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# Corn-based Food Production in South Dakota: A Preliminary Feasibility Study

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# Corn-Based Food Production in South Dakota:
## A Preliminary Feasibility Study

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# 1. Corn food market: executive summary

Agriculture is evolving from an industry based on producing commodities to one focused on producing and marketing intermediate and finished products. It has become increasingly important to conduct thorough market analyses to identify potentially profitable value added ventures. This preliminary feasibility study is one component of a multi-disciplinary research effort assessing the market potential of specialty corn products produced in South Dakota.

This preliminary feasibility study was based on three objectives:
1. define the product market for white and yellow corn flour,
2. identify underserved geographic locations and demographic groups in the U.S., and
3. assess the growth potential of these markets.

To identify what might become a viable market stragegy, we analyzed customers, competitors, exterior influences, and general conditions affecting U.S. and international food corn markets. We also examined opportunities and threats within the food corn markets.

## Key findings of the study

1. U.S. consumption of corn flour has increased by 150% since 1970. This growth rate is five times that of wheat flour consumption. Growth in the demand for corn flour is credited to increased consumption of several types of foods, particularly “Mexican” foods such as tortillas, tortilla chips, and corn chips.

2. White corn is preferred to yellow corn for producing tortillas, tortilla chips, and corn chips. If growth in corn food products continues to be tied to “Mexican” food products, some of the acres currently planted to yellow corn or other crops may be shifted to white corn production over time.

3. In recent years, white corn price premiums have declined as the white corn industry matured and supplies increased to meet demand. Price premiums currently range between $0.10 and $0.25 per bushel relative to the cash price for yellow corn.

4. Crop producer access to white corn marketing contracts is increasingly important in light of reduced price premiums.

5. The U.S. may attain some domestic growth in food corn markets, mainly due to a young and growing U.S. Hispanic population and family-friendly immigration policies. Culturally diverse employees and bilingual product labeling may be crucial to serving these Hispanic customers. New corn food product introductions will face strong advertising competition in the highly competitive Hispanic market.

6. The sustainability of growth in U.S. corn flour markets is dependent upon continued growth in the U.S. Hispanic (including Mexican) population, as well as continued acceptance of "Mexican" foods among people of non-Hispanic backgrounds.

7. "Mexican" foods made from white corn flour are well placed to meet the increasing demand for convenience among U.S. consumers, both at the retail and food service levels. Large flour producers are best positioned to grow with the processed tortilla industry.

8. If the domestic demand for these corn food products increases or if international demand for corn becomes more consistent, additional domestic processing facilities will be needed to support the increased production. Failure to invest in such infrastructure would result in increased corn processing outside the U.S. Mexico is one international processing competitor that may benefit from its close proximity to the U.S. regions (West, South, and Southwest) projected to have the largest increases in demand for corn flour and corn food products. U.S. foreign direct investment in Mexican corn chip and corn milling industries has further positioned these companies to meet any increases in demand.

9. White corn producers without direct access to domestic milling facilities must depend on the highly variable export market. Variations in the volume of white corn traded occur mainly because of Mexico's desire to protect its domestic white corn producers and on intense competition from South Africa. Recurring crop failures in South Africa have provided intermittent opportunities for the U.S. to market white corn to consumers in South Africa.

The improved agronomic performance of white corn varieties indicates that at the production level, white corn produced in South Dakota is increasingly competitive with yellow corn varieties. In addition, increased demand for corn food products by both Hispanic and non-Hispanic segments of the U.S. population suggests that the domestic markets for food products made from white and yellow corns will continue to grow in the foreseeable future. Despite these opportunities, the analyses presented in this report also indicate that white corn price premiums have declined in recent years and international market conditions and opportunities continue to fluctuate.

The combination of these factors suggests that, on the one hand, to begin white corn production appears to have become less lucrative in recent years. On the other hand, there may be financially rewarding opportunities for entering or investing in the white corn processing market. We provide a cautiously optimistic assessment of potential opportunities that may be available to South Dakota corn producers willing to organize to further investigate the feasibility of processing and marketing white corn products.

# 2. Corn food market: introduction

As agriculture evolves from an industry based on producing commodities to one focused on producing and marketing intermediate and finished products, it is increasingly important to conduct thorough market analyses for identifying potentially profitable value-added ventures.

## Research goals, objectives, and methodology

This was a preliminary economic feasibility study on developing and operating a corn dry milling facility in South Dakota that would process and market corn products destined for human consumption. We addressed three objectives:

1. define the product market for white and yellow corn flour,
2. identify underserved geographic locations and demographic groups in the U.S., and
3. assess the growth potential of these markets.

The resulting market analysis is a preliminary assessment of the economic viability of this investment and addresses whether the identified markets are of sufficient size to warrant further analysis. Ultimately, this research will assist South Dakota corn producers in deciding whether investing in a corn milling facility in South Dakota is financially viable. Results will also help regional, state, and local policy makers in considering value-added agriculture investment options.

Kraenzel (1998) utilized a two-stage Strategic Market Management System methodology for conducting market analyses (Fig 1). The initial stage, referred to as an external approach, considers customers, competitors, markets, outside influences, new opportunities, and strategies in conducting comprehensive market analyses. The second stage is an internal approach and examines commonly used firm and industry-level financial and economic performance measures.

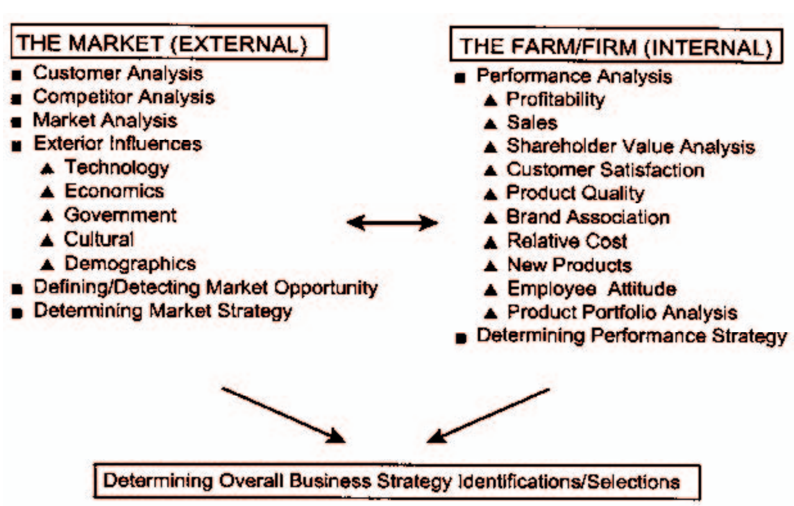



Figure 1. Strategic market management system of analysis. *Source: Kraenzel 1998*

For this study, we use the external approach to analyze customers, competitors, exterior influences, and general conditions within the corn food product market, including a summary of research findings pertaining to corn food markets as of May 2004. We also identify opportunities and threats associated with external influences on corn food markets.

An internal Strategic Market Management System analysis would examine profitability considerations internal to a firm. Should a full-scale feasibility study be deemed justified based on the findings of this preliminary feasibility study and related research, it may be advisable to complete an internal analysis at a later time.

## Corn usage trends

Corn is the leading U.S. field crop, based on both acreage and value of production measures (Boland et al. 1999). According to the U.S. Feed Grains Council 2000-2001 Value-Enhanced Grains Quality Report, seven states (Illinois, Indiana, Iowa, Minnesota, Missouri, Nebraska, and Ohio) typically provide over 70% of domestically produced corn and are the source of over 80% of all U.S. corn exports.

In the U.S., animals consume most of the commodity corn as feed. However, U.S.-produced commodity corn also is used for a variety of other purposes, including seed, industrial uses (fuels, adhesives, plastics, insulation, plywood, particle board), and for human consumption (sweetener, grits, meal, flour, oil). Figure 2 displays the various uses of U.S. corn, including exports, for 2002.

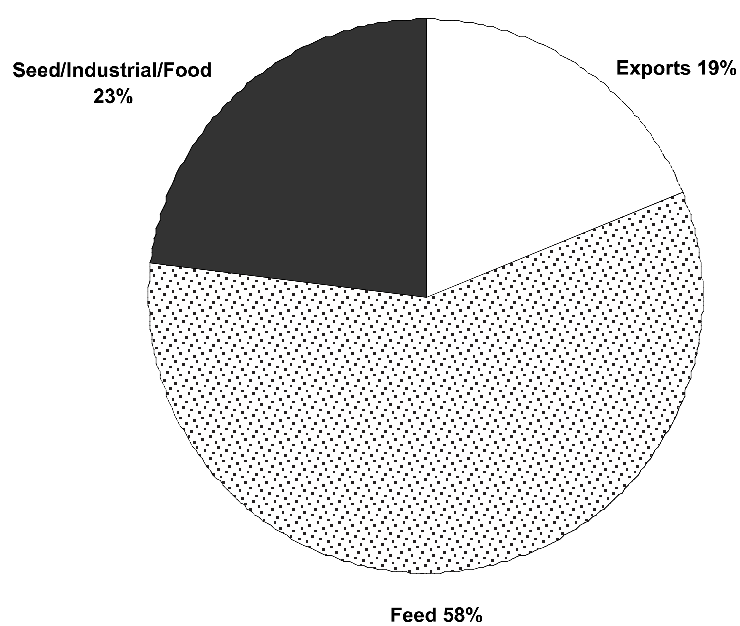



Fig 2. U.S. corn crop by end use (in percent of total usage, 2002).
*Source: USDA Economic Research Service 2003.*

While total use remains dominated by commodity corn, the demand for heterogeneous corn varieties has gained momentum over the last 2 to 3 decades.

The demand for differentiated corn has largely developed because processors and consumers seek varieties with specific traits or quality levels (Boland et al. 1999), resulting in the development of products with value-enhanced characteristics that emphasize compositional traits and segregated marketing practices. For example, major corn breeding efforts have emphasized high oil contents, high levels of amylopectin starch, and white color. Other varieties have been bred to withstand kernel damage during harvesting and handling or to grow in an organic agriculture setting or under pesticide-free conditions (USDA, Foreign Agricultural Service 1999).

Commodity corn has traditionally been marketed in large volumes, necessitating commingling of corn from different farms and geographical origins for storage and during rail and barge transportation. In contrast, value-enhanced corn production, processing, and marketing involve segregated harvest, storage, transport, and marketing practices. As a result, value-enhanced corn production is relatively resource (or capital) intensive for farmers, elevators, transporters, and processors in terms of storage bins, containers for shipment, cleaning processes, and other procedures needed to keep distinct varieties separate.

Due to the increased costs associated with product segregation, the production of value-enhanced corn can only be successful in the presence of significant price premiums to serve as compensation for these additional costs. Price premiums also have the potential to improve profit margins and stimulate interest among agricultural producers and seed companies in providing differentiated products to various end users.

The move away from a commodity orientation to an agriculture involving value-added products has prompted an increased awareness among growers to be mindful of end-user specifications. One way for producers to respond to end-user demands is to produce and market specialized varieties, such as those having increased oil or starch components, as well as varieties with increased processing efficiency (Boland et al. 1999).

Growers base their decision to adopt value-enhanced corn on expected net returns from growing these varieties, relative to those achieved from growing commodity corn and competing crops. Corn varieties valued for specific quality traits, such as those suitable for masa or tortilla production, and varieties lacking quality imperfections, including undesired colors or improper milling densities, are most likely to be adopted among corn growers focused on food corn product markets.

## Corn dry milling

Both yellow and white corn varieties are suitable for multiple value-added purposes. For example, yellow corn is used to produce corn food products (corn flour, corn chips, tortilla chips, tortillas, etc.), ethanol fuel, and livestock feed, while white corn is used to produce paper and corn food products. In this preliminary feasibility study, we focus on both white and yellow corn products destined for human consumption.

Quality specifications are used to determine the appropriateness of corn for different end uses. This process is monitored by the U.S. Federal Grain Inspection Service using six different quality grades. The top five grades and their specifications are listed in Table 1. The sixth grade, U.S. sample grade, does not meet the designated requirements of grades one through five and often includes stones, seeds, particles, or other quality imperfections such as an odor.

Table 1. U.S. Federal Grain Inspection Service grades and requirements for corn.
*Source: Rooney and Suhendro 2001.*

| | | *Maximum percent allowed* | | |
|---|---|---|---|---|
| *U.S. grade* | *Minimum test weight/bushel* | *Heat damaged kernels* | *Total damaged kernels* | *Broken corn and/or foreign material* |
| No. 1 | 56 lb | 0.1 | 3.0 | 2.0 |
| No. 2 | 54 lb | 0.2 | 5.0 | 3.0 |
| No. 3 | 52 lb | 0.5 | 7.0 | 4.0 |
| No. 4 | 49 lb | 1.0 | 10.0 | 5.0 |
| No. 5 | 46 lb | 3.0 | 15.0 | 7.0 |

At a minimum, food corn generally meets the requirements of U.S. No. 1 Grade, yellow or white dent corn (Rooney and Suhendro 2001). The end use largely determines whether additional quality provisions must be met. For example, provisions pertaining to color, moisture content, stress cracks, or density are often required in order to ensure processing efficiency.

The internationally accepted minimal quality standard of white corn is U.S. No. 2 or better. An increasing number of countries favor U.S. No. 1 corn. Generally, the moisture content is between 14% and 14.5%. Stress cracks are restricted to between 10% and 15%. The least negotiable quality standard pertains to aflatoxin requirements, which must not exceed 20 parts per billion (Boland et al. 2002). Additional conditions, such as organic production, may be driven by consumer demands.

The recent emergence of dry mill ethanol production in South Dakota has highlighted a need to consider further possibilities for adding value to co-products of the ethanol production process. Because of similarities among dry mill ethanol production and corn dry milling for human consumption, in this preliminary market study we will only consider corn that can be processed by dry milling.

Corn also may be processed by wet milling. Dry milling is credited with processing 70-75% of U.S. corn; the remaining 25-30% of U.S. corn destined for human consumption is processed by wet milling. Each process generates its own unique co-products (Davis 2001).

The North American Millers' Association (2004) describes corn dry milling as one of three alternative processes: 1) the tempering degerming process, 2) the stone-ground process, and 3) the alkaline-cooked process.

The tempering degerming process is the most common. Fine corn kernels and broken corn kernels are separated from whole kernels. Dirt and dust are removed using a wet cleaning process. Once the corn has been cleaned and has a moisture content of 20%, the outer parts of the corn kernels (pericarp, germ, and tip cap) are removed to access the endosperm. The endosperm is then degermed, dried, cooled, and sifted. Additional separation, roller, and degermination processes are used to create products with varying textures ranging from coarse to fine.

The second process, known as the stone-ground or nondegerming process, leaves nearly whole ground corn in the food products. This crude process removes some, but not all, of the hull and germ.

The third type of corn dry milling is the alkaline-cooked process. This process involves cooking the corn in a boiling lime solution for 5 to 50 minutes, steeping the corn for 2 to 12 hours, and then washing the alkali and loose pericarp off the corn. Finally, the corn product is ground into masa flour (North American Millers' Association 2004).

Figure 3 summarizes the production of masa corn flour and related corn products.

