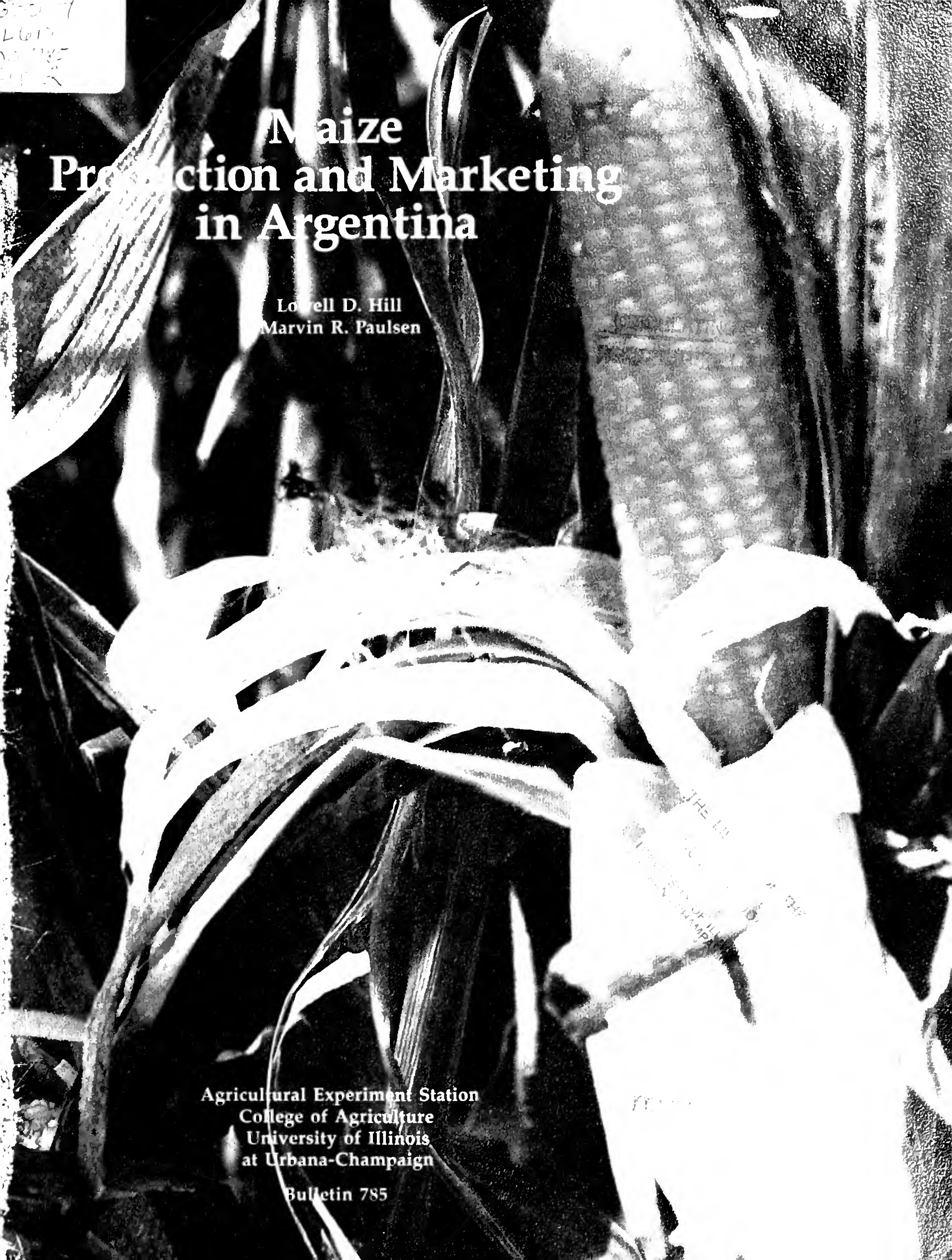


Maize Production and Marketing in Argentina

Lowell D. Hill
Marvin R. Paulsen

Agricultural Experiment Station
College of Agriculture
University of Illinois
at Urbana-Champaign

Bulletin 785

Maize Production and Marketing in Argentina

Lowell D. Hill
Marvin R. Paulsen

Agricultural Experiment Station
College of Agriculture
University of Illinois
at Urbana-Champaign

Bulletin 785

Abstract

Key Words: Corn, Maize, Argentina, Corn Quality, Grading Standards, Exports

The maize production, marketing, exporting, and quality control practices in Argentina are compared with those in the United States. Technology of production, marketing, and grading were found to be similar in both countries. Quality deterioration due to high-temperature drying and mechanical handling was also similar. Incentives for blending diverse qualities and moisture levels were found to be less under the Argentine pricing and grading systems. Moisture content in the market channel was lower in Argentina as a result of setting the base moisture at 14.5 percent. There are some differences in chemical and physical properties of U.S. and Argentine maize, but no evidence that either source was consistently superior for all uses.

Lowell D. Hill is Professor, Department of Agricultural Economics, and Marvin R. Paulsen is Professor, Department of Agricultural Engineering, University of Illinois at Urbana-Champaign.

Acknowledgments

The data in this report were obtained with the assistance of many people and agencies. Funds were provided by a State-Federal matching grant from the Illinois Department of Agriculture and Agricultural Marketing Service, USDA. Additional funds were provided by the College of Agriculture and Illinois Agricultural Experiment Station, University of Illinois at Urbana-Champaign. The research is a contribution to the North Central Regional Research Project NC-151, entitled "Marketing and Delivery of Quality Cereals and Oilseeds in Domestic and Foreign Markets."

The authors express their appreciation for the cooperation of many employees of La Plata Cereal Company, Buenos Aires, several country elevator personnel in the Pergamino area, and the Junta Nacional de Granos for their advice, data, assistance, and hospitality. A special thanks to Dr. James McGrann, Texas A & M University, whose assistance extended far beyond his fluency in Spanish. His communication skills were a major factor in the success of this research. Dr. Adolfo Coscia provided valuable assistance and advice through his published work and personal correspondence. Betty E. Hill provided the photographic description of the Argentine production and marketing system.

Numerous research assistants have contributed to the study through their analysis of samples, library research, and statistical analyses. These individuals include Beth Mullens, Jeanne Bailey, Gabriela Serrano Aguero, and Roderick Bunge. We also express our appreciation to the many friends we made in the Argentine production and marketing sector of the Pergamino region for their assistance and hospitality. Finally, we wish to acknowledge the assistance of Dee Lambert and Margaret Pepper for their patience in typing the many versions of the manuscript and Carolyn Evans and Robert Heister for their artistic and editorial expertise.

Contents

Urbana, Illinois *8M Crouse rah* July 1987

The Junta Nacional de Granos owns storage and export facilities at several ports.

Introduction

Argentina has always been an important force in world grain trade, but recent increases in production and changes in government policies place it as the number one competitor with the United States for feed grain sales in international markets. The importance of grain exports to the Argentine economy, policy changes encouraging farmers to use more fertilizers, and responsiveness of Argentine farmers to profit incentives all guarantee that Argentina will continue to provide a significant share of the world's feed grain needs, especially maize.

Information about the Argentine maize industry, its current and potential production, marketing practices, and maize quality is important not only for planning marketing strategies and identifying market opportunities for the United States, but also as an aid to Argentina in developing production and marketing strategies to meet policy goals and better serve their markets. Maize production and marketing practices are similar in the United States and Argentina but there are also important differences in maize quality characteristics. Understanding these relationships will enable each country to develop its production and marketing strategies more efficiently and to seek those markets where their grain has the greatest comparative advantage.

Research Objectives

The objectives of the research reported in this publication are (1) to describe the production and marketing system of Argentina with some comparisons to that of the United States; (2) to measure quality characteristics of Argentine maize at each point in the market channel from farm to export elevator and ocean vessel; and (3) to compare the incentives in the two countries for changes in marketing and production practices that could influence quality.

Maize Production and Marketing in Argentina

Production and Utilization of Maize in Argentina

Production

The production of maize in Argentina during the past four decades has ranged from a low of 836,000 metric tons in 1949 [10, p. 43] to a high of 12.9 million metric tons (mmt) during the record crop of 1981/82.[1] Crop size has increased from the 2-mmt to 5-mmt range in the 1950s to a 6-mmt to 10-mmt range in the 1970s (Table 1). Generally, there has been an upward trend in production but with extreme year-to-year variability as a result of weather conditions. The 1980/81 production of only 6.4 mmt was followed by a record crop of 12.9 mmt in 1981/82. Production returned to more normal levels during the next three years, with an average production of 9.37 mmt for the three years 1982/83, 1983/84, and 1984/85 (Table 1).

In comparison with production in the United States, Argentina has had greater year-to-year variation and a slower, overall rate of growth, but Argentina's share of total world production of maize has remained relatively stable, representing 1.98 percent of world production in 1951 and 2.11 percent in 1984 [10, pp. 42, 51; 9, p. 116]. During this same period, the United States' share of world production fluctuated from a high of 58.7 percent in 1952 to a low of 30.5 percent in 1983. The historical pattern for the U.S. has been one of slow but steady growth between 1951 and 1974, followed by rapid growth until 1982, when the U.S. harvested a record crop of 209 mmt. In 1983, production was cut almost in half by the government's Payment-in-Kind program (PIK). Production returned to normal levels of 194 mmt in 1984 [32, 33, 34].

The area of maize harvested in Argentina has fluctuated around the 1975/76 to 1984/85 ten-year average of 2.9 million hectares (7.2 million acres).[2] Between 1965/66 and 1984/85 the greatest change in any two consecutive years was a 36.3 percent increase from 2.5 million hectares (6.2 million acres) in 1980/81 to 3.4 million hectares (8.4 million acres) in 1981/82 [32]. In contrast to the relatively stable area that was harvested, the average production of 8.8 million metric tons between 1975/76 and 1984/85 comprises annual changes as great as 102 percent from one year to the next (Table 1).

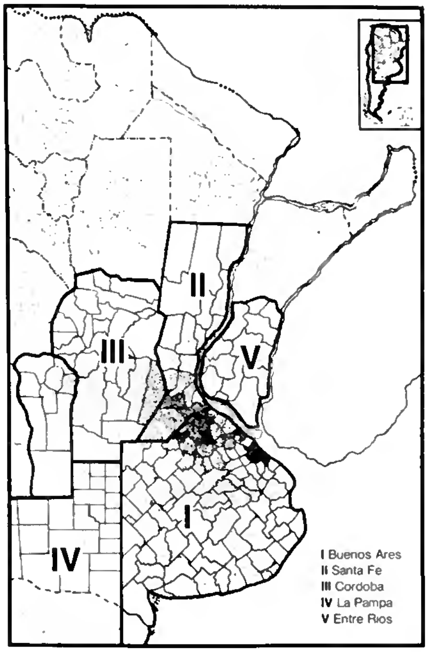


Figure 1. Production density for maize in Argentina. The production of maize is concentrated in the provinces of Santa Fe and Buenos Aires. (Adapted from: [14, p. 9])

[1] In this discussion, references to literature cited will be indicated within brackets. The first number within brackets refers to the source as numbered in the reference list. References to specific pages within the source will be preceded by the letter "p" followed by the page number(s) in question. For purposes of clarifying measurements, "tons" refers to metric tons and "mmt" to million metric tons.

[2] These are FAS marketing years, which lag one year behind the production years used in Argentine publications.

Harvesting maize in Argentina is a fully mechanized operation, as shown by this Vassalli combine with a 5-row Manerio header.

Maize production in Argentina is concentrated in a relatively small proportion of the total geographical area because of climate, topography, and soil conditions. The Maize Belt consists of the five provinces: Buenos Aires, Santa Fe, Cordoba, La Pampa, and Entre Rios (Figure 1). In 1980/81, Buenos Aires, alone, accounted for 37.5 percent of the area planted to maize and 47.1 percent of total production in Argentina. During the five-year period from 1980/81 through 1984/85 the three provinces of Buenos Aires, Santa Fe, and Cordoba accounted for 84.6 percent of the total production and 72.3 percent of the area planted to maize (Table 2).

Only a few Argentine farmers use dryers, usually a batch type.

Production technology in both the United States and Argentina has developed in a somewhat parallel manner. The use of maize combines has grown rapidly in both countries: as in the U.S., the maize combine is used on nearly all of the commercial acreage in Argentina. Harvesting by combines at moisture levels above 14.5 percent in Argentina requires artificial drying in order to meet the base moisture for pricing. Some drying may be done at the farm, but a large proportion is done at the country elevator.

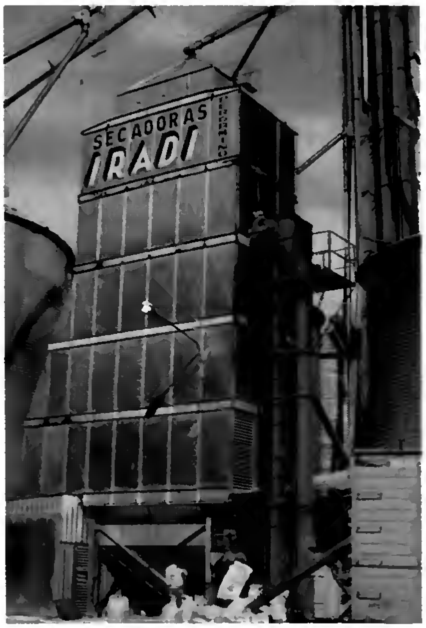
One distinction between harvesting technology in Argentina and the United States is that on the large farms in Argentina, maize is often harvested by custom operators who move from north to south as harvest progresses, much as custom harvesters move through the wheat country of North America from Texas to Canada. It is not unusual to see three to five combines in the same field or as many as sixteen or more combines on one farm where they can be efficiently distributed among several fields. The smaller Argentine farms, less than 200 hectares of maize (about 500 acres), often own their combines, just like their U.S. counterparts.

Inadequate moisture during the growing and pollination periods often limits yields regardless of fertilizer use, and under stress, yield response to nitrogen applications on flint varieties is uncertain. Combined with high prices on imported fertilizer, these factors have discouraged application of fertilizer by maize producers. Soil fertility has been maintained through crop rotations with legumes such as soybeans and alfalfa, which have been major sources of nitrogen for maize production. Because moisture is often a limiting factor during the growing season, herbicides used to control weeds would conserve moisture and increase yields; but the lack of domestic supplies, import restrictions, and high prices have reduced the economic incentives for the use of herbicides as well as fertilizers in Argentina.

