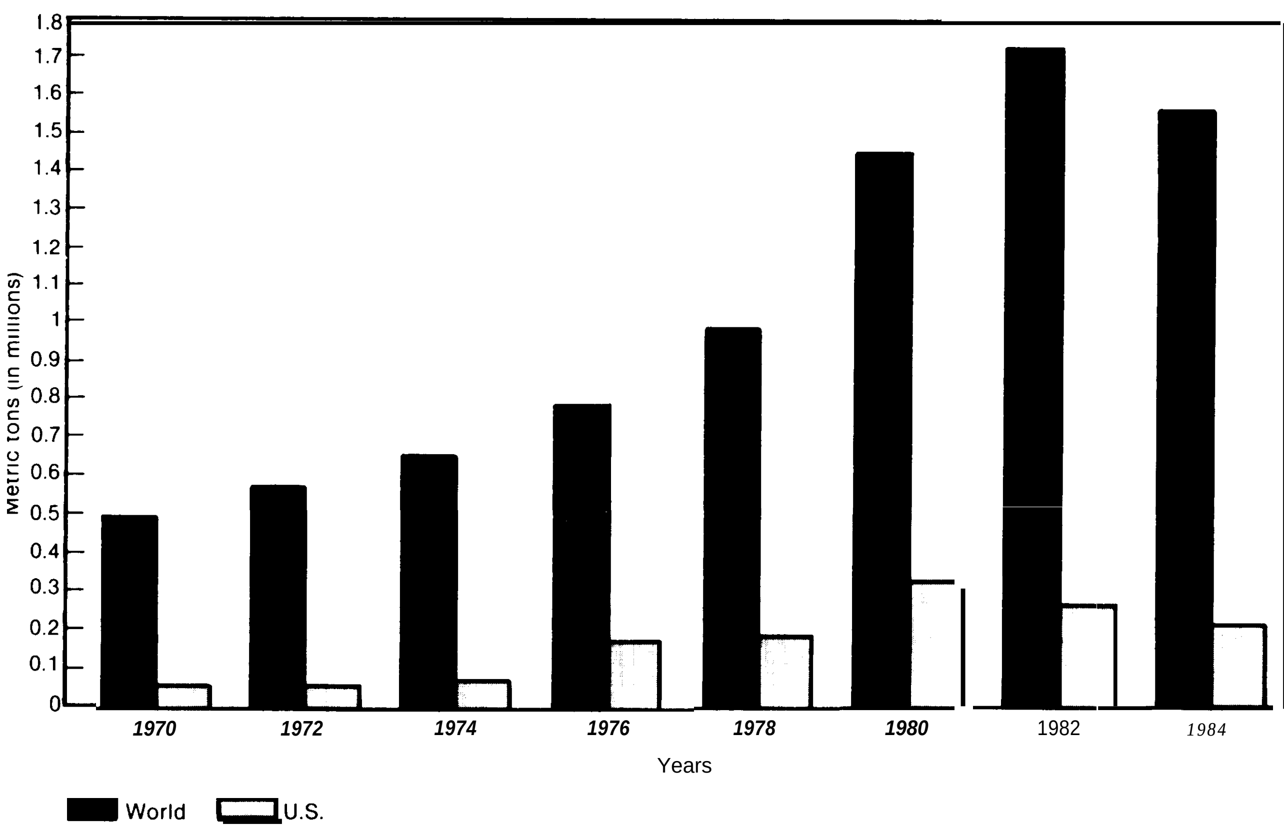
U.S. Trade

The U.S. poultry production process is highly efficient; technological competence in feed production and feed conversion make this industry, in the absence of foreign subsidies, competitive with that of France or Brazil. Still, exports represented only 3 percent of total U.S. poultry production in 1984, which was estimated at 7.5 million MT. Due to the volatile international poultry market, no processing facilities have been built solely for export purposes.

In 1985, the United States exported 234,000 MT of poultry meat, valued at $257.1 million. Cut chickens accounted for 71 percent of export value, followed by whole chickens at 10 percent, cut turkeys at 4 percent, and whole turkeys at 2.5 percent. The United States is the third largest poultry exporter, after France and Brazil. Current statistics may be misleading, however, because the U.S. market share is declining. Poultry exports by U.S. competitors increased at high rates during the late 1970s and early 1980s, while in recent years the entire world market has contracted. Future U.S. export success will depend on its ability to influence policies of other countries, or to develop more successful marketing strategies.