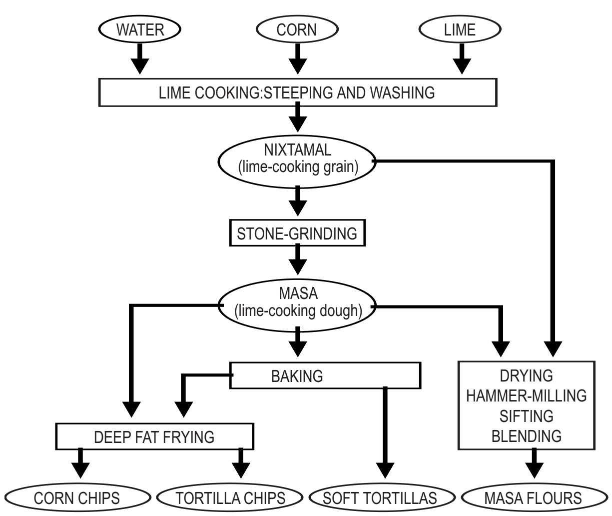



Figure 3. Flow chart, corn masa production and resultant products.

*Source: Serna-Saldivar et al. 2001.*

### Food and feed products of corn dry milling

Various products for both human and animal consumption are produced from corn dry milling. For example, human-grade corn can be processed into grits, meal, flour, oil, and hominy. Much of the information provided in this section was taken from the North American Millers' Association (2004).

Grits are the coarsest product from the corn dry milling process. Grits vary in texture and are generally used in corn flakes, breakfast cereals, and snack foods. Brewers' grits are used in the beer manufacturing process.

Corn meal is an ingredient in several products including cornbread, muffins, fritters, cereals, bakery mixes, pancake mixes, and snacks. The finest grade corn meal is often used to coat English muffins and pizzas. Regular corn meal, soy fortified corn meal, and a corn-soy blend are included as protein and caloric sources in products used for international food aid programs outlined in Public Law 480.

Corn flour is one of the finest textured corn products generated in the dry milling process. Some of the products containing corn flour include mixes for pancakes, muffins, doughnuts, breadings, and batters, as well as baby foods, meat products, cereals, and some fermented products. Masa flour is another finely textured corn product. It is produced using the alkaline-cooked process. A related product, masa dough, can be made using corn flour and water. Masa flour and masa dough are used in the production of taco shells, corn chips, and tortillas.

Crude corn oil is another product which can be expelled or hexane-extracted from the germ. This product must be further refined before it can be classified as an edible oil.

Hominy feed, an inexpensive source of calories and fiber for animals, consists of the byproducts, including germ cake, bran, broken corn, and other products of the corn dry milling process.

### Summary

We specifically analyze the production and processing of human-grade white and yellow corn into flour and other food products in this preliminary feasibility study. In the next section, we consider trends in yellow and white corn markets. In section 4, we analyze customers, using geographic and demographic characteristics. In section 5, we examine the various types of corn food products and explore their relative importance in corn food markets. In sections 6 and 7, we evaluate market size and growth projections of domestic and international corn food product markets. We conclude this marketing study in section 8 with a list of research findings and recommendations for South Dakota farmers to consider before investing in the corn food processing industry.

## 3. Yellow corn and white corn trends

The milling of yellow and white corns produces grits, meal, flour, and oil for use as ingredients in a variety of foods. While there is a diverse set of end uses of these products, the remainder of this preliminary feasibility study focuses on corn flour and its resultant food products. Such products include mixes (pancakes, muffins, doughnuts, breadings, and batters), baby foods, meat products, cereals, and fermented products, all of which utilize corn flour as a primary ingredient. In addition, taco shells, corn chips, snack foods, and tortillas are particularly dependent upon corn flour as their major ingredient.

Because many consumers perceive white corn to be more pure than yellow corn, white corn is often preferred by processors for certain food products including tortillas, corn chips, and snack foods. Boland et al. (2000) reported tortilla chips and tortilla wraps as the most common products made from white corn in the U.S. Similarly, in Mexico, approximately 95% of white corn produced in that country is converted into corn flour for producing tortillas.

However, as far as the mechanical process is concerned, the majority of the foods produced from corn flour can be made from either yellow or white corn. Additional production, marketing, and processing comparisons between yellow and white corns are discussed in the remainder of this section.

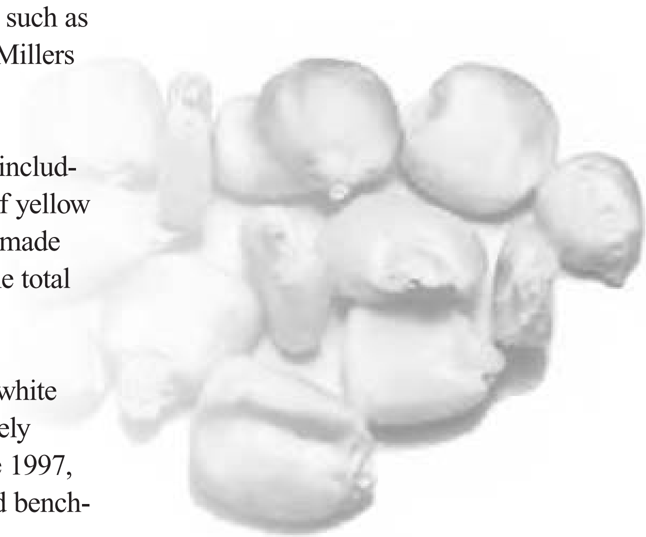
### Production

Historically, there have been tradeoffs between white and yellow corn production and marketing. For example, between 1950 and 1970, white corn lacked the yield competitiveness of yellow corn. Yellow corn production was enhanced disproportionately because more production research was targeted toward improving yellow corn than white corn. As a result, high yielding yellow corn varieties have long dominated the market.

Some industries still rely on white corn as a primary product ingredient. This led to financial support for white corn research by the corn milling industry starting around 1975. More recently, white corn research at institutions such as the University of Tennessee has been supported by the American Corn Millers Federation and the Snack Food Association (Hearon 1998).

**Acres planted.** In 2002, the total area planted to food corn in the U.S. included 900,000 acres of white corn and between 1.2 and 1.5 million acres of yellow corn (Illinois Specialty Farm Products Report 2003). Thus, white corn made up approximately 38-43% and yellow corn approximately 57-63% of the total food corn acres planted in 2002.

The U.S. Feed Grains Council has estimated that domestic demand for white corn is 50 million bushels per year. To satisfy this demand, approximately 400,000 acres of white corn must be planted. Figure 4 shows that since 1997, U.S. white corn acreage has consistently exceeded the domestic demand bench-



mark. White corn price premiums peaked in 1998 and likely induced the noticeable increase in acres of white corn planted in 1999.

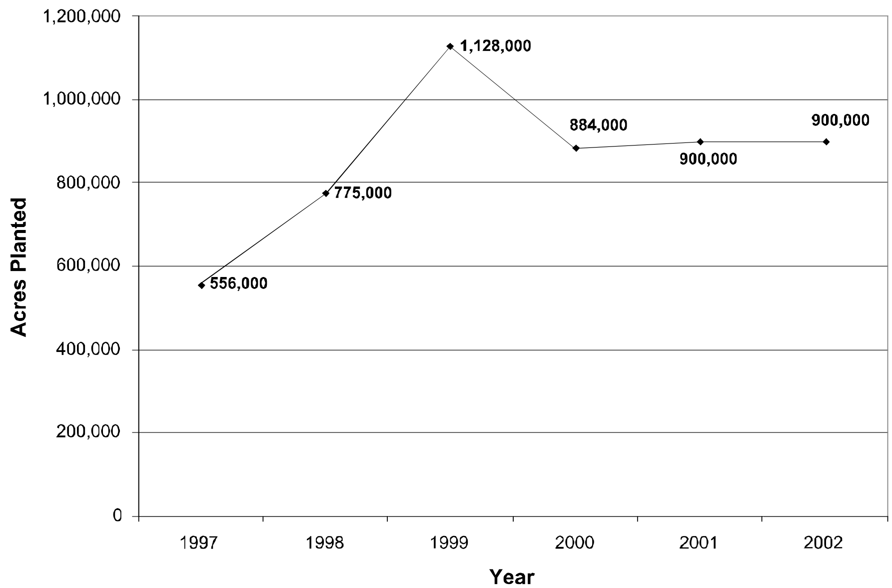



Fig 4. Cropland planted to white corn in the U.S., total acres, 1997-2002.
*Source: Boland et al. 2002.*

The rapid growth in the number of acres planted to white corn in the U.S. during the late 1990s has leveled off since the turn of the century. Hansen (2003) attributes this steady U.S. production pattern to global production variability and saturated domestic processing capacity.

The stable pattern of white corn production in recent years may further suggest that producers are skeptical about finding a consistent market for their product and have adopted somewhat conservative planting behaviors.

Appendix A lists the number of white corn acres harvested by U.S. state and by groups of states from 1997 through 2002. The number of white corn acres harvested in Kentucky, Nebraska, and Texas is disproportionately higher than those of the remaining states and groups of states (Fig 5). Kentucky, Nebraska, and Texas accounted for at least 53% of the total harvested acres in the U.S. for all years between 1997 and 2002.

General white corn production patterns for years 1997-2002 are also displayed in Figure 5. In most states, production increased between 1997 and 1999 and decreased between 1999 and 2000. Between 2000 and 2002, the number of acres planted to white corn generally leveled off for all states except Kentucky, where white corn acres planted increased in both 2000-2001 and 2001-2002.

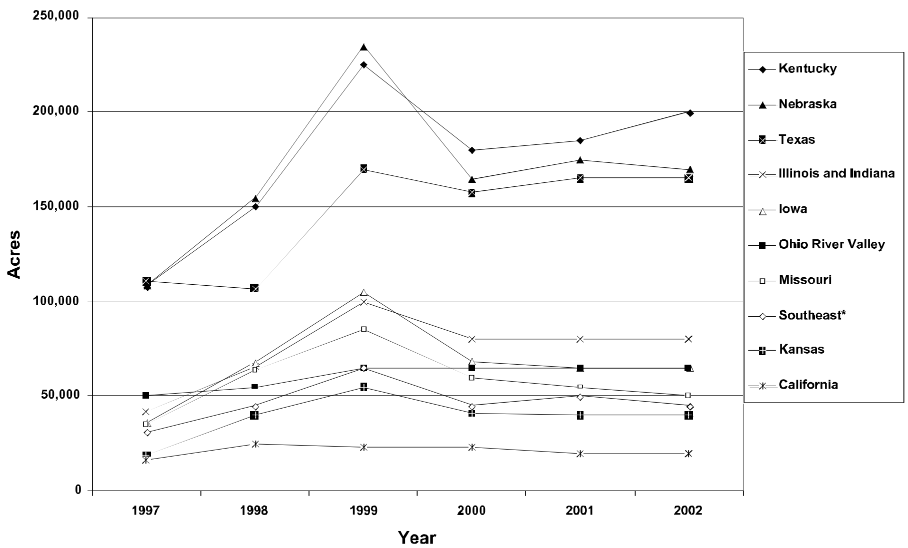



Fig 5. White corn planted in the U.S. by state (acres), 1997-2002. *Source: Boland et al. 2002*.

**Yields**. The number of acres of white corn harvested in the U.S. doubled in the last 20 years, from fewer than 450,000 acres in the 1980-81 period to nearly 900,000 acres in the 2001-02 period (Dahl and Wilson 2002). Over the same time period, yield per acre also increased, resulting in a quadrupling of white corn production in the U.S. from 29 million bushels in 1980-81 to 135 million bushels in 2001-02.

Dahl and Wilson (2002) reported white corn yields were typically lower than those of yellow corn during the 1980s. Improved white corn yields in the 1990s enhanced the competitiveness of white corn relative to yellow corn varieties. According to the U.S. Feed Grains Council, average white corn yields improved from 85-95% of those of yellow corn in the late 1990s to 98% of yellow corn yields in 2000. Among the respondents to the U.S. Feed Grains Council survey, most producers had white corn yields ranging from 90-100% of yellow corn yields, while 18% of producers reported that white corn outperformed yellow corn in terms of yield (U.S. Feed Grains Council 2001).

State-specific and regional information on average yields of white corn in the U.S. was published by Boland et al. (2002), using 1999 production data. The average yields in bushels per acre were 140 for California, 135 for Nebraska, Kansas, Missouri, and Iowa, 133 for Kentucky, the Ohio River Valley, Illinois, and Indiana, 127 for the southeastern part of the U.S., and 122 for Texas. Because some increases in average yield were achieved since 1999, the yields reported here likely underestimate actual current yields. The Illinois Specialty Farm Products Report (2003) estimated U.S. white corn yields at 145 bushels per acre, compared to yellow corn yields of 155 bushels per acre.

**Marketing**

Contracting the production of white corn has risen since 1995. In that year, approximately half of the U.S. white corn crop was grown under contract and the other half was sold on the cash market (Sparks 2003). Currently, the majority of white corn production in the U.S. is produced under contract. In particular, the U.S. Feed Grains Council's 2001/2002 Value Enhanced Grains Quality Report stated that for reporting year 2001-02 approximately 60-65% of white corn was grown under contract. The remainder was sold at cash markets.

Price premiums received by producers of white corn serve as compensation for the relatively high costs of production and costs of preserving the identity of the corn throughout the marketing channel. In addition, contract production may alleviate some of the risks involved with marketing the crop at spot markets.

Figure 6 shows gross price premiums and yields of white corn relative to commodity corn.

The largest price premium ($0.45 per bushel) occurred in 1998 and the lowest ($0.13 per bushel) in the most recent year, 2003. A general downward trend in white corn price premiums was compensated by an upward trend in white corn yields since 1995. These diverging paths were particularly pronounced since 1999 and may be attributed to the increasing yield consistency of white corn.

While Figure 6 is helpful in describing white corn price premiums, it suggests the need for a yield-adjusted price premium comparison over the time period. Figure 7 displays the yield adjusted price premiums from 1995 to 2003 as determined by the U.S. Feed Grains Council.

White corn price premiums, when adjusted for yield, have generally declined since 1998. The declining premiums suggest that white corn markets are maturing and coming to resemble a commodity market structure with relatively small profit margins.

