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The Role of Quality in Corn Import Decisionmaking

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The Role of Quality in Corn Import Decisionmaking. By Stephanie A. Mercier. Commodity Economics Division, Economic Research Service, U.S. Department of Agriculture. Agricultural Economic Report No. 684.

Abstract

U.S. corn exports continue to dominate the world coarse grain market with little change in U.S. market share. The lack of gains in the U.S. share over the past few decades has renewed interest in the question of whether corn cleaning would help the competitiveness of U.S. grain. Mandating cleaner corn under current production and marketing practices would have little appreciable effect on the market share or value of U.S. corn exports. The bottom line is that the world corn market is functioning fairly well, based on importers' knowledge of the type and the characteristics of corn they generally receive from various exporters. This study focuses on the function of quality in the import decisionmaking process, particularly as it relates to the cleanliness of corn.

Keywords: World coarse grain trade, grain quality, broken corn and foreign material (BCFM), import decisionmaking, end-use characteristics, market segmentation

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Foreword

This report is a product of the International Grain Quality Project conducted jointly by the Agriculture and Trade Analysis and Commodity Economics Divisions of the Economic Research Service. This report concentrates on the role of quality in the international corn market. Other reports will examine the same issue for the world wheat and soybean markets.

The main source of information for this report is a series of case studies on the corn and coarse grain markets and grain import decisionmaking in eight countries. The original case studies are available, upon request, from the individual authors. Countries covered and study participants are as follows:

Egypt--Shahla Shapouri and John Parker
Japan--Lois A. Caplan
Mexico--Constanza M. Valdes and Mark S. Ash
Russia--Sharon S. Sheffield and Roger Hoskin
South Korea--Nancy Morgan and Terri Raney
Spain--Mildred Haley and Mary Anne Normile
Taiwan--Sophia Wu Huang and William Lin
Venezuela--Parveen Setia and Erin M. Dusch

All working papers listed above are available from the Economic Research Service.

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Summary

U.S. corn exports continue to dominate the world coarse grain market with little change in U.S. market share, despite a perception among many importers that U.S. corn is inferior in quality to corn from some other countries. Quality ranks second to price in import decisionmaking, particularly among feed-use buyers. Quality is more important for corn processors, many of whom already purchase high-quality corn under the U.S. system of grades and standards. There was little interest in major importing countries in paying more for U.S. corn with greater cleanliness (or low levels of broken corn and foreign material (BCFM)), or increasing imports of U.S. corn under such conditions. In the present U.S. corn production and marketing system, there is little incentive in the domestic or international market to clean U.S. corn beyond BCFM levels already attained as a result of normal handling.

The determination of the quality of corn traded in the world market encompasses both the underlying conditions and policies of the major corn-exporting countries and the shifting consumption patterns and policy structures in the importing countries. The chief factors affecting quality from the exporter side appear to be the corn drying, cleaning, and handling practices of the various marketing systems; the dominant corn genotypes and adoption of hybrid corn; and the relative incentives between yield and quality created by government policies. On the importer side, quality factors rate as important in imports for food or industrial use; government policies often regulate those imports. For imports destined for feed use, the composition of livestock production, the level of domestic grain production, and producer and consumer support policies have more effect on buying decisions than quality considerations.

This study examines the market structure and import decisionmaking process in key corn-importing countries. Of the countries studied, most import corn primarily for feed purposes, and a few import substantial amounts for industrial processing. Some countries (such as those in Latin America and Africa) use corn as a food staple, but few import corn for that use. The world market's responsiveness to corn quality differs between the two submarkets; food and industrial demand are considered together for the purposes of this analysis. The source of imported corn depends on a number of factors, including price, quality, trade-servicing reliability, transportation costs and convenience, the availability of export credit, and intergovernmental relations. Corn quality is considered secondary to price (and related considerations, such as transportation costs and export credit) in import decisionmaking in most of the markets that predominantly import for feed use. Quality is viewed as most important by importers for food or industrial purposes, which makes up 10-30 percent of total import demand in these eight corn-importing countries.

The level of BCFM ranks high among quality factors listed by both feed manufacturers and corn processors, although for somewhat different reasons. BCFM is a concern to feed compounders because it detracts from grain storability while the presence of BCFM lowers the yield of primary products in corn wet-milling operations. Moisture content helps determine corn storability and the presence of aflatoxin requires care in handling and mixing feed; both of these factors, therefore, are of considerable concern to feed manufacturers. Corn processors are more concerned with intrinsic characteristics of the grain (such as starch content, protein content, kernel hardness, and kernel uniformity).

Despite these concerns, the opportunity to purchase cleaner U.S. corn provoked very little response among major corn importers for the following reasons: (1) U.S.

exports already dominate the world coarse grain market (holding more than half of the world coarse grain market and nearly 75 percent of the world corn market over the last 5 years), (2) relative prices are much more important than quality in the corn feed submarket, which includes at least 70 percent of all imports, (3) many of those importers who are interested in low-BCFM corn already buy U.S. No. 1 or No. 2 corn (with 3 percent or less BCFM content at export inspection), and (4) many of those same importers typically find greater additional breakage occurring in U.S. corn than in corn from other origins between export loading and delivery at processing facilities. In short, importers find the prospect of contracting for lower BCFM corn unattractive given current cleaning and handling practices in the U.S. corn marketing system. Adoption of drying, handling, and shipping practices, or corn hybrids that provide corn with less breakage susceptibility could alter importers' perceptions that U.S. corn typically arrives with greater breakage than corn from South Africa or Argentina, and could make the prospect of purchasing low-BCFM U.S. corn more appealing.

The Role of Quality in Corn Import Decisionmaking

Stephanie A. Mercier

Introduction

The quality of U.S. grain has been a matter of public debate since the mid-19th century, and creation of the first set of uniform grain standards under the U.S. Grain Standards Act in 1916 (Hill, 1990).[1] The lack of gains in the U.S. share of the corn market over the past decades has renewed interest in whether cleaning corn would help the competitiveness of U.S. corn. In the case of corn, grain quality (in particular the amount of *broken corn and foreign material (BCFM)* in U.S. corn), and macroeconomic and commodity policy have been emphasized as factors affecting U.S. competitiveness in the world market.[2] A similar report on the costs and benefits of marketing cleaner wheat has already been issued.

Title XX (Grain Quality) of the Food, Agriculture, Conservation, and Trade Act of 1990 (FACTA) outlines the steps that the U.S. Department of Agriculture (USDA) must take to determine if "establishing or amending the standards would...enhance the competitiveness of exports of wheat, corn, barley, sorghum, and soybeans from the United States." The title also instructs the Administrator of the Federal Grain Inspection Service (FGIS) to revise and, if necessary, establish standards that include "economically and commercially practical levels of cleanliness" if it is shown that the benefits outweigh the costs of imposing such standards, and if other conditions specified in the title are also met.

This study assesses whether additional cleaning of corn would help maintain or even increase the U.S. corn export market share and whether cleaner corn would increase export receipts enough to offset higher net cleaning costs. The report also examines the major players in the decisionmaking process and what factors are considered in the importers' purchase decisions. It also assesses the role of a range of quality factors, especially cleanliness, in purchasing decisions.

Background

While the United States continues to dominate the world coarse grain market, U.S. corn exporters have

[1]Names in parentheses refer to sources listed in the references at the end of this report.

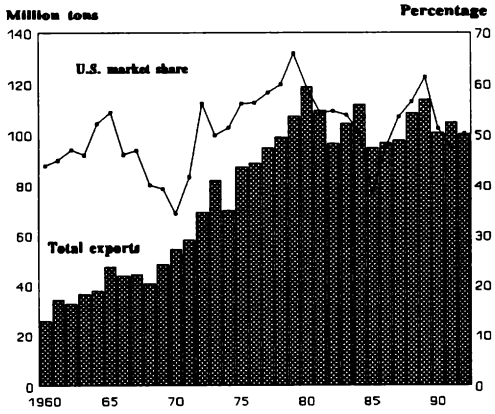
[2]Italicized terms are defined in the glossary.

faced increased competitive pressure over the last several years. The U.S. share of the world coarse grain market has fluctuated since the 1970's after peaking at over 60 percent in both 1979 and 1989 and dropping to less than 40 percent in 1984 (fig. 1). What factors are causing some coarse grain importers to choose alternative sources of coarse grains? This study examines several possibilities: other exporters may offer better prices (including subsidies for feed grain exports competing directly with U.S. corn) or credit terms; shifts in purchasing patterns might stem from perceived or actual quality differences between the various export sources; and changes in consumer tastes, importer policies, or trade agreements could be influencing the grain flow. Macroeconomic conditions, such as the strong U.S. dollar in the early 1980's, and U.S. agricultural policy decisions, such as the high loan rates for U.S. grains, have contributed to the decline in U.S. agricultural exports that occurred in the mid-1980's (Haley, 1989). Given the number and diversity of countries that commonly import corn or other coarse grains (at least 90 countries imported some corn or other feed grains in 1992), it is likely that quality, price, trade measures, and political arrangements are all considered in import decisions. Previous studies suggest that quality is an important determinant of the sourcing decision for corn imports, but always in light of the price/quality tradeoff (U.S. Congress, 1989).

While the mandate for this study, contained in Title XX of the 1990 FACTA, focuses the quality issue very narrowly on the lack of cleanliness (that is, excessive BCFM), cleanliness is only one of many quality factors affecting purchasing decisions. Perceived deficiencies in end-use characteristics (table 1) and a lack of uniformity between and within export shipments have been noted as quality issues in previous studies (U.S. Congress, 1989). This study assesses the factors determining corn-purchasing behavior by foreign buyers, focusing particularly on the role of grain cleanliness (defined in this study as the presence of BCFM, a *grade-determining factor*) in import decisionmaking. Corn quality is generally recognized as a complex issue, but BCFM is a factor that is easily measured and for which there are technical solutions.

This study builds upon a report on the domestic costs and benefits of additional corn cleaning (Lin and Lin). The domestic study evaluates the costs of cleaning U.S. corn to meet tighter BCFM standards and identifies and evaluates the domestic benefits likely from selling lower

Figure 1
U.S. share of world coarse grain market



BCFM corn. That study concluded that cleaning U.S. corn to a low BCFM level (2.5 percent at export or 1.5 percent at other points) is not economically feasible at current market premiums or discounts unless benefits from any potential increases in U.S. export revenue offset the additional net cost of cleaning, which is estimated to be at least $50 million.

This study is based on a series of case studies, in which the market structures and import decisionmaking processes of corn-importing countries were examined. The role of corn quality was examined in that framework, placing quality in the context of a world market that consists of feed demand, industrial demand, and food demand, each potentially embodying a different set of decision criteria. These case studies were integrated with earlier work. Corn quality data collected both within and outside the country studies were examined to provide supporting evidence for the trading behavior observed in this study.

Brief Description of Study

The first section, "The World Corn and Coarse Grain Market," describes the world market setting, including the submarkets for feed, food, and industrial use. It briefly discusses the institutions, programs, and regulations in coarse grain sectors that affect the quality of corn and other coarse grains available for export. This section highlights the relevant features affecting quality in U.S. corn and those of other major exporters, including China, Argentina, South Africa, and Thailand. Extensive use is

made of the survey information collected by the Office of Technology Assessment in 1989.

The second and third sections of this study, "Importers and Import Decisionmaking" and "Quality Comparisons and Prevailing Price Relationships," report on individual case studies of eight countries that currently import U.S. corn (table 2). The countries were selected to represent a cross-section of major importers of corn in order to characterize importer behavior. These studies consist of background material gathered on each country's corn market and the results of personal interviews of corn millers, feed manufacturers, traders, cooperatives or trade association officials, and government officials involved in each country's corn purchasing decisions. These sections draw heavily on both qualitative and quantitative information gathered in these separate country studies, as well as on previous research. This section examines the major components of corn demand--feed, food, and industrial. The examination of major importers' responses is organized around a two-stage purchasing procedure (similar to a standard budgeting process): the first stage focuses on how a country's total feed grain import needs are established, including the general role of quality, and the second stage examines how the country sources its imported grain.

The fourth section "Comparisons of U.S. Corn Performance and Importers' Needs" examines aggregate U.S. corn quality shifts and their implications for the U.S. market. It compares FGIS export data with quality data available from other major exporting countries. The nature of corn market segregation and competition is examined and the effect of cleanliness on U.S. export demand for corn is evaluated, along with potential responses to increased cleanliness by competitors.

Table 1--Major corn quality characteristics

Physical	Wholesomeness	Intrinsic
Broken corn and foreign material	Live insects	Starch content
Heat-damaged kernels	Insect damage	Protein content
Kernel size	Toxic weed seeds	Kernel density
Moisture content	Pesticide residues	Oil content
Total damaged kernels	Mycotoxins (*aflatoxin*)	*Breakage susceptibility*
Test weight	Fungi	Hardness
Stress cracks	Odor	Color

Table 2--Countries featured in individual case studies

Country	Description	Country	Description
Egypt	LI, ME	South Korea	HI, ASIA
Japan	HI, ASIA	Spain	HI, EU
Mexico	MI, LA	Taiwan	HI, ASIA
Russia	L-MI, ASIA-EU	Venezuela	MI, LA

Key: LI=low-income, MI=middle-income, HI=high-income, LA=Latin America, EU=Europe, ME=Middle-East.

The World Corn and Coarse Grain Market

More than 35 countries grow at least 1 million tons of corn.[3] However, corn production remains centered where it began, in the Western Hemisphere. More than 60 percent of the world's output of corn and more than 70 percent of the world's corn trade originates there. Much smaller amounts of corn for export are also produced in Asia, Africa, and Europe (table 3).

While the corn market is not as differentiated as the wheat market, it does have diverse end-uses. Corn for livestock and poultry accounts for just under 70 percent of total world corn demand. A smaller share is used in the food and industrial sectors to produce a diverse group of products, including cornmeal, tortillas, *corn starch, high fructose corn syrup (HFCS)*, and alcohol (see appendix table 1). Those different end-uses create diverse quality needs for imported corn, which is crucial for this study.

Corn for Processing

Corn is processed for human food products and for industrial products in many countries around the world. A fraction of world corn exports is used for these

[3]All units of measure, unless specified otherwise, are on the metric system.

Table 3--Exports and production of major corn exporters (Oct.-Sept. marketing year)

Country	1988/89	1989/90	1990/91	1991/92	1992/93[1]	Five-year market share
	Million metric tons					*Percent*
Exports:						
United States	50.5	60.0	44.5	40.6	44.5	74.4
China	3.7	3.1	6.6	9.3	9.0	9.8
Argentina	2.7	2.9	3.6	5.9	6.7	6.7
South Africa[2]	2.0	2.9	0.7	0.8	0.0	2.0
Thailand	1.2	1.3	1.2	0.4	0.1	1.3
Subtotal	60.1	70.2	56.6	57.0	60.3	94.2
World	65.5	74.4	58.8	61.6	62.3	100.0
	1988/89	1989/90	1990/91	1991/92	1992/93[1]	Share of output exported
	Million metric tons					*Percent*
Production:						
United States	125.2	191.2	201.5	189.9	240.8	25.3
China	77.4	78.9	96.8	98.8	96.0	7.1
Argentina	5.0	5.2	7.6	10.6	11.5	54.6
South Africa	12.4	8.9	8.3	3.1	8.5	15.5
Thailand	4.2	4.1	3.8	3.6	3.6	21.8
Subtotal	224.2	288.3	318.0	306.0	360.4	20.3
World	400.6	462.3	476.9	483.9	528.3	13.7

[1]Figures for 1992/93 are estimates. [2]South Africa was a net corn importer in 1991 and 1992. Source: U.S. Department of Agriculture, Foreign Agricultural Service (USDA/FAS), 1993.

purposes, primarily in developed countries. Corn's use as a staple food grain occurs primarily in the developing world--in the Western Hemisphere (in Central and South America), where the grain originated, and Subsaharan Africa. In countries such as Mexico and Venezuela, corn is ground into flour or meal and used to make low-cost staple food products, such as corn tortillas. In contrast, demand for corn for wet-milling is strongest in higher income countries, where corn intermediate products contribute to industrial processes and to prepared food products (see appendix A for details on corn dry- and wet-milling).

The Livestock Feed Market

Corn is widely used in livestock feed rations because of its wide availability and high energy content. It contains more *metabolizable energy* for both swine and poultry than other feed grains except wheat (and sorghum for swine), and it is usually priced less than wheat. Feed rations for nonruminant animals (like poultry and swine) must have high energy and low fiber content. Both of these attributes are found in corn. The ingredients used in rations for a given livestock type depend on two primary factors: the ingredient's nutritional composition (primarily its protein and energy contents), and its price

relative to other competing ingredients. Corn is one of many feeds farmers and livestock producers can choose for their animals. Thus, corn trade must be examined within the context of its broader markets. The feed grain market consists of trade in corn, sorghum, barley, oats, and wheat. The broader feed market includes many ingredients in addition to grains. These include pasture, roughage, oilseed and animal meals, grain and nongrain byproducts, and cassava (Ash, 1992).