As can be seen in figure 5-16, U.S. poultry exports grew slowly in the early 1970s, but then increased rapidly-by 135 percent between 1974 and

Figure 5-16.—World and U.S. Poultry Meat Exports



SOURCE: *FAO Trade Yearbook,* Food and Agriculture Organization of the United Nations, Vols. 32-38, 1970-1984, Rome, Italy.

1976, and by 73 percent between 1978 and 1980. Between 1970 and 1981, total U.S. export volume increased by over 400 percent. However, export volume dropped considerably after 1981, from 395,500 MT to 233,900 MT in 1985. And even during the high-growth years of the 1970s, the U.S. world market share declined. This can be attributed to the rapid rise of Brazil and France to major world export status.

The huge poultry export gains made by this country in the late 1970s resulted primarily from exports of whole broilers to the Middle East; particularly high volume sales to Egypt occurred in 1981, Although a decrease in exports to the Middle East is projected for the latter part of the 1980s, almost one-half of current world poultry exports are directed to this region. Since 1981, however, the EEC and Brazil have penetrated the Middle Eastern market, virtually excluding American opportunities. As can be seen in figure 5-15, only 3 percent of U.S. poultry exports were sent to the Middle East in 1983.

The best prospects for future growth lie in exports of cut parts to the Far East, where large market size and fast growth exist in tandem. Between 1972 and 1983, the Far Eastern share of the U.S. poultry export market jumped from 27 to almost 50 percent. Although growth is expected to continue, rates will slow, largely as a result of persistent export competition from Thailand, China, and Brazil.

The United States exports cheaper parts, including backs, tails, and necks, to developing countries. Caribbean countries represent the largest markets for U.S. chicken parts, while 24 percent of all 1983 poultry exports were destined for Latin America.

Competitors

During the 1970s, Brazil grew from a poultry importer to the world's second leading exporter after France. The Brazilian drive toward the production and export of HVPS was one facet of an attempt to reduce its balance of payments problems; subsidies for shipping and production have allowed Brazil to become increasingly competitive in the Far East and Middle East, In 1973, Brazil exported only 30 MT of poultry meat; by 1982, exports had jumped to 297,000 MT, although this figure fell to 281,000 in 1985. Still, between 1979 and 1983, Brazil's exports grew at an average annual rate of 88 percent in value. The Brazilian industry was parented by the United States during the 1970s, through exports of both breeding stock and processing technology.

France and Brazil dominate the Middle Eastern market, having taken over the whole-broiler trade in Iraq, Egypt, and the Arabian Gulf. Principal competitors in Far Eastern markets include Denmark, China, and Thailand, with Brazil gaining strength. Thai poultry exports to the Far East are growing at a rate of 94 percent per year, and Brazilian sales of chicken legs to this region are already having an impact on U.S. sales.

Issues

Foreign subsidization is the primary cause of the U.S. market losses during the late 1970s. Most of France's poultry subsidies under CAP have taken the form of capital investments, which amortize over a long period and cannot be easily retracted through policy initiatives. These investments have been enhanced by capital grants to governments in the Middle East for whole-broiler imports.

Many regions of the world have become self-sufficient in poultry production in recent years. High feed conversion ratios, relative to beef or pork, make poultry one of the most efficient sources of livestock protein. Generally speaking, poultry production is the first livestock-producing enterprise that a newly industrialized country will undertake; many former importers developed into exporters during the preceding decade.

In 1981, the National Broiler Council filed a Section 301 petition with the U.S. Trade Representative, who consequently filed a complaint with GATT under the subsidies code, alleging that subsidized EEC exports of whole broilers preempted the United States from participating in important markets. Subsequently, Brazil was charged by the petition as well. The United States maintained that poultry producers in the EEC and Brazil benefited from preferential credit terms, exemptions from income taxes, rural credit loans at reduced rates, and subsidized feed corn for poultry produced for export. Furthermore, the EEC and Brazil employed export subsidies to occupy a "more than equitable share" of the market. By 1983, Brazilian exporters were underbidding U.S. exporters in the Middle East, particularly in Egypt, by $350 to $400 per metric ton, although the United States contends that costs of production are comparable in the two countries. Today, the Section 301 trade petition is still pending.