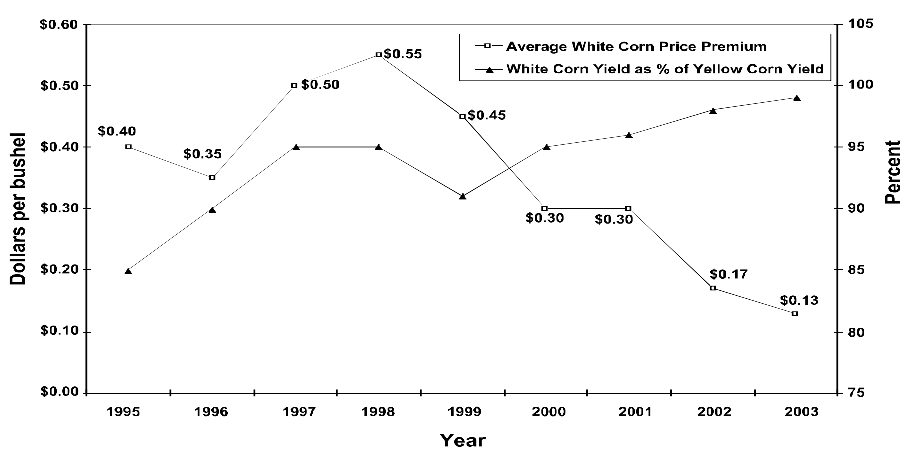



Figure 6. Domestic white corn price premiums and relative yields, 1995-2003.
*Source: U.S. Feed Grains Council Value-Enhanced Grains Quality Reports 2000-2002.*

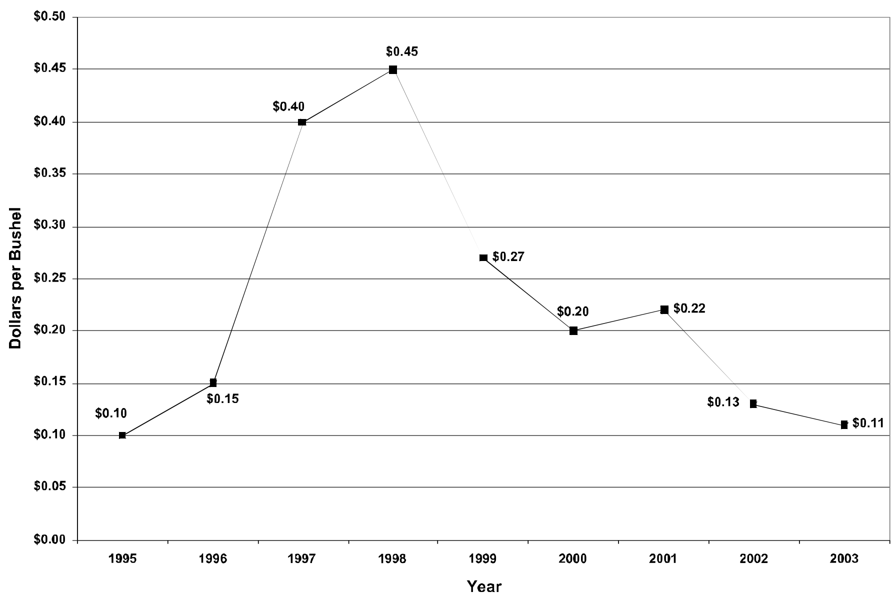



Figure 7. Yield adjusted price premiums for white corn, 1995-2003.
*Source: U.S. Feed Grains Council Value-Enhanced Grains Quality Reports 2000-2002.*

## Processing

The physical characteristics of white corn are similar to those of other types of corn suitable for human consumption. Its distinguishing characteristic is its color, which is also considered its value-enhancing trait. Because white corn is generally used in food production, purity in terms of the corn's color is considered extremely important by processors. Processors also prefer white corn varieties with attributes that ensure processing efficiency such as large, uniform kernels and high specific gravity (Boland et al. 2000).* In general, white and yellow corns have similar processing efficiencies.

Current milling capacity in the U.S. is close to 100% (Boland et al. 2000). Therefore, production above current levels would require opening new domestic milling facilities or processing additional grain abroad. Boland et al. (2000) reported that access to milling facilities is a determinant in whether white corn is processed domestically or internationally. Because contracts between producers and processors are common in the white corn market, major dry milling plants are generally located in areas where white corn production is most concentrated. Western Nebraska, eastern Illinois, central California, Texas, Oklahoma, southern Indiana, and Kentucky have dry milling facilities. Corn produced in other locations, however, is commonly exported and processed abroad.

* Specific gravity is the density of a substance in comparison to that of water. Because it is expressed without units, specific gravity is the same in all measurement systems. For example, if an object is two times as heavy as an equal volume of water, its specific gravity is two. Its density is two grams per cubic centimeter, or two kilograms per liter, or two metric tons per cubic meter.

### Summary

In this section, we have described the emergence of yellow and white corn in food corn markets. The increase in yellow corn production is largely attributed to research funds allocated to improve the agronomic traits of yellow corn. In spite of the lack of funds to improve yields and other agronomic traits, the competitiveness of white corn has increased over time. In 2002, white food corn acres totaled 900,000 compared to 1.2 to 1.5 million acres of yellow food corn.

One explanation for the narrowing of the production gap between white and yellow food corns is the narrowing of the yield gap in the U.S. to 145 bushels per acre for white corn compared to 155 bushels per acre for yellow corn. Yield adjusted price premiums have declined in recent years in this maturing market dominated by contract production.

Nearly 60% of U.S. white corn production acres are located in Kentucky, Nebraska, and Texas. Over 70% of U.S. corn dry milling is located in Illinois, Texas, Indiana, North Carolina, Nebraska, Kansas, and Kentucky. In general, both white corn production and processing are taking place in the Midwest and Texas. Additional white corn production and processing are taking place in states in the northeastern and southeastern regions of the U.S.

## 4. Corn food market: customer analysis

White corn flour has become increasingly popular in the U.S. as an ingredient in various food products such as tortillas, not only among people with Hispanic backgrounds but also among the U.S. population at large.

Tortillas are a staple food in the diets of many individuals of Hispanic descent. Thus, a large portion of the growth in the domestic demand for tortillas and white corn is directly attributable to the rapid rise in the segment of the U.S. population of Hispanic origin (Hispanics were the fastest growing ethnic minority in the U.S. over the 10-year period from 1990 to 2000).

Many people of non-Hispanic origin consume tortillas as “roll-up” style sandwiches and desserts. In fact, the continued popularity of specialty breads, bagels, English muffins, and pitas may have delayed an even greater shift toward white corn based products among people of non-Hispanic descent.

In this section, we discuss changes in the demographic make-up of the U.S. in general and by region, particularly in relation to the consumption of white corn products. Examining demographic data is essential in conducting a thorough market analysis for value-enhanced corn varieties and corns with specific processing traits such as white corn.

### Demographic trends

Sparks (2003) identified 21st century consumers as unique when compared to past generations, in that no single factor can be identified that fully explains the changes in what, where, when, and how modern-day consumers eat. The “what” factor holds that consumers have diverse tastes and preferences and increasingly adopt ethnic-style foods. It is difficult to estimate “where” the 21st century consumer will eat his or her meals, with today’s consumers dividing their food budget between home (52.5%) and away from home (47.5%) (Sparks 2003). The increased number of women in the workforce and ample recreational activities have limited “when” meal preparation occurs. These combined factors translate into “how” the 21st century consumer eats.

In short, consumers prefer variety in their food, but desire minimal preparation or serving time to accommodate busy lifestyles.

Beyond identifying 21st century consumers, it is useful to quantify factors driving changes in the demand for specific products. Growth in the tortilla industry, for example, is related to several factors. Kohn (2004) identified an increasing Hispanic population as the most powerful influence and credited this ethnic group with 54% of the tortilla industry growth in 2002. According to the same source, the growing popularity of tortillas among the non-Hispanic population represented 36% of the industry’s growth; the remaining growth was attributed to increased institutional use of tortillas.

Product demands of the twenty-first century North American consumer are clearly conveyed to the food industry. Sparks (2003) reported that these demands are articulated through trends in economic prosperity, demographics, and information access. In the remainder of this section, we examine each of these forces in the context of the demand for corn food products.

**Economic prosperity.** Increased hours of employment and a higher incidence of women in the workplace have contributed to economic prosperity and shifts in food selections among U.S. consumers. Sparks (2003) described today's consumer as "money rich" and "time poor." Consequently, most consumers demand foods that require limited preparation and consumption time. Consumers are particularly drawn to versatile foods which complement a variety of existing food selections. Tortillas, for example, are used for traditional "Mexican" foods and as wraps for deli sandwiches and desserts.

Besides changes in the types of food eaten at home, consumers are also consuming more meals away from home. Projections for 2010 suggest that expenditures on food away from home will be 49% of the food budget, up from 26% in 1970 (Sparks 2003). As a result, the food service industry has been the fastest growing part of the five main segments of the food and fiber sector in recent years. (The other four segments are the farm input industry, farming, processing, and distribution.) Clearly, long-term competitiveness in the corn food product industry is dependent on penetrating the food service sector in addition to the retail sector.

**Demographic changes.** One way to analyze demographic data is by age group. An analysis of age group-specific trends offers valuable insights on food product consumption dynamics.

It is widely known that U.S. and Canadian populations are aging. To illustrate this phenomenon, the age group of individuals of 45 years and over is projected to capture over 90% of the population growth between 2000 and 2010, while the age group consisting of individuals younger than 45 years will only be responsible for the remaining less than 10% of the overall population growth during the decade (Sparks 2003).

The Bureau of Labor Statistics study of consumer expenditures in 2002 recognized the "above average" food spending habits of people in the 25-34, 35-44, 45-54, and 55-64 age groups. That is, individuals in these age groups spent more money on food than the U.S. average per capita consumption expenditure level. In addition, the study revealed that individuals under age 25 spent more of their food budgets away from home than did individuals in any other age bracket. Individuals aged 65 and over spent more of their food budgets at home than individuals in any other age group (U.S. Bureau of Labor Statistics 2004).

These figures suggest that retail food products should accommodate the lifestyles and nutritional needs of older populations while food service products should be targeted to younger populations. Above average food expenditures of individuals ages 25-64 highlight the potential for success in both retail and food service outlets.

Clearly, there are opportunities for targeting young consumers. For example, the 10-19 year old age group numbers 40 million in the U.S. and spends over $85 billion per year (Sparks 2003). Sparks further reported that the Rand Youth Poll projects at least a 4% annual growth in this group's spending through 2005.

In addition to dividing the overall population by age group, separating the population along gender lines provides further insights into consumer spending behavior. Grain-based food product marketers tend to target females in particular, regardless of age. Schroeder (2001b) attributed gender-based marketing efforts to the unique nutritional needs of women and their heightened interest in nutrition.

Schroeder (2001b) also reported that grain-based food marketing efforts target Hispanics, due to recent growth trends of this segment of the U.S. population. Between the 1990 and 2000 U.S. censuses, for example, the U.S. Hispanic population increased by 57.9% to 35.3 million people. During this same time, the U.S. population, as a whole, grew by only 13.2%.

Schroeder (2001b) further reported that among people of Hispanic origin, the number of people of Mexican descent grew by 52.9%, those with Puerto Rican roots rose by 24.9%, the number of people of Cuban descent increased by 18.9%, and the number of "other" Hispanic (those originating from Central and South America or the Dominican Republic) soared 96.9% over the 10-year period from 1990 to 2000.

The diversity within the Hispanic market suggests that a wide variety of products are needed to satisfy the unique tastes and traditions of Mexicans, Puerto Ricans, Cubans, and other Hispanics. Schroeder (2001a) also noted that employees with language and cultural ties may ultimately be needed to successfully penetrate the Hispanic food market.

The U.S. Census Bureau's 2000 growth projections for the U.S. population for the year 2020 range from 304 to 355 million people. The high estimate implies a compound population growth rate of approximately 1.25% over the next 2 decades. Consequently, annual food product sales driven solely by general population growth are expected to experience very modest increases over this time period.

While the U.S. population as a whole is not projected to increase dramatically, individual segments of the population are expected to undergo considerable growth. Past and projected future changes of the shares of individual subpopulations within the general U.S. population are pictured in Figure 8 for 2000, 2020, and 2040.

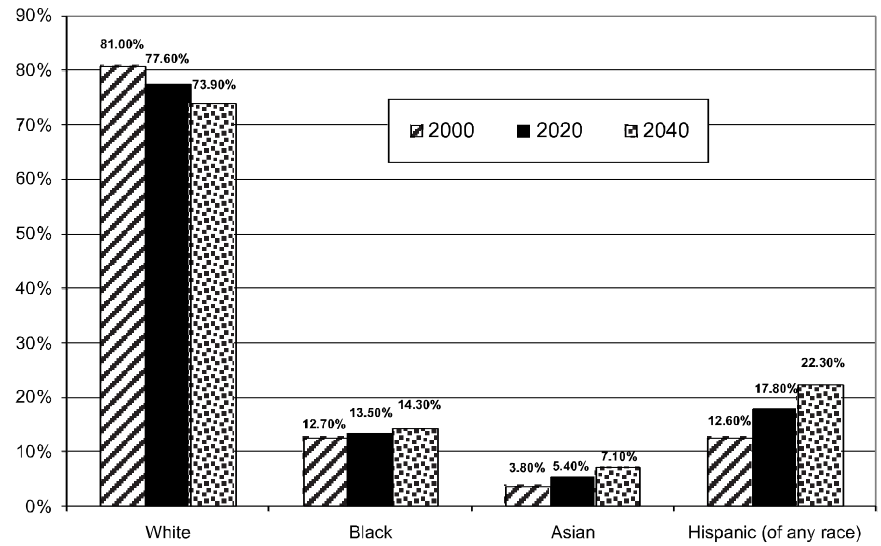



Fig 8. U.S. population composition in 2000 and projections for 2020 and 2040.
*Source: U.S. Census Bureau 2004.*

The projection is for little change in the Black and Asian shares but a dramatic increase in the number of Hispanics and a large decrease in the number of whites as shares of the total population between 2000, 2020, and 2040. The Hispanic population is projected to increase by nearly 1.3 million people annually through 2040 (U.S. Census Bureau 2004).

Demographic trends identify the U.S. Hispanic population as a young and growing population. The average age of Hispanics is 26.5 years, compared to 38.1 years for non-Hispanic whites. Consequently, growth occurs because a large portion of the Hispanic population is still in the child bearing years. Immigration further increases the U.S. Hispanic population.

The Specialty Food Distributors and Manufacturers Association projected that the Hispanic segment of the U.S. population will be responsible for a projected growth in food sales of 6.5% per year between 2000 and 2050. This will further broaden the food spending gap between Hispanics ($102 per week) and non-Hispanics ($85 per week) (Schroeder 2001a). Thus, based on their strong food spending habits and the prevalence of corn food products in their diets, Hispanics are an influential group in the corn food product market.

**Information access.** Sparks (2003) identified information access as a powerful link between consumers and the food industry. Consumers rely on many sources of product information including, but not limited to, television, the Internet, other consumers, and product labels. The diversity among corn product consumers suggests that culturally diverse employees and bilingual product labeling may be crucial to penetrating the portion of food markets made up of Hispanic consumers in particular (Schroeder 2001a).

The Specialty Food Distributors and Manufacturers Association recognizes Hispanics as brand-loyal customers (Schroeder 2001a). The Association has targeted Hispanics by informing this segment of the population about specific products through product introductions and advertising.

The importance of the Hispanic food markets has also been recognized by grain-based food companies, eight of which (Kraft Foods, Inc., The Quaker Oats Co., Gruma Corp., Nestlé, Kellogg Co., Nabisco, Inc., Bestfoods, and The Pillsbury Co.) were among the top 50 advertisers in the Hispanic market. Jointly, these grain-based companies spent over $65 million on attracting Hispanic consumers in 2001. It is evident that new corn food product introductions will face strong advertising competition in the Hispanic market.

## Geographic trends

Household spending on grain-based foods is estimated to be 10% higher among Hispanics than among those not of Hispanic ancestry (Tortilla Industry Association 2001). As a means of identifying important geographic corn product demand centers, the 10 largest U.S. cities in terms of total population and Hispanic population are listed in Table 2.

Table 2. Total and Hispanic populations of major U.S. urban centers, 2000.

| | *Total population* | | *Hispanic population* | | *Percent Hispanic* |
|---|---|---|---|---|---|
| *City* | *Number* | *Rank* | *Number* | *Rank* | *of total population* |
| New York, N.Y. | 8,008,278 | 1 | 2,160,554 | 1 | 27.0 |
| Los Angeles, Calif. | 3,694,820 | 2 | 1,719,073 | 2 | 46.5 |
| Chicago, Ill. | 2,896,016 | 3 | 753,644 | 3 | 26.0 |
| Houston, Texas | 1,953,631 | 4 | 730,865 | 4 | 37.4 |
| Philadelphia, Pa. | 1,517,550 | 5 | 128,928 | 24 | 8.5 |
| Phoenix, Ariz. | 1,321,045 | 6 | 449,972 | 6 | 34.1 |
| San Diego, Calif. | 1,223,400 | 7 | 310,752 | 9 | 25.4 |
| Dallas, Texas | 1,188,580 | 8 | 422,587 | 8 | 35.6 |
| San Antonio, Texas | 1,144,646 | 9 | 671,394 | 5 | 58.7 |
| Detroit, Mich. | 951,270 | 10 | 47,167 | 72 | 5.0 |
| San Jose, Calif. | 894,943 | 11 | 269,989 | 10 | 30.2 |
| El Paso, Texas | 563,662 | 23 | 431,875 | 7 | 76.6 |

*Source: Tortilla Industry Association 2001.*

Eight of the 10 largest cities in the U.S. were also among the 10 largest Hispanic population centers, with Hispanics representing more than one-fourth of the population. Schroeder (2001a) reported that California and Texas accounted for approximately half of the total U.S. Hispanic population in 2000—31.1% of the population in California and 18.9% of the population in Texas in 2000.