As a grain rich in energy (a feed *concentrate*), corn competes with other feed ingredients for use in the feed rations of the major livestock groups: poultry, swine, and cattle. The major grain used varies considerably throughout the world, depending on such factors as consumer preferences for fat content and skin coloring in meat products, domestic and trade policies for grain and oilseeds, and local availability of different feed ingredients. For example, in the United States, feed grains account for about 73 percent of all concentrates fed. Corn accounts for 80 percent of that total, while protein meals make up only 14 percent of total feed concentrates (Ash, 1992). Some countries feed less grain and more protein meals. In the European Community (EC) (due mostly to the high relative cost of EC-grown grains), about 25 percent of feed rations consist of protein meal. Among grains, barley and wheat are more commonly fed to EC livestock than corn (holding only a 25-percent share), because they are grown more widely in the EC (USDA, Economic Research Service (ERS), Dec. 1992). Livestock producers in Russia include less than 7 percent protein meal in their rations. Sorghum is a common feed grain in Venezuela and Mexico, because corn is reserved (by policy) for human use. Barley is commonly fed in Africa and the Middle East, because it grows best in drier climates. Relative prices of feed grains depend on local production, government policies, transport costs, and tastes.

Contrasts Between Major Exporters

The United States dominates the world export market for coarse grain, normally holding a 60-80 percent share of corn trade and a 50-70 percent share of total coarse grain trade. The exports of major corn exporters typically account for only one-quarter or less of their total domestic supply; Argentina is an exception, exporting just over half its annual output. Corn traded volume dropped by 17 percent between 1980/81 and 1992/93 (excluding intra-EC trade), showing considerable year-to-year variability. Exports increased substantially only for China, a net corn importer in 1980. Exports from South Africa and Thailand declined in recent years, for domestic demand reasons in Thailand and due to policy in South Africa.

Most corn produced in the world is destined for feed use within the country of origin--in fact, a significant amount of corn is fed directly to farmers' livestock. Unlike wheat, corn is not marketed by class for distinctly different end-uses, but the differences between the two major types of corn, dent and flint, sometimes cause importers for food use to prefer white flint corn for its harder endosperm. White flint corn, grown under contract for food use, is believed to be produced on about 500,000 acres in the United States, although no separate data have been available since 1981 (USDA/Statistical Reporting Service, 1982). Among major corn exporters, only South Africa exports large amounts of white corn, because it is generally lower yielding than yellow corn, is more costly to grow, and is demanded less by importers.[4]

Production and Marketing Systems

Corn production practices differ somewhat among the major corn-exporting nations. *Hybrid corn*, which first became available on a commercial basis in the 1930's, had been fully adopted in the United States by the early 1960's (Griliches, 1957; Dixon, 1980).[5] Hybrid seed produces corn with more predictable and uniform quality characteristics than do open-pollinated seed. In China, hybrid corn adoption did not become widespread until the 1970's (Carter and Zhong, 1988).

South Africa produces both white and yellow hybrids (about a 50-50 ratio) using fertilizer and other chemicals. Yields are quite low, however, mostly because average rainfall in its major growing areas is one-third less than in the U.S. Corn Belt (USDA/World Agricultural Outlook Board (WAOB), 1987). In Argentina, hybrid corn is planted. Production is gradually shifting from the traditional flint varieties toward dent varieties, although both are defined in the grades. In Thailand, reliance on scattered monsoon rains and the greater cost of hybrid seeds (300 percent higher than open-pollinated seeds)

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[4]In 1991/92, U.S. white corn exports were about 500,000 tons (USDA/Agricultural Marketing Service (AMS), 1992).

[5]Hybrid corn is inherently more productive than open-pollinated varieties, and responsive to higher rates of fertilization, higher plant populations, and other new cultivation practices.

have slowed the adoption of hybrid corn, now accounting for about half of planted area (Schwartz and Brooks, 1990). Corn grown in Thailand is typically hard, yellow flint corn.

The differences in handling and marketing practices used by major exporters have large effects on differing corn quality for export, since production practices are quite similar. Most of the major corn producers except China use similar soil preparation and cultivation practices and similar harvesting technology (such as self-propelled combines). Two key differences are corn moisture content at harvest and steps taken to reduce the moisture level. U.S. and Argentine corn is typically harvested at high moisture content (20-30 percent) and dried to more storable levels (14-15.5 percent). About half of U.S. corn is dried onfarm, while in Argentina most drying takes place at the country elevator. Moving corn quickly from field to storage or to market is a priority for corn farmers, so U.S. farmers usually operate their driers at high temperature (with rapid cool-down) to reduce drying time. Excess drying heat is a top contributor to stress cracks and corn breakage. Other problems such as heat-damage and reduced milling yield also result from this practice. There is, however, some movement in both countries toward using noncontinuous systems (such as combination drying, which involves high temperature initially, then air drying to remove the last few percentage points) which reduces breakage susceptibility. There is also an effort underway in the U.S. system to spur adoption of specific genotypes, which are easier to dry and less prone to crack (U.S. Congress, 1989).

In South Africa and Thailand, grain driers are rarely used, as corn is dried in the fields. In Thailand, the resulting higher moisture content of their corn and a more humid climate increase their corn's susceptibility to aflatoxin (Schwartz and Brooks, 1990). Most corn is field-dried in South Africa before it is harvested. In addition, dry weather typically continues after harvest, thereby allowing additional ambient air drying. The South African climate reduces problems (such as aflatoxin infection) that may occur in other climates during field-drying. Large-scale drying facilities are rare in China but some natural-air drying occurs when farmers store ear corn in traditional wicker storage bins, which allow good air circulation. As a result, Chinese corn exports appear to average slightly lower moisture contents than U.S. corn. The shortage of modern combines also reduces breakage in Chinese corn. More grain-drying facilities are now being built in both Thailand and China.

The number of times corn is handled during marketing and the method by which it is moved also affect its breakage susceptibility. Even within a given marketing system, corn moved by barge typically experiences more breakage than corn moved by rail or truck, since barges are not gravity-unloaded. Grain in barges also seems to be more susceptible to insect and mold damage, because it spends more time in transit, and the barges often have a less even moisture distribution than rail cars. The difference in moisture distribution arises because river grain facilities usually have fewer storage bins to separate out grain on the basis of moisture content than do country and subterminal elevators that load *hopper cars*.

The United States and Argentina deliver corn for export to country elevators and then move the corn through the system to export facilities. Most U.S. corn destined for export moves to *export elevators* via barges on the Mississippi River system to the Gulf of Mexico, since the Midwest produces around three-quarters of all U.S. corn (USDA/National Agricultural Statistics Service, 1992). Argentine corn moves from country elevators to export facilities by truck (or rail if exported from Buenos Aires). South African corn moves to market by truck. Both the Argentine and South African distribution systems have fewer intermediate points and less handling than the U.S. system. In Manchuria, the largest corn-producing region in China, corn is delivered primarily by truck to grain stations along the central rail lines and is shipped by rail to the chief port of Dalian. Most corn in China is bagged in burlap sacks and moved on open rail cars to export facilities, although some hopper cars are being acquired for bulk shipping.

The United States and Argentina are also major exporters of other commodities (notably wheat and soybeans), so their production and distribution systems are quite extensive. A significant drawback to the Argentine system is that it has relatively little storage capacity, which limits its ability to export corn at times other than immediately after harvest (March-May). The storage situation could change as the system is transferred to private hands, following the 1991 dissolution of the state grain board, the Junta Nacional de Granos (JNG). The limited storage situation has one advantage for Argentina, in that its corn is less likely to be broken in storage. The South African grain distribution system (both storage and transport) is considered to be efficient by world standards.

The Thai and Chinese transportation systems affect their ability to compete in the world market. Both countries'

transportation systems best serve nearby markets, and their small vessels are highly suited to many Asian ports. However, the shallowness of Thai ports and their inability to fully load large vessels offset some of their competitive edge in markets outside of the Pacific Rim (Schwartz and Brooks, 1990). Improving China's inefficient rail system could result in reduced corn exports, because it might become cheaper to ship internally than to export it.

Effect of Government Policies on Corn Quality

Government policies in many corn-exporting countries (notably in the United States and China), encourage the production of corn. However, governmental support has focused on increasing yield (through price supports for U.S. corn and input subsidies for Chinese corn) rather than expanding corn cropland. World corn planted area has risen less than 0.5 percent since 1980. Among the major corn exporters, planted area apparently expanded steadily in China until 1991 and in the last 3 years in Argentina. Price supports are used in the United States and Thailand and were used in the 1980's in South Africa and Argentina, although the offsetting use of export taxes effectively penalized Argentine corn producers (Webb and others, 1990). The current transition in China, from a command to a market economy, also changes the incentives for producers in grain-surplus areas. Producers may now sell corn to domestic customers on the open market for cash rather than to the government for IOU's, which may reduce farmers' need to seek to export to earn hard currency. Since 1980, all of these policies have contributed to raising average corn yield in all major exporting countries except South Africa. Most policies tend to emphasize yield over quality, such as in U.S. grain programs (see box).

No major corn-exporting country currently uses explicit export subsidies to sell corn on the world market, although competing grains, such as barley and feed-quality wheat, are sold under subsidy by the EC and the United States. China and South Africa are the only major corn exporters with monopolistic state trading agencies. The pricing policies of *CEROILS*, China's state trader, are not entirely transparent to other exporters. In 1992, private trading of Chinese corn for export began on a small scale. The South African Maize Board still handles 90 percent of the annual crop (and all export corn), although producers in certain areas are permitted to market domestically on their own behalf. The South African Government, through its Maize Board, establishes producer prices that once were sometimes above world levels, although the recent introduction of a sliding scale has reduced the Board's reliance on this instrument for export. U.S. corn (and sorghum) exports are promoted in some markets through the assistance of export credit guarantee programs (GSM-102 and GSM-103). To some extent, the use of subsidies or export credits to assist exports reduces the need of traders to use quality as a marketing tool (Larue and Lapan, 1992). Food aid programs are not typically used to promote corn exports, as corn is most often used as a feed grain. Most corn food aid goes to noncommercial markets in times of severe crop shortfalls. Between 1988 and 1990, corn exported under all U.S. food aid programs accounted for less than 3 percent of total exports (USDA/ERS, 1988-90).

Regulations on plant breeding practices often affect corn quality. While plant breeders focus primarily on yield, they also focus on such characteristics as breakage susceptibility, starch content, and disease resistance. Large multinational companies distribute much of the world's hybrid corn seed. Argentina controls variety release through a mandatory licensing mechanism, but the committees that examine potential varieties focus primarily on yield and disease resistance. In China, the central government, for the most part, still controls the sale of purchased agricultural inputs, including hybrid seed. China's extension service develops new varieties, but the varieties are developed for the growing conditions in northeast China, which is the main corn-growing region. This creates greater genetic uniformity in Chinese corn but greater susceptibility to weather shocks. The South African Maize Board provides financial support to projects that study corn quality and conducts quality testing during the marketing season. The South African Ministry of Agriculture and the private sector both carry out research. The dominant use of open-pollinated varieties in Thailand precludes much quality control through plant breeding, although efforts by the Thai Ministry of Agriculture to encourage adoption of hybrid genotypes have been succeeding slowly. None of the major corn exporters regulates the release of corn hybrids based on end-use performance.

In the United States, plant breeding is conducted both in the agricultural experiment station system and by private seed companies. U.S. breeders typically focus on improving corn yield, disease and pest resistance, and harvesting ease; less attention is paid to improving quality factors. Some recent breeding work has produced waxy corn (for higher starch yield in wet-milling), high-lysine corn, and corn with reduced breakage susceptibility (Paulsen and others, 1989). Few rules govern the release

Effect of U.S. Commodity Programs on U.S. Corn Quality

Many aspects of the U.S. commodity programs tend to encourage farmers to emphasize crop yield over crop quality. In the mid-1980's, U.S. corn producers could enter their grain into government stockholding programs for payments (nonrecourse loans or Farmer-Owned Reserve) without suffering market-based discounts on lower quality grain.

One domestic remedy for the emphasis on yield has been to provide end-use based premium and discount schedules for grain entering government programs, so the government does not always serve as the chief outlet for low-quality grain. USDA regulations currently assess discounts based on the grade-determining factors as well as moisture and mixed corn and market discounts prevailing in the previous year (USDA/Commodity Credit Corporation, 1993). U.S. No. 1 corn receives a small premium and corn that is U.S. No. 3 or lower receives discounts. Other changes have been adopted to discourage the movement of low-quality grain into government stocks. These actions have not been major factors since activated, however, because low levels of stocks and high market prices have precluded much grain forfeiture.

U.S. government programs tend to encourage farmers to achieve high yield rather than maintain consistent quality attributes. For example, a target price for corn of $2.75/bu, in effect guarantees farmers a given return for a significant portion of their crop regardless of market conditions or the crop's quality. The mandated set-aside also encourages farmers to take their poorest land out of cultivation and concentrate their attention on boosting yield on the remaining acres. The freezing of program yields that occurred with the 1985 Food Security Act reduced the incentive of farmers to continue boosting yields at the expense of all other factors, but no aspect of U.S. programs explicitly encourages U.S. farmers to enhance the quality of their grain.

of new U.S. corn varieties, except State seed laws that require that varieties or hybrid genotypes be accurately identified on seed bags. Title XX of the 1990 FACTA requires that grain submitted for public testing be evaluated on specific agronomic and end-use factors and that results be disseminated to interested parties.

The quality standards established by the U.S. Government in the grain grades and standards serve as a benchmark for most corn contracts (see appendix table 5). All major corn exporters have quality standards, but factors included vary considerably (U.S. Congress, 1989; Bender, Hill, and Valdes, 1992). These standards have some combination of broken corn and foreign material (or impurities) in common, but no other universal factor exists (see appendix table 6). While the U.S. system has five grades, other major exporters have two or three different grades. This indicates a greater distinction between the grades, which in turn encourages importers to buy the highest graded corn from these countries. All U.S. grain exports must be officially inspected and graded based on U.S. grades and standards, and be tested for aflatoxin. This testing was mandated after the 1988/89 crop year, in which some drought-stressed corn in the Midwest was contaminated with aflatoxin. Since BCFM is a grade-determining factor for U.S. corn, corn is often cleaned at each elevator level to keep BCFM below the grade limit, as handling typically causes more breakage. The domestic study found that about 65 percent of U.S. elevators handling corn have cleaners (Lin and Lin).

Argentine grain inspection became optional with the end of the Junta, and private surveyors now handle most inspections. Argentine corn is usually cleaned both before being dried and during loadout, and South African corn is cleaned upon arrival at export and just before loading onto ships. China possesses grade standards, but export grain is rarely graded.

Importers and Import Decisionmaking

The world's corn and coarse grain exporters create a package of characteristics among which importers must choose. Each trade made implies that buyers have chosen based on an array of factors that characterize a transfer of grain, including the price and quality of the grain and how reliably and rapidly delivery is completed.[6] Quality, among the various factors considered by importers, is usually second to price as a determinant of source of corn or coarse grain purchases. Differing uses for imported corn (feed, food, or industrial) result in importers' preferring different combinations of quality characteristics.

Eight country case studies were conducted of major importers of U.S. corn (table 4). Examining the market structures and buying practices of these countries reveals how the world corn market might respond to changing the price and quality of U.S. corn. These eight countries are the largest importers of U.S. corn (accounting for 80 percent of total U.S. exports), and represent different income levels of importers and corn end-uses. Four of these countries have been importing more corn since the mid-1980's (Venezuela, Japan, Korea, and Taiwan), and the others have been importing less. With the ratification of the North American Free Trade Agreement (NAFTA), Mexican imports are expected to increase. Spanish extra-EC imports are limited by a reduced-levy quota.

A series of interviews conducted in-country by a team of ERS analysts formed the basis of each country study. Guidelines were formulated with the help of experts in the U.S. grain trade and were tailored to the importer's situation with input from U.S. Embassy and trade association officials. The interviews were designed to promote understanding of the respondents' roles in import decisionmaking, to identify the key factors entering that decisionmaking process, and to explore their views of the relative quality performance of U.S. corn with respect to the desired set of factors for end-products. The importance of BCFM was examined within the matrix of decision criteria and potential quality factors. Table 5 gives a summary of results.

This section of the report consists of three major parts: (1) identification of the major users of corn, such as livestock producers, feed compounders, corn processors, and traders, and their influence over quality specifications in export contracts; (2) the composition of domestic consumption and policies that affect import volume determination; and (3) the factors, including price, credit, trade-servicing relationships, and quality, that influence grain import sourcing.[7] At the risk of oversimplification, decisionmaking is evaluated within the structure of a two-stage purchasing procedure (Hjort, 1988).

First, the government or the private sector estimates import needs by forecasting domestic corn and feed grain production (if any) and consumption. These levels may be affected by government intervention, so relevant policies are examined. Import needs are tailored to end-users' demands, within financial and policy constraints and import priorities.

Second, import needs are met by selecting the type(s) and source(s) of feed grains. The import decisionmaking framework incorporates elements such as price offered (and related factors such as export credit and transportation costs), grain quality, trade-servicing reliability, and presence of trade agreements or political ties with some exporters. The importance attached to each element varies among importers and types of end-uses. Importers for feed purposes implicitly add an intermediate step, deciding which particular feed grain type to seek.