Both the EEC and Brazil maintain that their policies are necessary to maintain domestic production through managing surpluses, and as a result do not fall under GATT's purview. USDA analysts do not expect a favorable resolution of the case, due to weaknesses in the GATT process regarding the gathering of sufficient litigation data.

The USA Poultry and Egg Export Council is currently matching funds with the USDA for market development, market maintenance, and trade servicing for poultry parts exports. Three out of the five overseas cooperator offices are located in the Far East, reflecting the importance of these markets.

Wheat Flour

Background

Wheat flour is unique in that it is a bag commodity and yet is not produced at port; as a result, the economic benefits of flour exports are particularly high. In 1961, the United States supplied 50 percent of the world's wheat flour exports. The U.S. market share has since fallen, due to subsidized EEC competition and to increased flour production capability in developing and newly industrialized countries. In 1984, the United States held only 15 percent of the world market share, with the EEC capturing nearly 60 percent. While the United States benefits from efficient wheat flour production, a significant proportion of current U.S. wheat flour exports are shipped as relief, under Titles I and 11 of Public Law 480.

Global wheat flour exports are not expected to increase, since most purchasers have the milling capacity to convert wheat to flour themselves. Still, world trade has remained steady over the past 20 years, as production capacity has generally kept pace with population growth.

U.S. Trade

U.S. wheat flour exports have decreased in volume and in world market share over the past 15 years. The United States exported 727,000 MT of wheat flour in 1985, valued at $155.1 million. This represented approximately 3.4 percent of the value of total U.S. exports of raw wheat. In 1970, the United States exported 1.2 million MT of wheat flour (see figure 5-17). Compared to the 1985 figure, exports have decreased by 39 percent over the last 15 years, an average annual decrease of over 2 percent. World trade in wheat flour, on the other hand, increased from 5 million MT in 1970 to 6.7 million MT in 1984, an increase of 26 percent (see figure 5-17). The United States lost over one-half of its world market share between 1970 and 1984, holding 11 percent in 1984, compared to 24 percent in 1970.

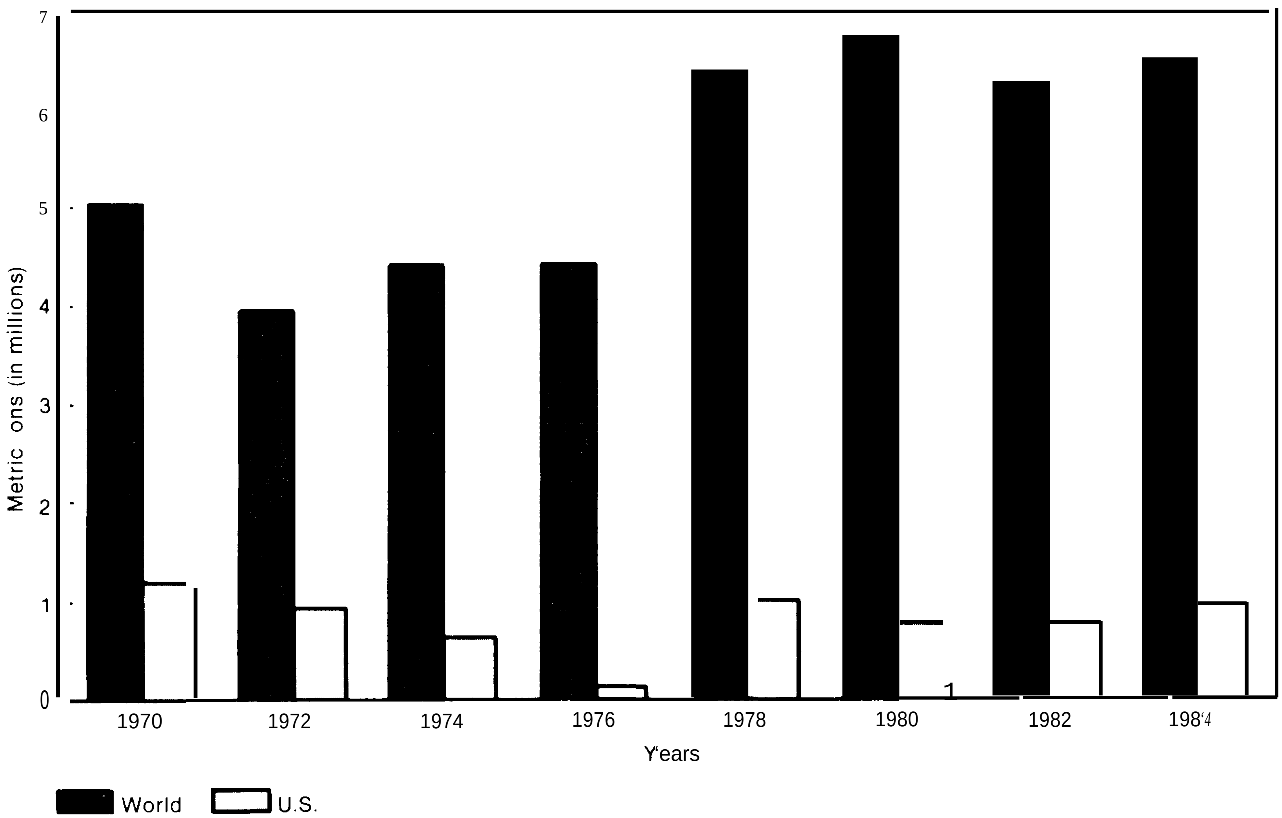
The largest growth markets for wheat flour are developing countries with growing populations that have not yet established milling capacity. The excess capacity available in the developed countries has worked to keep the return on milling small, and in some cases negative; as a result, many developing countries have chosen not to mill. In 1983, 88 percent of U.S. wheat flour exports were destined for Africa, primarily Egypt (see figure 5-18).