Before 1977, import taxes in the form of *ad valorem* tariffs were 60 percent for fertilizer and 65 percent for agricultural chemicals [15]. In 1977/78, the government began a gradual reduction in the tariff schedule, and in 1983/84, the new government encouraged the use of fertilizer through an exchange system where credit advanced for fertilizer purchases can be repaid with a portion of the harvest. The effectiveness of this strategy is demonstrated in fertilizer consumption data. Nitrogen consumption increased from 48 mmt in 1982 to 91 mmt in 1984 [20]. Although this program has been quite popular with wheat producers, the Junta is extending the program to other crops, and it holds promise for increasing maize yields.

Genetic improvements in maize have generated many new varieties in Argentina. Most major seed companies are represented in Argentina and have provided significant improvement in yields through the introduction of new genetic traits. An emphasis upon higher-yielding varieties and higher response to nitrogen largely dictates the producers' choice of variety. These same factors also influence the choice of genetic material by plant breeders. The seed industry is relatively concentrated with two international companies providing over 50 percent of the seed maize sold in 1983 [13]. Although Argentina has been recognized for many years as the primary source of flint corn (also called Duro Colorado or Plate Maize) plant breeders have introduced dent genetic classes, resulting in semident or pure dent varieties in some local areas.[3]

Producers with large farms often use custom harvesters who operate several combines in the same field.



Most country elevators use oil-fired dryers to lower the moisture level in freshly harvested maize.

Utilization

The Argentine maize crop is distributed among several industries including wet milling, dry milling, livestock feed, and exports. The primary industrial use of maize is in the wet milling industry for the production of starch, although small quantities are also used by dry millers who grind maize along with other grains for human consumption. Industrial use of maize has shown a steady increase from 233,500 tons in 1960/61 to 1,543,000 tons in 1983/84 (Table 3). This represents an increase from a 4.8 percentage of production in 1960/61 to a 16.2 percentage in 1983/84 — not much different from the U.S. percentage of production used by wet and dry milling industries. The use of maize for livestock feed in Argentina is much less than in the United States — approximately 33.7 percent of 1982/83 total utilization in Argentina [7, p. 2], compared with 62.0 percent in the United States [31, p. 22]. Although maize is an important ingredient for the relatively large Argentine broiler industry and the increasingly important swine industry, these livestock classes consume only a small percentage of the total volume. It is important to recognize that industrial use in the Argentine statistics includes some maize used by processing firms in the production of complete feeds for broilers and hogs. In addition, very little maize is fed to beef cattle even though cattle are used to glean maize fields after harvest. The majority of Argentine maize production moves into the export market. The five-year average for the period from 1980/81 to 1984/85 is 62.5 percent.

Argentine beef cattle receive little grain, except when gleaning fields after harvest.

[3] For information on farmers' preferences for flint varieties, see "Porque Argentina Produce Maiz Flint" [6].

Exports

World markets were important to Argentine maize producers as early as the beginning of the twentieth century. Average annual maize exports from Argentina in the 1911/12 to 1913/14 period were 4.82 mmt, accounting for 54.9 percent of the world trade (Table 4). The United States' exports were small by comparison, with an annual average during this period of 1.21 mmt or 13.8 percent of world trade.

During the next forty years, however, the trade balance began to shift. Between the 1951 to 1955 period and the 1976 to 1980 period, average Argentine maize exports increased from 0.92 mmt to 6.4 mmt, while the average U.S. maize exports increased from 2.6 mmt to 53.6 mmt. During the next thirty-year period, Argentina's export market share decreased by 50 percent, dropping from 17.8 percent in the 1951 to 1956 period to 8.9 percent in the 1977 to 1980 period. In contrast, the U.S. export market share increased by 50 percent, growing from 50.6 percent in 1951 to 1955 to 74.5 percent in 1977 to 1981 (Table 4).

Production and exports increased rapidly in both countries, but the United States continued to gain its market share at the expense of Argentina. Throughout the decade of the 1970s, the U.S. market share increased steadily 'from 40.9 percent in 1970/71 to 78.8 percent in 1979/80. In contrast, Argentina's share dropped from 20.5 percent in 1970/71 to 7.6 percent in 1979/80. However, Argentine market shares rebounded to 10.9 percent after the United States suspended grain sales to the USSR in January 1980. The U.S. market share dropped to 71.5 percent in 1980/81 and to 69.5 percent in 1981/82. Both Argentina and the United States lost market shares in 1981/82 as a result of increased production and exports by both Thailand and South Africa [25, p. 23].

The major Argentine ports for exporting maize are Buenos Aires, Rosario, Villa Constitucion, Bahia Blanca, and San Nicolas (Figure 2). Two ports handled 71.8 percent of the total exports in 1980/81: Buenos Aires handled 27.4 percent, and Rosario handled 44.4 percent (Table 5). Both ports have generally lost their market share since 1970, declining from 80.0 percent in 1970/71 to 60.2 percent in 1984/85. Most other ports showed relative gains during this period, with especially dramatic increases in Bahia Blanca and San Nicolas. Years of large exports from Argentina tend to benefit the minor ports, as capacity constraints limit volume at Buenos Aires and Rosario during high-volume periods.

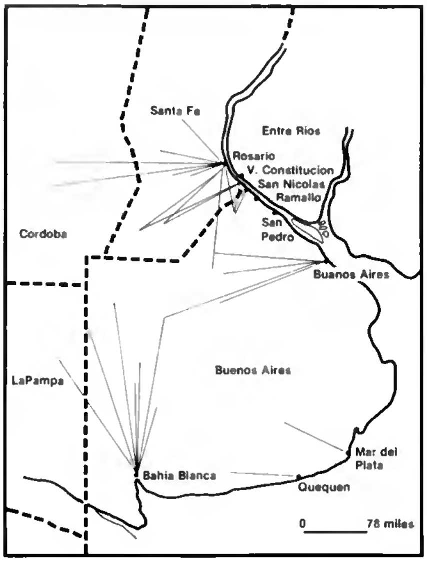


Figure 2. Major Argentine ports exporting grain. The major Argentine ports for exporting grain are Buenos Aires, Rosario, Villa Constitucion, Bahia Blanca, and San Nicholas. (Adapted from: (3, p. 2])

A major explosion at the export elevator in Bahia Blanca in 1985 caused a drop in its market share from nearly 8 percent in 1984/85 to only 0.5 percent in the first six months of 1986. Proposals by Italy, the Soviet Union, and the World Bank to remodel and expand the Bahia Blanca port are being considered, but as of 1987, no construction has been initiated. The higher volume accompanying expansion would also require the reorganization of rail facilities and the modernization of assembly and discharging operations, which may shift the relative shares among the ports as well as alter the relative profitability and production of maize in the hinterland serving the Bahia Blanca port [19, p. 24B].

The destination of Argentine exports has shifted over time in response to economic incentives and government policies affecting international trade. In 1973/74 Italy and Spain received 65.9 percent of all maize exported from Argentina (Table 6). The Netherlands, United Kingdom, People's Republic of China, and USSR were also important destinations, each receiving from 2.3 to 4.9 percent of Argentine exports.

Major shifts in destinations occurred between 1973/74 and 1974/75. The percentage going to the USSR increased to 19.7 percent, Mexico entered the market taking 12.4 percent, and the People's Republic of China purchased 473,000 tons for 8.1 percent of the market. Over the next two years the USSR dropped to 4.2 percent, Mexico to 0.1 percent, and the People's Republic of China to zero. Spain increased its share, receiving more than one-fourth of Argentina's exports of maize in 1976/77.

From 1974/75 to 1979/80 there was a general downtrend in the share of Argentine maize exports delivered to Mexico, Spain, and Italy. The Italian preference for Argentine Plate maize appeared to be weakening throughout this period, as evidenced by their declining share in every year except 1975/76, when Italy maintained purchases of 1.5 mmt in the face of a major decline in Argentine exports: from 5.8 mmt in 1974/75 to only 2.6 mmt in 1975/76 (Table 6). In contrast, the USSR's share grew erratically, fluctuating from a low of 4.2 percent in 1976/77 to 60.6 percent in 1979/80. The rapid growth of the USSR's share in the late 1970s prepared the stage for the near Soviet dominance of Argentine exports in the early 1980s.

In late 1980 and early 1981, political events dramatically altered the destinations of Argentine maize exports. After the 1980 invasion of Afghanistan by the USSR, the United States responded by suspending American grain sales to the Soviet Union. Consequently, Argentine shipments to the USSR increased to 2.97 mmt in 1980 and jumped to 8.0 mmt in 1981 (84.1 and 87.7 percent of Argentine exports, respectively). Shipments to the United Kingdom had already dropped to nearly zero in calendar years 1980 and 1981 as a result of the price premium being paid by the USSR, but the Falkland Islands incident, starting April 2, 1982, resulted in a "total ban on imports from Argentina" on April 10, 1982, [1, p. 1] and the United Kingdom's share of Argentine maize exports remained at zero through 1984. Shipments to Spain and Italy continued to drop, with especially dramatic decreases in 1980 and 1981 (Table 6) as the price premiums offered by the USSR directed the export flow away from Western Europe. Resumption of normal grain trade between the United States and the Soviet Union reduced Argentine exports to the USSR in 1982, 1983, and 1984, but price relationships shifted the flow back to the USSR in 1985. Spain and Italy also regained some of their former relative importance in 1985.

Maize Production and Marketing  in Argentina

Organization of the Argentine Markets[4]

The handling and transportation system for Argentine maize is organized around the export market, with facilities designed to move maize as needed from the production areas into the major ports in order to meet export demand.

Market Channel

Country elevators provide the marketing services of transporting, storing, drying, cleaning, and fumigating, as well as the merchandising functions of pricing, buying, and selling.

Most of the storage and drying services are provided by commercial facilities. Chiang and Blaich reported that the total country elevator storage capacity in Argentina in 1976 was 9.8 mmt, of which 5.3 mmt were located in the Buenos Aires province [4, p. 6]. Approximately 90 percent of the 5.3-mmt storage capacity was owned by private and cooperative firms. The remainder was owned by the Junta. Total storage capacity at the country elevator had increased to 11.6 mmt by 1981; 9.5 percent was owned by the Junta Nacional de Granos [4, p. 6]. The average storage capacity of the 62 elevators owned by the Junta Nacional de Granos was only 5,500 mt (about 200,000 bushels); privately owned facilities were similar in size.

Very little farm storage was reported in the 1960 and 1969 studies summarized by Chiang and Blaich. Their estimate for 1980 was 5 mmt, up from 1.4 mmt in 1960 [4, p. 3]. Estimates for 1986 show a slow upward trend to 6.3 mmt on farms; over two-thirds are located in the province of Buenos Aires [14].

Throughout the marketing year, grain is transported by truck and rail from storage locations in the country to the port elevators. The rail system in Argentina is often reputed to be inefficient and poorly coordinated: for

A unit train of hopper cars carries Argentine maize to one of several port elevators along the Parana River.

[4] Much of the information in this section was derived from Coscia [5]. Country elevators also serve the exporters and processors by storing supplies at harvest and delivering maize into the market as prices and consumption require.

The manager of a country elevator in Pergamino weighs and records deliveries of maize from local farmers.

A sample of maize is weighed carefully as part of the grading process at the country elevator.

Trained inspectors check samples for damaged kernels at the inspection department of the Junta Nacional de Granos in Buenos Aires.

High-temperature dryers and metal storage bins provide drying and storage services for Argentine farmers

example, there are three different gauges of track. However, modern covered hopper cars are in common use and often move in units of 10 to 50 cars between several origins and the major ports. Barges are also used to move maize from river elevators to the ports, usually to be unloaded directly onto ocean vessels. Barges are particularly important in completing the loading of vessels at Buenos Aires that, when fully loaded, cannot cross the silt and bedrock bar at the mouth of the Parana River. During periods of heavy volume, trucks may also be unloaded directly into vessels.

Port elevators are primarily load-out facilities, but they also provide some storage capacity. Total storage capacity at the 14 major port elevators was 1.155 mmt in 1980. More than half of this storage was located at the two ports of Rosario and Bahia Blanca (Table 7). Buenos Aires was a distant third in the 1980 list but has since added additional space.

Ownership of port elevator storage space is divided among private firms and the Junta Nacional de Granos. Delivery to the ports from country elevators is about equally divided between truck and rail, with barge transportation appearing only in the data for Buenos Aires. Buenos Aires is heavily dependent upon rail services (62 percent of the 1979 deliveries were by rail). Additionally, the rails carry the majority of grain coming to Bahia Blanca (Table 7). Based upon the volume of all grains handled, the port of Bahia Blanca is nearly tied with Rosario for first place. However, these data reflect large volumes of wheat moving into Bahia Blanca, a port which is a distant sixth in relative volume of maize exports

(Table 5). Rail share, when considering transport to all ports, has generally declined from 55.7 percent in 1974, to 28.6 percent in 1985 and an estimated 20 percent in 1986 [2, p. 17].

The services, procedures, and equipment of the country elevators in Argentina are quite similar to those of the country elevators in the United States. As trucks and tractors pulling wagons arrive from the farm, they are weighed and a sample is taken to establish any quality grade discounts. Samples are tested for moisture, foreign material, broken maize, and damaged kernels. Not all of the elevators test for all of the factors all of the time. Many elevators keep a file sample from each farmer's deliveries to enable an appeal of grade by the farmer to the official inspection service — The Junta Nacional de Granos inspection department.

Because nearly all of the maize in Argentina is harvested at moisture levels above the 14.5 percent maximum established as the base for pricing, heated air dryers are used at most country elevators. These grain dryers are generally fuel-oil fired. They are similar in design (sometimes identical) to the cross-flow type dryers operating in the United States. The use of both low-temperature drying methods and dryeration techniques will increase in importance as Argentine elevator operators become more sensitive to the breakage problems that occur during handling. Because of the price incentive to deliver No. 1 maize into the market system, elevators operate cleaners and aspirators both before and after the dryer. These screenings are generally returned to local feeders. There is little incentive for returning any of the fine material back into the grain itself because increasing the broken kernels or foreign material would lower the grade and therefore lower the price.

The Role of Cooperatives in Grain Marketing

The marketing channel for maize in Argentina is focused upon the export destinations. The structure of the industry is a mixture of private firms, cooperatives, and governmentally owned facilities. At the port elevators, the multinationals provide most of the facilities, although the Junta Nacional de Granos owns facilities in all major ports, including one of the largest port elevators located at the port of Buenos Aires.

Cooperatives serve an important function in the Argentine grain marketing system. A major characteristic of Argentine grain production is that very few farmers have grain storage and drying facilities. Therefore, the farmer sends his maize to country elevators for drying, storage, and marketing. In Argentina, approximately 48 to 50 percent of all grain harvested goes to cooperatives, with the rest being handled by private firms. Although Argentine cooperatives provide many different services for the farmer, including drying, storing, exporting, and processing grain, the cooperative's most important function is marketing the farmer's grain. Cooperatives also offer the farmer agricultural production inputs, credits, household goods, and food items at wholesale prices.