Quality Comparisons and Prevailing Price Relationships

Most buyers in the eight case study countries regarded the price of imported corn, not quality, as the most important criterion, although Spanish importers regarded the EC-U.S. Enlargement Agreement to be most important.[8] Although quality and price are examined as separate

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[6]Though not couched in these terms in the interviews, buyers really judge in terms of a price-value tradeoff.

[7]In market economies, the decision on how much to import in a given year is made individually by traders and corn end-users, but can be aggregated over all firms to yield total import demand for that country.

[8]The EC-U.S. Enlargement Agreement, implemented in January 1987, provides reduced-levy access to non-EC imports of at least 2 million tons of corn and 300,000 tons of sorghum into Spain. It occurred after U.S. complaints to the General Agreement on Tariffs and Trade (GATT) about loss of access to the Spanish market after Spain's entry into the EC in 1986. This access is not limited to U.S. corn and sorghum, but the calendar-year nature of the agreement and seasonal marketing for Argentine corn tends to favor U.S. grains.

Table 4--Summary of national corn sectors in study

Country	Respondents interviewed	Interviews represent percent of import market	Per capita consumption[1]	Domestic production[1]	Trade/domestic policies	Total imports[1]
	Respondents	*Percent*	*Kilograms*	*Million tons*	*Policies*	*Million tons*
Egypt	7 traders 1 government 6 private 1 poultry producer 1 feedlot operator 4 government officials	99	107 feed 20 food	3.78 white 0.95 yellow	Feed subsidy until 1988; minimal government procurement input subsidies	1.5
Japan	6 traders 4 feed processors 1 starch processor 1 starch industry association representative 2 vegetable oil producers	100	97 feed 38 industrial	.002	Only licensed feed mills can import corn duty-free; Tariff-quota on nonfeed uses; Starch manufacturers must buy domestic potato starch in order to import corn for starch production duty-free	16.4
Mexico	3 traders 1 wet-milling association 4 wet-millers	75 (wet-millers)[2]	173	14.10 white	Import licenses, price supports	1.8
Russia	1 state trader 1 government official 3 officials representing 20 feed mills	100	68	3.3 (1986-90 average)	State trading and procurement system; limited private activity	5.5 (1991)

See footnotes at end of table.

Continued--

Table 4--Summary of national corn sectors in study--Continued

Country	Respondents interviewed	Interviews represent percent of import market	Per capita consumption[1]	Domestic production[1]	Trade/domestic policies	Total imports[1]
	Respondents	*Percent*	*Kilograms*	*Million tons*	*Policies*	*Million tons*
Spain	4 private traders 1 cooperative 1 wet-miller 2 feed manufacturers	83	108 feed 20 FSI[3]	2.8 (1990-91)	Reduced-levy quota of 2 million tons of corn imports; Production quota for HFCS; High support prices for all grains, export subsidies under CAP, and variable levies for over-quota imports	1.7 (1990-91 average)
South Korea	2 feed mills 1 wet-mill processor 1 livestock cooperative 1 trader 1 feed grain association	95	3 FSI	.09	Support for domestic producers	6.95
Taiwan	6 feed mills	15	273 feed 7 other	.40	Guaranteed price for domestic producers (NT15/kg.)	5.47
Venezuela	2 associations 3 traders 3 feed processors	46	30 feed (yellow) 57 food (white)	.05 yellow .98 white	Minimum import price, 15 ad valorem tariff	.48 (1990-91 average)

[1]Production, consumption, and import figures are from 1992, unless specified otherwise. [2]Interviewees included corn wet-millers who represent 75 percent of Mexican wet-mill market. [3]FSI is food, seed, and industrial use of corn.

Table 5--Summary of country interview results

Country	Market shares[1]	Use breakdown	Sourcing factors[2]	Quality factors[2]
Egypt	U.S. 73% Argentina 12% EC 4% Other 11% (1991-92 average)	Feed 82% Food 12% Industrial 4% Seed 1% (1992)	Price Quality Source diversification	Kernel size/uniformity Broken corn Insect damage Foreign material Aflatoxin/weed seeds
Japan	U.S. 85% China 8% South Africa 5% Argentina 1% (1989-91 average)	Feed 72% Industrial 28%[3]	Price Quality Trade servicing End-user needs Safety	BCFM Crude protein Moisture Starch Hardness/breakage
Mexico	U.S. 90% Argentina 5% S. Africa 5%	Food 75% Feed 12% Industrial 6% Others 7%	Price Credit Trade servicing Quality	Aflatoxin BCFM Moisture
Russia	U.S. > 90%	Feed 85-90% Industrial 5-10% Food 5%	Credit availability Price	BCFM (especially dust) Moisture Breakage susceptibility Aflatoxin Noxious weed seeds
South Korea	U.S. 24% China 61% (1991)	Feed 80% Industrial 20%	Price Quality Credit availability Service reliability	BCFM Starch yield
Spain	U.S. > 90%	Feed 84% Industrial 16%	Enlargement Agreement Trade servicing Quality	BCFM Moisture Hardness Heat damage
Taiwan	U.S. 95% S. Africa 3% Argentina 1%	Feed 97% Others 3%	Price Quality Reliability of supply	Moisture Aflatoxin BCFM Crude protein
Venezuela	U.S. > 90% Argentina < 10%	Feed 90% Food 10%	Price Timely, reliable supply Trade servicing Quality	Moisture BCFM/aflatoxin Crude protein

Note: Self-sufficiency ratios shown in table 8. [1]Market share figures are from 1992, unless specified otherwise in table. [2]Sourcing and quality factors are listed in order of overall importance. [3]Source breakdown for Japanese industrial corn imports in 1992 were as follows: U.S. 87%, South Africa 10%, and China and Argentina, less than 1%.

factors in the import decision criteria, the perceived quality of the corn to be imported and the price importers are willing to pay are often strongly related. Many buyers treat price and quality as a tradeoff and accept slightly lower quality if they are receiving a favorable price. In the world coarse grain market, an importer's attitude toward the tradeoff between price and quality largely depends on the final use of the corn. If the corn is destined for industrial or food processing, the purchaser may place more emphasis on acquiring certain quality attributes. If the corn is intended for feed manufacturing, however, the importer is more likely to compare the price of protein and energy in a corn shipment with similar component prices for other feed grains. Even within the feed market, however, many importers prefer certain sources based, in part, on their views of the relative quality of suppliers' grain.

Aggregate Quality Comparisons

While the United States dominates the world corn market, major importing countries regard South African corn and, in many cases, Argentine corn as being of better quality than U.S. corn. This comparison holds up under empirical examination (table 6). Some Asian importers (primarily corn starch producers) prefer South African corn (although its availability outside Africa has been limited for many years) to U.S. corn because of its lower BCFM, higher starch, lower moisture content, fewer stress-cracked kernels, and larger kernels. This quality difference appears to occur as a result of different drying practices and different corn varieties. Argentine corn is sometimes preferred, for its lower BCFM and golden kernel color. A few respondents expressed concern about the higher moisture content and greater aflatoxin

Table 6--Aggregate quality comparisons among selected major corn exporters, 1984-90[1]

Factor	Units	1984	1985	1986	1987	1988	1989	1990
Argentina:[2]								
Sample size	Number	915	981	988	493	544	286	----
Moisture	Percent	12.8	12.7	12.8	12.8	12.6	12.5	----
Damaged kernels	Percent	2.0	1.6	1.7	1.5	1.9	2.1	----
BCFM	Percent	1.0	1.1	1.2	1.5	1.4	1.8	----
South Africa:								
Sample size	Number	----	----	----	1,828	133	615	465
Moisture	Percent	----	----	----	12.5	12.5	12.1	12.6
Damaged kernels	Percent	----	----	----	5.9	8.0	3.9	3.6
BCFM	Percent	----	----	----	1.6	1.5	1.2	1.0
Test weight	Lb/bu	----	----	----	59.3	58.3	57.9	58.6
United States:								
Sample size	Number	1,675	1,516	1,092	1,646	1,881	1,954	1,923
Moisture	Percent	14.1	14.7	14.5	14.0	13.7	13.9	14.1
Damaged kernels	Percent	4.2	3.1	3.8	4.6	4.4	4.1	2.6
BCFM	Percent	3.5	3.4	3.3	3.3	3.4	3.4	3.3
Test weight	Lb/bu	55.7	55.9	56.3	56.8	57.1	57.1	56.9

Note: ---- = data not available. [1]Factor definitions and measurement technologies differ between exporters; measures generally taken prior to exporting. [2]Argentina added test weight as a grade-determining factor in 1991. Source: Bender, Hill, and Valdes, Appendix C, 1992.

susceptibility of Argentine corn as compared with U.S. corn, although relative rankings on these two factors vary, depending on which country's corn users are questioned.

The quality of U.S. corn was widely regarded as more variable than corn from South Africa or Argentina. U.S. corn is generally preferred to Chinese and Thai corn on quality grounds. Chinese corn is viewed as having lower test weight than U.S. corn. The relative prices in South Asia for U.S. and Chinese corn imply that the perceived quality gap has been narrowing recently, and in 1992/93, quality problems with U.S. corn caused Korean millers to switch from U.S. to Chinese corn. Meanwhile, some Asian markets are complaining about high moisture content in 1993/94 Chinese corn. Many markets view Thai corn with caution because of chronic aflatoxin problems. The recent expansion of the Thai poultry industry has also limited Thai corn availability for export and forced Thailand to import Chinese corn in 1991-92.

While many importers find South African and Argentine corn contains less BCFM than U.S. corn, no respondents indicated filing complaints over the level they found in U.S. corn. Some importers expressed dissatisfaction with the "certificate final" rule of U.S. contracts, because BCFM in U.S. corn inevitably increases as it moves to the importers' facilities. A few Spanish importers cited problems with BCFM levels in U.S. corn 5-6 years ago, but no problems have occurred recently. A few complaints were registered in Venezuela, Russia, and Japan about excessive grain dust and/or the lack of freshness of U.S. corn. A few respondents suggested that U.S. corn might have been stored 3-4 years.

Aggregate Price Relationships

Continuing price differentials appear to exist with respect to different origins of imported corn, but these relationships seem to stem as much from transportation cost differentials as from quality differentials. For example, in Eastern Hemisphere markets (such as Egypt, Russia, and Taiwan), U.S. corn costs more than Argentine corn, the difference ranging from $3-$12 per ton (table 7). In Mexico, however, a price $1 higher for U.S. corn on a *f.o.b.* basis over Argentine corn turns into a price $16 higher for Argentine corn *c.i.f.* because of shorter distances and lower transport costs for U.S. grain to Mexican ports. Argentine corn is often priced below U.S. corn on a f.o.b. basis. Due to the terms of the Enlargement Agreement between the EC and the United States, the majority of Spanish imports of reduced-levy corn occur between January and April, when Argentine traders cannot deliver large amounts of corn for export. Many Spanish importers regarded Argentine corn as better quality than U.S. corn, though many pay a higher average price for U.S. corn because they can get it year-round. This implies a premium for timely delivery, rewarding the storage capability for U.S. corn in some foreign markets.

The price relationship between U.S. and Chinese corn in South Korea results in part from quality differences, although price undercutting by CEROILS also occurs. South Korean importers differ in the premium they are willing to pay for U.S. corn over Chinese corn, depending on the corn's ultimate use. The 1992 premium for feed was around $3/ton, while Korean wet-millers pay a premium of $5-$7/ton. The margins were larger in the 1980's, implying that the quality relationship between U.S. and Chinese corn has changed, although part of the decline could stem from easier delivery for Chinese corn.

When Japanese starch processors have acquired South African corn, they have paid up to a $13/ton quality premium (on a landed basis) for it, although Japanese feed processors (accounting for more than 70 percent of imports) pay no premiums. Taiwanese importers have paid smaller quality premiums for South African corn ($1-$3/ton). A bilateral corn trade agreement exists between South Africa and Taiwan, but South Africa has been unable to fulfill it recently. The premiums paid reflect quality preferences; any differences in transportation costs are treated separately.

The role of transportation costs in determining price differentials is consistent with how highly price ranks among sourcing factors for the importing countries studied. The overall responses from six of the countries placed price (credit availability for Russia) at the top of the list of sourcing criteria. Spanish importers listed the Enlargement Agreement as the prime criterion affecting import source, because the levy on corn bought under quota is much lower than the normal EC variable levy. Without the Agreement, they believe that few corn imports from outside the EC would occur. While the consensus response from Korean and Japanese corn importers (table 5) indicates price is the key factor, industrial corn users in both countries rank quality as the prime criterion. With respect to BCFM, the chief quality factor examined in this study, no corn importers indicated an interest in paying a premium for or expanding its U.S. corn share if BCFM levels were lowered by more cleaning.

Table 7--Summary of key price and quality results

Country	Sample price relationships				Average BCFM	Anticipated change in imports of U.S. corn due to lower BCFM	Expected premium from low-BCFM corn
	Year/basis	*----Dollars per ton-----*					
Egypt		Arg.	U.S.	France	U.S. 4%[1]	No increase expected	No increase expected
	1992/c.i.f.	128	133	133			
Japan		U.S.	China	S. Afr.	Corn for feed[2]	No increase expected	No increase expected
	1991/c.i.f.	134	133	133	U.S. 4-5%		
					Arg. 2-3%		
					Corn for industrial[2]		
					U.S. <=3%		
Mexico		Arg.	U.S.		U.S. 3%[2]	No increase expected	No increase expected
	1989/f.o.b.	111	112				
	1989/c.i.f.	140	124				
Russia		U.S.	China		U.S. 3.5%[1]	No change expected	No change expected
	1991/f.o.b.	108	115				
		U.S.	Hungary				
	1992/*c&f*	131	127				
South Korea		China	U.S.		U.S. 3.4%[1]	No increase expected	No increase expected; already
	1991/c&f	125	133		China 7%		pay a premium for U.S. corn
Spain	Not available				U.S. 3-4%[1]	No increase allowed	No increase expected
					Argentina <1%	under Enlargement Agreement	
Taiwan		U.S.	Arg.	S. Afr.	U.S. 2.4%[1]	No increase expected	No increase expected
	1989/c.i.f.	141	--	142			
	1990/c.i.f.	139	--	141			
	1991/c.i.f.	133	130	---			
Venezuela		U.S.	Arg.		U.S. 5%[1]	No increase expected	No increase expected
	1993/f.o.b.[3]	113	85				
	1993/f.o.b.	95	100				

[1]Reflects informal survey of BCFM at unloading. [2]Reflects FGIS export inspection numbers. [3]Two sets of prices for Venezuelan corn imports reflect a split season that prevails because of Argentina's marketing season; the first set represents relative prices during Argentina's harvest (March-May), and the second set represents prevailing prices during the rest of the marketing year.

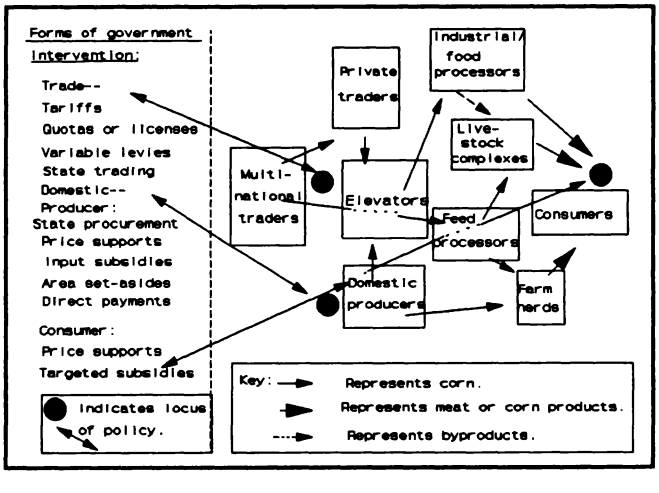
The World Feed Grain Market for Corn

The livestock sector consumes the vast majority of imported corn. Feed use as a share of total corn consumption exceeds an average of 70 percent in most regions in the world, except in areas where food use (Latin America and Subsaharan Africa) or industrial use (Northern Europe) account for a significant portion of demand. Within the countries examined in this study, six of the eight countries use at least 80 percent of their corn (domestic and imported) for livestock feeding. This section discusses how preferences for composition of feed grain demand are determined, in terms communicating derived demand from livestock sector and why domestic production is unable to fill it.

Major Players in Import Decisions

In a given country's feed sector, there are three groups operating in tandem: livestock farmers, feed manufacturers, and grain traders (fig. 2). Livestock and poultry producers, both large and small scale, generate the basic demand for feed grains. In countries where arable land is abundant, many livestock farmers also raise crops and feed their stock mostly from grains grown onfarm. The excess demand for feed grains and other feed ingredients is met by feed compounders. If the feed manufacturers cannot get enough grain from domestic sources, they must seek grain on the international market (table 8). Most feed processors acquire grain on the world market through traders, though some large-scale firms trade themselves. These tiers of players have become highly integrated in some countries, particularly in poultry production. In the corn sectors where private traders have a role (accounting for seven of eight), end-users have a general voice in deciding the types and quality of feed they use, though feed processors and traders usually standardize import contract specifications in line with the general preferences reflected by relative prices.

Figure 2
Corn market structure and policies in a typical corn-importing country



Livestock Producers. Per capita consumption of meat and dairy products has grown since 1975 in most of the countries examined in this study (see appendix table 2). The exceptions have been Venezuela and Mexico, where per capita consumption of beef and pork, respectively, has fallen because economic reform has driven up the relative prices of some meats. Milk use has also declined in Mexico and Russia because of economic reforms. Russian meat demand has also fallen recently, though it was still above 1975 levels in 1991.