## Summary

We described important consumer-related conditions in the food and food service industries. One of the most noticeable changes was the increased adoption of ethnic foods among the general consumer population. In addition to variety, consumers prefer convenience foods which require limited time for preparation and consumption. Accordingly, attention to changing consumer demands is vital to both new product introductions and to the longevity of existing products.

Specific subpopulations that are particularly influential in corn food product markets were also identified. The U.S. Hispanic subpopulation, for example, constitutes a young and growing group, consuming diets rich in corn. In addition, Hispanics spend more money on food each week than non-Hispanics ($102 compared to $85).

Large Hispanic populations are generally located within large population centers as evidenced by the fact that eight of the 10 largest cities in the U.S. were also among the 10 largest Hispanic population centers. On a related note, nearly half of the U.S. Hispanic population in 2000 lived in California or Texas. The location of the U.S. Hispanic population directly impacts current regional demand and indicates areas of above average corn food product demand in the future.

# 5. Corn food market: product analysis

In this section, we describe trends in the production and processing of corn and corn food products.

## Production

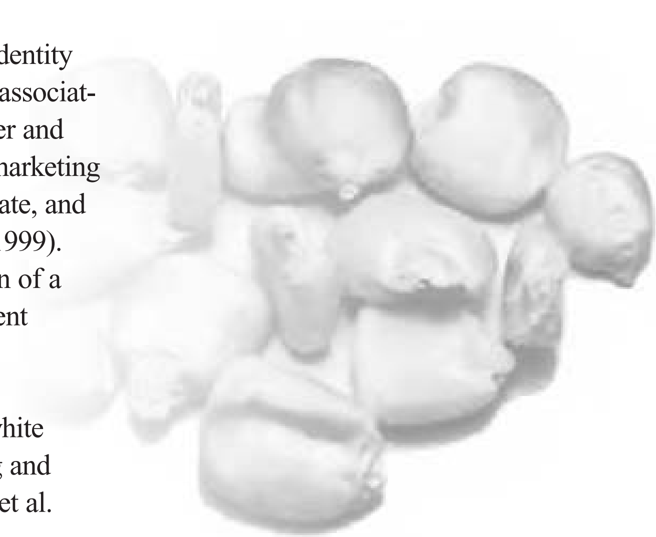
The U.S. supply of traditional "Mexican" food products (tortillas and corn chips) is largely dependent upon white corn production. White corn varieties represent 80% of the corn used in these products, and the remaining 20% consists of yellow corn varieties. Nevertheless, only about 1% of the 9.5 billion bushels of corn produced each year in the U.S. is white corn (Sparks 2003).

White corn is the limiting ingredient in corn products destined for direct human consumption. Therefore, in this section and throughout this report, we specifically emphasize the supply of white corn. Factors influencing the supply of white corn include input costs, technology, production subsidies, and price expectations.

**Input costs**. The most important input costs associated with value-enhanced corn over and above those involved with conventional corn production are directly tied to preserving the identity of the crop during harvest, storage, handling, processing, and transportation. Additional costs are those associated with the seed of specific value-enhanced corn varieties, which are generally high in comparison to those of traditional commodity lines. Riley and Hoffman (1999) pointed out that even in the absence of seed cost differences between commodity corn and value-enhanced corn, the supply of the latter is constrained by time and financial resources involved with cleaning harvest equipment between different uses, costs involved with providing distinct storage space, and costs associated with establishing marketing or production contracts.

Identity preservation requires very stringent handling procedures. Crops must be isolated at all stages, including in the field, during on-farm and elevator storage, and during shipment to the end user.

Segregating crops is less stringent and less costly than preserving the identity of crops from plow to plate, but both procedures have additional costs associated with isolated handling facilities or technology for quality testing over and above those involved with commodity corn. The costs involved with marketing value-enhanced crops depend greatly on the availability of rapid, accurate, and inexpensive tests to verify or quantify the value-added trait (Dunahay 1999). Further, both the ability of the food system to ascertain the preservation of a crop's identity and the successful segregation of crops require transparent regulatory oversight.



**Technology**. Producer adoption and, therefore, the overall supply of white corn, depends directly on the availability of technologies for evaluating and improving the agronomic performance of white corn varieties. Wicks et al.

(1988) evaluated 75 white corn hybrids in terms of their yield, moisture, and agronomic characteristics. One-third of the hybrids evaluated in 1986 and 1987 were acceptable with respect to these characteristics, but only one of the 75 varieties (SD62xSD65) was further identified as being of average milling quality by The Quaker Oats Company.

South Dakota's climate requires early white corn varieties which can reach maturity and have sufficient kernel drydown time before the onset of a hard freeze. Researchers at South Dakota State University have continued to investigate the performance of early white corn varieties in South Dakota as part of the Early White Food Corn Performance Test (EWFCPT) project coordinated by Larry L. Darrah of the USDA-ARS at the University of Missouri in Columbia, MO. Performance results as reported by Beauzay and Wicks (1999 and 2001) are included as Appendices B and C.

In general, the 1999 and 2001 results show that early varieties are becoming more competitive with yellow corn in terms of yields and days to relative maturity. Existing hybrid success and continued corn breeding improvements favor development of a dry milling facility or whole kernel processing facility in South Dakota (Beauzay and Wicks 2001).

In the future, technology may also prove useful in reducing producer costs associated with identity preservation regulations. The transition from a commodity-based system of production to one tied to end-user specifications requires quality control at various stages of the food supply and demand system. The USDA Grain Inspection, Packers, and Stockyard Administration (GIPSA) has traditionally ensured that commodity grades and standards are maintained via sampling, inspection, and measurement procedures that assess cleanliness and damage levels (Dunahay 1999).

While commodity testing procedures are quick and relatively inexpensive to administer, the testing of value-enhanced crops may require genetic properties to be identified or physical contents to be tested to ensure trait or nutritional integrity. Dunahay (1999) reported that the timely development of low-cost identity preservation technology will prove vital to the development of the value-enhanced grains market. White corn is one of many specialized corn varieties which may benefit from such innovations.

**Production subsidies**. Wicks et al. (1988) reported no differentiation between white and yellow corns regarding federal farm program payments. Consequently, payment parity was dependent upon the yield competitiveness of white corn to yellow corn. This yield-based payment scheme did not foster adoption of white corn varieties in the past because white corn yields have traditionally lagged yellow corn yields. Thus, producer adoption of white corn varieties was dependent upon whether the expected price premiums associated with marketing the white corn would be sufficient to offset relatively low yields. While white corn yields have become comparable to those of yellow corn in recent years, price premiums have dropped, so that there are continued trade-offs between the adoption of white vs. yellow corn.

**Price expectations.** A principal reason for producer adoption of value-enhanced corns such as white corn is to capture the price premiums that exist in this market. Despite premiums, there is risk embedded in the volatility of annual premium adjustments, which continues the trade-off uncertainties in choosing white vs. yellow corn.

Boland et al. (1999) identified factors that help explain fluctuating price premiums of value-enhanced corn, three of which are applicable to the white corn market. First, commodity corn is the measuring standard for white corn. Consequently, white corn is particularly popular when commodity corn yields are low and the yield gap is essentially nonexistent. Second, the international white corn supply depends on planting decisions, weather conditions, and disease emergence around the world. Third, price premiums frequently adjust in response to changes in supply and demand. Producers must combine their own assumptions about each of these three price-determining factors when assessing their price expectations in the white corn market.

Contracting is a formal arrangement that relies on the inverse relationship between price expectations and supply. In the value-enhanced corn market, contracting mechanisms provide a means of reducing producers' risk and ensuring product quality. On the one hand, producers stand to benefit from contract mechanisms because production risk can be shared by both producers and processors. On the other hand, producers are adversely affected by contracts because of the inherent loss of independence (Riley and Hoffman 1999). As the premium gap between commodity and value-enhanced corn narrows, fewer farmers may be willing to sign such contracts, because their perceived costs involved with contracting (loss of independence) may exceed their perceived benefits (premiums).

## Processing

Corn processing has followed the trends of most industries, becoming increasingly concentrated over time. Wicks et al. (1988) identified 88 corn dry mills in the U.S. Three-fourths of these mills were located in California and the southern states, and one-fourth of these mills were located in the Midwest. Recently, Sparks (2003) created a geographical snapshot of U.S. white and yellow corn production and corn dry milling facilities (Fig 9).

In general, current corn production and processing facilities are concentrated in the Corn Belt, Texas, and California in close proximity to corn production, corn product consumption, or trade with Mexico (Dahl and Wilson 2002; Sparks 2003). A complete list of the 50 corn dry millers identified by Sparks

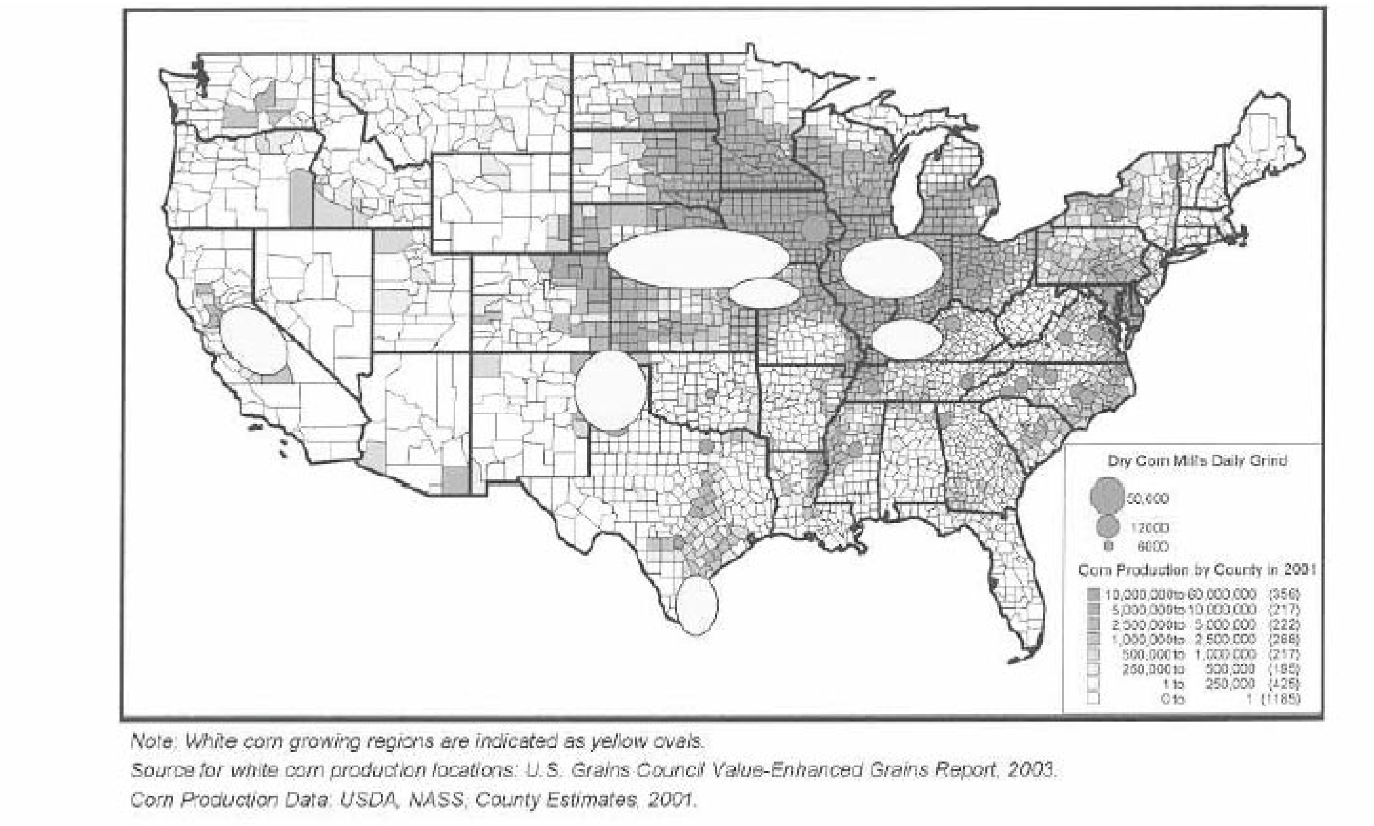



Fig 9. U.S. white and yellow corn production and corn dry milling facilities. *Source: Sparks 2003.*

(2003) is in Appendix D. Individual milling capacities for 2003, as listed in Appendix D, were used to calculate milling capacity by state (Fig 10).

Milling facilities exist in 22 different states. Nearly 60% of U.S. total daily grind capacity is concentrated in Illinois, Texas, Indiana, and North Carolina. The closest milling facilities to South Dakota are located in Nebraska, Iowa,

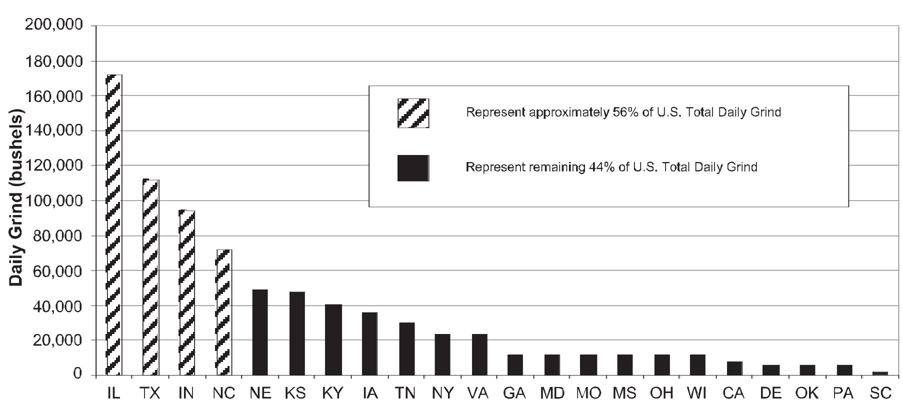



Fig 10. Capacities of U.S. corn dry milling facilities by state, 2003.
*Source: Milling and Baking Annual (2002); and Sparks (2003).*

Missouri, and Wisconsin. These facilities and their respective daily grind capacities include ADM Milling in Lincoln, Neb. (13,000 bushels), Bunge Milling in Crete, Neb. (36,000 bushels), Quaker Oats in Cedar Rapids, Iowa (36,000 bushels), Quaker Oats in St. Joseph, Mo. (12,000 bushels), and Didion Milling in Cambria, Wis. (12,000 bushels).

The scale of U.S. corn dry milling facilities is displayed in Figure 11. Eleven mills with a daily grind capacity of at least 20,000 bushels are responsible for approximately 50% of the nation's corn dry milling. The 28 mills whose daily grind ranges from 12,000 to 19,999 bushels provide nearly 43% of the nation's processing capacity. A complete list of the location and daily grind capacities of U.S. corn dry milling companies is Appendix D.