North Africa and India are expected to be the major growth markets for U.S. flour exports in the future. In addition, China promises to be a major wheat flour importer, with growing instant noodle and cookie industries in South China and no regional mills to serve them. Japan, however, has gained early entry into this market.

Competitors

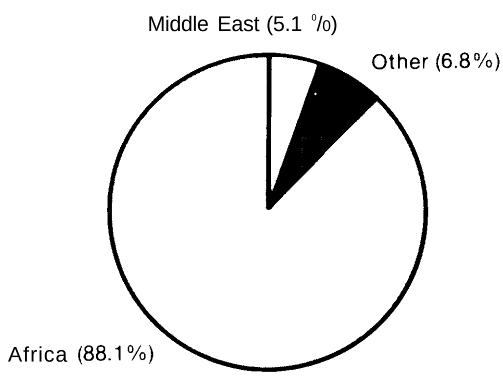
The United States, Canada, France, and Australia are the major exporters of wheat flour, followed by Argentina, West Germany, and the United Kingdom. Processing subsidies along with CAP have allowed the EEC to penetrate most of the world market, although the Egyptian market is a battleground for U.S. and EEC exporters; both countries have employed subsidies to gain shares in Egypt. Also, Japan, which holds only 3 percent of the global flour trade, subsidizes exports and is increasing shares in Far Eastern markets.

Figure 5-17.—World and U.S. Wheat Flour Exports



SOURCE: *FAO Trade Yearbook*, Food and Agriculture Organization of the United Nations, Vols. 32-38, 1970-1984, Rome, Italy

Figure 5-18.—U.S. Wheat Flour Exports by Destination, 1983



SOURCE "U S Exports Schedule E Commodity Groupings, Commodity by Country," Bureau of the Census, Department of Commerce, FT-410 reports, 1984

Issues

Except for trade servicing, U.S. promotional efforts for wheat flour are limited. Blended credit incentives have been rendered inoperative by recent cargo preference rules, which add approximately **$60** per ton to agricultural products financed with government support; effectively, this leaves only Public Law **480** programs intact. Export subsidies-in-kind, or "export PIKs" were applied to flour exports to Egypt for **8** months in 1983, during which time U.S. producers were competitive with the EEC. The Export Enhancement Program (EEP), formalized in the **1985** Farm Bill, has continued this policy, although to a lesser degree; U.S. performance now matches that of most other competitors in world markets, with the prominent exception of France.