Among the corn-importing countries studied, grain feeding of beef cattle occurs primarily in those countries where constraints on pasture land exist. Cattle are largely *finished* on grain in large-scale commercial feedlots in Taiwan, and to a lesser extent in Egypt and Spain. About 30 percent of Japanese beef cattle are raised in small-scale operations under a system in which animals are grain-fed their entire lives to provide tender cuts of meat that are highly prized in Japan. Dairy operations typically require considerably more grain feeding than do straight beef operations, because milk output increases when cows are fed grain. A domestic dairy industry exists in most countries in the world because milk is rarely a traded commodity.

Exclusively grass-fed dairy operations do exist, but their milk output per head is typically only a fraction of the productivity of grain-fed dairy cattle. Farmers in the most developed countries most often raise dairy cattle as relatively small-scale, specialized activities. Producers in the EC and Japan run *dual herds*, and in the developing countries these cattle often serve a third role, as draft animals. In Asian developing countries, the milk-bearing, draft animals are often water buffalo.

Among the countries in this study, only Japan is a significant pork importer, and one of their chief sources is Taiwan. In seven of the eight countries (except Egypt, a Muslim country), most swine are raised in modern confinement operations, which exhibit considerable

Table 8--Domestic corn sectors and per capita income in study countries, 1992

Country	Corn self-sufficiency[1]	Feed/use ratio[2]	Per capita GDP[3]
	Percent		*Dollars*
Egypt	77.6	90.0	741
Japan[4]	0	75.8	29,524
Mexico[5]	90.9	15.2	3,122
Russia[6]	56.7	79.9	4,618
South Korea	1.3	71.9	6,513
Spain[5]	58.4	81.3	13,509
Taiwan	6.6	92.7	10,000
Venezuela	57.6	35.0	3,019

[1]Reflects self-sufficiency of total corn demand. [2]The ratio between domestic feed use of corn and total domestic corn consumption. [3]GDP = gross domestic product. [4]Only 2,000 tons of corn were produced in Japan in 1991. [5]GDP figures for 1991. [6]Data are for FSU-12 (republics of the former Soviet Union). Estimates suggest only 1-2 million tons of corn are produced within the Russian Republic. Sources: USDA/ERS, 1993, and International Monetary Fund, 1993.

vertical integration between feed manufacturing, livestock feeding, and livestock processing sectors. Large-scale, modern poultry facilities, operated by large firms and farmer-owned cooperatives, account for the majority of poultry production in Spain, Mexico, Venezuela, Taiwan, Japan, and South Korea. State agencies in Russia and Egypt operate similar large-scale (though less modern) poultry operations, although small private operations also exist in those countries (Bishop and others, 1990). The integrated poultry system, in which one firm controls all the stages of production (hatching eggs, raising the broilers, and processing and shipping the meat), is common for most poultry operations in the study countries. (For additional details on the livestock sector, see appendix B.) These large-scale pork and poultry facilities exercise considerable influence in the selection of grains for imports, with the largest firms importing directly.

Feed Processors. Specialized dairy operations and the production of swine and poultry in confinement operations require efficient feed mixing. This requirement has led to the development of a compound feed industry in most countries. The compound feed processors acquire the feed ingredients from various sources (domestic and foreign), accurately mix them in specific ratios, and sell the feed to the livestock producers. In countries that import most of their livestock feed ingredients, corn was predominantly used in four of the countries (table 9). Other major imported feed grains are sorghum (Mexico and Japan), barley (Russia and Japan), and feed wheat (Russia and South Korea).

Significant economies of scale are usually present in the manufacture of formula feed, some economies resulting from government policies. These economies have been captured to a large extent in the countries examined in this report. The major exception is Egypt, where 90 percent of domestically produced corn is fed on farms. Most of the remaining Egyptian corn supply (domestic and imported) goes directly to livestock feeding facilities.

In other countries, economies of scale have been captured either by large private firms or by farmer-owned agricultural cooperatives or associations. Large commercial poultry and hog operations often custom-mix their own feed rations. Large-scale feed processors and cooperatives have often diversified their operations by becoming involved in ownership of large commercial poultry and hog operations. Many of the large-scale feed processors in countries with private markets buy directly from the exporting countries. The small- and medium-sized firms deal through international traders.

Traders. On the importer side, state traders in the world coarse grain market play a major role in only a few countries. The dominance of the private sector is probably due primarily to the use of corn and other coarse grains as feed ingredients, not as a food staple. Governments, especially in developing countries,

Table 9--Corn use as share of total feed grains and total feed concentrates, 1992

Country	Corn feed use	Total grains fed	Total feed concentrates[1]	Share of corn in concentrates
	Thousand metric tons			*Percent*
Egypt	5,220	6,535	7,071	73.8
Japan	12,550	18,090	22,978	54.6
Mexico	2,500	9,815	12,789	19.5
Russia[2]	9,230	125,987	132,251	7.0
South Korea	5,060	6,450	10,764	47.0
Spain	3,480	11,137	17,225	20.2
Taiwan	5,350	5,701	8,041	66.5
Venezuela	550	1,085	1,756	31.3

[1]Feed concentrates generally defined as total of feed grains and oilseed meals. For Spain and South Korea, this figure also includes about 2 million tons of nongrain feed ingredients, such as manioc, corn gluten feed, and *distillers' dried grains*.
[2]Figures for FSU-12. Source: USDA/ERS, 1993.

traditionally devote considerable attention to the maintenance of stable supplies of basic food staples to feed the population. This is the case in the few countries (such as Mexico) where corn products like tortillas are a food staple. In contrast, governments typically do not support meat and livestock product consumption, and the responsibility for acquiring livestock feed falls to the private sector.

Among the countries examined in this study, the Russian coarse grain sector is the most heavily influenced by the government. The Russian state trading organization, Exportkhleb, handles all agricultural imports, including feed grains. The grain acquired by Exportkhleb is then allocated to the various state feed manufacturing enterprises by Roskhleboprodukt, a joint stock committee which was previously the state committee on grain.

The Egyptian government officially ended its monopoly on corn imports in 1987, although it remained a major importer until the early 1990's because of lack of storage facilities and cautiousness by private traders. The Mexican state agricultural marketing agency, *CONASUPO*, was the primary agricultural importer prior to 1985 reforms, but now grants licenses to private importers. CONASUPO primarily procures domestic corn for food processing, except when crops are poor.

In other countries, most corn imports are handled by either large firms, often affiliated with multinational grain trading firms, or trading associations or cooperatives. The exceptions, discussed above, are the large integrated feed/livestock firms, which conduct their own trading operations. Import decisions in most of these countries are somewhat constrained by government policies, but actual deals are conducted by businesses (local and national) interested in maximizing profits and keeping their customers, the feed processors and livestock producers, satisfied with their products.

Key Factors Affecting Import Volume Decisions

Government intervention plays a major role in determining the volume of corn imports. Domestic production of corn or other feed grains contributes substantially to the total grain supply in five of the eight countries examined, and domestic producers are supported in their efforts (see table 4). Some countries' trade policies channel corn imports into desired end-uses, and also restrict the flow of corn.

Domestic Production. Of the countries featured in this report, four have significant domestic corn production (see table 8). While South Korea, Taiwan, and Japan have little feed grain production of any kind, Russian farmers produce other types of feed grains, including wheat, barley, rye, and oats. Even with reduced feed demand, Russia does not deliver enough grain to market to be self-sufficient, mainly because the rate of government procurement is declining. In addition, attaining self-sufficiency is hampered because of grain losses (estimated at up to 30 percent) during handling and

distribution, poor feeding practices used on state farms, and heavy demand for meat products.

Only 17 percent of Spanish grain production in 1991 was corn, but Spain also produces other coarse grains for feed use. Spanish livestock producers also typically use imported feed wheat (from other EC countries) and nongrain feeds (from outside the EC). In Egypt, Mexico, and Venezuela, corn is the primary coarse grain produced. However, use of domestic corn for livestock feed is common only in Egypt. The elimination of the Egyptian government feed subsidy in 1988 raised domestic corn prices, leading to increased domestic production and reduced imports. Mexico uses sorghum (with the total share of imports going from 20 percent to 67 percent in the last 5 years) as its primary grain ingredient for livestock feed. Venezuela also feeds considerable sorghum, although corn is now the major feed ingredient. In Mexico and Venezuela, most domestic white corn is used for food purposes, while domestic yellow corn is used for feeding livestock.

Domestic Consumption. Feed use of corn and other coarse grains is a derived demand, depending upon a given population's demand for meat and livestock products. Overall consumption of meat is driven primarily by income. Consumption choices between various meat types are determined primarily by relative prices, cultural preferences, and dietary concerns, particularly in developed countries. The demand for imported feed grain occurs because many countries (encouraged in some instances by government policy) prefer to import the bulk feed ingredients (grains and oilseeds) and raise the livestock themselves. In this way, countries spend the value-added portion of the meat price in the domestic economy, and they can better tailor the final product to local consumer tastes. Since meat is regarded as a luxury good with respect to the entire market basket of food products, meat consumption is typically correlated with higher per capita income. While some countries import both wheat for food purposes and corn for feed purposes, an examination of relative per capita incomes of customers for U.S. corn and wheat found per capita income to be 50-70 percent higher on average in corn-importing countries than in wheat-importing countries (Childs and Mercier, 1989).

Because meat and livestock products are not viewed as part of a staple diet, their production and consumption are not as subject to direct government intervention in most countries to the extent that such barriers exist for grain. *Phytosanitary and sanitary regulations* exist in most countries; though some are justified on a scientific basis (such as restrictions on beef exports from regions having hoof-and-mouth disease problems), many of these regulations are widely regarded as concealed trade barriers. Producers in four of the countries studied are protected by direct trade barriers (see appendix table 4). The higher incidence of trade and other barriers for meat and livestock imports compared with those for feed grain imports suggests that government policy generally promotes importing feed rather than meat.

Consumer preferences for certain characteristics of meat and eggs and processor preferences about feed attributes can also have an impact on the composition of feed demand. For example, since 1986, the Spanish have shifted to white-colored poultry and away from pink-colored poultry. The white color results from a wheat-heavy feed ration. Color plays a role in preferences between sources of corn as well. For example, Japanese and Venezuelan consumers prefer the brighter yellow color that Argentine flint corn imparts to chicken egg yolks, so Argentine corn typically makes up a substantial share of layer rations in those countries. Taiwanese processors dislike the pale color of feed mixtures dominated by barley and the bitter taste sorghum imparts to feed rations. Thus, they import corn as their main feed grain.

Key Factors in Determining Import Source

The process of choosing the feed grain for import implicitly contains an intermediate step within the decisionmaking process. Once the supply of domestic feed has dictated the need to import feed grains (both at industry/national and firm levels), buyers then decide which grain best suits their needs. In most countries, these decisions are made on a case-by-case basis, by private companies, not as part of the country's annual import needs, as is the case with state grain traders. Consumer or processor preferences, as described above, can sometimes play a role. However, usually the relative prices of energy and protein embodied in the various grains are the key criteria. Since corn is the most widely available grain on the world feed market, its price generally drives the market.

Price is viewed as the prime criterion for importers of corn for feed purposes in six of the eight countries. The exceptions are Russia, where credit availability is the prime constraint on corn imports, and Spain, where the scope of the Enlargement Agreement is most important.[9] Credit (which affects the net price of corn) ranked among the top three factors in Mexico and South Korea. No export subsidies are offered by countries that are consistent corn exporters. About one-third of the top 50 importers of U.S. corn have been recipients of some GSM credit guarantees over the last few years, including five of the eight countries studied (Russia, Venezuela, South Korea, Mexico, and Egypt). These countries' reliance on credit for U.S. corn imports ranges from Russia, which is nearly totally dependent on credit for buying U.S. grain (except for food aid imports), to Egypt, which in 1992 was in the very unusual position of being able to forgo export credit guarantees because of a favorable cash position.[10] Export credit is seen as important by buyers in the other three countries, although not all transactions are covered (only 15 and 20 percent in Venezuela and South Korea). In Korea, GSM credit sometimes permits feed users to choose U.S. corn over Chinese, and might play a role in the price premium for U.S. corn. The GSM credit program allows Korean grain buyers some latitude because Korean commercial letters of credit are limited to 60 days, and not all U.S. deals are completed within 60 days because delivery takes 2-4 weeks as opposed to 2 days from China.

The trade-servicing capability of an exporter, defined as the ability to provide cost-effective, reliable, and timely deliveries, is also related to price considerations and the choice of a supplier. Various aspects of trade servicing were listed as important decision criteria in six of the eight countries. U.S. corn exporters generally rate well in this category, because of the size of the U.S. grain marketing system. The size of vessels that carry U.S. grain to distant ports reduces per-unit costs, as does the ability of U.S. traders to draw grain from storage for trading year-round. In Japan (and some other Asian markets), the inability of large ships to deliver to smaller ports puts U.S. corn at a disadvantage versus corn from China, which moves on smaller vessels. The construction of a large feed storage facility near a major deepwater port in Hokkaido, Japan, should lessen China's advantage in this respect, because large ships carrying U.S. grain will be able to deliver their cargo nearer feed-processing facilities. The proximity of U.S. Gulf ports to Mexican and Venezuelan ports gives U.S. traders a cost advantage over competitors for those two markets (U.S. freight rates are $15-$20 per ton lower to Mexico than rates for Argentina). U.S. corn is also moved by rail to Mexico, but rail costs have slightly exceeded the costs of Gulf transport. The importance placed by feed manufacturers on the ability to import corn year-round and save money in shipping costs has in some cases caused them to select U.S. corn over corn from other origins, even when they regard U.S. corn as lower quality.

On the importer side, the lack of storage facilities and high cost of credit in Venezuela causes feed manufacturers to prefer U.S. corn over Argentine, because they are assured of reliable delivery within a week. The perception of Taiwanese traders that Argentine shipping is unreliable also gives U.S. traders an advantage in the Taiwan market. Processors in Taiwan and Venezuela regard Argentine corn to be of superior quality to U.S. corn, yet U.S. exporters hold at least 90 percent shares of both markets. Taiwan's desire to maintain good political relations with the United States also contributes to the size of the U.S. market share. The size of the U.S. marketing system, especially in comparison with other major corn exporters, gives U.S. traders a cost edge in most markets.

Though quality is not the prime criterion in the import decisionmaking processes of feed manufacturers interviewed in this study, quality still does play a role. In fact, quality ranks second to price in four of the eight study countries: Egypt, Japan, South Korea, and Taiwan (table 5). Specific quality factors that are of concern include BCFM, moisture content, aflatoxin, crude protein, and kernel hardness or breakage susceptibility. Feed manufacturers are often preoccupied with grain storability, and they tend to stress quality characteristics, such as BCFM and moisture, which affect their ability to store grain without loss of value. This preference is particularly acute for feed manufacturers in humid climates. Such climates tend to accelerate insect or mold damage or aflatoxin infection if it is already present. The

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[9]The EC-U.S. Enlargement Agreement is structured on a calendar-year basis, so all reduced-levy imports for a given year must be contracted for by December 31, and delivered by April 30 of the next year. The agreement ran from 1986-90, and has been renewed every year since. Because the EC Commission waits until all nongrain feed imports are completed for the year before allocating import licenses, the bulk of corn and sorghum imports into Spain occur between January and May, which occurs before Argentina's corn harvest.

[10]Prior to 1992, Egypt was a heavy user of GSM credit. Egypt also received U.S. corn imports under the Commodity Import Program of the U.S. Agency for International Development and Section 416.b.

BCFM content of corn enters even more strongly into the process if the dust component of the BCFM is large.

Excessive grain dust may create several hazards within an elevator facility, including health risks to workers and greater chance of dust explosions. High dust levels also can slow the unloading process at port. *Intrinsic values* of the corn are of less concern to feed compounders, unless crude protein content is very low. Low-protein corn, if intended for *balanced feed* rations, can require slightly more protein meal in order to attain the correct balance or else sacrifice weight gain, so a few countries rated minimum levels of crude protein as key. Kernel hardness is also rated highly by some feed manufacturers.

Most of the U.S. corn imported by these countries for feed is purchased under very straightforward contract specifications. The majority call for U.S. No. 2 or No. 3 corn, with few specifications beyond existing grade factor limits except moisture content and aflatoxin.[11] Most contracts specify moisture maximums, ranging from 14 to 15.5 percent. Five countries (Japan, Taiwan, South Korea, Venezuela, and Mexico) specified tight limits on aflatoxin (from 0-50 parts per billion). Spain requires inspection of imported corn for the substance. Aflatoxin levels were also mentioned as a top quality concern in Russia and Venezuela, and as a factor apart from quality as a criterion for Japanese corn users. No respondent mentioned current problems with aflatoxin in U.S. corn.