The first Argentine agricultural cooperatives were formed by European immigrants in the 1900s. Primitive transport systems, combined with the unfair trade practices of country elevators, provided incentives for farmers to support the cooperative movement. Although Argentine cooperatives, today, provide many services as well as exert political influence on behalf of agriculture, the early cooperative movement was intended to help farmers both market their grain more efficiently and obtain supplies at lower prices.

The premiums paid for No. 1 maize generate the incentive for removing broken kernels and foreign material.

Since the 1960s, Argentine cooperatives have accounted for 15 to 20 percent of the annual grain exports. Although most cooperatives export on a FOB basis, they are working towards exporting under CIF conditions, which would allow cooperatives to participate in the shipping business. In 1984, a change in Argentine law allowed farmers to create export consortia or cooperatives for facilitating exports. This important transition in Argentina's grain marketing structure provides Argentina's producers with a larger role in grain exports.

High-speed harvest and lack of on-farm storage put pressure on the receiving capacity of country elevators. Trucks wait their turn at the scales.

Maize Production and Marketing in Argentina

Pricing Policies and Practices for Argentine Maize

Since the majority of Argentine maize moves to export, prices are closely tied to world markets. Prices at each of three major ports are established daily at the Bolsa — the grain exchange located at Buenos Aires, Rosario, and Bahia Blanca. Members of the exchange establish both cash and futures prices through the interaction of buyers and sellers in an open bidding process similar to the procedures at the Chicago Board of Trade. The cash and futures prices are not fixed but are a reflection of demand and supply conditions both locally and worldwide.

Pricing at the Country Elevator

Following the close of the market, a committee representing the various participants in the market meets to evaluate the day's trading and to agree upon a representative price for maize and other grains that were traded. Prior to the opening of the market the following morning, this price, which represents the market price for maize delivered to each port, is circulated by radio and becomes the base price for the industry for that day. The price differs among the three port cities, in part owing to transportation differences among the geographical locations but also in response to the market forces in the national and local areas. Export elevators use this price as a base for bidding on maize delivered to their plants. The actual price may differ slightly among buyers as well as among sellers. Most of the maize delivered to the export elevator is purchased from country elevators and is delivered to the port by trucks or railcars.

The elevator pays the freight to the port and generally selects the mode of transport, based upon freight rates and the availability of railcars. From most locations, rail freight is generally cheaper than trucks, but railcars for grain are in short supply and often unavailable during the required time schedule. Price quotations to producers are the prices established by the Bolsa at the closest port area. The Bolsa price functions as a base for bid price much as the Chicago cash market might function as a base price for No. 2 maize in the United States.

Prices to producers are quoted on the basis of No. 2 yellow maize (see Table 8 for a description of No. 2 grade factors). However, actual payment to the producer is determined by subtracting the necessary charges and discounts from this base price. These charges include freight from the farm to the elevator, freight from the elevator to the port, a charge for loading and unloading, a drying charge for any grain above 14.5 percent moisture, and charges for fumigation and storage. If any noxious weed seeds are present, farmers are also charged for cleaning. Most of these charges are established for the season and remain fairly constant regardless of variations in daily market prices. In addition, there is a commission charge which is usually calculated as a percentage of the base price.

Transportation from the farm is often arranged by the elevator manager, and the cost is included as a marketing charge to be deducted from the payment to the farmer. A few farmers have their own trucks, and farmers located near the elevator may use tractors and wagons.

The transportation charge from the elevator to the port is also included as a marketing charge to farmers, regardless of the eventual destination and disposition of the maize. The freight charge varies among elevators, depending upon the distance from the port, the port selected for delivery, and whether or not the manager uses a rail rate or a truck rate for calculating the cost.

The unloading charge at the elevator represents operating costs associated with grain handling. Storage rates are generally a fixed charge for an initial period plus a monthly rate thereafter.

The farmer also pays for fumigation and cleaning when insects and weed seeds are present. The drying charge is frequently based upon a fixed rate plus an additional charge per point of moisture above 14.5 percent. In addition to the drying charge, the industry uses standard shrink tables for adjusting the weight of grain to equivalent weight when dried to the base moisture of 14.5 percent. Although shrink tables provided by the Junta Nacional de Granos are calculated from the standard formula for calculating weight loss during drying, the values in the official table are equal to the actual water loss when drying to 13.5 percent — not 14.5 percent. Because the official base moisture is 14.5 percent, using the table of shrink factors results in a graduated scale on a per point basis. For example, the table shows a shrink factor of 2.31 percent for one percentage point of moisture when adjusting the weight of 15.5 percent maize to the equivalent weight at 14.5 percent. At 23 percent moisture, the table value of 10.98 percent is equivalent to a shrink factor of 1.29 percent for each percentage point above 14.5 percent [12]. In addition to water shrink, an additional 0.2 to 0.25 percent shrink is allowed for handling losses, and 0.3 percent is permitted for weight loss incurred during screening. These additional shrink factors are approximately equal to the 0.5 percent "invisible" shrink shown in the Minary Charts, commonly used by U.S. elevators.

A truck driver uses a grain probe to sample each load.

Price Competition in Argentina

Although prices to producers are uniformly quoted on the basis of prices at the major ports, elevators compete for farmers' grain through their charges for services. This can be illustrated by comparing the prices and charges of four elevators located in the province of Buenos Aires. These elevators provided prices and charges for the same quantity and quality on a given day. As shown in Table 9, charges for cleaning, transportation, and commission differ among firms. Freight charges from the farm to the elevator varied depending upon distance. Local transportation rates quoted by the elevator were often those established by local trucking firms, but in many cases farmers provided their own tractors and wagons, thus avoiding the commercial trucking charge. Freight charges to the port elevator also varied, depending upon the distance and the mode of transport. On the day of the interview, Elevator A was subtracting a charge of 27,878 pesos/100 kilos from each farmer's payment based upon the rail rate to Rosario.[5] Elevator C, a cooperative, was delivering maize to the port area of San Nicolas by truck and used a freight charge of 23,000 pesos/100 kilos.

Loading and unloading charges among the 4 elevators varied from 7,500 pesos/100 kilos at Elevator A to 10,000 pesos/100 kilos at Elevator B. Differences in elevator design, handling efficiency, and volume influenced costs, and these cost differences influenced charges. Fumigation charges also varied among elevators. Published shrinkage tables recommended 1.3 percent shrink for screening when weed seeds were present at a level that necessitated screening. All elevators reported the same factor for calculating screening losses. Charges in addition to shrinkage varied from 4,000 pesos to 7,000 pesos/100 kilos. Elevator C reported no charge for cleaning, but had the highest fumigation charge. Drying charges for 18.5 percent moisture maize varied from 10,500 pesos for Elevator C to 14,250 pesos at Elevator B. All elevators reported using standard shrink tables including 0.25 percent per point of moisture for handling losses.

All of the elevators that were interviewed reported commission charges calculated as a percentage of the base price. This commission, varying from 2.5 percent to 5.5 percent, could be considered similar to the merchandising charge common in the U.S. grain trade. Elevators B and D each included a 1 percent capitalization charge in their commission, to be retained by the elevator for future growth and investments. Although all of the elevators quoted identical prices, the net payments to farmers differed significantly among elevators. These differences resulted from differences in charges for services. The effects of these differences depend, in part, upon the quality of the maize delivered by the farmer.

In addition to the differences in charges, there are also several additional factors that influence the farmer's choice of market. These include waiver of drying charges or shrink at processing plants where the wet maize does not present a problem in storage and processing, and differences in waiting time for delivery and unloading at different elevators.

Each sample is emptied onto the canvas, and then mixed and bagged for quality analysis by elevator employees.

[5] Prices are given in 1983 pesos. The exchange rate in March of 1983 was 70,000 pesos per U.S. dollar. Inflation and devaluations since 1983 make the absolute values of little significance.

Maize Production and Marketing in Argentina

Quality Control in Argentine Maize

Grade-Determining Factors

Argentine maize is purchased on the basis of numerical grades, with price discounts for quality below No. 2 on any of the three grade factors included in official standards. There are three numerical grades for both dent and flint types — grade Nos. 1, 2, and 3. The limits for each grade (Table 8) are based on three factors — damage, broken grain, and foreign material [16]. **Damaged grain** is defined as those grains or pieces of maize grain that exhibit a significant alteration in their appearance. Types of damage include kernels or pieces of kernels that are fermented, sprouted, or moldy. **Broken grain** is defined as those pieces of maize that pass through a screen, excluding pieces of damaged maize. The screen specified by the Junta is to be constructed of hard aluminum with circular holes that are 4.76 mm (12/64 inch) in diameter. This is the same specification as used for the Broken Corn-Foreign Material sieve in USDA standards. **Foreign material** is defined as those grains or pieces of grain that are not maize as well as all other inert material. The standards further specify that 14.5 percent shall be the maximum moisture content. The grading tolerance for live insects is zero. Punctured grains resulting from insect infestation must be less than 3 percent, and the sample must not contain more than 2 seeds of the weed *Datura Ferox* (Jimsonweed) per 100 grams. A sample that exceeds any of the preceding tolerances is considered to be outside of the standard.

Moisture is not a grade-determining factor, but 14.5 percent is set as the maximum value for any grade. This moisture limit establishes the base for adjusting the quantity of maize containing excess moisture to the equivalent number of bushels at 14.5 percent, and this limit is specified as the maximum allowable on an export certificate.

In addition to the three numerical grades, the Junta has established a fourth grade for those years when harvesting and storage conditions result in

Modern export facilities using high-speed belts and bucket elevators provide efficient loading and inspection.

maize with damage beyond the limit for No. 3 (8 percent). Grade No. 4 has, in the past, been identical to grade No. 3 except that the maximum limit for damaged kernels was increased to 12 percent.

Inspection Procedures

When maize is delivered by farmers to the elevator, it is priced on the basis of its quality characteristics. Quality is determined by obtaining samples from each truck through the use of grain probes or from the equivalent of an end-gate sample during unloading. In addition to recording truck weights, elevator employees determine the moisture content and the percentage of broken kernels, foreign material, and damage. The sample is also inspected for *Crotalaria* (Rattlebox) seeds, *Datura Ferox* seeds (Jimsonweed), and insect damage. Duplicate samples of producers' grain are available for appeal to the Junta inspection laboratory in case of disputes. The Junta requires that all inspectors be trained and licensed, including those at the country elevator. The thoroughness of the sampling and analysis differs among elevator managers, and not all of the factors are always examined for each truck. However, because the selling price of the maize is determined by quality, with premiums paid for No. 1 maize, the elevator manager has an incentive to determine the quality and to assign appropriate discounts to all maize being delivered.

The grain is also priced according to quality as it is received at the port elevator or processing plants. Inbound trucks and railcars are sampled by probe, and those port facilities with sufficient bin space will do some segregation by quality factors. Outbound shipments from the port elevator are inspected by representatives of the Junta and by the representative of the seller. Inspections within the vessel may also be made by representatives of the buyer. Outbound maize may be sampled from the grain stream on the belt or from the downspouts in the export elevator. The Junta Nacional de Granos records the quality on the export certificate. When export volume exceeds the loading capacity of the export house, the Junta permits direct transfer from truck to vessel. In this case, the grade is established from truck samples and is determined at the original shipping point or by probe sample at the port. The direct truck-to-vessel technology is also used for special contract sales requiring identity preservation from the origin elevator to the vessel.

The Junta Nacional de Granos inspection laboratory provides official grading services for all export purchases and sales. A modern laboratory in Buenos Aires contains equipment for all quality measurements and standardization of the various tests. The laboratory also serves as an appeal board for official grades upon request of buyers or sellers throughout the market channel. The Board provides educational programs for the training and licensing of official inspectors. The training includes practical experience in grading and laboratory analysis.

Samples are drawn at frequent intervals from a downspout in the export elevator. Composites of these samples are used to determine the numerical grade for the export certificate issued by the Junta Nacional de Granos.

The Junta Nacional de Granos provides classroom instruction and laboratory facilities for training grain inspectors.

Samples of maize taken from farm trucks and wagons during unloading averaged 57.6 pounds per bushel, 94.3% whole kernels, and 13% stress-cracked kernels prior to drying.

Samples of flint maize taken from farmers' fields, combines, and trucks were air-dried immediately to prevent deterioration and minimize the development of stress cracks.

Maize Production and Marketing in Argentina

Quality Changes from Farm to Export Vessel in Argentina

In order to determine the quality characteristics of Argentine maize and the factors that alter its quality, a study was organized to identify quality at representative points in the market channel. These points included a random selection of farms in the Pergamino area of the Buenos Aires Province, a random sample of cooperative and private firms from the area, and samples taken from an ocean vessel being loaded with old-crop maize at Buenos Aires. The Pergamino area was selected because it is representative of the province of Buenos Aires, the largest maize-producing province in Argentina.

Location of Samples

Maize samples were collected from either combines or trailers at each of five farms. At five country elevators, samples of incoming maize were also collected with probes or by cutting the grain stream during the unloading of trucks and trailers. Dry maize was sampled either at the dryer discharge, from storage bins, or by probing at truck load-out points. All of the grain was new-crop (1983) maize, representing the average quality found at the five different locations during the harvest. Samples of old-crop (1982) maize were taken by probe in the hold of an ocean vessel at Buenos Aires. Any samples above 15 percent moisture were allowed to air-dry naturally in open containers before shipment to the United States for analysis.

Farm 1 was a 700-hectare (1,730-acre) family farm located 18 km northwest of Pergamino. About 240 hectares

Samples requiring official grades (including appeals from the country elevators) are analyzed by technicians at the Junta Nacional de Granos inspection laboratory in Buenos Aires.

Samples of maize taken from elevator storage bins after drying showed stress cracks in 24 to 82 percent of the kernels.

High prices for herbicides make grass control uneconomical in maize fields.

Maize from the combines was delivered by truck to a Tamequa portable grain bin until the commerical hauler returned from the elevator for the next load.

The commercial trucker empties the maize from the temporary bin for transport to the drying and storage facilities at the country elevator.

Farm wagons were unloaded by auger into commercial trucks while keeping ahead of the two combines operating in the field.

(593 acres) were in maize, with no commercial fertilizers being used. The maize was being harvested by custom operators using two Vassalli Ideal 3-16[6] combines with 5-row Manerio maize heads spaced on 70-cm rows. The maize variety was Morgan 400, which was estimated to yield about 6,000 kg/ha (96 bu/acre) on this farm. This was the only farm that was visited which had drying and storage facilities. The grain-handling facilities consisted of four storage bins, each with a 150-t capacity, a short bucket elevator to elevate maize for overhead cleaning before drying, and a second taller bucket elevator to elevate maize to a holding bin above a Margaria batch-type dryer. After drying, the maize was screened to remove the broken kernels before storage.