Horticultural Products

This section summarizes trade information on major horticultural products, including wine. U.S. exports of horticultural products reached approximately $2.8 billion in 1983, representing a fourfold increase over sales levels of 1972; by 1985, however, horticultural product exports fell to **$2.6** billion (see table **5-2).** Markets for most horticultural products reflect the diminishing dominance of the developed economies, and the growing importance of the oil-exporting and newly industrialized economies.

Fresh fruits represent the major U.S. horticultural export products, accounting for 28 percent of total horticultural export value in 1985. These were followed by tree nuts at ***20*** percent, fresh vegetables at **9** percent, fruit juice at 8 percent, dried fruits at 6 percent, and canned vegetables at 4 percent (see table s-3).

Foreign buyers rarely buy fresh horticultural products with the intent of further processing, due to the high premium involved in maintaining product integrity during transport. Horticultural products are considered to be "quality goods," and can only be imported by nations with comparatively high GNPs and sufficient discretionary incomes. However, as incomes and marketing infrastructure develop in some of the oil-exporting nations and in the newly industrialized countries of the Far East, these nations have become markets of high growth as well.

Fresh Citrus Fruit

Background.—While oranges dominate U.S. fresh citrus fruit exports, the U.S. share of the world orange market has not grown in the past 15 years. The Far East is the largest and fastest growing regional market for U.S. fresh citrus (see figure 5-19); Japan alone received 67 percent of U.S. exports in 1983. Extensive citrus production by Mediterranean growers has reduced the Western European market for U.S. citrus fruit to the status of a low-volume, seasonal importer. Mediterranean production also blocks the United States from Middle Eastern markets.

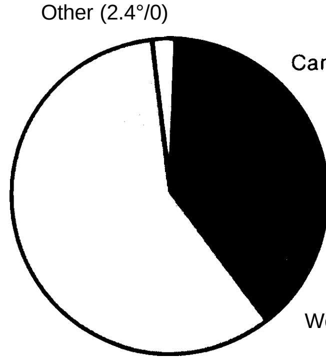
U.S. Trade.—The U.S. share of total world citrus exports has held steady over the past decade, at approximately 12 percent. In 1985, this country exported 768,000 MT of fresh citrus fruits, valued at $426 million; in terms of value, citrus fruit exports represented 59 percent of total fresh fruit exports. Fresh oranges are the leading U.S. citrus export commodity, with 385,000 MT exported in **1985,** valued at **$230** million. Fresh oranges ac-

Table 5-3.—U.S. Horticultural Exports, 1985 (thousands of dollars)

Total horticultural products	2,606,668
Total fruits and prepared, excluding juice	1,002,858
Fresh fruits	725,191
Fresh citrus	425,679
Fresh noncitrus (including melon)	299,512
Dried fruits	164,146
Other prepared fruit	113,521
Fruit juice, including frozen	199,590
Nuts and prep	511,999
Almonds, shelled	316,742
Other nuts	195,257
Vegetables and prep, total	710,721
Fresh vegetables	231,694
Frozen vegetables	91,984
Canned vegetables	99,054
Other, including dried	287,989
Alcoholic beverages	70,445
Wine	23,407
Other	111,055

SOURCE U.S Department of Agriculture, Foreign Agricultural Service, "U S Agricultural Exports, Oct 1980-Sept 1985," August 1988

Figure 5-19.—U.S. Citrus Fruit Exports by Destination, 1983



SOURCE: "U S. Exports. Schedule E. Commodity Groupings, Commodity by Country," Bureau of the Census, Department of Commerce, FT-41O reports, 1984 counted for 54 percent of the U.S. citrus export volume trade. Lemons and limes accounted for 21 percent of U.S. export sales in 1985. Grapefruit is also an important export commodity, with $87 million in 1985 exports, or 20 percent of the value of the U.S. citrus trade; however, grapefruit export share has dropped from its 1983 peak of 26 percent. It is important to note that citrus exports comprise only a small percentage of total domestic production,

In 1983, 58 percent of U.S. fresh citrus exports were destined for the Far East, compared to 44 percent in **1972 (see** figure 5-19). Today, the Far East receives about two-thirds of U.S. citrus exports. Japan is the top market for U.S. fresh citrus products, receiving almost 40 percent of total U.S. fresh citrus exports. Canada is currently the second major country market, holding 25 percent percent of total U.S. exports in 1983. Trade to the EEC is hampered by the proximity of Mediterranean producers, and by preferential tariffs granted by the EEC to these suppliers. Spain, Italy, South Africa, and Morocco are the principal suppliers of fresh citrus to the EEC.