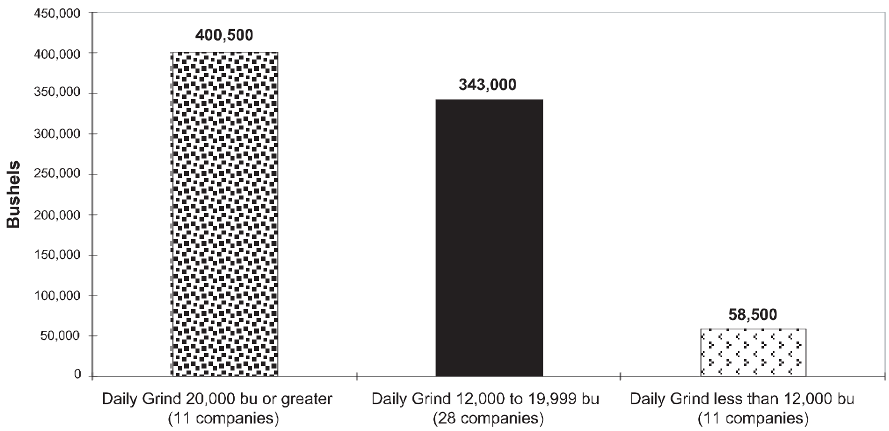



Fig 11. U.S. corn dry milling daily grind categories, 2003.
*Source: Milling and Baking Annual 2002; Sparks 2003.*

## Product trends

U.S. consumption of all corn products (corn flour and meal, hominy and grits, and corn starch) increased from 10.2 pounds per capita in the 1970-1974 period to 28.4 pounds per capita in 2000 (Sparks 2003). From 1970 to 1974, total consumption of corn flour and meal was 62% (or 6.3 pounds) of total corn consumption.

While the share of corn flour and corn meal consumption out of total corn consumption was the same in 2000 as in the previous (1970-1974) period, the absolute amount of corn flour and corn meal consumption increased dramatically to 17.5 pounds per capita. This is particularly impressive in comparison to other grain flours. Per capita consumption of corn flour increased 150% since 1970, compared to just 31% for wheat flour (Sparks 2003).

The increased quantity of corn flour consumed during the last 30 years has largely occurred because corn flour has become an established substitute for wheat flour in a variety of foods. Corn flour is a finely textured corn product which can be used to produce mixes (for pancakes, muffins, doughnuts, breadings, and batters), baby food, meat products, cereals, some fermented products, and masa flour and dough. Of these products, the greatest opportunity for

growth appears to exist for masa flour and dough, which are used as inputs in the production of taco shells, corn chips, tortillas, and related products.
In general, corn flour production takes place in close proximity to corn production, while finished corn product production occurs near population centers. This pattern is, in part, a function of the density of the products and the need to keep the costs of transportation as low as possible (Sparks 2003). This pattern is also a function of historical developments, whereby grain processing and trading provided employment opportunities that contributed to population growth, which favored the development of grain processing and trading facilities in or near cities. Consequently, corn is transported in flour form, rather than as finished consumer products.

The locations of finished corn product processing facilities, such as those producing tortillas and tortilla chips, resemble population densities of consumers of these products. For instance, over half of the U.S. tortilla production takes place in California and nearly one-fourth is in Texas. In contrast, tortilla chip production and consumption are more dispersed across the U.S. with California, Pennsylvania, Wisconsin, and Ohio each contributing more than 10% of tortilla chip production (Sparks 2003).

## Summary

Because white corn is the limiting ingredient in corn products destined for direct human consumption, factors influencing the supply of white corn (input costs, technology, production subsidies, and price expectations) were evaluated within this section.

South Dakota performance trial results (1999 and 2001) identified white corn varieties with yields and days relative maturity similar to yellow corn varieties. The closest milling facilities to South Dakota are located in Nebraska, Iowa, Missouri, and Wisconsin. In general, corn processing has followed the trends of most industries by becoming increasingly concentrated over time (88 dry mills in 1988 compared to 50 dry mills in 2003). Today, it is unusual to find a dry milling facility whose capacity is less than 12,000 bushels per day. In addition, nearly 60% of U.S. total daily grind capacity is concentrated in four states: Illinois, Texas, Indiana, and North Carolina.

U.S. consumption of all corn products more than doubled between 1970 and 2000 as corn flour emerged as a substitute for wheat flour in a variety of foods. While corn flour has many uses, the most lucrative appear to be in the production of taco shells, corn chips, tortillas, and related products. Corn flour is generally produced in close proximity to corn production while corn food products are produced near population centers. The processing facilities used to produce tortillas and tortilla chips mimic consumer densities; tortilla production is more concentrated in California and Texas while tortilla chip production is dispersed across the U.S.

## 6. Domestic corn food market: analysis

Corn flour and corn food markets in the U.S. expanded throughout the 1990s in response to increased demand for corn-based foods from both Hispanic and non-Hispanic consumers. Hansen (2003) reported that the U.S. demand for white corn stabilized in the recent past, although a slight demand increase is expected in the coming years. Here, we examine market size and growth trends in food corn processing and examine potential future opportunities that may develop in U.S. corn food markets.

### Market size and growth trends

Corn dry milling companies in the U.S. can be divided into three categories, based on the average amount of dry corn they are able to grind per day. In 2003, the three leading U.S. corn dry milling companies each had a capacity of more than 80,000 bushels of dry corn per day. Included in this top category were Gruma Corporation's Azteca Milling, six locations and a total capacity to grind 117,000 bushels of dry corn per day; Bunge Milling, two locations and a combined capacity to grind 86,000 bushels per day; and Cargill's Illinois Cereal Mills with two locations and a combined grind capacity of 86,000 bushels of dry corn per day.

A second tier of industry leaders each could grind between 20,000 and 50,000 bushels of dry corn per day and owned mills in one or two locations. The companies included in this category were J.R. Short Milling, Quaker Oats, ConAgra, Archer Daniels Midland, Lakeside Mills, and American Milling (Sparks 2003).

The remaining category includes companies with only one milling location each and a capacity to grind less than 20,000 bushels of dry corn per day.

The milling of dry corn in the U.S. is fairly geographically dispersed. That is, corn dry milling operations can be found in 22 different states. In contrast, processing of milled corn food products is more geographically concentrated. Sparks (2003) identified the contributions of individual states as shares of the total domestic processing of milled corn products for all uses, basing the analysis on 1997 Census of Manufacturing data, published by the U.S. Department of Commerce.* According to Sparks, Illinois, Indiana, and Kansas produced 52%, 20%, and 18% of the dry milled corn products in the U.S., respectively, for a combined total of 90% of the total U.S. production of dry mill corn products in 1997. No other state individually contributed more than 5% of total U.S. production of dry milled corn products for all uses.

To fully understand corn food product markets, it is important to not only analyze corn food producers in general, but producers of corn food for specific uses as well. In particular, we identify the leading corn flour millers and corn masa processors.

* The 2002 Census of Manufacturing report which updates this information was scheduled for release in late 2004.

In the broad category of corn flour production, GRUMA and Grupo Minsa rank first and second in the world in terms of their total production of corn flour. Sparks (2003) reported that three firms, Grupo Maseca's Gruman Corp., Grupo Bimbo, and Tyson Foods, dominate the U.S. masa corn milling industry.

The largest of these firms, Grupo Maseca's Gruman Corp., is the parent company of the Mission, Calidad, La Predilecta, and Guerrero brands and also supplies KFC and Subway with tortillas for wrap sandwiches. Grupo Maseca's Gruman Corporation's share of tortilla sales represents nearly half of all U.S. tortilla sales.

Grupo Bimbo is the second largest firm and includes the Tia Rosa and Mrs. Baird's labels. While the top two firms rely upon retail sales, the third largest firm, Tyson Foods, markets to the wholesale level, where the bulk of its sales are to restaurants and food-service companies. On a related note, Frito-Lay (owned by Pepsi) is recognized as the industry leader in the snack food tortilla chip sector (Sparks 2003).

Analysis of the food corn processing industry on the basis of corn flour production provides a broad overview of the industry. An alternative view of the processing industry specifically focuses on white corn processing. Dahl and Wilson (2002) identified the domestic firms with the greatest white corn processing capacity in 1995 and 1998 as Azteca (part of the Gruma Corporation), Frito-Lay, Quaker Oats, Martha White (White Lily), Archer Daniels Midland, and Minsa.

Azteca, Frito-Lay, and the combined others category experienced the largest growth in processing capacity between 1995 and 1998 (Fig 12). The processing capacity of each of these firms increased by more than 25% during this time period. In contrast, Quaker Oats, which processed 5.5 million bushels, experi-

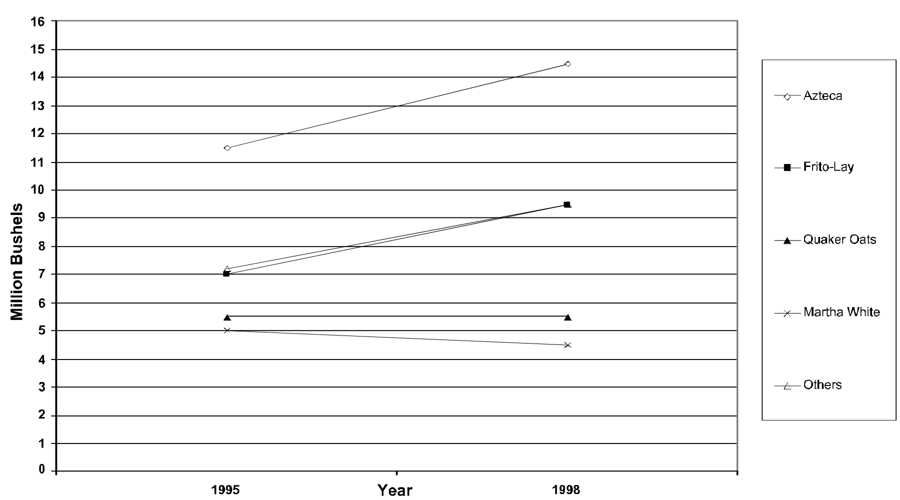



Fig 12. U.S. white corn processing capacity by company, 1995 and 1998. *Source: Dahl and Wilson 2002.*

enced no change in processing capacity, and Martha White's processing capacity declined by 10% from 5 to 4.5 million bushels during this time period.

Archer Daniels Midland and Minsa entered the white corn processing industry during this time period and reported processing capacities of 2.5 and 1.5 million bushels, respectively, in 1998 (Dahl and Wilson 2002). Archer Daniels Midland and the Gruma Corporation formed a strategic alliance in 1996 (Azteca Milling L.P. 2004).

Adjustments in white corn processing are noteworthy, but it is important to take into account that white corn products represent only a small portion of all processed corn products (Sparks 2003). Yellow corn products are among the highest selling processed grains in the market, serving as major ingredients in Doritos® chips and Gruman's Mission® tortilla bread. Foodstuffs referred to as processed corn products also may contain non-corn ingredients. For example, wheat flour products also constitute major ingredients in Doritos® chips and Gruman's Mission® tortilla bread.

## Future market potential

The corn flour and corn food product markets are expected to grow in the foreseeable future but at a slower rate than in the 1990s.

**Tortillas**. U.S. tortilla sales generally increased between 1998 and 2002 (Fig. 13).

Tortillas were identified as the fastest growing segment of the U.S. baking industry, as reported by Berry (2001) from the 2000 State of the Tortilla Industry Survey. In 2000, U.S. tortilla sales in wholesale markets totaled $4 billion, a 57% increase from 1996. The same survey reported that Americans consumed 84 billion tortillas in 2000. This represents 305 tortillas consumed per person per year, or nearly one tortilla consumed per person per day.

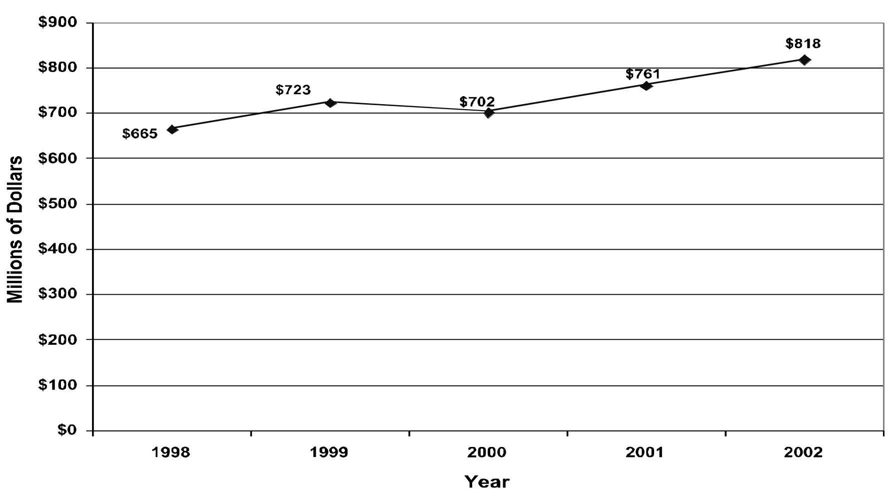



Fig 13. U.S. tortilla sales, 1998-2002. *Source: Bakingbusiness Staff (2002).*

Two major product developments are expected to support continued growth in the tortilla industry. First, flavored tortillas are expected to further stimulate growth, as additional flavors are adopted for popular wrap sandwiches. Second, tortillas of different shapes are expected to drive growth among families with children (Berry 2001).

Sparks (2003) identified tortilla production by state using 1997 Census of Manufacturing data published by the U.S. Department of Commerce. In 1997, California and Texas were the leading tortilla producing states, turning out 56% and 23% of the total value of tortillas made in the U.S., respectively. Other states identified in the report included Illinois, Colorado, Georgia, and New Mexico, producing 8%, 6%, 6%, and 1% of the total value of tortillas produced in the U.S., respectively.

Increased inclusion of tortillas in the diets of both Hispanic and non-Hispanic populations in the U.S. is expected to lead to tortilla production expansions in states in addition to California and Texas.

**Tortilla chips**. More than 70% of the ingredients of U.S. corn and tortilla chips is corn masa flour (Sparks 2003). Companies producing corn masa flour for this purpose include Grupo Minsa (Red Oak, Iowa, and Muleshoe, Texas); GIMSA-Grupo Industrial Maseca, S.A. de C.V. (San Pedro Garza Garcia, Mexico); Azteca Milling (Irving, Texas), Cargill (Minneapolis, Minn.), ConAgra (Omaha, Neb.), and Quaker Oats (Chicago, Ill).

While California produced 36% of the nation's corn chips, nine other states contributed at least 1% of the total U.S. corn chip production (Sparks 2003): Pennsylvania (17%), Wisconsin (12%), Ohio (11%), Illinois (7%), Kentucky and Tennessee (5%), Arizona (4%), Minnesota (2%), and Oregon (1%).

Between 1990 and 1998, the growth in both volume and sales of tortilla chips approached 33%, positioning tortilla chips as the second leading snack product in the U.S. after potato chips (Hearon 1998). More recently, the Snack Food Association identified tortilla chips as the closest rival to potato chips in the snack food market. Table 3 lists sales data of potato chips, tortilla chips, and other salted snacks, expressed in both total value and volume.

Table 3. Comparison of U.S. snack sales, 2001. *Source: Sparks 2003.*

| *Product* | *Sales ($ millions)* | *Volume (million pounds)* |
|---|---|---|
| Potato chips | $6,039 | 1,849 |
| Tortilla/tostada chips | $4,148 | 1,502 |
| All other salted snacks | $11,611 | 3,117 |
| Total salted snack sales | $21,798 | 6,468 |

The gap between sales of tortilla chips and potato chips continues to narrow. Recent consumer research conducted by AC Nielsen found that 89% of all U.S.

households regularly purchase potato chips and 76% of all U.S. households purchase tortilla chips. The repurchase rate for potato chips and tortilla chips is 21 and 32 days, respectively (Sparks 2003).