Farm 2 was a tenant farm located 19 km northwest of Pergamino. The maize was a Continental variety and, on this farm, was estimated to yield 80 bu/acre. The need for herbicide weed control was more evident here than on some of the other farms. No commercial fertilizer had been applied. Custom operators were harvesting with three Daniel D66 combines. Maize moisture was about 22 percent.[7] The maize was hauled by wagon to a Tamequa portable grain bin for temporary storage until trucks could return from the local elevator. The truck loading time was minimized by simultaneously unloading from the holding bin and from wagons.

Farm 3 was a 220-hectare (544-acre) family farm near Alfonso. The variety was Continental 77, which appeared to have both dent and flint characteristics. Differences in maize color, kernel crown indentation, and red and white cobs on adjacent plants indicated the varied genetic makeup. No commercial fertilizer had been used. The farmer owned a Guiberge combine with a 5-row Manerio maize head.

The genetic diversity in ears from the same field shows a gradual shift in emphasis of plant breeders from flint to dent varieties.

[6] Trade names are used in this publication solely for the purpose of providing specific information. Mention of a trade name, proprietary product, or specific equipment does not constitute a guarantee or warranty and does not imply approval of the named product to the exclusion of other products.

[7] All moisture contents in this study are expressed in percent wet basis.

Argentine gauchos at Sol de Mayo separate calves from the breeding herd at weaning time.

Maize was hauled by wagon to the farmstead where it was transferred by auger from wagon to commercial truck and then hauled to a cooperative elevator for sale.

Farm 4 was another family farm near Alfonso. No commercial fertilizer had been used here, but fertility was enhanced by a crop rotation that included alfalfa. Weed control methods included the use of 2-4D. The maize was DeKalb 4F34 and was being harvested by custom operators who used both a Vassalli Ideal 3-16 combine and a Bernadine combine.

Farm 5 was a 3,200-hectare (7,907-acre) farm located southwest of Rojas which was operated by a farm manager for an absentee owner. About 1,200 hectares (2,965 acres) were in maize. The rest were in alfalfa and permanent pasture that supported both a cattle feeding and a cow-calf operation. The maize ground had been fertilized with ammonium phosphate, and 2-4D had been applied for weed control. Several different varieties of maize had been planted, but samples were obtained from only two fields: one planted with Cargill 155 and the other with DeKalb 4F34. The estimated yield from these fields was 8,000 kg/ha or 128 bu/acre. The maize was quite high in moisture, and the combines were harvesting quickly to reduce potential field losses due to stalk lodging, which were estimated at 10 bu/acre. The manager was anxious to complete the harvest because of these potential losses. As many as 16 custom operators were harvesting simultaneously. The number varied from day to day, and combines were sometimes idled because of truck shortages or delays at the elevator. The combines that were operating included a New Holland TR85 with an 8-row Manerio head, a Vassalli, a John Deere 975 with a 6-row 642 head, and a Senor. The farm had neither drying nor storage facilities.

Five country elevators provided samples of inbound and outbound maize. Two of the elevators were owned by international grain firms and three were cooperative firms.

Many of the smaller elevators did not have truck hoists so trucks were unloaded by hand.

Elevator 1 was a cooperative with 350 members. The elevator had a 22,000-t storage capacity and received 900 to 1,000 t/day during harvest. Typically, maize came in on trucks or wagons from a 10-km radius. The cooperative had three dryers, each with a capacity of 20 t/hr when drying maize from 19 percent to 14.5 percent moisture. The temperature of the drying air was 125°C. The cooperative had several bucket elevators but no truck hoists. Trucks with numerous openings were unloaded by hand. Typically, grain from this elevator was transported by truck or rail to San Nicolas or Villa Constitucion for export shipment on the Parana River.

Elevator 2 was a cooperative with a 30,000-t storage capacity. They had five dryers, each with a drying capacity of 20 t/hr. The dryers were Iradi and Eureka brands, which were manufactured in Argentina, and were crossflow types that burned fuel oil.

Elevator 3 was a cooperative with 600 members. The storage capacity was 20,000 tons. The elevators had two dryers: an 80 t/hr Eureka and another dryer of unknown brand with a 40-t/hr capacity.

The elevator did not have truck hoists, but handling and cleaning operations were highly mechanized, with bucket elevators and mechanical cleaners.

Elevator 4 was privately owned and had a total storage capacity of 17,000 t. A typical storage bin had a 1,750-t capacity, with four 7.5 kw axial flow fans for aeration. Their Iradi dryer burned fuel oil and had a capacity of 70 t/hr. Maize was received direct from the field at moisture levels as high as 29 percent, but 22 percent was more typical in this area at the beginning of harvest. The Iradi dryer reduced moisture to approximately 16.5 percent with air temperatures of 110°C. At 16.5 percent moisture, maize was aspirated to remove beeswings and placed in storage, where additional moisture was removed by aeration. Before load out the dry maize was screened on a 4.76-mm sieve to remove broken kernels. The elevator was well equipped with bucket elevators having capacities ranging from 40 t/hr to 150 t/hr. Maize could be loaded on trucks or railcars for shipment to the port.

Elevator 5 was owned by a multinational grain company. Its 8,000-t storage capacity consisted of six 1,500-t bins, each equipped with three 7.5 kw fans at the bottom of each bin and three 3 kw fans on top of the bins. Their Iradi dryer had a capacity of 50 t/hr. The screenings were removed before the loading of railcars or trucks for export destinations and were returned to local feeders.

All elevators that were visited used cross-flow dryers heated by fuel oil. Many elevators were using multiple-pass drying if the maize was extremely wet. At some elevators, maize was removed from the dryer at about 16.5 percent moisture content, and aeration was used to cool and remove an additional two percentage points of moisture to meet the 14.5 percent maximum.

It would have been desirable to trace maize from the country elevators through each point in the market channel to export ship loading. However, this was not possible for numerous reasons. Nonetheless, systematic probe samples were taken in three layers from an export vessel being "topped off" in Buenos Aires. Probe samples from the first layer represented maize that was loaded onto the vessel at Rosario, the major export location. The two upper layers represented maize from a Buenos Aires port elevator used to top off the partially loaded vessel. Owing to the shallow draft at the mouth of the Parana River, most ocean vessels are partially loaded at upriver ports and then brought to the deeper port of Buenos Aires for topping off. The hold of each ship was divided into four quadrants: in this way, one sample could be taken from each quadrant, for each hold, and for each layer. Each sample consisted of three probes randomly spaced in the quadrant (Figure 3).

Analysis of Samples

The maize samples were returned to the Agricultural Engineering Grain Quality Laboratory at the University of Illinois for the following analyses.

Test weight was performed in duplicate. A pint cup was used because of the limited sample size.

Percent of broken maize was determined on one-half of the original sample through the use of 30 cycles on a Gamet sieve shaker with 4.76-mm and 6.35-mm sieves. The other half of the divided sample was used for physical separations.

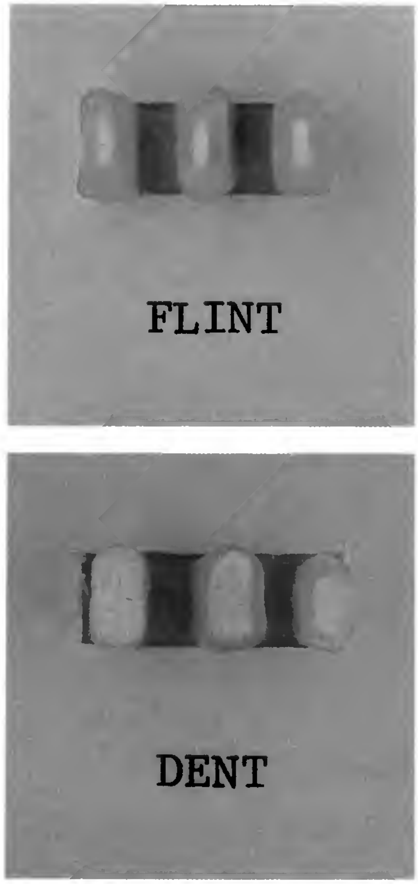
Whole kernels were determined by sorting whole kernels from a 50-g sample taken from the maize that was retained on top of the 6.35-mm sieve.

Stress cracks were determined by candling 100 kernels from the whole kernel sample and sorting them into categories of none, one, or multiple stress cracks.

Vitreous endosperm thickness was determined by sanding off about one-third of the crown end of the kernel and sorting the samples into categories of thick, thin, or negligible vitreous endosperm.

Breakage susceptibility was determined with a Wisconsin-type breakage tester [21]. Samples were equilibrated to approximately 13.7 percent moisture content before testing. A 200-g sample was selected from the maize retained on a 6.35-mm sieve. After the kernels were impacted in the breakage tester, they were resieved on the 6.35-mm sieve. The sample portion retained by the sieve was weighed and divided by the original sample weight to calculate the percentage of breakage.

Moisture Content at the time the breakage test was run was determined with a 100-g sample that was oven-dried at 103°C for 72 hours. The samples had been previously equilibrated to approximately 13.7 percent moisture to minimize the effect of moisture on the test for breakage susceptibility.



Cross-sections of Argentine flint and U.S. dent show a contrast, with the flint having a higher proportion of hard vitreous endosperm.

One hundred-kernel weights were determined by weighing two samples of 100 kernels each. Kernel weights were adjusted to oven-dried weights, and the two observations were averaged.

Floaters test is an indication of kernel hardness and was determined by placing 100 kernels into a solution of tetrachlorethylene and deodorized kerosene that was adjusted to a specific gravity of 1.275. The number of lower density kernels that floated was designated as the percentage of floaters.

Ethanol column test was used to indicate true density. One hundred preweighed kernels were placed in a graduated cylinder containing ethanol, and the density of the kernels was calculated by measuring the displaced volume.

Physical separations were performed to sort the samples into the following categories: maize, grains other than maize, weed seeds, and inert material such as cobs, husks, insects, dust, and miscellaneous material less than 1.4 mm in diameter.

Maize Production and Marketing in Argentina

Results of the Sample Analysis

Physical Properties of Argentine Maize

The analysis of the samples at the University of Illinois Agricultural Engineering Grain Quality Laboratory provided a description of the physical properties of the samples obtained at each point in the market channel.

Quality at the Farm. The samples had an average test weight of 773 kg/m^3 (60.1 lb/bu), indicating a high density (Table 10). Density was also measured by the ethanol column test, which gave an average value of 1.29 g/cm^3, and by the floaters test, which averaged only 16 percent floaters for farm-level samples. These results confirm that flint maize is very hard and very dense with a high proportion of vitreous endosperm. One hundred-kernel dry weights on samples from the five farms averaged 24.5 g. The high density of flint kernels was offset by the small kernel size. Since this maize had not been artificially dried, stress cracks (combinations of one or more cracks) were only 13 percent, and the test for breakage susceptibility generated only 11.7 percent breakage when samples were equilibrated to 13.7 $\pm$ 0.6 percent moisture content. The percent of whole kernels was relatively high — 94.3 percent. The percentage of broken corn and foreign material (BCFM) as determined with a standard USDA 4.76-mm sieve was relatively low — only 0.7 percent. Only 2.9 percent of the sample passed through a 6.35-mm screen. Thus, maize breakage and breakage susceptibility at the farm level were quite low and were comparable to values found in similar studies of U.S. maize [11].

Several samples of the flint varieties grown in Argentina were rated visually for thickness of vitreous endosperm. Because all of these samples rated very high in vitreous endosperm thickness, the test was discontinued, and it was concluded that Argentine flint and semident maize have a very thick layer of vitreous endosperm. Based upon previous experience [23], maize with a high test weight generally has a thick layer of vitreous endosperm.

Additional samples of freshly harvested maize were obtained from farm trucks and wagons as they arrived at five country elevators. Three composite samples were also obtained from all of the trucks delivered during a 12-hour period at selected elevators. These samples were representative of the maize delivered from farms in the area surrounding each of the elevators. The results of the tests are quite similar to the information obtained from the samples on the farms. For example, stress cracks were only 11.1 percent and breakage susceptibility was 13.6 percent (Table 11), quite close to the values of the on-farm samples. The percentage of whole maize was 95.1 percent, and screenings through the 4.76-mm sieve were 1.1 percent, which was slightly higher than the value obtained from combines and wagons at the farm. Many of the trucks that were sampled had been loaded at the farm with augers and temporary storage bins. This extra handling probably explains the increased BCFM relative to the samples at the farm.

One hundred-kernel dry weights indicate size and density values ranging from a low of 19.8 g to a high of 30.6 g, compared with a range of values from 24.8 g to 30.7 g found in an analysis of 359 samples of maize taken from a midwest milling facility [22].

The presence of other grains in the maize was extremely low — 0.002 percent at the elevators and 0.0 percent at the farms. The percentages of weed seeds at the farms (0.012 percent) and on inbound trucks at the country elevators (0.015 percent) were also low but higher than at any other place in the market channel. Cobs, husks, insects, dust, and fine material passing through a 1.4-mm sieve were 0.173 and 0.183 percent at the farm and on inbound trucks, respectively.

Quality at the Country Elevator. Most high-moisture maize in Argentina is dried artificially in cross-flow dryers at the country elevator. The drying techniques ranged from gentle to severe, with several elevators using some form of multiple-pass drying followed by dryeration techniques to reduce breakage and stress cracks during drying. Despite these efforts, stress cracks in the vitreous endosperm of the kernels were present in all samples of maize that were artificially dried. The percentage of stress cracks from individual dryers ranged from 24 to 82 percent with an average of 52 percent for all samples (Table 12). Because breakage susceptibility is influenced by the percentage of stress cracks, it was not surprising to find breakage susceptibility values averaging 46 percent on samples of maize with more than 50 percent of the kernels showing stress cracks.

Breakage susceptibility values for commercial U.S. dent maize can be predicted with the equation: BS = $1392.5e^{-(.287)(MC)}$, where BS is the break-

Directly under the spouting, breakage (as measured by USDA-BCFM sieves) reached 12.1 percent. Samples from the vessel clearly showed extensive breakage during loading.