Attitude Toward BCFM

BCFM ranks among the four most important quality factors in all countries surveyed, ranking first in four countries. While BCFM levels in U.S. corn are typically higher than levels found in South African or Argentine corn, no respondents indicated that they regularly specify limits tighter than the grade maximums or minimums on the U.S. corn they purchased. Several users stated that the level of BCFM typically rose significantly from the time it was inspected at the U.S. port. This reported phenomenon has been empirically confirmed, and appears to occur to some degree to imported corn from all origins (Hill and others, 1988; Cronje and others, 1991).[12] Most important, however, no country importing U.S. corn for feed appeared willing to pay a premium for corn with lower levels of BCFM. Furthermore, no buyer would expand imports of U.S. corn if lower BCFM levels were offered at the same price. This disinterest in lower BCFM is attributed to several factors: (1) U.S. corn already dominates the corn import market, and (2) feed processors have become accustomed to the level of BCFM in U.S. corn because its presence does not greatly impair operations.

The World Corn Market for Industrial and Food Uses

Corn processing for industrial purposes occurs in all the countries featured in this study, though it accounts for only 10-30 percent of use in these countries. Corn use for food purposes is a nontrivial share in three countries (Egypt, Venezuela, and Mexico), accounting for up to 75 percent of domestic use in Mexico (but only a small portion of imports). Quality requirements for processed corn are quite a bit stricter than those for corn used for feed purposes, because damaged or moldy kernels do not make the desired final product. In the survey countries where wet-milling of corn is common (except Venezuela), most of the corn designated for that use is imported. Corn processed for food is often domestically grown, and its producers are often protected to maintain a stable supply. Industrial imports of corn are generally subject to the same trade barriers as corn for feed purposes, except in Japan and Spain, which have production or import quotas to protect other domestic industries. Growth prospects for demand for corn imported for food are not bright, since corn for food is being displaced by wheat products in many countries. Industrial corn imports are growing in Japan and Korea (although expansion is limited by policy in Japan), and similar growth could occur in other developed countries as per capita income increases.

Major Players in Import Decisions

The wet-milling sectors in the countries studied are diverse in terms of both ownership and organization. In Japan and South Korea, producer associations are responsible for setting contracts for importing corn for their small member firms, while larger firms buy on their

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[11]Most contracts for U.S. corn state the grade to be delivered as "U.S. No. 2 (or 3) or better." Such specifications shall be referred to as U.S. No. 2 (or 3) (see appendix table 5).

[12]In a 1988 study of corn shipped between the U.S. Gulf and Japan, the BCFM level on an ocean-going vessel tracked from New Orleans to its unloading onto a Japanese coaster vessel rose from 3.9 percent at FGIS certificate issue to 9.3 percent at unloading. The coaster vessel was sampled by probe, and may have slightly overestimated BCFM. A 1989 study of corn between South Africa and Taiwan found that the percentage of broken corn (using a comparable sieve) increased from 0.8 percent at loading to 1.3 percent at unloading.

own behalf.[13] In Mexico, Spain, and Egypt, the wet-mill processors are small- to medium-sized firms, which buy directly or deal through private traders for imported corn. In Venezuela, one firm dominates 95 percent of the wet-milling market, and uses only domestically grown white corn. Taiwan's wet-milling industry, revived in late 1992, uses imported corn and the small Russian wet-milling industry uses only domestic corn. Russian starch producers also use potatoes as a feedstock. In general, wet-millers and traders (both individual firms or associations) jointly establish quality specifications for imported corn.

The dry-milling and corn-grinding (the latter a traditional method for tortilla flour production) sectors in Mexico, Venezuela, and to a lesser extent Egypt still produce corn flour (or meal) products for direct human consumption. In the other countries (except Taiwan, which has no dry-milling capabilities), the relatively small dry-milling sector produces goods for food consumption (breakfast cereal, grits, etc.) and for the industrial sector. The Mexican Government regulates the processing of corn for human consumption. CONASUPO acquires corn from both domestic producers and through imports in order to satisfy domestic consumption needs. It then sells corn to private firms for processing, and transfers some corn to another parastatal agency, *MICONSA*, which controls about 25 percent of the corn flour market. The rest of the Mexican dry-mill sector is widely diffuse, supporting more than 12,000 firms that process corn into dough, more than 10,000 firms that produce corn tortillas, and nearly 10,000 firms that make tortillas in integrated facilities. White corn for human consumption in Venezuela and Egypt is almost entirely domestically produced. In Egypt, most corn for human use never reaches the formal market. It is estimated that 1 million tons of corn were processed for food by dry-millers in 1991, a decrease of 50 percent from a decade earlier. The increased Egyptian government subsidy in the 1970's for balady bread, a low-cost wheat bread, caused a shift from unsubsidized consumption of corn bread during that time. Wheat flour prices increased between 1988-92, but that increase led to a shift between wheat bread types instead of increasing corn bread use.

Key Factors in Determining Import Volumes

Government intervention in the industrial processing sectors of these countries is limited except for Japan and Spain. Government intervention is considerable in countries where corn food consumption is important, such as Mexico. Corn processors are looking for very particular end-use characteristics in the corn they use and it can become very costly for them to deviate from these requirements. Thus, there is little substitution seen between domestic and imported corn used for processing.

Corn imported for industrial uses in Japan is restricted by two different policy measures, both of which were adjusted in September 1992. The first is a tariff quota, setting high tariffs (50 percent ad valorem or 12 yen/kg, whichever is higher) on imports of corn above a certain level for industrial use.[14] A second measure, which protects domestic potato producers, requires starch manufacturers to keep their use of imported corn and domestic potatoes within a certain ratio. To assure that corn imported duty-free for feed use does not enter industrial channels, feed processors must buy denatured corn (that is, corn mixed with soymeal, fishmeal, or bran, or corn that is *steam-flaked*).

Under the EC's Common Agricultural Policy (CAP), Spanish wet-millers are limited to producing no more than 83,000 tons of high fructose corn syrup (HFCS), despite having the capacity to produce nearly 300,000 tons. This restriction keeps HFCS producers from undercutting the prices of highly subsidized EC sugar. Industrial firms that use starch as an intermediate product in their manufacturing processes also receive subsidies to offset the high relative cost of EC grains.

Among the countries in this study with active corn wet-milling sectors, only Spain, Japan, Egypt, and South Korea currently produce significant amounts of HFCS, and none produce ethanol. The level of HFCS production, as discussed above, is restricted in Spain, and Japanese HFCS manufacturers have been assessed a surcharge (like an excise tax) on output since 1982. The remainder of the corn starch produced by wet-millers in these countries goes for other uses (see appendix A).

Considerable protection is afforded corn consumers and producers in Venezuela and Mexico since corn is a food staple in both countries. Mexican producers receive a guaranteed support price that is often well above world

[13]Zennoh, Japan's association of agricultural cooperatives, and the larger Japanese feed manufacturers, also buy corn for private starch makers.

[14]The 1992 industrial corn tariff-rate quota was 3.55 million tons, due to rise to 3.75 million by 1994. The permitted ratio of corn starch to potato starch produced was 9:1 in 1992, to be 11:1 in 1994.

price and several input subsidies, such as for credit, irrigation, and electricity. Through CONASUPO, the Mexican Government provides corn at subsidized prices for flour for tortillas, and pays a direct subsidy on corn processed goods (particularly tortillas) to 4.5 million low-income consumers (USDA/ERS, Sept. 1992). Guaranteed prices and a fertilizer subsidy to Venezuelan corn producers ended in 1992, and producers are now experiencing some financial problems in their absence. Although corn flour was removed from the basic basket of fixed-price goods in 1991, the Venezuelan Government agreed (with the corn-processing industry) on a 6-month moratorium on raising prices.

The majority of dry-milled products consumed in countries outside of Latin America and Subsaharan Africa are breakfast cereals, distilled beverages, and corn oil. Limited international trade exists in the products from corn wet- and dry-milling, although several million tons of corn byproduct feeds are imported by the EC. In the late 1980's, the value of world trade in corn products was less than a tenth of the value of trade in bulk corn (United Nations, 1991). HFCS is traded only short distances across land borders (such as between the United States and Canada) because of its relatively short shelf life. Trade in corn byproducts like gluten meal is quite robust, primarily because of its duty-free status as a feed import in the EC. EC feed processors imported more than 7 million tons of corn gluten feed and meal in 1991 (USDA/ERS, Dec. 1992).

Key Factors in Determining Import Source

The more rigorous quality requirements for corn used in the industrial and food-processing submarket necessitate a stronger role for quality in import decisionmaking than in the feed submarket. Price competition is more limited in the former submarket, and some importers of corn for industrial purposes pay premiums based on quality alone. Among feed users, only Korean buyers pay premiums based on quality considerations. Industrial users are concerned with a broader spectrum of quality characteristics than are feed users, although BCFM and moisture content rank as relatively important in both submarkets.

Price is ranked as an important decision criterion for most importers of corn for industrial purposes, although potential sources are limited due to tighter quality requirements. In general, the prices of competing sources of corn must be examined in a context of differing quality characteristics, particularly if buying from a new source would require adjusting the production process because of a key difference in characteristics (such as kernel size or thickness). Export programs (such as credit guarantees) offered to feed corn importers are also available to industrial corn importers, but play a lesser role in this submarket. In Spain, the Enlargement Agreement mechanism remains the primary determinant of source of imported corn for Spanish wet-millers, although for wet-milling, the quality of U.S. corn is generally preferred over that of Spanish corn.

Quality is explicitly rated as the top decisionmaking factor by corn wet-millers in Japan and South Korea, and among Spanish wet-millers is second to the limitations imposed by the Enlargement Agreement. These rankings differ from the overall rankings in table 5, which also reflect feed compounders' preferences. Discussions with wet-millers in other countries suggested similar concerns with quality. The importance of quality often leads these millers to pay more for the corn they import than would a feed compounder in the same country. Corn processors in a few markets indicated they often pay a premium for their preferred corn; Japan pays up to $13/ton more for South African corn, when it is available, and Korea pays an added $5-$7/ton for U.S. corn. Egyptian wet-millers also prefer U.S. corn, although no price premium was specified by respondents.

Among specific quality factors, BCFM is ranked as important by corn wet-millers. Fine broken kernels clog up the tanks in the wet-milling process, so wet-millers try to clean out at least fine BCFM before the corn enters the steeping vats. They receive only the price for byproduct feed for the BCFM removed through cleaning, which is normally only a fraction of the corn price (two-thirds or less) and much less than the value-added price of corn products. Corn wet-millers also consider starch content, protein content, corn hardness, total damaged kernels, and moisture content to be important factors in their decisionmaking process. Dry-millers are often interested in assuring kernel uniformity in their shipments. These specific quality concerns do not generally appear as additional contract specifications, although a few wet-millers in South Korea and Japan have experimented with small *identity-preserved* U.S. corn shipments (on the basis of such factors as waxy starch content or a field-drying requirement that reduces breakage susceptibility).

Attitude Toward BCFM

Corn wet- and dry-millers prefer to buy more U.S. No. 1 or No. 2 corn with corresponding lower BCFM content as

prescribed in the grade limits than do corn feed processors. Only a small share of U.S. corn exports are U.S. No. 1. This share likely goes exclusively for food or industrial use (see table 10). Many users emphasize that U.S. corn that shows 3 percent BCFM (such as U.S. No. 2) at FGIS inspection could end with considerably higher BCFM at destination due to damage to kernels caused during loadout and unloading operations.

Japanese industrial users prefer to purchase U.S. corn shipped from the Pacific Northwest (PNW) rather than the Gulf of Mexico, because they believe it arrives with less *foreign material*. The fact that PNW corn is not moved by barge could contribute to the perceived regional quality difference. Mexican wet-millers will pay higher prices for rail shipments directly from the Midwest than shipments through the Gulf because of lower corn breakage. Respondents indicated they would not anticipate a net benefit from contracting for a higher grade corn with lower BCFM, nor did they anticipate greater U.S. corn imports or an additional premium for cleaner U.S. corn. Import levels are effectively constrained in Spain and Mexico (for now), and U.S. corn already dominates the industrial corn submarket.

Comparisons of U.S. Corn Performance and Importers' Needs

Some changes in U.S. export corn quality are already occurring. FGIS inspection data from 1986 to 1991 suggest that the overall quality of U.S. corn exports is improving, due in part to importers' upgrading contract specifications from U.S. No. 3 toward U.S. No. 2.[15] Importers' concerns over corn quality also extend beyond BCFM to other quality characteristics that affect storability, and particularly for industrial and food users, to intrinsic characteristics (such as starch and oil content) that better meet rigorous end-use requirements.

This section summarizes information about quality preferences and the importance of quality in overall

[15]Although the 1992/93 corn crop had not yet been marketed at the time these interviews were conducted, it is important to note that many complaints were voiced by importers about the lower quality of the 1992 crop, particularly low test weight and high moisture content, caused by wet autumn weather and the resulting late harvest in the Midwest.

Table 10--U.S. total corn exports to selected countries, by share of U.S. grade, 1986-91 average

Country	No. 1	No. 2 or better	No. 3 or better	No. 4 or worse	Un-graded[1]
			Percent		
Egypt	0	96.3	0.6	0	3.1
Japan	.4	4.6	94.6	.2	0.1
Mexico	1.5	83.3	15.1	0	0
Russia	0	.1	93.5	0	6.2
South Korea	0	28.3	71.7	0	0
Spain	0	70.8	27.0	0	0
Taiwan	0	94.8	5.2	0	0
Venezuela	0	6.0	94.0	0	0
Total	.3	28.6	69.3	.1	1.7

[1]Shipped through St. Lawrence Seaway to Atlantic Ocean via Canada, goes out ungraded by FGIS. Source: USDA/FGIS, 1986-91.

import decisions for the corn markets featured in this report. Aggregate information available from other research is also provided to supplement information collected from the individual country studies. This section examines the market's relationship with quality: information on exporters' corn quality efforts provides an indication of their ability to compete with U.S. corn on a quality basis, the discussion on importers' preferences is a measure of customer corn quality expectations (both discussed above). An evaluation of U.S. export data allows us to complete the picture of how U.S. corn performs in the quality arena.

Quality Patterns in U.S. Corn Exports to Study Countries

U.S. overall corn exports over the last 5 years have shown a gradual pattern of shifting from purchasing primarily U.S. No. 3 corn to purchasing more U.S. No. 2. Those purchasers have been rewarded by receiving lower levels of BCFM. According to FGIS export inspection data for the eight countries studied in this report, most U.S. export corn is traded in a rather narrow range of quality (table 11). With respect to test weight, the averages for the eight countries over the period examined ranged from 57.26 lbs/bu to 55.82 lbs/bu, all within the test weight limit for U.S. No. 2. Similarly, moisture content varied less than 1.5 percentage points from the high average to the low average. The biggest difference appears with the BCFM factor, with the highest average country-level BCFM nearly 30 percent more than the lowest observed annual average BCFM level. Importers buying U.S. No. 2 corn seem to be basing that decision primarily on the BCFM content, because other major factors measured by FGIS differ little between grades. Between 1986 and 1991, U.S. No. 2 and U.S. No. 3 export corn differed by less than 2 percent in test weight and moisture.

Average BCFM levels in corn imports from the United States improved for five of the eight countries between 1986 and 1991 (table 11). Much of this progress can be attributed to an evolution in the grades of U.S. corn that these countries purchase (table 12). For Japan, South Korea, and Spain, the decline in average BCFM parallels an increase in the share of U.S. No. 2 corn bought. In Russia, the improvement occurred without a shift in grade distribution. In Taiwan, the share of U.S. No. 2 declined somewhat in the late 1980's, but rose again to nearly 100 percent in 1991. In Egypt and Mexico, the increase in BCFM was accompanied by a shift from buying U.S. No. 2 to buying No. 3. The shift is more pronounced in the Mexican case. The shift to buying U.S. No. 3 in both countries apparently resulted from smaller roles of state traders in importing, although CONASUPO's smaller role occurred as much because of improved domestic supply conditions as from policy shifts. The shift also suggests less importing for food and more for feed purposes. Corn with lower BCFM levels can be acquired if importers are willing to buy better graded corn, but improvements have been modest on average. This conclusion is supported by the results of a hedonic price analysis conducted on U.S. corn export and price data, which found food and industrial corn users valuing low-BCFM corn much more highly than corn imported for feed compounders (for more details, see appendix C).

Trade Implications of U.S. Corn Export Quality Patterns

Based on the country case studies, there is little reason to believe there would be any expansion of U.S. corn exports if cleaner corn were offered under the present production and marketing system. Seventy percent of the market (import demand for feed) is not highly quality-sensitive, and the level of industrial corn demand in the countries in which quality is an important component is in large part constrained by trade barriers. Cleaner U.S. corn, if offered in the world market, would not engender positive benefits, and could only serve to maintain U.S. market shares. The lack of interest in improved U.S. corn cleanliness is due to four major reasons: (1) U.S. corn exports already dominate the world coarse grain market; (2) relative prices are much more important than quality in the corn feed submarket, which includes at least 70 percent of all imports; (3) many of the importers who are interested in low-BCFM corn already buy U.S. No. 2 corn (with 3 percent or less BCFM content); and (4) many of those same importers typically find greater additional breakage occurring in U.S. corn than with corn from other origins between export loading and delivery at processing facilities.