Competitors.—Spain, Morocco, Israel, and the United States are the world's principal orange suppliers, followed by South Africa, Cuba, Egypt, Italy, and Cyprus. The above countries supply approximately three-quarters of world orange and tangerine exports. The United States is the world's leading exporter of grapefruit, followed by Israel; these two countries supply over 80 percent of the world grapefruit trade. Other significant exporters include South Africa, Cuba, and Cyprus, The United States is the second largest lemon exporter, after Spain.

Issues. —Current U.S. promotional efforts for citrus fruit are concentrated in the Far East, where restrictive trade practices still prevail. Japan and Korea maintain quotas on fresh oranges, and high duties are applied to citrus fruit in Japan, Korea, and Taiwan. In fact, Japanese orange quotas have increased over time. Japanese imports primarily occur during the summer, which creates inventory problems for U.S. exporters—cold treatment and fumigation procedures are required for several categories of citrus fruit exports, which are controlled in the Far East through insect and disease quarantines.

Fresh Noncitrus Fruit

Background .—U. S. noncitrus fruit exports comprise almost one-half of total fresh fruit exports; apples and table grapes are the major export commodities (see table 5-4). In 1985, the United States exported 408,000 MT of fresh noncitrus fruit, valued at $319 million.

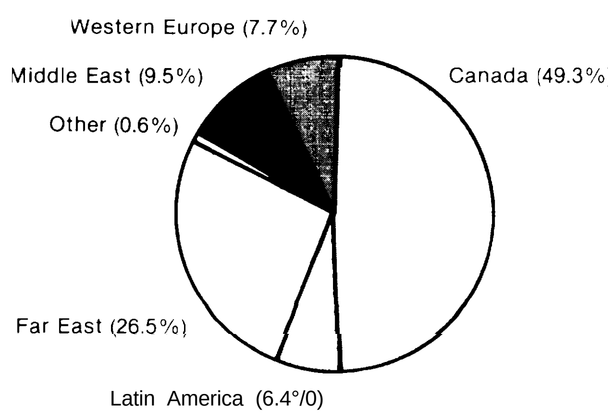
After Canada, the Far East is the major regional growth market for U.S. noncitrus horticultural products (see figure 5-20). Exports to the Far East have almost tripled between 1972 and 1981. Latin America, once a major market for U.S. apples, has fallen off as a result of import restrictions to reduce foreign debt problems. The remaining Latin American importers have turned to South-

Table 5-4.—U.S. Fresh Noncitrus Fruit Exports, 1985 Value (in millions of dollars)

Industry total	$319.0
Apples	108.7
Grapes	73.2
Strawberries	18,5
Prunes and plums	17.1
Pears	15.4
Peaches	14,4
Kiwi fruit	13,6
Cherries	13,3
Melons (not including watermelons, cantaloupes)	10,3
Avocados	8.9
Other	25.6

SOURCE U S Department of Agriculture, Foreign Agricultural Service U S Agricultural Exports, Oct 1980 -Sept 1985, August 1986

Figure 5-20.— U.S. Fresh Noncitrus Fruit Exports by Destination, 1983



SOURCE "U S Exports Schedule E Commodity Groupings, Commodity by Country, " Bureau of the Census, Department of Commerce FT-410 reports, 1984 ern Hemisphere exporters for inexpensive apples. U.S. apple exports to the EEC, while facing increased competition from the Southern Hemisphere as well, have held steady due to increased U.S. promotional programs.

Competitors.—The United States faces heavy competition in the Far Eastern fruit markets from Australia, New Zealand, Israel, Chile, and the EEC, in addition to Far Eastern producers which include Thailand, Taiwan, and China. Grape exports to Canada have faced increased competition from Chile.