Loading of the ocean vessel caused breakage when stress-cracked kernels impacted the spouting.

age susceptibility value determined by the Wisconsin Breakage tester using a 6.35-mm sieve and where MC is the wet basis moisture in percent [22]. Using this equation, the predicted breakage susceptibility for samples of U.S. dent maize obtained from over 1,000 trucks across 2 crop years was 31.5 percent when adjusted to a comparable moisture level of 13.2 percent. This average value for U.S. dent is slightly below the average breakage susceptibility value of the maize obtained from the dryers at the Argentine elevators. Given the small number of samples, this difference is not statistically significant. The importance of the comparison is to illustrate that the effect of high-temperature drying is similar for dent- and flint-type corn. The importance of drying temperature and technology in determining breakage is evident in a comparison of breakage susceptibility and stress cracks for the various dryers that were tested (Table 12). The data did not permit an analysis of drying methodology on these dryers, but it is evident that there exists a wide range in the severity of drying at the different elevators.

The premium paid for No. 1 clean corn is an incentive for using extra cleaners on the combine.

The screenings are collected and bagged for feeding or disposal, rather than including the foreign material in the maize delivered to the market.

An analysis of all samples taken from the elevators after drying and cleaning for storage showed only a slight decline in quality when compared with the samples taken from the farmers. The percentage of floaters after drying was 28.3 percent (Table 13): a significantly higher percentage than in the farm-level samples, which indicates reduced density as a result of high-temperature drying. The test weight of 765.2 kg/m^3 (59.4 lb/bu) was slightly lower than in the farm samples, but based upon a two-tailed "t" test, this was not a significant difference at the 95 percent level of probability. The percentage of screenings passing through a 4.76-mm sieve increased to 1.6 percent, compared with 1.1 percent in farm truck receipts. Based upon physical separations, the percentage of cobs, husks, insects, dust, and fine materials passing through a 1.4-mm sieve increased to 0.3 percent. Weed seeds were insignificant in these samples. The range in BCFM (as defined in U.S. standards) indicated significant differences between elevators and the ways in which they were handling their maize. One elevator showed an average BCFM value of 0.5 percent while another showed a high of 3.1 percent.

Nearly all of the elevators that were interviewed used cleaners both before and after drying in order to reduce the amount of broken maize and foreign material in outbound shipments. There was no evidence of blending once the material had been removed, although larger elevators were able to separate quality in different bins and then commingle them by drawing from more than one bin during load out. The screenings removed before and after drying were generally sold back to local feeders at a price of approximately 70 percent of the value of maize purchased from the farmer.

Samples of inbound and outbound maize from one elevator were used to indicate the changes in quality. Samples taken from 13 inbound trucks were compared with samples taken with grain probes from eight outbound trucks. The most significant differences were in those factors related to breakage and drying. Broken maize through the

6.35-mm (16/64-inch) and 4.76-mm (12/64-inch) sieves were 6.02 percent and 2.55 percent, respectively, compared with 3.73 and 1.14 percent in the inbound samples (Table 14). The percentage of whole kernels was 94.3 percent in the outbound samples compared with 96.1 percent in the inbound. Foreign materials (material other than maize) were quite low in both inbound and outbound samples, but there was a significant increase in the percentage of dust and inert materials, ranging from 0.21 percent inbound to 0.55 percent outbound. The percentage of kernels showing stress cracks increased from 10.2 to 60.5 as a result of high-temperature drying. The percentage of floaters increased, whereas one hundred-kernel weight and true density decreased, also the result of drying.

Quality in the Export Vessel. A vessel of Argentine maize destined for Singapore was loaded with 19,124 mt at Rosario and topped off with an additional 4,953 tons in Buenos Aires. Samples were taken in holds 1, 3, and 5 when the vessel arrived in Buenos Aires.

The sampling procedure was to combine three probe samples from each quadrant into a single composite sample for each quadrant of holds 1, 3, and 5 (Figure 3). The probes were 52 inches long so samples were obtained in fairly shallow layers. Only the top 52 inches could be sampled from the Rosario maize. As the 4,000 tons of maize were being loaded into the three holds at Buenos Aires, samples were taken from three layers in hold 1, two layers in hold 3, and three layers in hold 5. These samples represented approximately 1,500 tons in hold 1, 1,000 tons in hold 3, and 2,500 tons in hold 5. All of the maize that was loaded was from the 1982 crop, and the official certificate reported that the maize in the bottom layer was graded as No. 1 and the top-off maize was graded as No. 2. The top-off maize was of lower quality with respect to all quality factors with the exception of measures of density (Table 15). Test weight was slightly higher in the Buenos Aires top-off maize than in the maize loaded at Rosario. One hundred-kernel weights and true densities were essentially the same. However, other measures of quality related to breakage and foreign material were significantly worse in the top-off maize.

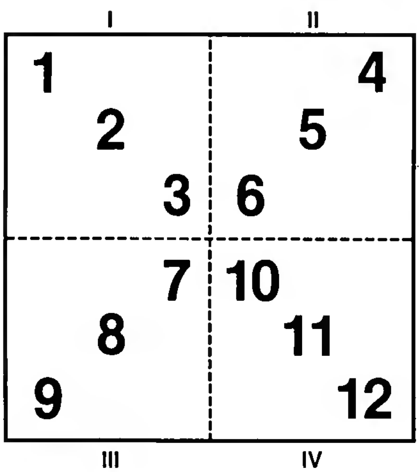
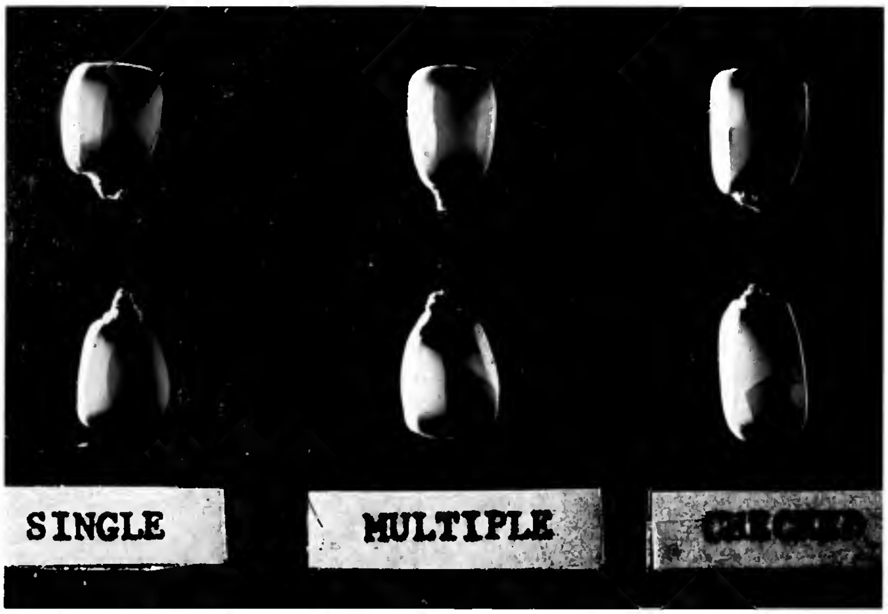


Figure 3. Sampling pattern for the ocean vessel in Buenos Aires. The numbers in each quadrant represent the placement of the three probes. These probes, in turn, were combined to produce a sample of approximately 1,000 grams.

Flint maize that was subjected to high temperatures during drying showed internal fractures . . .



. . . as does U.S. dent corn.

Because it was not possible to obtain samples from the export house during loading at the two locations, the reason for the difference could not be established. Whether or not the maize being delivered to the Buenos Aires port was of lower quality than that delivered to Rosario or the handling practices and blending procedures at Buenos Aires resulted in increased damage could not be ascertained.

Broken maize (material passing through a 6.35-mm sieve) was 5.1 percent in the maize loaded at Rosario but 9.9 percent in the maize loaded at Buenos Aires. BCFM (through the 12/64-inch sieve) also was significantly higher in Buenos Aires maize than in the Rosario maize (5.0 compared with 1.7 percent). The percentage of whole kernels was lower, and the percentages of stress cracks, breakage susceptibility, and floaters were higher in the Buenos Aires maize. The Buenos Aires maize also contained a higher percentage of other grains (0.29 percent compared with 0.05 percent) and inert materials (0.66 percent compared with 0.31 percent) than the Rosario maize.

The loading procedure was such that breakage increased during loading, and fine materials were segregated within the hold. Much of the loading was accomplished with the use of deflector spouts rigged with ropes to direct the grain stream into the corners and under the deck. In many cases, this meant that maize from the elevator loading spout hit the metal deflector surface at nearly a 90° angle. Breakage was evident in the dust arising from the holds as well as in the samples being taken. A special sample taken under the deflector spout (not included in the analysis because it was not in the probing pattern) contained 12.1 percent BCFM as measured with the 4.76-mm sieve. Much of the loading procedure resulted in pockets of fines beneath the spout that were in the range of 6 to 12 percent BCFM.

Although University of Illinois personnel were not allowed to take samples inside the export elevator, the certificate issued by the Junta Nacional de Granos based on samples from the outbound belt showed an average of 0.8 percent broken kernels through the 4.76-mm sieve in the elevator compared with the average of 5.0 percent for the top-off maize in the vessel (Table 16). Assuming that both sets of samples were representative, there was an increase of 4.2 percentage points in broken maize during the loading process between the export elevator and the ocean vessel.

Other quality factors (test weight and damage) were similar for both sets of samples, indicating that the samples taken without university supervision were at least representative on these factors. It would appear that loading procedures in Argentina create additional breakage much as they do in loading ocean vessels in the United States. The sampling variability in the vessel indicated that some segregation had taken place during loading, although the sampling pattern did not permit a systematic analysis of segregation.

Broken maize through the 4.76-mm sieve ranged from 2.4 percent to 8.9 percent among samples taken in the top-off maize. Similar variation was found in other factors related to breakage and breakage susceptibility. The range and standard deviation on the factor of breakage susceptibility were higher than those found in similar sampling programs on U.S. maize, indicating that the blending procedures in the U.S. market channel may generate a more uniform load with respect to factors other than particle size. Segregation problems caused by spout lines and fines appear to be similar.

Chemical Properties of Argentine Maize

A chemical analysis of 17 samples of the Argentine flint maize provided a limited comparison with average values for U.S. dent (Table 17). The analysis included eight samples selected at random, representing four different varieties from six different fields. Six samples from elevators were also analyzed. Three additional samples analyzed were composites from the ocean vessel. Two samples of U.S. yellow dent were composites from trucks received at a central Illinois processing plant in the fall of 1983. Even from this limited number of samples, it is evident that the protein content of flint maize varies with the variety (Table 17). The percentage of protein ranged from 8.65 to 11.74 in the Argentine samples, but in general, it was slightly higher than in the U.S. dent varieties.

Two composite samples from an Argentine export silo and from truck deliveries to an Illinois maize processor provide a broader base for comparison (Table 18). A comparison of sample 3 (Argentina) with sample 4 (Illinois) shows Argentine maize to have a higher content of fat, protein, and ash than U.S. maize, but a lower content of fiber and nitrogen-free extract. Samples 1 and 2 from individual varieties grown in Argentina show the range of variability. Any comparison of chemical properties between U.S. and Argentine maize requires recognition of a significant degree of variability within the varieties and geographical regions of both countries.

Quality Incentives in the Argentine Market

Argentine farmers and grain handlers respond to the economic incentives present in their system. These incentives include the price level and price differentials associated with grade factors. The incentive of world market prices has clearly stimulated increased acreage and production of maize as well as increased exports by Argentine farms and marketing firms. Higher prices and the adoption of lower cost technology have increased the profitability of maize production. However, opportunities for double cropping with soybeans and wheat have shifted some land into soybean production that would have been used for maize. Reduction of import tariffs and increased domestic production of fertilizer and herbicides may increase production in the future.

A base moisture of 14.5 percent for pricing maize and as a grade requirement for exporting maize provides an incentive to dry maize to a safe storage level. Most elevators were targeting their final moisture content near 14.5 percent either through direct drying or through partial drying followed by aeration and sometimes dryeration in storage. No evidence was found that high moisture maize was being blended with overly dried maize. Targeting final moisture at the base moisture of 14.5 percent provided little opportunity for an economic benefit from blending. Apparently, overdrying in storage occurs frequently, and delivery to the export elevator of maize with moistures below 12 percent is not uncommon. Although export elevators draw maize from several bins during the loading of vessels, there was no evidence of a supply of high-moisture maize to use in blending with maize at moisture levels below 14.5 percent.

Processors who offer relatively higher prices for high-moisture maize (that is, low discounts or a low shrink factor) provide an incentive to farmers for delivering maize a greater distance. Farmers often passed several country elevators in order to reach a processor offering to purchase wet maize without a drying charge.

A price differential is also established for No. 1 maize over No. 2 and for No. 3 below No. 2. No. 1 maize normally receives a 1.0 percent increase in price and No. 3 maize a 1.5 percent decrease in price, relative to the No. 2 base [12, p. 126]. These price differentials are an incentive for farmers to set their combines to reduce the amount of weed seeds and foreign material in the maize. Some of the combines that were observed had separate cleaners, with baggers on the combine to collect weed seeds and small pieces of maize that would be counted as foreign material in the grades at the country elevator. This same incentive is present at the country elevator, encouraging the removal of foreign material, fine material, and small broken pieces before shipment. Most elevators were using aspirators and cleaners. The No. 1 price premium is a deterrent to blending foreign material and screenings to reduce No. 1 maize to the No. 2 base.

Because only three grade factors are used to determine the numerical grade (that is, damage, broken kernels, and foreign material), it is relatively easy for both the farmer and the elevator to control the numerical grade of freshly harvested maize. Because farm deliveries seldom have high damage levels, only routine cleaning is required to produce No. 1 maize and generate the higher price. Incentives for drying to 14.5 percent moisture reduce the incidence of mold damage relative to the 15.5 percent base established by the grade for No. 2 maize in the United States.[8]

[8] Moisture was removed from U.S. grades in September 1985, and many elevators changed their base to 15.0 percent.

Comparison of U.S. and Argentine Quality

The production and marketing technology in Argentina and the United States are, in fact, quite similar with respect to combines, grain dryers, storage bins, and weighing and grading equipment. Pricing strategies are somewhat different, particularly in terms of charges for services and commission charges at Argentine elevators in lieu of elevator handling margins. In the United States, the elevator covers operating costs through a variable margin determined by the difference between the selling price and the bid price offered to the farmer. This margin is supplemented by charges for specific services such as drying or storage. The country elevator in Argentina gives the farmer a price bid equal to the prices established by their Board of Trade (Bolsa), reflecting prices in the export market. In both countries the cost for services, the elevator's cost of operation, and the transportation costs are then assessed as charges against the farmer. Competition among Argentine elevators is not based upon the bid price to producers but upon the charges for services and the elevator merchandising commission.