Potential Competitor Responses to Cleaner U.S. Corn

Even without a clear incentive to provide cleaner corn, it is still conceivable that U.S. traders might find it necessary to provide cleaner corn at the same price in order to maintain their market share. Though potential impacts of providing cleaner corn are difficult to quantify, it is important to address potential competitor responses to any effort that U.S. traders might make to improve the cleanliness of the grain they export. In terms of providing corn with lower BCFM, South Africa and

Table 11--Mean quality characteristics of U.S. corn exports to selected countries, 1986-91[1]

Country	Units	1986	1987	1988	1989	1990	1991
Egypt:							
Test weight	Lbs/bu	56.88	56.70	56.77	57.05	56.67	56.27
Moisture	Percent	14.31	13.83	13.64	13.75	14.15	14.28
BCFM	Percent	2.79	2.79	2.88	2.78	2.90	2.85
Japan:							
Test weight	Lbs/bu	56.37	56.96	57.26	57.20	56.94	56.71
Moisture	Percent	14.42	13.92	13.62	13.70	14.10	14.36
BCFM	Percent	3.60	3.59	3.63	3.65	3.47	3.31
Mexico:[2]							
Test weight	Lbs/bu	56.71	56.96	56.95	57.05	57.00	56.67
Moisture	Percent	14.60	14.01	13.75	14.06	14.18	14.58
BCFM	Percent	2.87	2.90	2.70	2.80	2.85	3.20
Russia:							
Test weight	Lbs/bu	56.49	56.76	57.07	57.00	57.06	56.94
Moisture	Percent	14.77	14.08	13.73	13.96	14.29	14.55
BCFM	Percent	3.73	3.76	3.71	3.69	3.72	3.52
South Korea:							
Test weight	Lbs/bu	56.32	56.73	57.27	57.43	56.99	56.43
Moisture	Percent	14.24	14.00	13.67	13.66	13.98	14.37
BCFM	Percent	3.37	3.43	3.38	3.34	3.10	2.93
Spain:							
Test weight	Lbs/bu	56.27	56.70	56.86	56.06	56.39	56.35
Moisture	Percent	15.10	14.08	13.75	13.99	14.39	14.62
BCFM	Percent	3.60	3.15	2.83	2.92	2.84	2.96
Taiwan:							
Test weight	Lbs/bu	55.82	56.55	57.05	57.15	56.82	56.54
Moisture	Percent	14.26	13.99	13.66	13.83	13.98	14.18
BCFM	Percent	2.85	2.77	2.81	2.83	2.75	2.70
Venezuela:							
Test weight	Lbs/bu	----	----	----	----	57.04	56.08
Moisture	Percent	----	----	----	----	13.88	14.14
BCFM	Percent	----	----	----	----	3.73	3.58

---- = No shipments made. [1]Figures are weighted means. Corresponding standard deviations are found in appendix table 7. [2]Just over 2.5 million tons of U.S. corn were shipped to Mexico during this period, which received U.S. grades but measures of grade-determining factors were not recorded. Most of this grain moved by truck or rail over land.

Source: USDA/FGIS, 1986-91.

Table 12--Share of grades in U.S. corn exports to selected countries, 1986-91

Country	1986	1987	1988	1989	1990	1991
			Percent			
Egypt:						
No. 2 or better	100.0	100.0	100.0	100.0	100.0	95.6
No. 3 or better	0	0	0	0	0	4.4
Japan:						
No. 1	0.1	0.2	0.9	0.4	0.3	0.5
No. 2 or better	.8	2.0	5.9	3.5	4.9	8.3
No. 3 or better	98.9	97.2	93.1	95.9	94.8	91.1
No. 4 or worse	.2	.6	.1	.3	0	0
Mexico:						
No. 2 or better	87.9	71.5	86.0	87.5	86.3	55.3
No. 3 or better	12.1	28.5	14.0	12.5	13.7	44.7
Russia:						
No. 3 or better	100.0	100.0	100.0	100.0	100.0	100.0
South Korea:[1]						
No. 2 or better	16.2	25.5	23.5	32.3	24.8	63.2
No. 3 or better	83.8	74.5	76.5	67.7	75.2	36.8
Spain:						
No. 2 or better	5.8	56.2	93.6	92.0	97.1	86.2
No. 3 or better	94.2	43.8	6.4	8.0	2.9	13.8
Taiwan:						
No. 2 or better	100.0	100.0	98.8	84.5	87.4	98.3
No. 3 or better	0	0	1.2	15.5	12.6	1.7
Venezuela:						
No. 2 or better	----	----	----	---	0	7.1
No. 3 or better	----	----	----	---	100.0	92.9

---- = No imports of U.S. corn into Venezuela were recorded for 1986-89.

[1]Korean purchases of U.S. corn for feed fell in 1991 due to increased purchases of Chinese corn and U.S. feed wheat.

Source: USDA/FGIS, 1986-91.

Argentina already achieve lower levels of BCFM in their export corn. However, both of these countries have other problems competing with U.S. corn in certain markets. Persistent drought and reduced emphasis on producing an exportable surplus have removed South Africa as a presence in most markets. In Argentina, the inadequate grain storage facilities and transportation systems and high interest rates raise marketing costs and make it difficult for Argentine traders to export outside of their harvesting season, thus hampering their ability to compete. If South African and U.S. corn had comparable BCFM levels, South African corn would still be preferred on the basis of other quality factors. Comparable BCFM levels between U.S. and Argentine corn would still result in some users preferring Argentine corn on the basis of its color and hardness and other users preferring U.S. corn

because it offers lower risk of aflatoxin infection. South Africa probably would not respond to a clean-grain strategy by U.S. corn exporters, because their advantage is so clear-cut. Constraints facing the Argentine marketing system limit traders' ability to respond, though they are likely to continue to try to undercut U.S. prices.

Among other corn exporters, traders in Thailand and China face importers' perceptions that, in some markets, their corn quality is inferior to the quality of U.S. corn. The quality gap between Chinese and U.S. corn is apparently narrowing, and both Chinese and Thai traders have already found markets for grain produced in excess of domestic demand. The feed demand created by the expanding Thai poultry industry in the last few years has limited the supply of corn available for export. A similar development could occur in China over the next decade, although recent information suggests that Chinese grain production capacity and stocks have been heavily underestimated in the past (Crook, 1993). Both countries are now installing more grain-drying capacity, but unless they adopt noncontinuous flow-drying practices and minimize high-temperature drying, such a move is only likely to increase the level of BCFM in their corn. As long as producers bag most of China's export corn, Chinese grain handlers will have limited capability to clean corn before shipping to distant markets. The structures of the two marketing systems limit their abilities to export cleaner corn in response to a U.S. clean-grain strategy, so any response would likely be price-related, or focus on other quality problems, such as aflatoxin (for Thailand) or test weight (for China). If China's trading system were liberalized, it is likely, in the short run, that CEROILS would try to expand market share at the expense of U.S. market share, perhaps into nearby markets that now receive Chinese corn with less BCFM than is in U.S. corn.

Implications

This study examined the role of quality in the import decisionmaking process in the world corn market to determine whether it would be of net benefit for the United States to offer cleaner grain on the world market. Cleanliness, gauged in terms of levels of BCFM in the world corn market, was viewed as a key (although secondary) concern by both feed manufacturers and corn processors, but for the most part they did not believe paying more for lower BCFM corn would create net benefits above what they already receive. Feed manufacturers place as much emphasis on corn with low moisture content and no aflatoxin (because of these factors' impact on grain storability) as on obtaining low-BCFM corn.

Although not often stated directly by interviewees during the country case study process, importers are not receptive to paying more for U.S. corn because they believe that corn bought under a contract for lower BCFM corn would still contain a higher level of BCFM at destination than was specified in the FGIS inspection certificate. The combination of continuous-flow, high-temperature drying, dominant corn genotypes, and the transportation and handling practices of the U.S. grain marketing system makes U.S. corn more likely to break during handling after inspection. Thus, U.S. corn tends to arrive at the foreign destination with considerably more broken kernels than is indicated on the official inspection certificate. Additional breakage occurs during loadout at the U.S. port and unloading at foreign ports. Corn produced by other countries, particularly South Africa and Argentina, does not break as readily during handling, although some quality degradation still occurs. The BCFM levels recorded on the FGIS inspection certificate reflect whether contract specifications are satisfied, but importers are often left with U.S. corn with a much higher BCFM content than the certificate indicates. Importers may file complaints but have no recourse to official appeal or arbitration mechanisms beyond challenging the accuracy of the original inspection results.

One option for reducing complaints about reporting practices for BCFM on official FGIS certificates is to include some measure of breakage susceptibility as an optional factor. While the equipment to measure this factor is not yet available on a commercially reliable basis, an interim solution could be to rate corn genotypes on a broad scale of breakage susceptibility, then report that information on the inspection certificate. Such steps would improve importers' ability to predict additional breakage that might occur between inspection and unloading.

If the U.S. corn industry wants to make buying low-BCFM corn a more attractive prospect to its importers, sector participants would likely have to take certain steps to assure that low-BCFM corn remains low-BCFM corn at destination. The U.S. grain handling system already has considerable capacity to clean corn within the *market channel*. A 1991 National Grain and Feed Association survey found that more than 65 percent of all elevators

had the capability to clean corn. The key is to maintain BCFM levels after cleaning.

Extensive research has been conducted on the most cost effective means of drying high-moisture corn without weakening the pericarp (or bran) of the corn kernel and thus making it less susceptible to damage (Kirleis and Stroshine, 1990). Alternative drying systems (including use of ambient air drying) have been developed that better achieve that aim, and such systems could be adopted more widely (at the cost of slower throughput for farmers), if outlets for such corn could be assured. The adoption of such practices is likely to be more feasible at the farm level than at country elevators, because farmers are more likely to store their crop for extended periods, and could therefore cool the grain for a long period at relatively low cost. A fairly high rate of adoption of these systems has already occurred in some regions of the Midwest as farmers replace their worn-out driers, because they have found that the cost of a longer drying period is more than offset by lower energy costs (Holmes, Klemme, and Lindholm, 1985).

A study comparing South African corn and air-dried U.S. corn at a Japanese wet-mill found the two to have similar properties except the U.S. corn had slightly higher moisture content (Hill and others, 1993). Similarly, research has been underway since the early 1970's to explore what hybrid corn genotypes are most resistant to cracking during handling, storage, and transportation (Paulsen, Darrah, and Stroshine, 1989). The results from these studies could be disseminated more widely and corn producers could be encouraged to adopt such crack-resistant genotypes.

If U.S. traders consistently demonstrate an ability to deliver low-BCFM corn, importers of corn for food and industrial uses might be more receptive to paying premiums for such corn. This is the portion of the export market (20-30 percent) that clean-corn marketers would likely focus upon. However, it is possible that some importers for feed purposes might also be willing to pay small premiums. The problems caused by BCFM do not create a major dilemma because BCFM is already incorporated in the U.S. grades and standards for corn, and importers can buy the grade they want. In addition, most BCFM is actually fragments of corn kernels, which are still usable, if not quite as valuable to most corn importers. When NAFTA is fully implemented and corn import licenses are eliminated (in 15 years), Mexican imports of U.S. corn and corn products are expected to increase substantially (USDA/Office of Economics, 1993).

Trade liberalization, if it occurs, would likely change the dynamics in the world coarse grain market and could change the importance of quality in corn import decisionmaking. On the one hand, liberalization of feed grain policies could allow grains to compete better with oilseeds (which now face few trade barriers) on the world market, which could enhance the value of corn imports. On the other hand, harmonization of phytosanitary rules under the GATT and other reductions in trade barriers could result in increased trade in livestock products and decreased trade in bulk commodities, including corn.

Conclusions

Factors such as corn quality and bilateral arrangements generally play secondary roles to price and price-related factors (such as transportation costs and export credit) in the competition for corn export market share. The importance of quality in import decisionmaking depends on the market, with importers of corn for food and industrial purposes emphasizing quality more than importers of corn for feed use. Interviewees in the study countries perceived U.S. corn to be inferior in quality to South African and Argentine corn, but superior to Thai and Chinese corn. Governmental intervention plays only a minor role in decisionmaking in the world corn market (both import and export sides), probably due to corn's dominant use as a livestock feed ingredient rather than as a food staple.

Mandating cleaner corn under current production and marketing practices would appear to have little appreciable effect on the market share or value of U.S. corn exports. The world corn market is functioning fairly well, based on importers' knowledge of the types and characteristics of corn they generally receive from various exporters. Promoting cleaner U.S. corn for export by encouraging production of less breakage-susceptible hybrid genotypes and changing handling practices would be aimed primarily at those markets in which U.S. traders compete with Argentina and China, since South Africa's presence has been reduced in the market.

Confronting corn quality as an issue broader than just cleanliness (that is, encompassing such factors as starch and protein content) would necessitate the involvement of more participants, such as producers, plant breeders, and testing equipment manufacturers, but could also generate a more pronounced response from importers. Improving the quality of export corn cannot be addressed solely in

terms of altering U.S. grain grades and standards, since BCFM is already included in the U.S. standards. Instead, solving the problem requires viewing grain quality in the context of an integrated U.S. corn production and marketing system. The entire system affects grain quality, so an efficient solution would influence the whole system. The most cost-effective strategy to increase sales to quality-sensitive industrial and food users would likely involve making changes, such as cooperatives and seed corn salesmen encouraging farmers to plant the variety least susceptible to breakage among roughly equal-yielding varieties, throughout the marketing system. None of these changes would be drastic in isolation. Achieving greater uniformity among major corn exporters in areas such as grades and standards (especially factor definitions), inspection procedures, and measurement technology would facilitate the task of comparing grains on the basis of quality. The sum of such changes could produce a U.S. system ready to take on all comers in the quality arena as it already does in most other aspects important in import decisionmaking.

Glossary

Aflatoxin--A toxic substance produced by the soil fungus Aspergillus flavus, which can infect corn and other crops (such as peanuts) when they are stressed during maturation. The infection can also spread under improper storage conditions. Scientists believe aflatoxin increases the chance of developing liver cancer when ingested by humans in concentrations of more than 20 parts per billion.

Balanced (or complete) feed--A nutritionally adequate feed for animals other than man. A specific formula is compounded to be fed as the sole ration and is capable of maintaining life and/or promoting growth without any additional substance except water.

Breakage susceptibility--The probability that a given corn kernel will crack during handling or transportation. It has been scientifically established that breakage susceptibility differs by corn genotype.

Broken corn and foreign material (BCFM)--A corn grade-determining factor that includes broken corn pieces that pass through a 12/64-inch sieve plus foreign material (defined below).

Catalytic hydrolysis--The typical chemical process to convert corn starch to corn syrup. This process involves acidifying a 35- to 40-percent starch slurry with hydrochloric acid and heating it under pressure to 140 degrees Celsius. To stop the process, the solution is discharged under pressure and neutralized with sodium carbonate.

CEROILS--The China National Cereals, Oils, and Foodstuffs Import and Export Corporation, which handles nearly all imports and exports of agricultural products for China.

C & f--Cost and freight to the designated delivery point, paid by the seller.

C.i.f.--Cost, insurance, and freight to the designated delivery point, paid by the seller.

Compound (or formula) feed--A feed mixture containing two or more feed ingredients designed to satisfy the nutritional requirements of a given animal type.

CONASUPO--Compania Nacional de Subsistencias Populares S.A., which is the Mexican National Basic Food Distribution Agency.

Concentrate--A broad classification of feedstuffs that are high in energy and low in crude fiber content (less than 18 percent).

Corn bran--The pericarp or seed coat of the corn kernel that is removed during processing and used as an animal feed.

Corn germ--The embryo found in corn kernels and frequently separated from the bran and starch endosperm during milling. This part of the kernel contains most of the oil.

Corn gluten feed--A byproduct of manufacturing of starch, high-fructose corn syrup, and corn oil (wet-milling of corn). Contains all fiber originally present in corn. Corn gluten feed is a medium energy, mid-level protein meal (21-23 percent protein), which competes with wheat bran, hominy feed, and brewers' dried grain in feed rations.

Corn gluten meal--Also a byproduct of the corn wet-milling process. Corn gluten meal has 60 percent protein content, competes with soybean meal and other oilseed meals.

Corn starch--A key byproduct of corn processing, it is the carbohydrate component of a corn kernel. A typical corn kernel contains 65-70 percent starch on a dry product basis. The product that results from corn wet-milling contains 99.75 percent carbohydrates and only 0.25 percent protein.

Denaturing--A process that deprives a substance of certain of its natural properties. In this case, the corn that is denatured to prevent its diversion into industrial channels in Japan renders the corn unusable for wet-mill processing by adulterating it with other feed ingredients (such as soymeal) or altering its starch composition.

Distillers' dried grain--A byproduct of the alcohol distillation process (yielding grain alcohol and ethanol). It is a feed ingredient preferred in the rations of high-producing dairy cattle, feedlot cattle, and calf starters.

Dual herds--In some countries, cattle are bred and raised in separate operations for specialized purposes, such as dairy and beef. In a few countries (such as in the EC and Japan), those two functions are combined in the same operation, called dual herds.

Endosperm--The middle portion of the corn kernel, consisting of two parts, the soft endosperm, opposite the tip of the kernel, and the hard endosperm, which is the interior portion of the kernel. The endosperm contains both starch and gluten. The endosperm is ground intact in the dry-milling process but is separated into starch and gluten in the wet-milling process.