Growth in tortilla chip consumption has followed a path similar to that of potato chips. In general, sales and volume growth are stimulated by the introduction of new flavors, textures, and ingredient combinations (Hearon 1998).

## Regional supply and demand outlook

This preliminary feasibility study includes estimates of future corn flour and meal consumption, based on population projections and per capita consumption averages. These general estimates of the potential future demand for corn flour and other corn food products provide indications about upcoming market opportunities for food corn and can assist individuals deciding whether to enter the food corn processing industry.

The U.S. Bureau of the Census provides three types of projections of the future total resident population of the U.S., including a lowest, middle, and highest population estimate.

In the middle series estimate, the U.S. population is projected to increase to 335,048,000 people by 2025. If the U.S. per capita consumption of corn flour and meal would remain unchanged from 2000 levels of 17.5 pounds per person per year, this would result in a total U.S. consumption of corn flour and meal of 5,863,340,000 pounds by 2025.

One driver of the increase in the demand for corn flour and corn meal is the general population increase. A second driver is that traditional Mexican foods, such as tortillas and tortilla chips, have gained market access in residential, restaurant, and institutional settings and are expected to make further inroads in the diets of the population at large. A third driver is the relatively rapid growth of the Hispanic population, which is currently credited for more than half (54%) of the demand for tortillas. That is, areas with large Hispanic populations will most likely continue to consume corn flour and meal in excess of the per capita national average consumption of these products.

A brief description of states with large and growing Hispanic populations provides a snapshot of concentrated centers of demand for corn flour and meal within the U.S. Existing and emerging states in the white corn industry are grouped by region in Table 4. Acres planted in 2002 were weighted by the average U.S. yield of 145 bushels per acre to establish total bushels of white corn production; 2003 daily grind capacities were multiplied by 260 days to determine annual corn dry milling grind capacities.

Table 4. White corn production and processing and consumer populations by U.S. region. *Source: Boland et al. 2002, Milling and Baking Annual 2002, Sparks 2003, U.S. Census Bureau 2000 and 2004.*

| *U.S. region* | *State(s) included in the region* | *White corn production (bu)* | *Corn dry milling annual grind (bu)* | *Hispanic population, 2025* | *Non-Hispanic population,2025* |
|---|---|---|---|---|---|
| West | Calif. | 2,900,000 | 2,080,000 | 21,232,000(43%) | 28,053,000 (57%) |
| South | Texas, Okla. | 223,925,000 | 30,680,000 | 10,475,000 (34%) | 20,765,000 (66%) |
| Southwest | Ariz, N.M., Colo., Nev., Utah | 0 | 0 | 5,221,000 (27%) | 14,186,000 (73%) |
| Northeast | N.Y., N.J., Mass., Conn., R.I., Ohio, W.V., Md., Pa. | 9,425,000 | 21,840,000 | 9.274,000 (13%) | 64,442,000 (87%) |
| Southeast | Fla., Miss., Ga., N.C., S.C., Va., Tenn. | 6,525,000 | 33,280,000 | 6,262,000 (10%) | 56,584,000 (90%) |
| Midwest | Ill., Kan., Mo., Neb., Iowa, Ind., Ky., Wis. | 87,725,000 | 120,640,000 | 3,469,999 (8%) | 41,026,000 (92%) |
| Northwest | Wash., Ore., Idaho, Wyo. | 0 | 0 | 1,505,000 (10%) | 13,085,000 (90%) |

The difference between the number of bushels produced and those processed is likely explained by the fact that estimates of the annual number of bushels of corn ground by dry milling include not only the amount of white corn but colored corns as well. Regions displaying excess capacity in Table 4 likely process other colors of corn in addition to white corn because current U.S. milling capacity is at 100%, as was documented by Boland et al. (2000). Regions in Table 4 with a shortage of milling capacity likely ship some of their production to other regions for processing.

Concentrations of consumers in general, and Hispanic consumers in particular, are important predictors of future demand because both are directly related to corn flour and corn food product consumption. The regions in Table 4 reflect different degrees of future demand when considering total and Hispanic population projections for 2025.

In Table 4, the West region consists of California only. This state processes a relatively small amount of white corn in comparison to its substantial consumer base. In light of the projected growth in white corn demand associated with increases in both Hispanic and non-Hispanic segments of the state's population, California will likely continue to depend on other states in terms of white corn production and dry milling unless the state increases its own white corn production and processing capabilities.

The South region includes Texas, a leader in existing white corn production and processing facilities, and its neighbor, Oklahoma, which currently has one processing facility. Like California, Texas is dependent on other states for white corn production and dry milling. Also like California, Texas' population in general and the Hispanic population in particular are projected to experience continued growth and lead to future growth in the demand for white corn in that state and the region.

The Southwest region currently lacks both production and processing capacity to satisfy its demand for white corn. The demand for white corn in the Southwest is projected to increase in conjunction with an increasing general population and a growing presence of Hispanics in this region. The neighboring West and South regions appear unprepared to meet the projected growing demand in the Southwest region amidst strong and increasing demands within their own regions.

The Northeast and Southeast regions are in a similar position in terms of their ability to produce and process white corn. Both regions have a moderate amount of white corn production and dry mill processing. In addition, both regions have highly concentrated urban Hispanic populations. Existing processing capabilities in the northeast region suggest that this region is well-positioned for the projected increases in demand in concentrated pockets in the cities of New York and Philadelphia. Similarly, the processing capacity in the southeast region primarily helps satisfy the demand for corn flour and meal in Florida. Both regions have adequate processing capacity and nearby access to Midwest production.

The Midwest region has a reputation as a leader in U.S. white corn production and processing. Population growth in this region is below that of other regions and its Hispanic population is projected to remain relatively small in comparison to that of other regions for 2025. The exception to this general rule is Chicago, where over one-fourth of the city's population was identified as Hispanic in 2000. Nonetheless, most white corn produced in the Midwest is exported to more populous areas elsewhere in the nation to help meet production and processing deficiencies in these other regions.

Food processing facilities located in areas with easy access to a consistent supply of corn are positioned to profit from growth in the corn flour and meal industry. For example, South Dakota's southern neighbor, Nebraska, is well-established in food corn production and processing. The Nebraska Corn Board credited the irrigation infrastructure with the state's success in producing and processing food grade corn. In 2002, nearly 80% of Nebraska's corn crop was produced using irrigation, enabling the state's producers to provide a consistent supply of high-quality corn for the milling industry even during the record drought of 2002 (Nebraska Corn Board 2003). Clearly, corn production areas with limited irrigation infrastructure that are periodically subject to drought conditions and increased aflatoxin levels are at a disadvantage to locations which can supply the food corn processing industry in a consistent manner, both in terms of quantity and quality.

The Northwest region currently lacks both production and processing capacity. The number of Hispanic people in this region is projected to remain the smallest of all the regions, but the region may absorb some of the West's growing Hispanic population in the long-term. It is unlikely that this region will be a source of strong demand for corn flour and meal in the near future.

Based on these assessments, the West, South, and Southwest regions offer the greatest potential demand for corn flour and corn food products. A presumed lack of processing expansion in these regions appears to indicate that these regions will continue to rely upon the development of corn production and processing industries in other regions of the U.S. The West, South, and Southwest regions also lie in close proximity to Mexico and therefore, international competitors will likely vie for serving consumers in these regions.

## Summary

Concentration in both corn milling and food processing appears to be increasingly common in this industry. In 2003, each of the three leading U.S. corn dry milling companies (Gruma Corporation's Azteca Milling, Bunge Milling, and Cargill's Illinois Cereal Mills) had a daily grind capacity in excess of 80,000 bushels.

U.S. corn dry milling operations are dispersed across 22 different states. However, Sparks (2003) reported that Illinois, Indiana, and Kansas produced 52%, 20%, and 18%, respectively, of all dry milled corn products in the U.S. in 1997. Three firms, Grupo Maseca's Gruman Corp., Grupo Bimbo, and Tyson Foods, dominate the U.S. masa corn milling industry. Grupo Maseca's Gruman Corp. and Grupo Bimbo are leaders in retail sales, while Tyson Foods has found success serving restaurant and food-service channels.

One corn food product, tortillas, reported steadily increasing sales between 1998 and 2002, with per capita U.S. consumption rates of nearly one tortilla per day. So far, U.S. tortilla production has been concentrated in California and Texas, but inclusion of tortillas in the diets of both Hispanic and non-Hispanic populations is expected to result in increased production contributions in a diverse collection of states.

This pattern will match the dispersed processing facilities common to corn chip production. Between 1990 and 1998, the growth in both volume and sales of tortilla chips approached 33% and positioned tortilla chips as a solid competitor to potato chips in the snack food industry. The gap between tortilla chips and potato chips is expected to continue to narrow in the future.

In general, the corn flour and corn food product markets are expected to grow in the foreseeable future, although at a slower rate than in the 1990s. Corn production areas with limited irrigation infrastructure that are periodically subject to drought conditions and increased aflatoxin levels are at a disadvantage to locations which can consistently supply the food corn processing industry.

Stable suppliers with localized processing facilities are best positioned to support corn flour and corn food product market growth projected to take place in the West (California), South (Texas and Oklahoma), and Southwest (Arizona, New Mexico, Colorado, Nevada, and Utah) regions of the U.S.

Increasing difficulties experienced by the corn processing industry to expand its corn processing capacity appears to indicate that these regions will continue to rely upon the development of corn production and processing industries in other U.S. regions or nearby Mexico to meet the regional demand for corn products.

# 7. International corn food market: analysis

U.S. corn food product market developments are closely linked to those in global corn food markets. An understanding of global corn food market developments is critical for making local investment decisions related to the food corn processing industry.

### International market size and growth trends

In examining current food corn market size and growth trends, it is useful to compare present conditions with past developments. In 1987, for example, approximately 93% of white corn production was consumed in the nations where it was grown. The Republic of South Africa was the leading exporter of food corn at this time. Other exporting nations included Zimbabwe, China, and the U.S., but the quantity of white corn exported by these nations was dependent on the degree to which their domestic demand was satisfied.

During the late 1980s, the leading white corn importers included Venezuela, Mexico, Japan, and some South African nations (Wicks et al. 1988).

Between 1988 and 1999, increased wholesale disappearance in the U.S. signaled greater levels of white corn consumption in the U.S. Concurrently, international white corn markets expanded even more than domestic U.S. white corn markets. As a result, U.S. white corn exports increased considerably between 1988 and 1992 and more than doubled from 1992 to 1999 (Boland et al. 2000). Appendix E displays U.S. exports to 27 different nations between 1988 and 1999 and shows that the international trade in white corn grew rapidly over this time period.

A detailed examination of the list of nations importing U.S.-produced white corn shows that there has been considerable change in this market since 1988. (Appendix F). Between 1988 and 1991, the primary importers of U.S. white corn were located in the Asian and North American continents, particularly in Japan and Mexico. Between 1992 and 1993, U.S. white corn exports were generally destined for the African, Asian, and South American continents. From 1994 to the present, however, most of the white corn produced in the U.S. and destined for export was absorbed within the North American continent. Specifically, during the period from 1994 to 1999, most U.S. white corn exports were shipped to Mexico.

The shifts in the export destinations of white corn emerging between 1994 and 1999 have since stabilized. Currently, international white corn production is concentrated in South Africa and the U.S. while white corn consumption is centered in Mexico (Boland et al. 2002). As the world's foremost exporter of corn, the U.S. wields a major influence on the international market of corn as a bulk commodity (Boland et al. 1999). White corn currently exported from the U.S. is generally used to produce corn flour-based products such as tortillas, muffins, and breads (Boland et al. 2002).

## Market potential

In most corn-producing nations—and in particular in the U.S.—white corn is produced in small amounts relative to yellow corn. Also as in the U.S., factors influencing white corn markets are different from those affecting yellow corn markets. The growth of white corn production in the U.S. has been achieved as a result of both increased domestic consumption and increased exports to other countries. Between 1980/81 and 2001/02, for example, domestic U.S. consumption increased from 26 million to 60 million bushels. U.S. exports of white corn increased from 7 million to 62 million bushels during this same time frame (Dahl and Wilson 2002).

In the 1970s and 1980s, price premiums for white corn over and above yellow corn prices averaged $0.70 per bushel (Wicks et al. 1988). White corn price premiums are inversely related to the crop's production levels. That is, high premiums in one year often induce more production in the following year, but the increased production ultimately contributes to lower premiums for the year of increased production. As a result of this relationship, white corn price premiums are highly dependent on developments taking place in the international white corn market.

The outlook for the white corn market is unpredictable due to fluctuating export opportunities for the U.S. in Mexico, South Africa, and other countries. Hansen (2003) estimated that production variability around the world may limit premiums to the $0.10 to $0.25 per bushel range. The impact of competing supplies from Mexico and South Africa on the U.S. is further examined in the remainder of this section.

**Mexico**. Because Mexico's large corn consumption surpasses the country's domestic production in most years, this country typically imports corn from the U.S. to satisfy its domestic demand for white corn (Boland et al. 2002). In the 1995/1996 marketing year, Mexico absorbed 28% of U.S. white corn exports. In some years, however, Mexico utilized over 80% of U.S. exports (Hansen 2003). Especially since the North American Free Trade Agreement was signed in 1993, Mexico has been the largest importer of U.S. white corn.

Total U.S. white corn export trends have closely resembled white corn export trends with its dominant trading partner, Mexico, since 1995 (Fig 14). U.S. exports to other countries have remained relatively stable over the same time period.

One of the challenges in the U.S./Mexico trading relationship is that the quantity of white corn exported from the U.S. to Mexico is highly variable from year to year (Figure 14) . This is largely due to inconsistencies in both the production of white corn in Mexico and the Mexican government's issuances of import permits called Cupos.

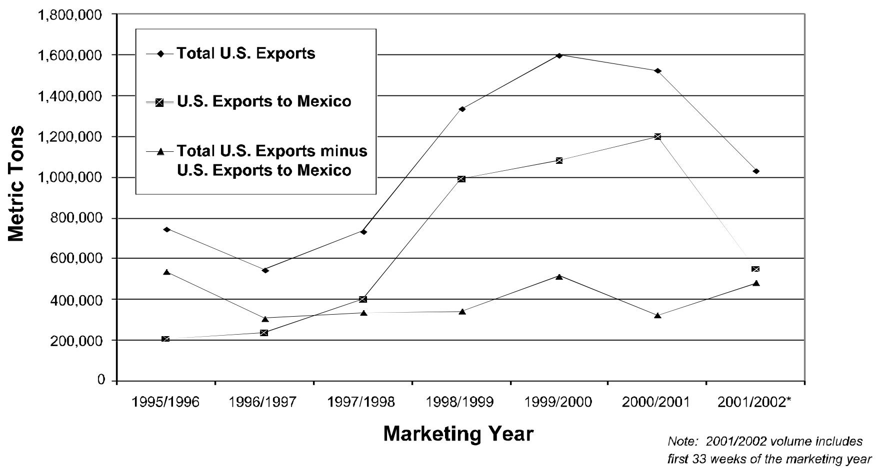



Fig 14. U.S. white corn export volume, 1995/1996 through 2001/2002. *Source: U.S. Feed Grains Council 2002.*

Boland et al. (2002) described how production and regulatory inconsistencies pose challenges for U.S. corn suppliers trying to establish long-term contracts. Mexican production is subsidized, beginning with the lowest required subsidy bids and ending when all domestic production has been purchased, so import permits are only granted if the amount of corn produced in Mexico does not satisfy that nation's demand. Consequently, the number and timing of import licenses distributed vary considerably from year to year depending on Mexican production.