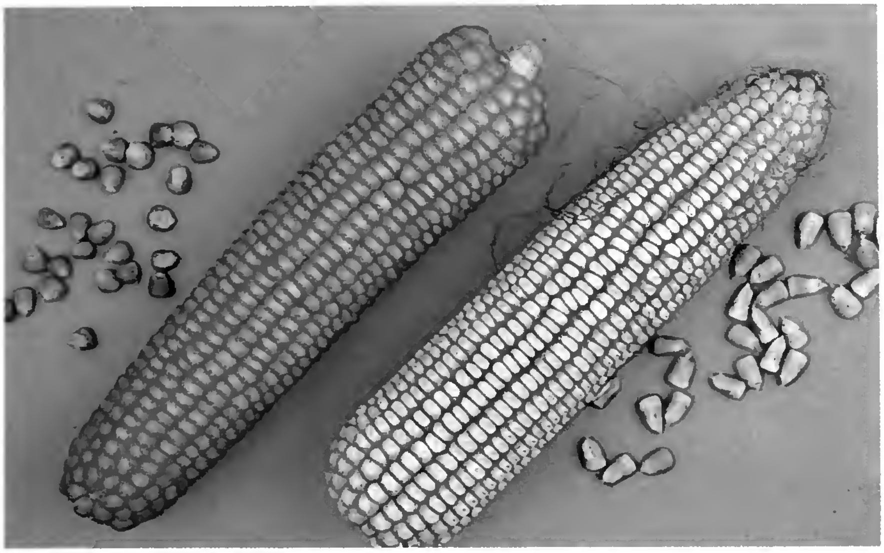
Shrink factors for adjusting maize to base moisture quantities are similar in both the United States and Argentina. The actual water loss calculated mathematically is used in constructing tables, and either a rule-of-thumb shrink factor or a table has been instituted that does not correspond exactly to the actual water loss. In both countries, the factors and tables used at various moisture levels often exceed the actual weight loss due to evaporation of water. In Argentina, the adjustment factor for drying from 15.5 percent to 14.5 percent moisture is equivalent to the loss when drying to 13.5 percent. In the United States, many elevators use a shrink factor of 1.3 percent to cover actual losses of 1.18 percent. These higher factors provide income to cover handling losses. "Invisible shrink" is explicitly recognized in both countries.

The grading standards of the two countries are similar with respect to the use of numerical grades and the identification of some of the important factors. For example, both countries identify damaged kernels, although the United States has a subset for this identification called *heat damage*. Both countries identify broken maize and foreign material as grade-determining factors, but the United States combines both into one measurement, whereas Argentina keeps them separate. Argentina does not use moisture as a grade-determining factor but sets a base of 14.5 percent as the maximum moisture for all grades. The United States has recently removed moisture as a grade factor, but 15.0 or 15.5 percent was commonly used as the base for establishing price until 1986. A comparison of grade standards in the two countries (Table 8) shows the differences in grade factors and factor limits. With some adjustment one can determine the similarity or differences between the effective quality generated by the two sets of standards.

The use of high-temperature dryers has resulted in breakage and stress cracks in both countries, despite some worldwide belief that Argentine maize neither experiences breakage nor contains stress cracks. The results of this study indicate that this is not true. High-temperature drying of flint varieties resulted in stress cracks and breakage just as it does in dent varieties. Argentina has moved rapidly toward combine harvesting at high-moisture levels, and the high-temperature dryers that must accompany this technology have generated an increasingly serious problem of breakage. The tests conducted in this research indicate that the percentage of stress cracks in Argentine flint varies with variety and drying temperature. Similar results have been found when testing U.S. maize [23]. The high-density, vitreous endosperm found in the flint varieties in Argentina is highly susceptible to stress cracks during drying. Both U.S. and Argentine producers and government agencies may need to focus on practices and incentives for reducing the problems associated with high-temperature drying.

Density and thickness of vitreous endosperm is much greater for flint varieties than in most commercial varieties of U.S. dent maize. The value of this for dry milling purposes is offset by the smaller size of kernels. Therefore, the yield of large flaking grits may not be much greater in Argentine maize that is free of stress cracks than in some varieties of dent maize that are free of stress cracks.

Chemical analysis of the Argentine samples indicates a slightly higher protein content than in average U.S. dent varieties but with significant variability. For wet milling purposes the hardness and the high density actually lengthen steeping time and may decrease the yield of starch relative to dent varieties of similar characteristics. Thus, it is not clear that flint has a unique advantage over U.S. dent maize for wet milling: its unique advantage has been the high content of carotene which produces dark yellow-skinned broilers and dark yellow egg yolks. The introduction of dent genetic material into Argentine commercial seed maize varieties may reduce the advantages of flintiness, density, and carotene content that have generated premiums in the past. The gradual shift from Spain and Italy as primary markets for Argentina to a wider range of geographical destinations suggests that customers may be reducing the importance that they have previously attached to these high carotene factors.



Flint-type maize is distinguished from dent-type by kernel shape and dark red color.

Summary

The research reported in this publication has been based upon a limited number of samples with restricted access to data and sampling locations. The research covers a relatively small number of locations and sampling points and should, therefore, be considered as a case study rather than as a complete representation of the entire Argentine maize industry. However, the data provide the basis for several conclusions about the chemical and physical characteristics of Argentine maize with comparison to U.S. maize. The following points summarize the more important characteristics:

1. The test weight of Argentine maize was higher than that of U.S. dent varieties, ranging from 778 to 797 kg/m^3 (60.5 to 61.9 pounds per bushel) on the samples collected from the vessel in Buenos Aires. True kernel density was also high, ranging from 1.24 to 1.31 g/m^3. The test weight for U.S. dent corn inspected for exports in 1985 ranged from 664 to 761 kg/m^3 (51.6 to 59.1 pounds per bushel).

2. The percentage of kernels floating in a 1.275 specific gravity solution indicates that Argentine maize is very hard and dense, and the endosperm thickness test indicates a very thick layer of vitreous endosperm in true flint varieties. Dent varieties contain a higher proportion of soft starch.

3. The number of kernels with stress cracks on freshly harvested maize averaged 13 percent. After artificial drying this increased to 52 percent. Breakage susceptibility values on a 6.35-mm (16/64-inch) sieve after artificial drying to approximately 13.7 percent moisture averaged 32 to 40 percent. With natural air-drying, breakage susceptibility values averaged 12 to 14 percent. These values are very similar to those found in dent corn subjected to similar stress.

4. One hundred-kernel weights indicated Argentine maize was of higher density on the average but with a wider range among samples than U.S. maize, owing to the difference in kernel size.

5. Throughout the market channel, whole-kernel percentages remained quite high, from 93 to 95 percent. The effects of additional handling during the discharge of maize from the ocean vessel have not been established. Similar studies of U.S. marketing showed similar results, with the percentage of whole kernels decreasing during the discharge of the vessel.

6. BCFM increases through the market channel, averaging 0.7 percent at the first point of measurement on the farm. At the incoming elevators, the average was 1.1 percent. After drying and cleaning, BCFM had increased to 1.6 percent, and after loading on one ocean vessel using old crop maize, the hold averages for BCFM were 5.0 percent. Weed seeds are highest at the farm and incoming country elevator level. The proportion of weed seeds in the total sample was near zero at the export elevator. Other grains, inert materials, and fines less than 1.4 mm are highest in the export elevator and were higher in the top-off maize at Buenos Aires than in the maize loaded at Rosario. These results are similar to those found in studies of U.S. exports.

7. Nearly all Argentine maize is harvested by combine and artificially dried. Most of it is trucked directly to country elevators at harvest because there is little on-farm storage. Typically, maize is artificially dried from moistures of 22 percent or greater to 14.5 percent. Dryeration or tempering techniques are frequently used in an attempt to reduce stress cracks, breakage susceptibility, and breakage. U.S. technology and practices are similar except that about 50 percent of drying and storage takes place on the farm.

Conclusions

1. Argentine and U.S. producers are competing for a world market with maize that exhibits similar quality characteristics. The genetic differences are becoming less pronounced as plant breeders strive for higher yields.

2. The technology of production, harvesting, and drying is similar for Argentine and U.S. maize. The quality problems (especially breakage) associated with this technology present a similar challenge to both countries.

3. As the quality distinctions between U.S. and Argentine maize decrease, the extent of overlap between importing customers will increase, and the shifts among trading partners will become more frequent, responding primarily to the delivered price.

4. The quality differentiation within either Argentina or the United States can provide new market opportunities to specific industries or firms, but only if a more discriminating grading and marketing system is developed to allow price differentials to direct each quality to its highest valued use and to provide the necessary incentives to producers.

References

1. Apple, R. W. 1982. "Europeans Ending Argentine Imports" in *The New York Times*, April 11: 1, 12.
2. Bolsa de Cereales de Buenos Aires. 1986. *Numero Estadistico*: 17.
3. Bolsa de Cereales de Buenos Aires. 1982. Unpublished tables.
4. Chiang, S. W. and Blaich, O. P. 1983. *Argentina's Grain Marketing System*. ERS Staff Report No. AGE 5830916. USDA-ERS, International Economics Division. Washington, D.C.: November.
5. Coscia, Adolfo A. 1980. *Comercializacion de Granos*. Buenos Aires: Editorial Hemisferio Sur S.A.
6. Coscia, Adolfo A. 1980. *Porque Argentina Produce Maiz Flint*. INTA. Estacion Experimental Regional Agropecuaria Pergamino. Boletin de Divulgation Tecnica 50. September.
7. Doane-Western. 1982. *World Agriculture Profile Alert*. May 28: 2.
8. Duval, L. 1916. "The Production and Handling of Grain in Argentina." In: USDA, *Yearbook of the Department of Agriculture 1915*. Washington, D.C.: Government Printing Office; 281-298.
9. FAO. 1985. *1984 FAO Production Yearbook*. Vol. 38. Rome.
10. FAO. 1966. *World Crop Statistics*. Area, production, and yield, 1948-64. Rome.
11. Hill, L. D., Paulsen, M. R., and Early, M. 1979. *Corn Quality: Changes During Export*. Agr. Exp. Sta. College of Agr. Univ. of Illinois, Sp. Publ. 58.
12. INTA (Instituto Nacional de Technologia Agropecuaria). 1980. *El cultivo del maiz*. Buenos Aires: September.

13. Jacobs, Eduardo, and Gutierrez, Marta. 1986. *La Industria De Semillas En La Argentina, Centro De Investigaciones Sociales Sobre El Estado Y La Administracion, Proyecto Organizacion De La Investigacion Agropecuaria (Proagro), Documento CISEA N°85, Marzo de 1986.* Buenos Aires: 43, Table 2.

14. Junta Nacional de Granos. 1986. *Capacidad de Almacenaje.* Buenos Aires.

15. Mielke, Myles F. 1984. *Argentine Agricultural Policies in the Grain and Oilseed Sectors.* Foreign Agricultural Economic Report No. 206. USDA-ERS, International Economics Division. Washington, D.C.: September.

16. Ministerio de Agricultura y Ganaderia. Junta Nacional de Granos. 1982. *Nuevas Normas Para la Clasificacion de Sorgo y Mais.* Buenos Aires.

17. Ministerio . . . . N.D. *Anuario 1982.* Buenos Aires.

18. Ministerio . . . . N.D. *Anuario 1981.* Buenos Aires.

19. Morgan, J. 1985. "USSR, Italy Back Plan for Argentine Port." *Journal of Commerce,* October 16: 24B.

20. Office of the Agricultural Counselor, Argentina. 1987. *Annual Agricultural Situation Report.* AR-7020, CERP 0400. Buenos Aires: February 27; Table 27.

21. Paulsen, M. R. 1983. *Corn Breakage Susceptibility as a Function of Moisture Content.* ASAE Paper No. 83-3078. St. Joseph, Michigan: American Society of Agricultural Engineers.

22. Paulsen, M. R. and Hill, L. D. 1985. "Corn Quality Factors Affecting Dry Milling Performance." *J. Ag. Engr. Res.,* 31:255-263.

23. Paulsen, M. R., Hill, L. D., White, D. G., and Sprague, G. F. 1983. "Breakage Susceptibility of Corn-Belt Genotypes." *Transactions of ASAE,* 26(6):1830-1836, 1841.

24. Secretary of State, Agriculture, Livestock and Fishery. 1985. Buenos Aires. Unpublished data.

25. South Africa Maize Board. 1985. *Report on Maize, 1935-1985.* Pretoria: October.

26. U.S. Agricultural Attache in Buenos Aires. Grain and Pulses Data Sheet. December 15, 1982.

27. USDA. *Agricultural Statistics.* Washington, D.C.

28. USDA-ERS. 1984. *Corn Background for 1985 Farm Legislation.* Washington, D.C.

29. USDA-ERS. 1983. *Feed Outlook and Situation Report.* Washington, D.C.: May; 18.

30. USDA-ERS. 1968. *World Trade in Selected Agricultural Commodities 1951-65.* Volume II: Food and Feed Grains: Wheat, Rice, Maize, Barley, and other cereals. Foreign Agricultural Economic Report No. 45. Washington, D.C.

31. USDA-FAS. 1985. *Grains, World Grain Situation, and Outlook.* FG-1-85. Washington, D.C.: January.

32. USDA-FAS. 1985. *Grains.* Foreign Agriculture Circular. Washington, D.C.: February.

33. USDA-FAS. 1982. *Grain Exports by Selected Exporters.* Foreign Agriculture Circular. Washington, D.C.: March.

34. USDA-FAS. 1978. *Grain Exports by Selected Exporters.* Foreign Agriculture Circular. Washington, D.C.: March.

35. USDA-FAS. 1970. *Grain Production and Marketing in Argentina.* FAS-M222. Washington, D.C.: December.

36. USDA. FGIS. 1985. *Official United States Standards for Grain.* Revised May 25, 1985. Revised pages, effective September 9, 1985.