Ethanol (or ethyl alcohol)--A colorless and volatile liquid that is flammable. Ethanol is produced commercially from molasses, grain, sulfite waste liquor, or wood waste. It is derived from the industrial fermentation of simple sugars, which are the results of the hydrolyzation (by enzymes) of starch or cellulose. Ethanol for fuel in the United States is produced primarily from corn starch. In the product that is sold as fuel for automobiles, gasohol, the solution is typically 10-percent ethanol, 90-percent gasoline.

Export (or terminal) elevator--An establishment that operates facilities for receiving and shipping grains in large quantities at a terminal market. These locations were frequently the final destination of much of the grain because these were often important locations for processing, hence the designation terminal.

Finishing--In a feeder-calf, feedlot operation, particularly common in the United States, calves are raised for the first several months of their lives on forage and then shipped to feedlots and fed exclusively on compound feeds. The second stage of this process, called finishing, permits producers to ship cattle for slaughter with greater fat content in their muscles, called marbling, which tends to make beef more tender and tasty.

F.o.b.--Free on board, specifies that the seller loads the ship or other conveyance at the specified delivery point, with the buyer paying freight charges.

Forage--Vegetative plants in a fresh, dried, or ensiled state (pasture, hay, silage or green chop), which are fed to livestock.

Foreign material--Includes dirt, pieces of cob, other grains, etc., and finely broken corn that pass through a 12/64-inch sieve, plus material on top of a 6/64-inch sieve, according to FGIS definitions.

Gluten--The tough, viscid nitrogenous substance remaining when the flour of wheat or other grain is washed to remove the starch.

Grade factor or grade-determining factor--Those characteristics of grain used to determine the numerical grade. The grade factor is based on quantitative limits (either maximums or minimums) placed on each factor for each grade.

Heating--A portion of a corn shipment is overmoist, and has begun deteriorating or fermenting in transit.

High-fructose corn syrup (HFCS)--HFCS is made from a dextrose (glucose) syrup, fully converted from starch hydrolyzates by means of isomerizing glucose to fructose with the use of an enzyme xylose isomerase. HFCS is used as a substitute for sugar, particularly in industrial preparation of foods and beverages.

Hominy feed--A byproduct of the corn dry-milling process. It is a preferred ingredient for dairy cattle rations. It is the equivalent of corn grain in feed value, although with higher protein and fiber content.

Hopper cars--A type of railcar designed especially for efficient handling of grain. Hopper cars are loaded into the top of the car and are unloaded by rolling back panels on the bottom of the cars, permitting the grain to drop onto conveyor belts that move it directly to grain bins for storage.

Hybrid corn--Hybrid corn is the product of a controlled, systematic crossing of specially selected parental strains called "inbred lines." Accompanying inbreeding is a rigid selection for the elimination of those inbreds carrying poor heredity and which fail to meet established standards.

Identity preservation--Segregation of a commodity from one point to the next in the marketing system. The initially identified commodity is delivered to the next point in the marketing system without being mixed with other units of the same commodity during handling and shipment.

Intrinsic value (or end-use value)--Characteristics critical to the end-use of grain. These are nonvisual and can be determined only by analytical tests. For example, the intrinsic quality of corn is determined by characteristics such as protein, oil, and starch content.

Marbling--The distribution of fat in streaks through meat. Highly marbled meat (with fat distributed fairly evenly through the meat) is normally a more expensive and more tender cut of meat than meat that is not marbled.

Market channels--The agencies and institutions through which products are moved from their original producers to the final consumers in the marketing of grain. The market channel includes all stages from the point of first delivery from the farm to the final consumer of raw or processed products.

Metabolizable energy--The level of energy from a given grain that can be absorbed in an animal's digestive tract. The metabolizable energy content for a given grain or feed ingredient differs between animal types because they have different digestive processes.

MICONSA--Maiz Industrializado de CONASUPO (Corn Industry of CONASUPO).

Moisture content--The amount of water in grain; measured by the weight of water as a percentage of the total weight of the grain including water.

Sanitary and phyto-sanitary regulations--Rules dealing with the wholesomeness of animal and plant products imported into a given country.

Steam-flaking--A preprocessing method for corn fed to beef cattle. In this process, corn is cooked 15 minutes at 200°F, then flaked to a thickness of about 0.8 mm. The digestibility of starch in steam-flaked corn is increased by 14 percent and feed efficiency is improved by 12 percent over unprocessed corn.

Steeping--The act of soaking grain in warm water to remove the soluble content or begin germination.

Test weight--Weight per unit volume as measured in pounds per bushel as defined in the United States. Determined by weighing the quantity of grain required to fill a 1-quart container. The international equivalent measure is kilograms per hectoliter (conversion factor 0.77).

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Appendix A: Details of Corn Processing Sectors

Corn is sometimes imported for processing into industrial or food products, although that corn typically accounts for only a small share of any country's total imports. This corn is processed into final products by two different processes, dry-milling and wet-milling. These processes manufacture a number of products intended both as intermediate goods as inputs in other industrial processes, and as final goods for consumers (appendix table 1).

Dry-Milling

Corn that undergoes dry-milling is typically made into food products. In this process, the corn kernel is separated into *corn germ*, *corn bran*, and *endosperm*. The endosperm is separated into intermediate products such as flaking grits, brewers' grits, corn meal, and corn flour. Corn oil is extracted from the corn germ and the remaining byproduct (germ cake) is incorporated into *hominy feed*, a livestock feed. The bran portion also enters the byproduct feed channels. The flaking and brewers' grits (large particles) produced from the endosperm are the basic ingredients for such food products as breakfast cereal, corn snack foods, and grain alcohol from brewing. Corn meal and flour (finer particles) produce such goods as bakery mixes, corn meal mixes, cereals, and industrial products like wallpaper paste (Hill and others, 1991). Most of the corn flour for tortillas in Mexico is ground in the traditional manner, which does not extract the corn germ and produces a flour with different end-use attributes (a shorter shelf life due to oil content and unique taste).

Wet-Milling

Corn is also the raw ingredient in wet-milling which produces starch, an essential intermediate product for many final products, both in the food and industrial sectors. The wet-milling process involves *steeping* corn in water (and small amounts of sulfur dioxide) to soften the kernels. The whole mixture (called a slurry) is processed to separate the corn germ, bran, starch and *gluten*. Starch can be further processed into corn sugars and corn syrups through *catalytic hydrolysis*, or may go into many manufacturing processes, such as ethanol production, paper making, textiles, commercial laundries, foundries, mining, petroleum refining, and adhesive manufacture. Most of the corn sugars and syrups are utilized in the food processing sector (Matz, 1959). Major byproducts of the wet-milling process are *corn gluten feed* and *corn gluten meal*.

Ethanol Production

Ethanol for fuel is produced primarily in the United States from corn using both the wet-milling and dry-milling technologies. Two-thirds of the U.S. ethanol is produced by wet-milling, during which the corn starch produced is

Appendix table 1--Composition of corn import demand in study countries

Country	Dominant dry-mill products	Dominant wet-mill products	Rankings of livestock use of corn[1]
Egypt	Corn flour Corn bread	Corn starch HFCS	1. Cattle 2. Poultry
Japan	Corn grits Corn flakes Alcohol	HFCS Corn starch Glue	1. Poultry 2. Swine 3. Cattle
Mexico[2]	Corn flour Corn tortillas Corn flakes Corn meal	Corn starch Corn syrup	1. Poultry 2. Swine 3. Dairy
South Korea	Corn meal Corn flour	Corn starch Corn syrup HFCS	1. Swine 2. Poultry 3. Dairy 4. Cattle
Spain	Corn flour	HFCS Corn starch	1. Poultry 2. Swine 3. Cattle
Russia[2]	Corn meal	Corn starch Alcohol Corn oil Corn syrup	1. Cattle 2. Swine 3. Poultry
Taiwan	Minimal dry-milling	Corn starch HFCS	1. Swine 2. Poultry 3. Cattle
Venezuela[2]	Corn flour Corn meal Corn bread	Corn starch HFCS	1. Poultry 2. Swine 3. Dairy

[1]Excludes corn used as silage. [2]Industrial or food processing sectors use primarily or exclusively domestic corn.

fermented into alcohol, and the remaining third is produced using dry-milling technologies. In this latter process, the corn is milled but not separated and the entire mixture is mashed and fermented (with the help of yeast) into alcohol (U.S. Department of the Interior, Environmental Protection Agency, 1990). Technically, any grain or grass can be used as the starch feedstock for the production of ethanol (such as the use of sugar cane in Brazil). However, since corn is so plentiful in the United States and corn processing facilities already exist for other products, corn millers can produce ethanol profitably (with the help of tax breaks from State and Federal governments).

Appendix B: Major Players in Feed Sector

The major share of the world's trade in corn is used in livestock feeding, although the share of corn (and other coarse grains) used for livestock feeding varies considerably among countries. The propensity to use corn depends both on the composition of meat and poultry demand and on the types of feed ingredients grown domestically (appendix table 2).

The Livestock Sector

The feeding of *compound feed* for finishing cattle for beef in large-sized commercial feedlots occurs in Japan and Taiwan and to a lesser extent in Egypt and Spain. These countries, particularly Japan and Taiwan, have constraints on the availability of pasture land. Japan, South Korea, and Taiwan import a substantial share of their annual beef consumption, ranging from 45 percent for Japan to more than 90 percent for Taiwan. Among those examined, these same countries have relatively low per capita beef consumption levels. Sixty-five percent of the cattle butchered for beef in Japan are culled dairy cattle, which are fed primarily in commercial feedlots (Australian Bureau of Agricultural and Resource Economics, 1988). The remainder of the cattle are raised in the wagyu system, where they are almost entirely grain-fed and often produce highly *marbled* meat. Most beef cattle elsewhere are primarily forage-fed and require little or no grain feeding.

Mexico produces large numbers of forage-fed feeder calves (1 million head annually over the last few years) and ships them to the United States to be *finished* on grain in U.S. feedlots (particularly in Texas). U.S. producers in turn ship slaughter cattle and processed beef back to Mexico. The North American Free Trade Agreement (NAFTA) should expand this trade pattern (USDA, Office of Economics, 1993).

The world's dairy sector also requires a great deal of compound feed, since a cow's productivity increases significantly when it is fed grain. Because fluid milk is consumed worldwide and is an expensive and perishable commodity to ship, most countries support a dairy sector of some type. Grass-fed dairy operations do exist, but their milk output per head is only a fraction of the productivity of grain-fed dairy cattle.[16] Producers in a few countries run dual herds (such as in the EC and Japan), but in most cases raising dairy cattle is a specialized activity. Because raising dairy cattle is such a labor-intensive activity (even with computer automation), there are not as many economies of scale to capture as with confined poultry and hogs facilities, although a few operations with as many as 1,000 head of dairy cattle do exist.

Smaller operations, with much of the grain and forage raised on the farm, are still quite common throughout the world. Milk production has been constrained in Mexico because of high production costs and controlled prices in the fluid milk market. Dairy cattle demand a substantial share of compound feed in many countries (20-30 percent in the EC, 16 percent in South Korea).

Pork production also occurs in most areas of the world, with the exception of the Arab world, where pork consumption is prohibited by Muslim tenets. In seven of the eight countries, most swine are raised in modern confinement operations, with increasing vertical integration between feed manufacturing, hog feeding, slaughtering, and marketing. Many hogs are raised on large collective farms in Russia (with up to 13,000 head per operation), but the shortage of balanced feed ingredients has kept much of pork production in small-scale, traditional operations (Shagam, 1990). Even on large state complexes, feed formulations are crude and operations are relatively inefficient (feed efficiency per head is 60 percent lower than the U.S. average). Few

[16]Both New Zealand dairy operations (grass-fed) and U.S. dairy operations (grain-fed) are regarded as highly efficient. U.S. dairy cattle produced on average twice as much milk per head in 1992 as did New Zealand dairy cattle. When considered on a fat equivalent basis, however, that advantage falls to 53 percent (USDA/ERS, 1993).

Appendix table 2--Per capita meat and milk consumption for 1975 and 1991

Country	1975				1991			
	Beef	Pork	Poultry	Milk	Beef	Pork	Poultry	Milk
	Kilograms per person							
Egypt	6.4	[1]	3.3	NA	8.6	[1]	4.2	38
Japan	3.7	10.5	6.9	44	9.1	16.7	14.2	67
Mexico	16.6	13.2	5.3	149	21.0	9.4	8.4	118
Russia[2]	26.3	22.2	6.2	353	29.2	22.1	11.4	347
South Korea	2.0	2.5	1.6	NA	5.1	11.8	4.8	NA
Spain	13.2	17.7	17.4	158	12.5	48.0	21.0	177
Taiwan	1.0	19.3	8.2	NA	2.2	36.0	23.0	NA
Venezuela	23.5	5.9	11.5	91	18.5	5.3	16.5	158

NA=not available. [1]Total pork consumption in Egypt is less than 5,000 tons annually. [2]Data for Russia is for former Soviet Union. Source: USDA/ERS, 1993.

swine are raised in Egypt, because it is a Muslim country in which eating pork is limited primarily to non-Muslims and tourists. The integration of the pork industry has led to higher productivity, due to better management techniques, more efficient feeding, and improved animal genetics.

Large-scale, modern poultry facilities, operated by large firms and farmer-owned cooperatives, dominate the world production of poultry. The integrated poultry system, in which one firm either owns or contracts for all the separate stages (hatching eggs, raising the broilers, and processing and shipping the meat), requires very precise quality control and carefully mixed feed rations. This system has led to low feed-to-meat conversion rates and permitted poultry producers in many countries to sell their product at lower prices than those of competing meats (such as beef and pork). Two lesser factors have also contributed to greater demand for poultry meat: (1) the increasing concern about cholesterol in human diets in many developed countries has increased consumer preference for poultry meat, which has lower fat content than the red meats; and (2) the poultry industry has also done a good job of packaging its meat in convenience foods and marketing products through fast-food outlets. The general shift, particularly in developed countries, from the red meats (pork and beef) to poultry, has led to greater demand for balanced feed production. In most of the countries studied, the poultry industry is one of the biggest users of compound feed, ranking first or second.

The locational concentration of livestock raising and the effort to capture economies of scale has led to the development of large-scale feed manufacturing in most of the countries studied. In Russia, the feed-processing cooperatives are clustered around large urban centers with nearby livestock-feeding operations, such as Moscow and St. Petersburg. In countries where most feed ingredients are imported (such as in Spain, Japan, South Korea, and Taiwan), the feed-manufacturing plants are located near port areas. Such locations save on transportation costs and reduce the retail prices of feeds. In Mexico, the poor transportation infrastructure limits national feed distribution, so economies of scale are realized only on a regional basis. Mexican imports of U.S. complete feeds have increased sharply since 1987. Although the size of feed-compounding firms in many of these countries has permitted them to capture economies of scale in the acquisition of raw ingredients and the distribution of the finished product, in a few of the countries studied (notably Venezuela, Taiwan, and Spain) the expansion of the industry has gone too far. These countries are able to produce far more compound feeds than are needed locally.

Agricultural and Trade Policies Affecting Feed Use of Corn

In agricultural markets around the world, governments intervene on behalf of producers and/or consumers to control or support prices. Such policies include intervention in domestic markets as well as in trade, though their use is less pervasive in coarse grain markets than in grains which are used primarily for food. The types of policy instruments used in the eight countries examined in this study are discussed below.

Domestic Policies

Aside from the Russian system, the most extensive policy system among the countries studied is in Spain, whose membership in the EC entitles its grain producers to support under the Common Agricultural Policy (CAP). The CAP provides producers with support prices above world levels (despite cuts in the reform package approved in June 1992), per-hectare compensatory payments, variable import levies to protect against foreign competition, and export subsidies to sell surplus grain on the world market. These policies have protected Spanish corn producers, resulting in a 70-percent decline in corn imports since before joining the EC. Other countries with substantial support for domestic corn production and use do so primarily to protect human consumption.

In Egypt, the state pays fixed prices (below world levels in the 1970's and below domestic market prices in the 1980's and 1990's) for domestic corn that it procures, and, as a result, little of the domestic corn crop reaches government grain bins (only 4 percent in 1992). The Egyptian Ministry of Agriculture and Land Reclamation also provides production credit and subsidizes selected inputs, such as irrigation water (Gardner, 1988).

For climatic reasons, the Russian Federation grows relatively little corn for grain, despite repeated efforts to expand cultivation. Russian farmers annually produce around 1 million tons of corn for grain.[17] The state agricultural system produces corn in addition to other grains. The price of meat in Russia was freed in 1992 along with the prices of most other food items, and prices rose at a rapid pace. The higher prices for food have choked off some consumer demand for these goods and have led to reduced demand for feed ingredients.

Trade Policies

The most notable policy mechanism affecting the flow of corn imports in these countries is the U.S.-EC Enlargement Agreement, without which it is unlikely Spain would import any extra-EC feed grains. Shifting trade policies in Venezuela (illustrated by the current minimum import price system, the third policy system in 2 years) periodically restrict corn imports. Mexico retains an import licensing system for corn and barley imports (licenses granted by a committee with government and private representatives) and a 15-percent seasonal tariff on sorghum imports, although these policies are due to be phased out for U.S. grains under NAFTA.