Issues.—Import barriers constitute the major obstacles facing entry of U.S. fresh noncitrus horticultural products to the Far East. A high import duty structure constrains the expansion of the Taiwanese market for U.S. products, although duties have been reduced in recent years. Japan uses insect and disease quarantines to limit U.S. fruit imports, particularly of apples and pears. Cherries are permitted limited entry, subject to fumigation requirements. While Korea still imposes heavy restraints, this market is opening slowly. Hong Kong is one of the largest markets for U.S. apples and table grapes. Finally, future technological advances in China may stimulate increased exports, expanding competition in fresh fruit markets in the Far East.

Shelled Almonds

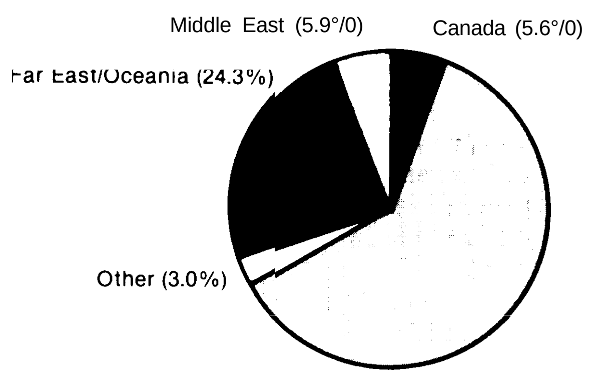
Background.—Shelled almonds are the top U.S. tree nut export, and are among the four highest unit value items described in this study. The United States is the world's top almond producer, followed by Spain; future export growth looks promising, The Far East, though a fast-growth region, holds only a small share of the U.S. export market. In contrast to developments in other U.S. horticultural product markets, the EEC has remained the most significant market for U.S. shelled almonds over the past decade. Spain's entry into the Community, however, may offset U.S. dominance in Europe, forcing the United States to look for new markets in the Far East, the Middle East, and the Caribbean. In terms of value, shelled almonds are the world's leading horticultural export commodity.

U.S. Trade .—Since entering the tree nut export trade in 1971, the United States has become the world's largest exporter, followed by Turkey, Brazil, Italy, and Spain; Brazil and the United States are the fastest growing suppliers. Between 1972 and 1981, U.S. tree nut exports increased annually on average by 20 percent in value and 13 percent in volume. After a brief decline between 1981 and 1983, new peaks were reached in 1985, when the United States exported 222,000 MT of tree nuts, valued at $512 million. Exports of tree nuts have increased faster than any other horticultural export product. Shelled almonds enjoyed continuous export growth between 1970 and 1980, from 27,000 to 81,000 MT—an increase of 200 percent, or average annual volume increase of over 16 percent. Sales fell off to 56,000 MT in 1983, a decrease of 41 percent, but since then this commodity has rebounded to an all-time export high of **185,000** MT in **1985.**

The majority of U.S. tree nut exports are destined for developed economies, and Western Europe is the largest regional market (see figure 5-21). The leading country markets for U.S. shelled almond exports are West Germany, Japan, the United Kingdom, Canada, France, and The Netherlands.

Competitors.—Spain is the second largest exporter of shelled almonds, followed by Italy, Portugal, Morocco, and Turkey. Turkey and Spain

Figure 5-21 .—U.S. Shelled Almond Exports by Destination, 1983



SOURCE: "U.S. Exports: Schedule E. Commodity Groupings, Commodity by Country," Bureau of the Census, Department of Commerce, FT-41O reports, 1984.

are the principal competitors for U.S. almond markets in France and West Germany.

Issues.—The Western European market for U.S. tree nuts is expected to decline with the inclusion of Spain, the world's second largest almond producer, into the EEC. Assuming that Spanish almonds will be included in CAP, tariff protection may bring about increased almond acreage and more intensive, higher yielding production. The Spanish presence could also hurt U.S. almond exports to non-EEC Europe, the United States' third largest regional market; surpluses generated from expanded EEC production may enter these countries at reduced prices. In light of these possibilities, the United States has commenced serious efforts to maintain its European almond export market. A recently concluded U.S.-Italian trade agreement, for example, calls for relaxed import duties on almonds, pending approval from the governments of both countries.