Table 1. Area Harvested, Production, and Exports of Argentine Maize, 1951/52 to 1984/85

Year[a]	Area harvested (1,000 hectares)	Production (1,000 metric tons)	Exports (1,000 metric tons)
1951/52 (50)	1,714	2,670	480
1952/53 (51)	1,431	2,040	633
1953/54 (52)	2,856	3,550	1,150
1954/55 (53)	2,414	4,450	2,050
1955/56 (54)	1,863	2,546	268
1956/57 (55)	2,240	3,870	1,206
1957/58 (56)	1,957	2,698	793
1958/59 (57)	2,448	4,806	2,093
1959/60 (58)	2,361	4,932	2,728
1960/61 (59)	2,415	4,108	2,068
1961/62 (60)	2,744	4,850	1,838
1962/63 (61)	2,757	5,220	2,889
1963/64 (62)	2,645	4,360	2,590
1964/65 (63)	2,971	5,350	3,442
1965/66 (64)	3,062	5,140	2,667
1966/67 (65)	3,274	7,040	3,855
1967/68 (66)	3,450	8,000	4,117
1968/69 (67)	3,378	6,560	3,229
1969/70 (68)	3,556	6,860	3,765
1970/71 (69)	4,017	9,360	5,559
1971/72 (70)	4,066	9,930	6,441
1972/73 (71)	3,147	5,860	2,537
1973/74 (72)	3,565	9,000	4,702
1974/75 (73)	3,486	9,900	5,716
1975/76 (74)	3,070	7,700	3,485
1976/77 (75)	2,766	5,855	3,238
1977/78 (76)	2,532	8,300	5,231
1978/79 (77)	2,660	9,700	5,916
1979/80 (78)	2,899	9,000	5,965
1980/81 (79)	2,490	6,400	3,417
1981/82 (80)	3,394	12,900	9,098
1982/83 (81)	3,170	9,600	5,765
1983/84 (82)	2,970	9,000	6,056
1984/85 (83)	3,025	9,500	5,800

[a] Years in parentheses denote production years used for aggregating world crops. Split years (e.g., 1982/83) are Foreign Agricultural Service marketing years which are lagged 1 year behind the production years used in Argentine publications.
Source: Data from 1951/52 to 1959/60 are taken from [35, p. 35]; data from 1960/61 to 1984/85 are taken from [32, p. 6].

Table 2. Area Planted and Production of Maize in Argentine Provinces, 1978/79 to 1984/85

	Buenos Aires	Santa Fe	Cordoba	La Pampa	Entre Rios	Other provinces	Total
	Area planted (1,000 hectares)						
1978/79	1,330 (40.3)[a]	519 (15.7)	700 (21.2)	220 (6.7)	148 (4.5)	383 (11.6)	3,300
1979/80	1,242 (37.5)	460 (13.9)	700 (21.1)	300 (9.1)	135 (4.1)	473 (14.3)	3,310
1980/81	1,500 (37.5)	541 (13.5)	855 (21.4)	338 (8.5)	246.9 (6.2)	519.1 (13.0)	4,000
1981/82	1,281 (34.7)	530 (14.3)	874.8 (23.7)	290.8 (7.9)	169.1 (4.6)	549.3 (14.9)	3,695
1982/83	1,075 (31.3)	523 (15.2)	820 (23.8)	280 (8.1)	195.5 (5.7)	546.5 (15.9)	3,440
1983/84	1,195 (34.3)	465 (13.3)	848 (24.3)	276 (7.9)	121 (3.5)	579 (16.6)	3,484
1984/85	1,300 (34.2)	440 (11.6)	1,060 (27.9)	310 (8.2)	NA (0)	690 (18.1)	3,800
	Production (1,000 hectares)						
1978/79	3,670 (42.2)[a]	2,100 (24.1)	1,918 (22.0)	310 (3.6)	126 (1.4)	576 (6.6)	8,700
1979/80	2,520 (39.4)	1,515 (23.7)	1,220 (19.1)	221 (3.5)	104 (1.6)	820 (12.8)	6,400
1980/81	6,073 (47.1)	2,505 (19.4)	2,723 (21.1)	259 (2.0)	570 (4.4)	770 (6.0)	12,900
1981/82	4,160 (43.3)	2,000 (20.8)	1,900 (19.8)	185 (1.9)	299 (3.1)	1,056 (11.0)	9,600
1982/83	3,280 (36.5)	1,630 (18.1)	2,650 (29.4)	180 (2.0)	232.6 (2.6)	1.027.4 (11.4)	9,000
1983/84	4,130 (43.5)	1,270 (13.4)	2,540 (26.7)	270 (2.8)	127 (1.3)	1,163 (12.3)	9,500
1984/85	4,820 (37.9)	1,680 (13.2)	4,110 (32.3)	390 (3.1)	NA (0)	1,720 (13.5)	12,720

[a] Number in parentheses represent each province's percentage of the total.
Sources: The data for 1978/79 and 1979/80 are from [17, p. 8]. Data for 1980/81 to 1984/85 are from [3, 24].

Note: Table 3 appears on page 33.

Table 4. Annual Maize Exports for the United States, Argentina, and the World, and Comparison of Market Shares, 1911 through 1983/84

Year[a]	Export volume, mmt			Market share, %	
	World[b]	Argentina	U.S.	Argentina	U.S.
1911-13 average	8.78	4.82	1.21	54.9	13.8
1951/52	4.478	0.480	2.776	10.7	62.0
1952/53	4.666	0.633	2.224	13.6	47.7
1953/54	5.609	1.150	3.603	20.5	64.2
1954/55	5.148	2.050	1.701	40.0	33.0
1955/56	5.817	0.268	2.718	4.6	46.7
1951-55 average	5.144	0.916	2.604	17.8	50.6
1956/57	6.643	1.206	2.885	18.2	43.4
1957/58	7.338	0.793	4.233	10.8	57.7
1958/59	9.511	2.093	4.409	22.0	46.4
1959/60	9.960	2.728	5.288	27.4	53.1
1960/61	12.083	2.068	5.142	17.1	42.6
1956-60 average	9.107	1.778	4.391	19.5	48.2
1961/62	19.900	2.914	10.481	14.7	52.7
1962/63	20.001	2.614	10.069	13.1	50.3
1963/64	21.800	3.422	12.068	15.7	55.4
1964/65	23.900	2.667	14.240	11.2	59.6
1965/66	27.800	6.421	16.737	23.1	60.2
1961-65 average	22.680	3.610	12.719	15.9	56.1
1966/67	26.300	4.118	12.137	15.7	46.1
1967/68	29.000	3.229	15.546	11.1	53.6
1968/69	26.300	3.764	13.300	14.3	50.6
1969/70	30.900	5.558	15.548	18.0	50.3
1970/71	31.401	6.442	12.853	20.5	40.9
1966-70 average	28.780	4.622	13.877	16.1	48.2
1971/72	34.899	2.538	19.869	7.3	56.9
1972/73	44.501	4.702	31.536	10.6	70.8
1973/74	53.500	5.715	31.241	10.7	58.4
1974/75	46.299	3.485	29.186	7.5	63.0
1975/76	60.599	3.239	43.459	5.3	71.7
1971-75 average	47.960	3.936	31.058	8.2	64.8
1976/77	60.599	5.230	42.773	8.6	70.6
1977/78	66.099	5.916	49.479	9.0	74.9
1978/79	71.101	5.964	54.181	8.4	76.2
1979/80	78.399	5.957	61.801	7.6	78.8
1980/81	83.700	9.099	59.820	10.9	71.5
1976-80 average	71.980	6.433	53.611	8.9	74.5
1981/82	71.901	5.766	49.964	8.0	69.5
1982/83	66.899	6.056	47.501	9.1	71.0
1983/84[c]	66.099	5.999	48.260	9.1	73.0
1981-83 average	68.300	5.940	48.575	8.7	71.1

[a] Argentine crop years have been shifted forward one year to correspond with U.S. marketing years (i.e., 1956/57 crop year for Argentina is recorded as 1957/58 marketing year).
[b] Includes intra-EC trade.
[c] Forecast as of August 13, 1984.
Sources: 1911 to 1913 data from [8, p. 289]. 1951/52 to 1960/61 data: World and U.S. data from [30, pp. 125-134]. Argentine data from [35, p. 35]. 1961/62 to 1982/83 data from [28, pp. 48, 50]: 1961/62 to 1978/79 are July/June years, thereafter October/September.

Table 5. Volume of Maize Exported from Argentina by Port of Origin, 1970-1985, in Thousand Tons

Calendar year	Buenos Aires	Rosario	Villa Constitucion	Bahia Blanca	San Nicolas	Quequen	Other ports	Total
1970	1,956.7	2,236.3	339.8	64.3	140.5	67.9	436.2	5,241.7
	(37.3)[a]	(42.7)	(6.5)	(1.2)	(2.7)	(1.3)	(8.3)	(100)
1971	2,378.3	2,524.5	492.1	66.0	152.5	28.1	471.8	6,113.3
	(38.9)	(41.3)	(8.0)	(1.1)	(2.5)	(0.46)	(7.7)	(100)
1972	1,164.1	1,373.3	279.7	1.5	96.0	0.2	124.4	3,039.2
	(38.3)	(45.2)	(9.2)	(0.05)	(3.2)	(0.01)	(4.1)	(100)
1973	1,760.1	1,757.1	404.6	118.5	99.3	0.0	186.0	4,325.6
	(40.7)	(40.6)	(9.4)	(2.7)	(2.3)	(0.0)	(4.3)	(100)
1974	1,985.5	1,808.7	544.7	376.0	209.6	44.9	644.5	5,613.9
	(35.4)	(32.2)	(9.7)	(6.7)	(3.7)	(0.80)	(11.5)	(100)
1975	1,640.5	1,311.5	338.1	207.6	197.8	14.1	291.4	4,001.4
	(41.0)	(32.8)	(8.4)	(5.2)	(4.9)	(0.40)	(7.3)	(100)
1976	1,374.7	880.3	302.0	191.5	137.3	10.0	162.8	3,058.6
	(44.9)	(28.8)	(9.9)	(6.3)	(4.5)	(0.30)	(5.3)	(100)
1977	2,090.5	1,990.4	683.4	249.5	67.0	49.1	344.0	5,474.0
	(38.2)	(36.4)	(12.5)	(4.6)	(1.2)	(0.90)	(6.3)	(100)
1978	2,127.0	1,908.2	960.8	331.3	289.9	58.1	309.3	5,984.5
	(35.5)	(31.9)	(16.1)	(5.5)	(4.8)	(1.0)	(5.2)	(100)
1979	1,742.4	1,885.7	936.2	368.4	598.2	20.5	412.7	5,964.1
	(29.2)	(31.6)	(15.7)	(6.2)	(10.0)	(0.34)	(7.0)	(100)
1980	966.1	1,564.2	483.0	141.7	225.7	0.01	144.0	3,524.6
	(27.4)	(44.4)	(13.7)	(4.0)	(6.4)	(0.0)	(4.1)	(100)
1981	1,973.9	2,907.8	934.6	961.5	716.4	102.2	1,515.6	9,112.1
	(21.7)	(31.9)	(10.3)	(10.6)	(7.9)	(1.1)	(16.6)	(100)
1982	1,302.8	1,599.4	585.8	354.9	382.7	0.0	988.7	5,214.2
	(25.0)	(30.7)	(11.2)	(6.8)	(7.3)	(0.0)	(19.0)	(100)
1983	1,702.2	2,468.3	596.9	435.5	579.8	21.0	672.7	6,476.5
	(26.3)	(38.1)	(9.2)	(6.7)	(9.0)	(0.3)	(10.4)	(100)
1984	1,311.5	1,708.7	562.8	431.8	711.9	109.4	722.3	5,558.4
	(23.6)	(30.7)	(10.1)	(7.8)	(12.8)	(2.0)	(13.0)	(100)
1985[b]	883.1	2,123.0	357.7	26.8	565.2	43.0	998.7	4,997.5
	(17.7)	(42.5)	(7.2)	(0.5)	(11.3)	(0.9)	(20.0)	(100)

[a] Numbers in parentheses represent individual port's percentage of total export volume.
[b] 1985 data includes data for January through July.
Sources: 1970 to 1981 data from [17, p. 74]; 1982 to 1985 data from [3, 24].

Table 6. Export Volume in 1,000 metric tons and Market Shares of Argentine Maize by Country of Destination, 1973/74 through 1985[a]

Year	Italy	Spain	USSR	Nether-lands	United Kingdom	Mexico	Peoples Republic of China	Total Argentine exports
1973/74	2,772	600	246	115	120	1	252	5,111
	(54.2)	(11.7)	(4.8)	(2.3)	(2.3)	(0.02)	(4.9)	
1974/75	2,056	556	1,148	59	5	723	473	5,831
	(35.3)	(9.5)	(19.7)	(1.0)	(0.09)	(12.4)	(8.1)	
1975/76	1,520	225	213	68	1	289	...	2,595
	(58.6)	(8.7)	(8.2)	(2.6)	(0.04)	(11.1)	(0)	
1976/77	1,893	1,109	184	126	133	25	...	4,384
	(43.2)	(25.3)	(4.2)	(2.9)	(3.0)	(0.6)	(0)	
1977/78	1,381	1,069	1,608	142	94	48	59	5,997
	(23.0)	(17.8)	(26.8)	(2.4)	(1.6)	(0.8)	(1.0)	
1978/79	1,838	1,573	1,387	147	53	21	131	6,664
	(27.6)	(23.6)	(20.8)	(2.2)	(0.8)	(0.3)	(2.0)	
1979/80	709	314	2,461	55	21	...	...	4,060
	(17.5)	(7.7)	(60.6)	(1.4)	(0.51)	(0)	(0)	
1980[b]	328	1	2,965	74	...	...	...	3,525
	(9.3)	(0.4)	(84.1)	(2.1)	(0)	(0)	(0)	
1981	300	225	7,989	98	...	...	...	3,525
	(3.3)	(2.5)	(87.7)	(1.1)	(0)	(0)	(0)	
1982	227	397	3,301	92	...	...	132	5,214
	(4.4)	(7.6)	(63.3)	(1.8)	(0)	(0)	(2.5)	
1983	395	697	2,002	102	...	...	49	6,477
	(6.1)	(10.8)	(30.9)	(1.6)	(0)	(0)	(0.8)	
1984	335	591	1,090	62	...	...	...	5,558
	(6.0)	(10.6)	(19.6)	(1.1)	(0)	(0)	(0)	
1985	502	956.4	2,038.7	107.4	...	197.4	...	3,238.2
	(7.1)	(13.6)	(29.0)	(1.5)	(0)	(2.7)	(0)	7,040.8

[a] Market shares are in parentheses and indicate a volume less than 1,000 mt.
[b] 1980 to 1985 reporting period has been shifted to a calendar year.
Sources: 1973/74 to 1979/80 data from [33, 34]. Data for 1980 to 1985 are from government publications [24]. Estimates vary by source; so do the time periods used for crop years, marketing years, and calendar years. No consistent sources were found that covered the entire period.

Table 3. Industrial Use of Argentine Maize 1960/61 to 1983/84

Year[a]	Production (1,000 mt)	Industrial use (1,000 mt)	Industrial use (Percent)
1960/61	4,850	234	4.8
1961/62	5,220	231	4.4
1962/63	4,360	209	4.8
1963/64	5,350	206	3.9
1964/65	5,140	284	5.5
1965/66	7,040	422	6.0
1966/67	8,510	379	4.5
1967/68	6,560	452	6.9
1968/69	6,860	559	8.1
1969/70	9,360	623	6.7
1970/71	9,930	749	7.5
1971/72	5,860	1,016	17.3
1972/73	9,700	1,181	12.2
1973/74	9,900	1,145	11.6
1974/75	7,700	1,603	20.8
1975/76	5,855	1,378	23.5
1976/77	8,300	1,372	16.5
1977/78	9,700	1,169	12.1
1978/79	8,700	1,035	11.9
1979/80	6,400	1,350	21.1
1980/81	12,900	1,299	10.1
1981/82	9,600	1,366	14.2
1982/83	9,000	1,496	16.6
1983/84	9,500	1,543	16.2

[a] Argentine crop year March 1 through February 28.
Source: 1960/61 to 1978/79 from [17, 18]; 1979/80 to 1983/84 from [24].