A decrease in U.S. white corn exports appears likely in the future as the 14-year North American Free Trade Agreement transition period ends in 2008 and over-quota tariffs are implemented by the Mexican Government (Zahniser and Coyle 2004).

Sparks (2003) observed differences between U.S. white corn and white corn flour exports to Mexico. Each year between 1993 and 2002, the amount of white corn exports generally increased. During the same time period, however, annual white corn flour exports remained relatively constant in the 20,000 to 40,000 metric tons range. A different phenomenon began in 2002 when white corn flour exports increased to approximately 60,000 metric tons per year, a 50% increase from the previous export record.

The large increase in U.S. white corn flour exports was attributed to poor weather conditions and decreased planting incentives for Mexican farmers. Changes in the Mexican tortilla industry also helped precipitate this change. The Mexican tortilla industry increased its reliance on imported corn flour from 21% in 1991 to 50% in 1997. The consistency of dough made from corn flour offers production efficiencies (decreased water use and waste generation, improved hygiene, decreased fuel and labor costs, increased tortilla yield, and extended tortilla shelf life) beyond those associated with using white corn directly in the production process (Sparks 2003).

Berry (2002) reported that an industry traditionally dominated by family businesses producing fresh tortillas has experienced noticeable growth in industrially produced tortillas made from corn flour. Mexican and U.S. consumers who are increasingly willing to substitute packaged tortillas for fresh tortillas were identified as the main drivers of this trend. Large flour producers, such as Gruma and Grupo Minsa, are best positioned to grow with the processed tortilla industry.

Zahniser and Coyle (2004) identified 45,000 tortilla producers and 10,000 corn millers in Mexico. While tortilla processing is distributed across Mexico, corn flour production is increasingly concentrated both in terms of geography and number of firms. Two companies, Gruma and Grupo Minsa, currently control more than 90% of the country's corn flour production.

Gruma and Grupo Minsa are also leaders in global food corn markets. Specifically, Gruma is the world's largest producer of corn flour and tortillas. Gruma, headquartered in Monterrey, Nuevo León, maintains a visible global presence with plants in Central America, Europe, Venezuela, and the U.S. Grupo Minsa is also established internationally with six plants in Mexico, two in the U.S. (Texas and Iowa), and one in Guatemala (Zahniser and Coyle 2004; Bolling et al. 1999). Gruma and Grupo Minsa both depend upon growth in international markets, particularly in the U.S. where demand for Mexican food continues to increase.

As a result of the North American Free Trade Agreement, increases in U.S. white corn and white corn flour exports to Mexico were met by increased Mexican exports of finished corn food products to the U.S. Foreign direct investment in the food corn industry has also grown for the two countries. For example, the United Kingdom, Canada, and Mexico are the leading host countries for total U.S. foreign direct investment (Bolling et al. 1999).

U.S. foreign direct investment in Mexico between 1994 and 1998 was concentrated in the industries displayed in Table 5. Corn chips/other snacks and corn milling were two of the leading areas of U.S. foreign direct investment in Mexico.

Table 5. U.S. foreign direct investment in Mexican industries, 1994-1998. *Source: Bolling et al. 1999.*

| *Processed food industry* | *1994-1998 investments ($ millions)* |
|---|---|
| Beer and malt | 1,115 |
| Nonalcoholic beverages | 719 |
| Corn chips, other snacks | 426 |
| Other miscellaneous foods | 363 |
| Corn milling | 271 |
| Products from sugar | 104 |

Bolling et al. (1999) identified the synergy between investment and trade that developed between the U.S. and Mexico. That is, as U.S. dollars increased in value relative to the Mexican peso, U.S. investors channeled financial assets toward Mexico. Some of these funds were invested in corn processing facilities. As long as labor costs are relatively low in Mexico compared to those in the U.S., the production and processing of food corn products will continue to increase and U.S. consumers will continue to purchase low priced products produced in Mexico.

**South Africa**. The trading relationship between the U.S. and South Africa adjusts with each harvest season. As the world's top two producers of white corn, South Africa and the U.S. each enjoy comparative advantages in geographically "local" export markets.

The ability of the U.S. to penetrate African markets is largely dependent on South African production and weather conditions. In the South American market, however, the two nations compete on the basis of unique harvest cycles and varying kernel textures/characteristics. In particular, South Africa harvests between April and July compared to the traditional fall harvest cycle of the U.S. The harder South African white corn kernel also offers additional processing efficiency for producing flour-based food items (Boland et al. 2002).

The U.S. and South Africa maintain a unique relationship in white corn markets in Asia (U.S. Feed Grains Council 2002). While Asian consumers prefer the naturally dried South African corn, U.S. corn is acceptable for meeting production shortages in the South African crop.

The different growing seasons of South Africa and the U.S. allow U.S. producers to utilize South African corn estimates when making production decisions. In 2002, for example, a short South African crop identified export opportunities for U.S. white corn producers. Historically, export opportunities have arisen for seasonal movement of U.S. white corn to the African continent (Hansen 2003). However, U.S. white corn exports to South Africa are unpredictable at best.

**Other countries**

For the most part, consumers in developed countries demand food products similar to those of North American consumers (Sparks 2003). In some instances, however, these consumers desire food products meeting quality and health standards in excess of those demanded by North American consumers.

Consumers in developing countries, on the other hand, are generally less concerned with quality in their quest for affordable food products. Middle and/or upper income consumers in developing countries select similar products as North American consumers.

Most U.S. white corn exports are shipped by April, and declining exports typically follow in the summer months. Morley (2001) reported the percentages of U.S. total exports shipped by May 1 between 1998 and 2001 as follows: 1998 (90%), 1999 (78.5%), 2000 (64.8%), and 2001 (68.6%). This seasonal pattern has developed in response to the South African and Mexican harvest cycles upon which the U.S. depends the most.

While approximately 80% of U.S. white corn is exported to Mexico, some of the white corn produced in the U.S. is also exported to Japan, the Philippines, and Central and South American countries (Hansen 2003). In addition to these markets, Sparks (2003) sees additional export opportunities for serving the unmet convenience food needs of European consumers.

## Summary

An analysis of international trends in producing, processing, and marketing flour products made from white and yellow corns shows that, internationally, the production of white corn remains small compared to yellow corn production. In 1987, nearly all white corn was consumed in the nations where it was grown. Since then, both imports and exports of white corn have increased.

Most white corn is produced in South Africa and the U.S. and most white corn is consumed in Mexico. A smaller quantity of white corn produced in the U.S. is exported to Japan, the Philippines, and Central and South American countries.

Complex trading relationships exist between the U.S., Mexico, and South Africa. In general, the U.S. and South Africa enjoy comparative advantages in regional markets. These two nations compete on the basis of distinct harvest cycles and varying kernel textures and other characteristics. In general, the trading relationship between the U.S. and South Africa adjusts with each harvest season, largely because the necessity to trade and the volume traded are dependent upon South Africa's annual white corn supply.

Since 1995, U.S. white corn export trends, in general, have closely resembled white corn export trends with its dominant trading partner Mexico. However, export patterns to Mexico of U.S. white corn were different from those of white corn flour during this time period. U.S. white corn exports generally increased on an annual basis, whereas U.S. white corn flour exports leveled off in the 20,000-40,000 metric ton range until 2002, and increased to 60,000 metric tons in 2003. The large increase was attributed to poor weather conditions, decreased planting incentives for Mexican farmers, and consumers substituting industrially-produced tortillas for fresh tortillas.

# 8. Corn food market: summary and recommendations

The approach taken in this research was to conduct an external analysis of the corn food markets. This type of market analysis is a preliminary, but essential, step before conducting a full-scale feasibility study of a possible food corn processing facility in South Dakota.

## Summary

The three objectives addressed in this report are:
1. define the product market for white and yellow corn flour,
2. identify underserved geographic locations and demographic groups in the U.S., and
3. assess the growth potential of these markets.

**Production**. Corn grown in the U.S. and used for feed, food, and industrial purposes generally originates in a small collection of states. According to the U.S. Feed Grains Council 2000-2001 Value-Enhanced Grains Quality Report, seven states (Illinois, Indiana, Iowa, Minnesota, Missouri, Nebraska, and Ohio) typically contribute over 70% of domestically produced corn and are responsible for over 80% of all U.S. corn exports.

Food corn generally meets the requirements of U.S. Number 1 Grade, yellow or white dent corn (Rooney and Suhendro 2001). In addition to this standard, attributes ensuring processing efficiency (such as moisture content, stress cracks, or density) or satisfying specific consumer demands (including color) may be specified by the end-user.

According to the Illinois Specialty Farm Products Report, 40% of total food corn acres in the U.S. were planted to white corn in 2002. Yellow corn was grown on the remaining 60% of total food corn acres.

White corn production represents just 1% of the 9.5 billion bushels of corn produced and utilized for food, feed, and industrial purposes in the U.S. each year (Sparks 2003).

The U.S. Feed Grains Council estimated that the domestic demand for white corn is 50 million bushels per year. To meet this demand, approximately 400,000 acres of white corn must be planted. White corn production has consistently exceeded the domestic demand benchmark of 400,000 acres since 1997.

Beginning in 2000, white corn production stabilized at roughly 900,000 acres. This sustained level of production confirms the important role of export markets, considering the saturated domestic markets and near complete domestic processing capacity.

White corn production is somewhat concentrated within three states: Kentucky, Nebraska, and Texas. Jointly, these states accounted for at least 53% of the harvested acres in the U.S. for all years between 1997 and 2002.

White corn yields are increasingly competitive with those of yellow corn. The Illinois Specialty Farm Products Report (2003) estimated U.S. white corn yields at 145 bushels per acre, compared to yellow corn yields of 155 bushels per acre.

In the past, white corn varieties performed poorly in South Dakota because the state's climate prevented white corn varieties from reaching maturity, leading to an insufficient kernel drydown time before the onset of a hard freeze. Continued corn breeding by researchers at South Dakota State University, however, has resulted in early white corn varieties that are increasingly competitive with yellow corn, both in terms of yields and in the number of days needed to reach maturity.

**Processing**. Corn may be processed by way of either wet or dry milling. Approximately 25% to 30% of processed corn is wet milled and the remaining 70% to 75% of processed corn is dry milled (Davis 2001). As a result of the distinct approaches of wet and dry milling, both processes produce unique co-products.

Current milling capacity in the U.S. is close to 100% (Boland et al. 2000). Therefore, production above current levels would require opening new domestic milling facilities or processing the grain abroad.

According to Sparks (2003), Illinois, Indiana, and Kansas produced 52%, 20%, and 18% of the dry milled corn products in the U.S. in 1997, respectively. Thus, these three states produced a combined total of 90% of the total dry mill corn products in the U.S.

Corn processing has followed the trend of most industries, in that it has become increasingly concentrated over time. Wicks et al. (1988) identified 88 corn dry mills in the U.S. Three-fourths of these mills were located in California and the southern states, and one-fourth were located in the Midwest. More recently, Sparks (2003) identified 40 companies which together own 50 corn dry mills in 22 different U.S. states.

The corn dry milling industry consists almost entirely (93%) of mills with a capacity to grind at least 12,000 bushels per day. Eleven mills have a daily grind capacity of at least 20,000 bushels and are responsible for approximately 50% of the nation's corn dry milling. There are 28 mills with a daily grind capacity ranging from 12,000 to 19,999 bushels. Jointly, these 28 mills provide nearly 43% of the nation's processing capacity.

The leading U.S. corn dry millers (Gruma Corporation's Azteca Milling, Bunge Milling, and Cargill's Illinois Cereal Mills) each had a grinding capacity in excess of 80,000 bushels per day in 2003. Six companies in a second tier of industry leaders each had a grinding capacity of between 20,000 and 50,000 bushels per day. The third tier of corn dry millers included 31 small-scale millers, each having a capacity of less than 20,000 bushels per day (Sparks 2003).

Sparks (2003) identified three dominant firms, Grupo Maseca's Gruman Corp., Grupo Bimbo, and Tyson Foods, in the U.S. corn masa milling industry.

To minimize costs of transportation, corn flour production takes place in close proximity to corn production, while finished corn product production occurs near population centers.

Approximately 80% of "Mexican" food products made from corn contain white corn varieties, whereas only 20% of these food products contain yellow corn varieties (Sparks 2003).

Over half of the U.S. tortilla production takes place in California, and nearly one-fourth occurs in Texas.

Tortilla chips are produced throughout the U.S. For example, California, Pennsylvania, Wisconsin, and Ohio each contribute over 10% of the total U.S. tortilla chip production (Sparks 2003). California produces 36% of the nation's corn chips, and nine other states contribute at least 1% of the total U.S. corn chip production.

**Marketing**. Fifty-eight percent of all corn produced in the U.S. is used for feed, 23% is used for seed, industrial purposes, and food, and 19% is destined for exports.

Contract production is common in the white corn market. Specifically, the U.S. Feed Grains Council 2001/2002 Value Enhanced Grains Quality Report stated that for reporting year 2001-2002 between 60% and 65% of white corn was grown under contract. The remainder, between 35% and 40%, was sold at cash markets.

White corn premiums, when adjusted for yield, have generally declined since 1998. The declining premiums suggest that white corn markets are maturing, coming to resemble a commodity market structure with relatively small profit margins.

Corn food product marketing has responded to consumer demands with respect to flavor, textures, ingredients, shelf-life, and product shape. Increased emphasis has been placed on tortilla marketing, in response to the identification of (1) tortillas as the fastest growing segment of the U.S. baking industry; and (2) tortilla chips as the second leading snack product behind potato chips.

**Geographic and demographic opportunities**. Today's consumers have diverse tastes and preferences, and many consumers have come to adopt ethnic-style foods in their regular diets. Many people of non-Hispanic origin have incorporated tortillas and other white corn-based products into their diets. As a result, white corn flour has become increasingly popular as an ingredient in various food products such as tortillas, not only among people with Hispanic backgrounds but also among the U.S. population at large.

Kohn (2004) identified an increasing Hispanic population as the most powerful driver of the growth in the demand for tortillas. Fifty-four percent of the growth in the tortilla industry in 2002 was attributable to this ethnic group. The important role of the Hispanic population segment in the growth of the tortilla industry is four-fold. First, on average, this ethnic group is young, so that its per-capita food consumption exceeds that of the population at large. Second, Hispanics have been, and are projected to be, the most rapidly growing segment of the population. Third, Hispanic diets traditionally include corn food products. Fourth, Hispanics spend more on grain-based foods than do non-Hispanics.

Between 1990 and 2000, the U.S. Hispanic population increased by 57.9% to 35.3 million people. In particular, the number of people of Mexican descent increased by 52.9%. By comparison, the U.S. population as a whole grew by only 13.2% over the same period.

Eight of the 10 largest cities in the U.S. were also among the 10 largest Hispanic population centers in 2000. Hispanics represented more than one-fourth of the population in eight of the 10 largest cities. In each of these Hispanic population centers there is a concentrated demand for corn products.

Kohn (2004) noted the growing popularity of tortillas among the non-Hispanic population, contributing 36% of the tortilla industry's growth in 2002. The remaining growth in tortilla consumption in 2002 was due to increased institutional use of tortillas. Increased use of corn food products in institutional meals ultimately mirrors home and away-from-home meal trends.

The convenience and variety provided by tortillas and other corn food products have accommodated demographic changes, including an increased number of women in the workforce, increased recreational activities, and increased away-from-home expenditures on food.

Demographic changes and consumer expenditure patterns suggest that retail food products should be developed and marketed to accommodate the lifestyle and nutritional needs of older populations (65 and over) in particular. Food service products should especially be targeted to younger populations, particularly those under age 25. Above average food expenditures of individuals aged 25-64 highlight the potential for success in both retail and food service outlets.