South Korea uses a quota system for corn imports, but its purpose is to restrict which firms can import corn rather than restrict import levels. Korean industry experts have implied that the quota restriction raises feed costs to nonquota holders by 15-20 percent. Taiwan lifted the quota system in 1988, although an informal joint purchasing system still persists between feed manufacturers and a government "Fair Trade Committee." No explicit limits apply to corn imports for feed use in Japan, but the Ministry of Finance requires that imports be *denatured* to keep them out of industrial use. Corn for industrial use has a separate tariff quota system.

Appendix C: The Effect of Quality on Corn Export Price Determination

This section summarizes a portion of the work conducted at ERS in the Grain Quality Project. This study examined the role of quality in the price determination process for U.S. corn exports. A number of approaches can be used to measure objectively the market valuation of various grain characteristics. The approach adopted here, the hedonic price approach, which was developed in the 1970's, incorporates differences in product quality.

The major shortcoming that previous hedonic studies suffered from is inadequate data; either the data are highly aggregated or cover a relatively narrow geographical region and/or chronological period. The most important advance of this study is its use of an unprecedentedly rich data set containing a cross-section of individual transaction prices and corresponding quality factors to examine the U.S. role in the world corn market. The data cover 50 countries over the period between January 1990 and December 1991. This study examines the relationship between price and quality attributes that U.S. corn importers consider in their sourcing decision, and other factors that influence how corn price differs between countries.

This approach assumes that profit-maximizing corn millers or feed processors demand inputs for their production processes that yield specific end-use results, and thus seek inputs with such characteristics that create products with those desired results. The models estimated

[17]For 1990/91-1992/93, corn production in the 12 non-Baltic republics of the former Soviet Union averaged 9 million metric tons (USDA/WAOB, 1993).

actually reflect the intersection of the demand for and the supply of quality characteristics. The general hedonic structure is represented by the quality characteristics derived from the shipment-level data. The shipment-specific quality and price portion of the data set were constructed by matching FGIS export inspection data with export data on quantity and value collected by the Bureau of Census of the Department of Commerce. The data set was created by matching individual shipment observations based on import destination, U.S. port of exit, month and year of shipment, and shipment size. The price was derived by dividing shipment value by shipment size, and represents a transaction price for each particular shipment.

The quality factors used as independent variables in this analysis were BCFM, total damaged kernels, moisture content (measured in percentage content), and test weight (measured in bushels per pound). The quality information is derived from the FGIS export data set. Although the data series was not long enough to provide convincing evidence of periodicity, data plots suggested somewhat higher prices tend to prevail in late spring and early summer (May and June), so dummy variables representing those months were included. A categorical variable for crop year (parts of three crop years were contained in the data set) was also included.

Empirical Results

The equations in the analysis were estimated with weighted least squares, with the size of shipment as the weighting variable. The weighted least square technique was used to minimize the chance of a small, tightly specified corn shipment skewing the results. A loglinear specification was estimated, but discarded because of poor statistical fit. The linear specification, used in most previous analyses of this type and in keeping with the theoretical model, was deemed to be most appropriate. Durbin-Watson statistics calculated for the equations found borderline first-order serial correlation with the first two equations, but corrections for autocorrelation did not improve the estimation results significantly.

Four separate equations were estimated in this study (appendix table 3). The second set, examining temporal stability of implicit prices for corn quality characteristics, will not be discussed here. The first and second equations split the data set along lines approximating the feed versus the food and industrial uses submarkets, since such information was not provided in the data set. The decision rules used were somewhat arbitrary, based on knowledge of corn importing country's market structure.

Appendix table 3--Corn export price equations, export submarkets

Variable	Feed exports	Food and industrial exports
Intercept	80.64*	289.12*
	(3.07)	(3.13)
Grade	0.532	7.265
	(0.67)	(1.01)
Broken corn and foreign material	-1.249	-6.18
	(-1.75)	(-1.53)
Moisture content	-3.937*	-11.190*
	(-4.83)	(-6.85)
Test weight	1.630*	0.002
	(3.99)	(0.01)
Damaged kernels	0.206	-2.549*
	(0.71)	(-1.98)
May dummy	4.325*	----
	(4.27)	
June dummy	2.617*	----
	(2.58)	
Crop year	-1.494*	-4.751*
	(-3.02)	(-2.75)
White corn	----	30.074*
		(6.49)
R^2	0.19	0.615
DW	1.75	1.98
Number	659	120

Note: t-statistics in parentheses. *Indicates coefficient with 5-percent significance level.

Most of the variables in these equations behave as expected, with only a few exceptions. In this summary, we focus on the behavior of the quality-related characteristics. Grade appears not to be a useful predictor of the shipment price, since the signs are contrary to expectation and the coefficients are not statistically

significant. The presence of BCFM is generally seen as detrimental to the value of a corn shipment, so the expected sign for its coefficient is negative. The signs of the BCFM coefficients in these equations are consistent with the relative importance importers attached to its presence, with a strong negative coefficient found in the food/industrial use equation. Feed importers profess to be concerned about BCFM content, but typically buy U.S. No. 3 (or better) corn, which has BCFM no more than 4 percent when it is inspected at U.S. ports.

The coefficient for damaged kernels shows the expected sign in the food and industrial use equation, and is statistically significant. The implicit price for damaged kernels is unexpectedly negative in the feed use equation, but the coefficient is not statistically significant. In interviews, importers in general did not attach much significance to this factor, nor did measured levels often approach grade limits.

Moisture content, while not a grade-determining factor in U.S. grades and standards, is nonetheless considered to be an important characteristic by most corn importers. Feed manufacturers usually store their grain for longer periods than do corn processors, so this characteristic holds more importance for them. This hierarchy is reflected by the relative sizes of the negative coefficients for moisture content found in the three equations.

Test weight is a grade-determining factor in the U.S. corn grades and standards, and high test weight is regarded as being positively correlated with yield of dry products for the milling industry. Test weight is influenced by other factors (environmental and handling) which can cause it to become a poor predictor of milling yield (Hill and others, 1991). Low test weight can be an indicator of corn that experienced high-temperature drying. However, few importers regard test weight to be a key determinant in their import decisionmaking process. In addition to the lack of importance attached by many importers to test weight, there is also considerable uniformity in the test weight of U.S. corn exports. In the data analyzed in this study, the standard deviation of test weight for the entire sample was less than 0.75 lbs/bu. Within the data set, only 1 shipment out of 777 observations had test weight below the grade limit for U.S. No. 2 (54 lb/bu). The test weight coefficient shows a positive and statistically significant sign in the feed corn equation, but is not statistically significant in the food/industrial corn equation. The reason for the lack of significance in the latter equation is not clear, except that the coefficient of variation in those shipments with respect to test weight is at most one-third of the variation seen in the other measured factors, and importers had no reason to feel anxiety about test weight in U.S. corn in these crop years.

Although the data were split somewhat arbitrarily, the two submarket models do suggest that importers of U.S. corn for different end-uses do place different values on the three key quality factors for which they possess information.

Appendix table 4--Trade and domestic policies affecting the livestock sector of selected countries

Policy	Country	Commodity
Trade policies:		
Import ban	Egypt	Beef
Tariff quota	Japan	Beef
Import quota	South Korea	Beef
Export refunds	Spain	Beef, poultry, dairy
Variable levies	Spain	Beef, poultry, pork, dairy
Domestic policies:		
Government procurement	Japan, Spain	Beef
Support prices	Spain, South Korea	Beef
Production quotas	Japan, EC	Dairy
Consumer subsidies	Mexico	Dairy
Price controls	Venezuela	Dairy
State controls	Russia, Taiwan	Dairy

Source: Webb and others, 1990.

Appendix table 5--Current U.S. corn grades and grade requirements

Grade	Minimum: Test weight	Maximums: Heat-damaged kernels	Maximums: Total damaged kernels	Maximums: Broken corn and foreign material
	Lb/bu	*Percent*		
U.S. No. 1	56.0	0.1	3.0	2.0
U.S. No. 2	54.0	.2	5.0	3.0
U.S. No. 3	52.0	.5	7.0	4.0
U.S. No. 4	49.0	1.0	10.0	5.0
U.S. No. 5	46.0	3.0	15.0	7.0

U.S. sample grade:

(a) Does not meet the requirements for the grades U.S. No. 1, 2, 3, 4, or 5; or

(b) Contains more than eight stones which have an aggregate weight in excess of 0.20 percent of the sample weight, two or more pieces of glass, three or more crotalaria seeds (Crotalaria spp.), two or more castor beans (Ricinus communis L.), four or more particles of an unknown foreign substance(s) or a commonly recognized harmful or toxic substance(s), eight or more cockleburs (Xanthus spp.), or similar seeds singly or in combination, or animal filth in excess of 0.2 percent in 1,000 grams;
or

(c) Has a musty, sour, or commercially objectionable foreign odor; or

(d) Is *heating*, or otherwise of distinctly low quality.

Source: USDA/FGIS, 1988.

Appendix table 6--Grade-determining factors for corn in selected exporting countries

Specifications	Argentina		China	South Africa	Thailand	United States
Number of grades	3	3	3	2	5	
Broken kernels		x			x	
Foreign material		x		x	x	
Broken kernels and foreign material						x
Total damaged kernels		x			x	x
Heat-damaged kernels						x
Test weight		x				x
Moisture content				x		
Defective kernels			x			
Other colored kernels				x		x
Total defects				x		
Minimum purity index			x			
Weevilled kernels				x		

Note: x=factor included in country's official standards for corn.
Source: Bender, Hill, and Valdes, 1992.

Appendix table 7--Variation between quality factors for U.S. export corn

Country	1986	1987	1988	1989	1990	1991
				Standard deviation		
Egypt:						
Test weight	0.63	0.69	0.77	0.63	0.68	0.67
Moisture	.18	.38	.38	.47	.42	.36
BCFM	.19	.36	.13	.10	.12	.26
Japan:						
Test weight	1.26	.85	.81	.91	.73	1.00
Moisture	.50	.45	.48	.56	.52	.36
BCFM	.65	.65	.79	.69	.65	.74
Mexico:						
Test weight	.62	.95	.75	.43	.51	.64
Moisture	.63	.45	.53	.82	.50	.54
BCFM	.47	.57	.58	.41	.50	.56
Russia:						
Test weight	.61	.68	.49	.74	.68	1.07
Moisture	.24	.31	.40	.56	.39	.30
BCFM	.27	.18	.28	.28	.23	.36
South Korea:						
Test weight	1.10	.76	.62	.58	.65	.68
Moisture	.35	.47	.48	.56	.57	.35
BCFM	.42	.43	.50	.58	.50	.60
Spain:						
Test weight	.69	.61	.68	.59	1.19	.90
Moisture	.38	.45	.34	.39	.24	.17
BCFM	.44	.51	.33	.27	.29	.37
Taiwan:						
Test weight	1.02	.80	.56	.59	.63	.54
Moisture	.27	.41	.47	.58	.51	.22
BCFM	.11	.13	.18	.25	.27	.16
Venezuela:						
Test weight	—	—	—	—	.45	.56
Moisture	—	—	—	—	.37	.29
BCFM	—	—	—	—	.42	.44

— = No U.S. corn exported to Venezuela in these years.
Source: USDA/FGIS, 1986-91.

U.S. Department of Agriculture
Economic Research Service

SUMMARY OF REPORT AER-675

More Cleaning of All U.S. Export Wheat Does Not Pay; But Targeting Cleaning to Specific Markets Can Pay

December 1993

Contact: William Lin (202) 219-0840

Cleaning all U.S. export wheat beyond current practice is not economically feasible, according to a new report by USDA's Economic Research Service. Costs of additional cleaning would outweigh benefits by at least $8 million per year in the short run. The best strategy of promoting cleanliness of U.S. export wheat is to target clean wheat for niche markets, those that use wheat to meet very specific end-use demands for high-quality food products.

Concern over the quality of grain exported from the United States versus the quality of competitors' grain has increased in recent years. Some observers believe that selling grain that contains higher levels of dockage and foreign material than that of our competitors has reduced U.S. competitiveness in the world grain market. (Dockage is all matter other than wheat, such as chaff, stems, and stones. Foreign material is all matter other than wheat after dockage is removed; it is the most difficult material to remove from wheat.) Advocates argue that improving the cleanliness of U.S. grain will increase market share or is necessary to maintain U.S. market share at current levels. Critics argue that improving cleanliness will increase marketing costs, reduce profits, and diminish U.S. competitiveness.

In response to a request from Congress, the Economic Research Service (ERS), in cooperation with researchers at land-grant universities and the U.S. grain industry, conducted a study on the costs and benefits of cleaning U.S. grain. *Costs and Benefits of Cleaning U.S. Wheat* presents an overview and implications of this study and summarizes two other ERS reports produced in response to this study. The first, *Economic Implications of Cleaning Wheat in the United States*, focuses on the costs and domestic benefits of cleaning wheat. The second, *The Role of Quality in Wheat Import Decisionmaking*, focuses on importers' preferences with respect to cleanliness and other quality factors, and assesses the benefits of cleaning export wheat for international markets.

The wheat industry could gain $8 to $10 million in net benefits if it targets wheat cleaning to the cleanliness-conscious markets, which account for about 20 percent of all U.S. wheat exports. These markets include Italy, Venezuela, Togo, Ghana, and possibly Japan and the Philippines. The United States competes with Canada and Australia for these markets. Targeted wheat classes for cleaning are primarily dark northern spring (DNS) and durum wheat exported from the Pacific and Gulf ports.

While selling cleaner U.S. wheat in cleanliness-conscious markets may increase export prices or enhance the U.S. competitive position, cleanliness is not the most important factor affecting importers' demand for wheat. Price considerations, cleanliness, quality considerations, and institutional factors all influence the selection of a supply source in the world wheat market. In the many low-income countries that account for a majority of world wheat imports, wheat price, not quality, is the most important factor in the purchase decision.

To Order These Reports...

The information presented here is excerpted from ***Costs and Benefits of Cleaning U.S. Wheat: Overview and Implications,*** AER-675, by William Lin and Mack Leath. The cost is $9.00.

Two companion reports, ***Economic Implications of Cleaning Wheat in the United States,*** AER-669, by Bengt T. Hyberg, Mark Ash, William Lin, Chin-zen Lin, Lorna Aldrich, and David Pace, and ***The Role of Quality in Wheat Import Decisionmaking,*** AER-670, by Stephanie A. Mercier, each cost $12.00.

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Economic Research Service

SUMMARY OF REPORT #AIB-688

Three Forces Drive World Feed Wheat Trade

February 1994

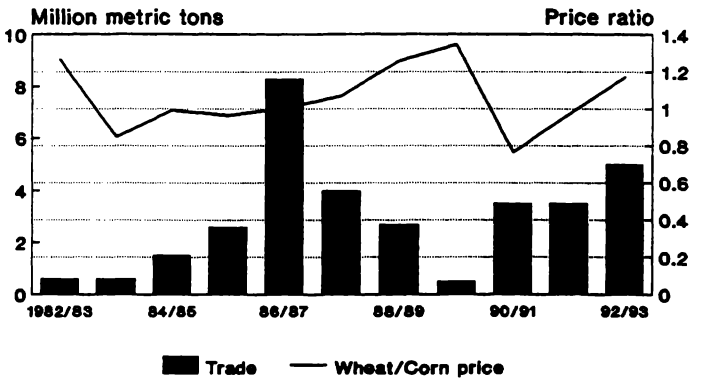
Contact: Sara Schwartz, 202/219-0825

Competitive prices and abundant wheat supplies generally increase trade in wheat for feeding. Certain types of market conditions increase the probability that large volumes of feed wheat will be traded. These market conditions include: damaged wheat in exporting countries that leads to heavy price discounts; abundant total wheat supplies that drive down export prices, often aggravated by fierce and subsidized competition among exporters; and a combination of the first two conditions that lowers relative wheat prices. *World Feed Wheat Trade: A Market Analysis*, a recent report from USDA's Economic Research Service, examines the key factors affecting feed wheat trade and thus develops a framework for evaluating the necessary conditions.

While the annual volume of feed wheat trade fluctuates widely, it has been increasing since the mid-1980's. Although much wheat that is traded and fed is low quality, there is no standard definition of feed wheat; any wheat can be used for feeding. Trade accounts for only a small and irregular portion of world consumption of wheat for feed, but feed wheat trade critically affects the volume of total wheat and coarse grain trade.

The world market for feed wheat is relatively small, with few countries importing wheat for feed, even in years when relative prices are attractive. Policy impediments and other factors, such as the irregular availability of low-priced wheat, restrict import demand. The world market is undergoing some structural change because of reduced demand by the former Soviet Union (FSU) and Eastern Europe, major importers in the past. Because of reforms and economic changes, the livestock sectors in these countries are contracting, and feeding of all grains is declining. In the short term, this will further increase the dominance of South Korea, which now has close to monopsony power in the world market. Other countries could import more feed wheat, but this would require more flexibility in imports or policy changes.

World feed wheat trade and wheat/corn ratio 1/



1/ Feed wheat prices unavailable. Ratio comprised of composite milling wheat price to US Gulf f.o.b. corn price.

To Order This Report...

The information presented here is excerpted from ***World Feed Wheat Trade: A Market Analysis,*** AIB-688, by Peter Riley, Sara Schwartz, and Karen Ackerman. The cost is $7.50.

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