Table 7. Grain Storage Capacity and Volume of Grain Handled at Argentine Ports

Port	Storage capacity, 1980 (1,000 tons)	Volume of grains handled, 1979 (1,000 tons)	Transport share, 1979, %[a] Rail (%)	Truck (%)	Barge (%)
Rosario	391	4,009	57	43	0
Bahia Blanca	206.1	3,984	48	52	0
Buenos Aires	170	2,381	62	36	1
San Nicolas	67.5	778	6	94	0
Quequen	93	1,028	1	99	0
Santa Fe	64	801	22	78	0
Villa Constitucion	55	1,527	29	71	0
Others	110.5	770	...	...	...
Total	1,157.1	15,278	42	58	2

[a] Figures do not always add up to 100% due to rounding.
Source: [4, pp. 10-15].

Table 8. Comparison of U.S. and Argentine Grading Standards for Maize

Grade	% Moisture		% BCFM[b]	% Brokens	% FM[c]	% Total damage		Test weight (lb/bu)		% Heat damage	
	U.S.[a]	Arg.	U.S.	Arg.	Arg.	U.S.	Arg.	U.S.	Arg.	U.S.	Arg.
1	14.0	14.5	2.0	2.0	1.0	3.0	3.0	56.0	nf[e]	0.1	nf
2	15.5	14.5	3.0	3.0	1.5	5.0	5.0	54.0	nf	0.2	nf
3	17.5	14.5	4.0	5.0	2.0	7.0	8.0	52.0	nf	0.5	nf
4[d]	20.0	14.5	5.0	5.0	2.0	10.0	12.0	49.0	nf	1.0	nf
5	23.0	...	7.0	...	...	15.0	...	46.0	nf	3.0	nf

[a] Moisture as a grade-determining factor was removed from U.S. standards effective September 9, 1985.
[b] Broken corn and foreign material.
[c] Foreign material.
[d] Grade No. 4 is established by Junta Nacional de Granos in those seasons where high damage levels make it impossible to reach Grade No. 3 for export contracts. It differs from Grade No. 3 only in the percent of total damage.
[e] Not a factor.
Source: [12, p. 122; 36].

Table 9. Comparison of Charges in Pesos for Maize Delivered by Argentine Farmers to Four Elevators in the Pergamino Area[a]

Services	Elevator code[b]			
	A	B	C	D
Commission	15,000	33,000	24,000	27,000
Drying	14,000	14,250	10,500	12,750
Loading and unloading	7,500	10,000	9,000	9,000
Screening	4,000	6,000	0	7,000
Freight to nearest port	27,878	21,558	23,000	21,558
Fumigation	5,000	6,000	9,000	7,000
Total charges	73,378	90,808	75,500	84,308
Price/Quintal	660	660	660	660

[a] Charges are given in 1983 pesos. As a result of inflation and devaluation, actual numbers have little significance except to show the relative difference at a point in time. All charges were provided for the same day for a truck sale of 100 kg of No. 2 flint corn at 18.5 percent moisture containing sufficient weed seeds to require screening.
[b] Elevator A was privately owned. Elevators B, C, and D were cooperatives.
Source: Personal interviews with four managers at four country elevators, 1983.

Table 10. Quality Characteristics for Six Samples of Argentine Maize Collected from Combines on Five Farms

Quality measure	Mean	Standard deviation	Range Low	Range High
Test weight, kg/m³	773.0	21.0	736.0	793.0
lb/bu	57.6	1.6	54.9	59.1
Broken corn < 16/64″ sieve, %	2.9	0.7	2.0	3.9
BCFM < 12/64″ sieve, %	0.7	0.4	0.3	1.3
Whole kernels in 50 g, %	94.3	3.1	90.4	98.2
Stress cracks, %	13.0	8.7	4.0	24.0
Breakage susceptibility, %	11.7	3.1	9.7	17.8
Floaters, %	16.0	14.4	2.0	41.0
100-kernel dry weight, g	24.5	1.9	21.1	26.1
Density, g/cm³	1.29	0.03	1.23	1.33
Physical separations				
Other grains, %	0	0	0	0
Weed seeds, %	0.012	0.018	0	0.046
Cobs, husks, insects, dust, and material < 1.4 mm, %	0.173	0.080	0.096	0.311

Table 11. Quality Characteristics for Twenty-Six Samples of Argentine Maize Collected from Incoming Trucks and Trailers at Five Country Elevators

Quality measure	Mean	Standard deviation	Range Low	Range High
Test weight, kg/m³	769.0	15.8	719.4	789.5
lb/bu	59.7	1.2	55.9	61.3
Broken corn < 16/64″ sieve, %	3.6	1.0	2.4	5.8
BCFM < 12/64″′ sieve, %	1.1	0.6	0.4	2.5
Whole kernels in 50 g, %	95.1	2.4	87.6	98.2
Stress cracks, %	11.1	4.0	4.0	20.0
Breakage susceptibility, %	13.6	3.2	8.6	21.6
Floaters, %	12.5	8.0	2.0	37.0
100-kernel dry weight, g	24.4	1.9	19.8	30.6
Density, g/cm³	1.29	0.02	1.25	1.33
Physical separations				
Other grains, %	0.002	0.009	0	0.045
Weed seeds, %	0.015	0.042	0	0.210
Cobs, husks, insects, dust, and material < 1.4 mm, %	0.183	0.180	0.025	0.809

Table 12. Breakage Characteristics of Argentine Maize after Drying

Sample no.	Dryer identification	% BCFM	% Stress cracks	% Breakage susceptibility
035	A	1.47	82	43.30
036	A	1.04	82	46.80
037	A	1.34	70	49.40
065	B	0.88	24	13.25
069	C	0.88	70	44.90
070	C	1.11	26	22.85
071	D	1.11	46	48.05
072	E	1.67	78	45.25
074	F	0.59	36	25.15
078	G	0.65	40	25.50
079	H	1.55	36	29.20
081	I	2.15	32	26.45
082	I	0.85	50	29.75
Average	...	1.18	52	34.60

Table 13. Quality Characteristics for Twenty-three Samples of Artificially Dried Argentine Maize Loaded Out of Five Country Elevators

Quality measure	Mean	Standard deviation	Range	
			Low	High
Test weight, kg/m³	765.2	10.0	744.5	786.7
lb/bu	59.4	0.8	57.8	61.1
Broken corn 16/64" sieve, %	4.9	1.1	3.2	7.1
Broken corn 12/64" sieve, %	1.6	0.8	0.5	3.1
Whole kernels in 50 g, %	94.6	1.9	91.0	98.2
Stress cracks, %	55.4	17.0	24.0	82.0
Breakage susceptibility, %	37.2	9.5	13.3	49.4
Floaters, %	28.3	13.5	2.0	57.0
100-kernel dry weight, g	23.4	0.86	21.2	25.3
Density, g/cm³	1.28	0.02	1.24	1.30
Physical separations				
Other grains, %	0.085	0.152	0	0.583
Weed seeds, %	0.008	0.012	0	0.056
Cobs, husks, insects, dust, and material < 1.4mm, %	0.298	0.295	0.033	1.118

Table 14. Quality Characteristics of Receipts and Shipments of Maize at an Argentine Elevator, 1983

Quality measure	No. of samples	Mean	Standard deviation	Range Low	Range High
Outbound truck shipments[a]					
Test weight, kg/m³	8	767.06	5.59	758.62	744.05
lb/bu	8	59.59	0.43	58.94	60.14
Broken corn < 16/64″ sieve %	8	6.02	0.71	5.26	7.08
BCFM < 12/64″ sieve, %	8	2.55	0.43	2.01	3.10
Whole kernels in 50 g, %	8	94.25	1.53	92.40	97.20
Stress cracks, %	8	60.50	6.02	54.00	72.00
Breakage Susceptibility, %	8	39.82	1.49	38.05	42.90
Floaters, %	8	31.13	9.14	13.00	42.00
100-kernel dry weight, g	8	23.50	0.65	22.19	24.33
Density, g/cm³	8	1.27	0.01	1.25	1.28
Physical separations					
Other grains, %	8	0.09	0.05	0	0.15
Weed seeds, %	8	0.01	0.02	0	0.06
Dust and inert material, %	8	0.55	0.36	0.16	1.12
Inbound truck receipts[b]					
Test weight, kg/m³	13	766.34	9.96	747.54	779.87
lb/bu	13	59.54	0.77	58.08	60.59
Broken corn < 16/64″ sieve, %	13	3.73	1.02	2.42	5.39
BCFM < 12/64″ sieve, %	13	1.14	0.55	0.41	2.10
Whole kernels in 50 g, %	13	96.09	1.75	92.80	98.20
Stress cracks, %	13	10.15	4.20	4.00	20.00
Breakage susceptibility, %	13	14.68	2.14	10.00	18.20
Floaters, %	13	11.15	5.96	2.00	24.00
100-kernel dry weight, g	13	24.51	2.48	19.85	30.60
Density, g/cm³	13	1.29	0.02	1.26	1.33
Physical separations					
Other grains, %	13	0	0	0	0
Weed seeds, %	13	0.01	0.02	0	0.06
Dust and inert materials, %	13	0.21	0.16	0.08	0.63

[a] After drying, the maize was loaded on eight trucks for shipment to the port. Representative samples were taken from each truck.
[b] Representative samples were taken from each of 13 trucks delivering corn from farms.

Table 15. Comparison of Quality Characteristics of Maize Loaded at Rosario and Buenos Aires

Quality measure	Mean	
	Rosario	Buenos Aires
Test weight, kg/m³	778.0	785.0
lb/bu	58.0	58.5
Broken corn: 16/64" sieve, %	5.1	9.9
Broken corn: 12/64" sieve, %	1.7	5.0
Whole kernels in 50 g, %	94.7	92.7
Stress cracks, %	42.8	53.3
Breakage susceptibility, %	31.7	40.4
Floaters, %	16.1	22.7
100-kernel dry weight, g	24.1	24.8
Density, g/cm³	1.29	1.29
Physical separations		
Other grains, %	0.05	0.29
Weed seeds, %	0.01	0.01
Cobs, husks, insects, dust, and material < 1.4 mm, %	0.31	0.66

Table 16. Variability of Quality Characteristics for Sixteen Samples of Argentine Maize from Top Layers of Export Vessel Loaded at Buenos Aires

Quality measure	Mean	Standard deviation	Range	
			Low	High
Test weight, kg/m³	785.0	4.7	778.0	797.0
lb/bu	58.5	0.4	58.0	59.4
Broken corn < 16/64" sieve, %	9.9	3.0	6.0	15.0
BCFM < 12/64" sieve, %	5.0	2.0	2.4	8.9
Whole kernels in 50 g, %	92.7	2.2	87.8	95.6
Stress cracks, %	53.3	11.8	28.0	76.0
Breakage susceptibility, %	40.4	5.3	31.1	49.7
Floaters, %	22.7	7.0	16.0	39.0
100-kernel dry weight, g	24.8	0.72	23.4	26.6
Density, g/cm³	1.29	0.02	1.24	1.31
Physical separations				
Other grains, %	0.291	0.368	0.012	1.431
Weed seeds, %	0.009	0.005	0	0.017
Cobs, husks, insects, dust, and material < 1.4 mm, %	0.659	0.391	0.257	1.864

Table 17. Chemical Properties of Maize From Argentine and United States Origins, by Percent[a]

Origin	Sample no.[b]	Moisture	Fat	Fiber	Ash	Protein	NFE[c]
Argentine farm	1	11.01	5.41	1.75	1.67	9.05	82.12
	2	11.28	5.48	1.93	1.68	8.65	82.27
	3	14.23	5.04	2.03	1.75	8.65	82.53
	4	13.54	4.96	1.86	1.58	11.15	80.44
	5	13.16	6.30	1.84	1.68	11.09	79.09
	6	12.60	5.77	1.81	1.52	11.74	79.16
	7	13.60	4.76	2.09	1.55	10.22	81.38
	8	12.60	5.33	1.84	1.65	11.45	79.72
Argentine elevator	9	16.87	5.28	2.01	1.54	10.65	80.52
	10	14.22	6.17	1.75	1.52	10.55	80.02
	11	14.43	6.01	1.87	1.45	10.37	80.31
	12	15.81	5.59	1.91	1.52	10.74	80.24
	13	12.56	4.96	2.06	1.51	10.14	81.32
	14	14.77	5.48	1.95	1.55	10.72	80.30
Argentine export elevator	15	12.53	5.75	1.97	1.44	9.61	81.23
	16	12.54	5.18	1.94	1.37	9.25	82.25
	17	13.06	5.27	2.02	1.51	9.62	81.59
U.S. processor	18	14.41	3.60	2.09	1.34	8.95	84.02
	19	14.00	4.42	2.00	1.43	8.48	83.67
	20	13.95	4.96	1.85	1.48	9.05	82.66
U.S. exporter	21	12.67	6.11	1.60	1.55	10.05	80.68

[a] Samples were analyzed by Analytical Bio-Chemistry Laboratories, Missouri. All analyses are on a dry matter basis.
[b] Samples 1 to 8 were from Argentine farms. Samples 9 to 14 were from Argentine elevators during 1983 harvest. Samples 15 to 17 were from Argentine export elevators. Samples 18 to 20 were randomly selected from truck deliveries at an Illinois processing plant during 1983 and 1984. Sample 21 was a composite obtained by diverter sampler at a U.S. export elevator.
[c] Nitrogen free extract.

Table 18. Chemical Analysis of U.S. and Argentine Composite Samples

Characteristic	Argentine field samples (No. 1)	Argentine field samples (No. 2)	Argentine composite, export house (No. 3)	Illinois composite, mill receipts (No. 4)
Moisture, %[a]	12.60	11.28	12.67	13.95
Fat, %	5.77	5.48	6.11	4.96
Fiber, %	1.81	1.93	1.60	1.85
Protein, %	11.74	8.65	10.05	9.05
Ash, %	1.52	1.68	1.55	1.48
NFE, %[b]	79.16	82.27	80.68	82.66

[a] All data have been converted to a percent of dry matter in the sample.
[b] NFE = nitrogen free extract.