The potential decline of the EEC market has directed U.S. promotional efforts to the Far East, and to other smaller growth markets in the Middle East and the Caribbean. U.S. attempts to develop a market for almonds in the Far East have been successful. The United States is the only supplier of almonds to Japan, and the outlook is good for markets in Hong Kong, Singapore, and Taiwan.

Vegetables

While total U.S. fresh and processed vegetable exports approached ***1985*** fruit export levels in value, there are no single vegetable commodities which match the importance of the leading fruit and nut items. Total U.S. fresh and processed vegetable exports reached $710 million in ***1985,*** compared to $1.1 billion for fruit; the two leading vegetable export commodities, canned corn and frozen french-fried potatoes, were valued at $44.8 million and $40.5 million, respectively (see table 5-5).

Certain vegetable commodities show export promise. For several reasons, however, U.S. vegetables and vegetable products have less potential than do other HVPS. Fresh vegetables, considered luxury foods, are shipped almost entirely to developed countries. These countries are generally located in the Northern Hemisphere, where the climate is comparable to that of the United States. As a result, competition from local or nearby producers is intense, increasing the importance of marketing. In contrast, there are many fruits that cannot be produced in or near major markets.

Table 5-5.— Leading Vegetable Exports, 1985 Value (in millions of dollars)

Fresh vegetables:	
Lettuce	$36.2
Tomatoes	36.0
Onions	27,7
Celery	15.0
Potatoes	13,7
Broccoli	13,6
Asparagus	13.5
Carrots	10.9
Processed vegetables:	
Canned corn	$44.8
French-fried potatoes	40,5
Dehydrated onions	32.7
Frozen corn	21,9
Potato flakes	10.2

SOURCE U S Department of Agriculture, Foreign Agricultural Service "U S Agricultural Exports, Oct 1980 Sept 1985, August 1986

The development of fast food industries, particularly in the Far East, has stimulated some growth in U.S. exports of processed vegetables. U.S. frozen french-fried potatoes show more promise for export growth than any other U.S. vegetable or vegetable product.

Wine

U.S. exports of wine comprise less than 2 percent of total production. Nevertheless, U.S. wines have attained a foothold in the world market over the past decade. Assuming continued success for promotional programs, wine may become an increasingly important agricultural export commodit y.

U.S. exports grew exponentially during the 1970s, but have slowed since 1981. Several factors contributed to this development. For example, the high value of the U.S. dollar was synchronous with the introduction of new, inexpensive wines from Italy and France. U.S. wines are not price competitive with these new labels.

Although several forces continue to impede U.S. wine exports, positive developments are occurring as well. Large crushes in the United States have raised industry concerns about high import percentages, and have increased pressures to export. These concerns have translated into government policy directives; promotional programs have been instituted in high potential growth markets. The Wine Equity Act, which mandates a Presidential investigation of foreign tariffs, was recently incorporated into the Trade Bill and passed by Congress. EEC barriers to imports of U.S. wines were reduced through an agreement signed by the United States and the European Commission in July ***1985.*** The recent Provincial government of Quebec has also reduced barriers.

Canada accounts for one-half of U.S. wine exports. The United Kingdom is the second major market, with a 15 percent share that grew throughout the 1970s, but has since remained constant. The third major market, Japan, promises to be the most significant growth market for U.S. wines. Exports to Japan have grown steadily since 1974, with no slowdowns since 1981; 1983 exports totaled 1.5 million liters, or $2.4 million. Singapore and Hong Kong are among the fastest growing countries for world wine imports.

Appendix

Contributions

Appendix

Contributions

This technical memorandum is the product of several contributing authors. Kenneth A. Cook, OTA, wrote chapters 1-4 and the initial draft of the introduction, drawing chapter 4 from ***The Potential for Technology Transfer of U.S. Agricultural Technology,*** an OTA contract report prepared by Robert E. Evenson, Jonathan Putnam, and Carl Pray, Yale University, 1985. Jamie Grodsky wrote chapter 5, drawing from her 98-page OTA working paper, U.S. ***Trade in High Value Agricultural Products.*** Daniel Chenok, OTA, conducted final research, revision, and editing of the technical memorandum, and worked with Henry Kelly, OTA, and Andrew Wyckoff, OTA, to rewrite and expand the introduction.