**Corn food market growth potential**. U.S. consumption of all corn products (corn flour and meal, hominy and grits, and corn starch) increased from 10.2 pounds per capita in the 1970-1974 period to 28.4 pounds per capita in 2000. Over the same time period, corn flour and corn meal consumption increased from 6.3 to 17.5 pounds per capita. The increase in corn flour and corn meal consumption is particularly impressive in comparison to that of other grain flours; per capita consumption of corn flour increased by 150% since 1970, compared to just 31% for wheat flour (Sparks 2003).

Demographic trends and associated changes in consumption patterns signal growth opportunities for corn food product marketing. Between 2000 and 2010, for example, the 45 and over age group is projected to be responsible for a large share of the U.S. population. Products specifically targeted to this age group in both retail and food service outlets will have a high potential to succeed. Additional marketing opportunities exist within the 10 to 19 year old age group, whose spending is projected to increase at a rate of at least 4% per year through 2005.

Sales data indicate growth opportunities for specific corn food products including masa flour and dough, which are used as inputs in the production of taco shells, corn chips, tortillas, and related products. Consumer willingness to substitute packaged tortillas for fresh tortillas suggests that industrially produced tortillas can compete in an industry previously dominated by small-scale family operations. Industrially produced tortillas are also expected to support continued retail and food-service growth in tortilla sales through product development of flavored tortillas and tortillas of varying shapes (Berry 2002).

Corn food market growth is expected to take place in various locations. In general, restaurants and food service locations will benefit from increased away-from-home food expenditures. In the domestic market, the increased inclusion of tortillas in the diets of both Hispanic and non-Hispanic populations is expected to extend production and processing beyond the traditional locations of California and Texas. In the international market, Sparks (2003) foresees additional export opportunities for serving the unmet convenience food needs of European consumers.

The potential for growth in corn food markets is dependent upon several highly variable international factors. Historically, seasonal U.S. exports of white corn to the African continent occurred, but only in years of production shortfalls in some African nations (Hansen 2003). Uncertainty has also existed in Mexican corn markets as a result of the number and timing of import permits issued by the Mexican government.

The U.S. is particularly sensitive to inconsistencies in this trading relationship. For example, U.S. total white corn export trends since 1995 mirror white corn export trends with its dominant trading partner, Mexico, while exports to other countries have remained relatively stable over the same time period. Amid the many and diverse sources of variability in the international market, Hansen (2003) estimated that white corn price premiums may be limited to the $0.10 to $0.25 per bushel range.

### Findings and recommendations

1. U.S. consumption of corn flour has increased by 150% since 1970. This growth rate is five times that of wheat flour consumption. Growth in the demand for corn flour is credited to increased consumption of several types of foods, particularly "Mexican" foods such as tortillas, tortilla chips, and corn chips.

2. White corn is preferred to yellow corn for producing tortillas, tortilla chips, and corn chips. If growth in corn food products continues to be tied to "Mexican" food products, some of the acres currently planted to yellow corn or other crops may be shifted to white corn production over time.

3. In recent years, white corn price premiums have declined as the white corn industry matured and supplies increased to meet growing white corn product demand. Price premiums currently range between $0.10 and $0.25 per bushel relative to the cash price for yellow corn.

4. Crop producer access to white corn marketing contracts is increasingly important in light of reduced price premiums.

5. The U.S. may attain some domestic growth in food corn markets, mainly due to a young and growing U.S. Hispanic population and family-friendly immigration policies. Culturally diverse employees and bilingual product labeling may be crucial to serving these Hispanic customers. In addition, new corn food product introductions will face strong advertising competition in the highly-competitive Hispanic market.

6. Whether or not growth in U.S. corn flour markets will be sustainable is dependent upon continued growth in the U.S. Hispanic (including Mexican)

population, as well as the further acceptance of "Mexican" foods among people of non-Hispanic backgrounds, both at home and away from home.

7. "Mexican" foods made from white corn flour are well placed to meet the increasing demand for convenience among U.S. consumers, both at the retail and food service levels. Large flour producers are best positioned to grow with the processed tortilla industry.

8. If the domestic demand for these corn food products increases or if international demand for corn becomes more consistent, additional domestic processing facilities will be needed to support the increased production. Failure to invest in such infrastructure would result in increased corn processing outside the U.S. Mexico is one international processing competitor that may benefit from its close proximity to the U.S. regions (West, South, and Southwest) projected to have the largest increases in demand for corn flour and corn food products. U.S. foreign direct investment in Mexican corn chip and corn milling industries has further positioned these companies to meet any increases in demand.

9. White corn producers without direct access to domestic milling facilities must depend on the highly variable export market. Variations in the volume of white corn traded occur mainly because of Mexico's desire to protect its domestic white corn producers and intense competition from South Africa. Recurring crop failures in South Africa have provided intermittent opportunities for the U.S. to market white corn to consumers in South Africa.

The improved agronomic performance of white corn varieties suggests that, at the production level, white corn produced in South Dakota is increasingly competitive with yellow corn varieties. In addition, increased demand for corn food products by both Hispanic and non-Hispanic segments of the population suggests that the markets for food products made from white and yellow corns will continue to grow in the foreseeable future.

Despite these opportunities, the analyses presented in this report also reveal that white corn price premiums have declined in recent years and that international market conditions and opportunities continue to be variable. The combination of these factors suggests that, on the one hand, producing white corn appears to have become less lucrative in recent years, but, on the other hand, there may be financially rewarding opportunities for entering or investing in the white corn processing market.

U.S. regions including the West (California), South (Texas and Oklahoma), and Southwest (Arizona, New Mexico, Colorado, Nevada, and Utah) offer the greatest potential demand for corn flour and corn food products. A presumed lack of processing expansion in these regions appears to indicate that these regions will continue to rely upon the development of corn production and processing industries in other regions of the U.S. The West, South, and Southwest regions also lie in close proximity to Mexico and, therefore, international competitors will likely vie for serving customers in these regions. U.S. foreign direct investment in Mexican corn chip and corn milling industries offers further evidence that these companies are positioned to meet any increases in demand.

Corn product processing facilities have traditionally located in states with large population centers (and large Hispanic population concentrations). In contrast, a proposed corn flour production facility in South Dakota would be geographically separate from large concentrations of consumers, entailing a relative disadvantage for corn flour production in the state.

Based on the analyses outlined in this report, we provide a cautiously optimistic assessment about potential opportunities that may be available to South Dakota corn producers willing to organize themselves and further investigate the feasibility of processing and marketing white corn products.

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# 10. Appendices

A. U.S. white corn production (acres), 1997-2002

| *State* | *1997* | *1998* | *1999* | *2000* | *2001* | *2002* |
|---|---|---|---|---|---|---|
| Kentucky | 108,000 | 150,000 | 225,000 | 180,000 | 185,000 | 200,000 |
| Nebraska | 108,500 | 155,000 | 235,000 | 164,500 | 175,000 | 170,000 |
| Texas | 110,500 | 107,000 | 170,000 | 157,500 | 165,000 | 165,000 |
| Illinois and Indiana | 42,000 | 66,000 | 100,000 | 80,000 | 80,000 | 80,000 |
| Iowa | 36,000 | 68,000 | 105,000 | 68,250 | 65,000 | 65,000 |
| Ohio River Valley | 50,000 | 55,000 | 65,000 | 65,000 | 65,000 | 65,000 |
| Missouri | 35,000 | 64,000 | 85,000 | 59,500 | 55,000 | 50,000 |
| Southeast[a] | 31,000 | 45,000 | 65,000 | 45,000 | 50,000 | 45,000 |
| Kansas | 19,000 | 40,000 | 55,000 | 41,250 | 40,000 | 40,000 |
| California | 16,000 | 25,000 | 23,000 | 23,000 | 20,000 | 20,000 |
| **U.S. Total** | 556,000 | 775,000 | 1,128,000 | 884,000 | 900,000 | 900,000 |

*[a]Includes Mississippi, Georgia, North Carolina, South Carolina, Virginia, and Tennessee*

*Acreage data displayed for 2002 are USDA estimates of harvested acres as of June 2002.*
*Source: Boland et al. 2002.*

B. Southeast Research Farm (Beresford, S.D.) white corn production trials, 1999

| *Entry* | *Yield (bu/acre)* | *Percent Water* | *Plant ht (cm)* | *Ear ht (cm)* | *Days Relative Maturity* |
|---|---|---|---|---|---|
| Dekalb DK665W | 128.2 | 18.7 | 270.7 | 99.9 | 116 |
| B73 x Mo17 yellow check | 127.2 | 20.9 | 294.9 | 117.9 | 115 |
| Vineyard V433W | 126.4 | 21.5 | 306.1 | 114.3 | 113 |
| Novartis NX 7208 | 124.4 | 19.4 | 294.3 | 123.6 | 112 |
| LG Seeds NB749W | 122.5 | 24.1 | 295.5 | 129.3 | 115 |
| Wilson 1780W | 120.0 | 23.8 | 270.1 | 108.5 | 114 |
| Asgrow RX 776W | 118.3 | 18.6 | 246.5 | 83.4 | 114 |
| Whisnand 50AW | 118.2 | 20.0 | 308.4 | 140.3 | 111 |
| Pioneer Brand 3394 yellow check | 118.1 | 20.9 | 274.5 | 98.1 | 110 |
| Deiner DB 114W | 116.8 | 21.6 | 272.9 | 111.1 | 114 |
| Novartis N71-T7 | 116.7 | 20.1 | 293.7 | 118.5 | 111 |
| IFSI 95-2 | 115.1 | 20.2 | 297.2 | 133.1 | 112 |
| Wilson 1790W | 114.0 | 20.3 | 275.3 | 115.1 | 113 |
| Pioneer Brand X1138AW | 112.5 | 16.9 | 299.8 | 109.7 | 114 |
| Whisnand 51AW | 112.2 | 18.8 | 307.5 | 135.3 | 112 |
| AgriGold A6530W | 110.4 | 19.4 | 288.7 | 126.0 | 114 |
| LG Seeds LG2558W | 106.5 | 16.0 | 268.7 | 84.5 | 109 |
| Wilson 1851W | 105.3 | 21.1 | 294.0 | 115.8 | 116 |
| LG Seeds LG2596W | 104.6 | 16.6 | 252.3 | 83.1 | 112 |
| Pioneer Brand 32K72 | 103.8 | 16.0 | 291.8 | 105.4 | 114 |
| Garst 8527W | 100.3 | 14.5 | 235.9 | 83.9 | 108 |
| Trisler T-4211W | 99.2 | 19.2 | 307.9 | 143.1 | 111 |
| Pioneer Brand 32P93 | 98.1 | 17.2 | 285.0 | 94.9 | 111 |
| Zimmerman Z76W | 95.2 | 17.1 | 298.3 | 113.0 | 111 |
| Pioneer Brand X1128BW | 94.4 | 13.7 | 258.7 | 100.4 | 111 |
| IFSI 90-1 | 90.8 | 18.6 | 296.1 | 123.3 | 114 |
| Pioneer Brand 32Y52 | 89.1 | 5.9 | 293.8 | 112.4 | 115 |
| LSD (a=.05) | 19.6 | 3.0 | 12.8 | 10.8 | |
| C.V. (%) | 10.9 | 9.7 | 2.8 | 5.9 | |

*Source: Beauzay and Wicks 1999.*

C. Southeast Research Farm (Beresford, S.D.) white corn production trials, 2001

| *Entry* | *Yield (bu/acre)* | *Percent Water* | *Days Relative Maturity* |
|---|---|---|---|
| IFSI 95-2 | 158.2 | 20.3 | 112 |
| Pioneer Brand 32K72 | 148.8 | 22.3 | 114 |
| Pioneer Brand 3394 (yellow check) | 132.4 | 19.2 | 110 |
| Pioneer Brand 34P93 | 131.4 | 19.1 | 111 |
| Asgrow RX776W | 128.1 | 22.6 | 114 |
| Vineyard V445W | 126.7 | 26.2 | 115 |
| Zimmerman E8272 | 125.1 | 25.7 | 115 |
| Pioneer Brand 32H39 | 121.7 | 20.6 | 115 |
| Pioneer Brand 33T17 | 120.9 | 21.5 | 113 |
| Monsanto EXP 162W | 120.6 | 19.4 | 112 |
| NC+ RE557W | 117.8 | 21.2 | 114 |
| Vineyard Vx6122W | 117.4 | 21.0 | 112 |
| Vineyard V433W | 113.4 | 23.1 | 114 |
| Whisnand 50AW | 107.8 | 21.0 | 111 |
| Vineyard V431W | 106.7 | 20.4 | 113 |
| Zimmerman 1790W | 103.4 | 26.0 | 113 |
| Whisnand 100W | 102.6 | 22.9 | 112 |
| Zimmerman E2010 | 95.6 | 21.7 | 113 |
| Lfy (FR810 x Lfy728W) | 92.5 | 25.8 | 115 |
| B73 x Mo17 (yellow check) | 91.7 | 20.3 | 115 |
| Vineyard V420W | 91.1 | 18.3 | 110 |
| Zimmerman Z75W | 89.7 | 22.1 | 112 |
| Lfy (MBS62W x Lfy728W) | 79.4 | 23.6 | 115 |
| Grand means | 113.2 | 22.0 | -- |
| LSD (a=.05) | 25.5 | 2.0 | -- |
| C.V. (%) | 13.1 | 5.2 | -- |

*Source: Beauzay and Wicks 1999.*

D. Corn dry milling companies by location and milling capacity, 2003

| *Dry Corn Milling Companies* | *City* | *State* | *Daily Grind (bu)* |
|---|---|---|---|
| ADM Milling Co. | Lincoln | Neb. | 13,000 |
| | Jackson | Tenn. | 12,000 |
| Agricore, Inc. | Marion | Ind. | 12,000 |
| Allen Brothers Milling Co. | Columbia | S.C. | 2,000 |
| American Milling Co. | Cahokia | Ill. | 20,000 |
| Amherst Milling Co., Inc. | Amherst | Va. | 12,000 |
| Arrowhead Mils, Inc. | Hereford | Texas | 12,000 |
| Ashland Milling Co. | Ashland | Va. | 12,000 |
| Azteca Milling (Gruma Corp) | Madera | Calif. | 8,000 |
| | Evansville | Ind. | 22,500 |
| | Henderson | Ky. | 4,500 |
| | Amarillo | Texas | 30,000 |
| | Edinburg | Texas | 18,000 |
| | Plainview | Texas | 34,000 |
| Bunge Milling | Danville | Ill. | 50,000 |
| | Crete | Neb. | 36,000 |
| Cargill Illinois Cereal Mills Div. | Paris | Ill. | 50,000 |
| | Indianapolis | Ind. | 36,000 |
| Cereal Food Processors, Inc. | Bonner Springs | Kan. | 12,000 |
| Champlain Valley Milling Corp. | Westport | N.Y. | 12,000 |
| Clifton Mill Co. | Clifton | Ohio | 12,000 |
| Clover Hill Milling Co | Maryville | Tenn. | 6,000 |
| ConAgra Corn Processing | Atchison | Kan. | 36,000 |
| Crescent Mills (Hopkinsville Milling) | Hopkinsville | Ky. | 6,000 |
| Didion Milling, Inc. | Cambria | Wis. | 12,000 |
| H. R. Wentzel Sons, Inc. | Landisburg | Pa. | 6,000 |
| Hodgson Mill, Inc. | Effingham | Ill. | 2,000 |
| Hopkinsville Milling Co. | Hopkinsville | Ky. | 12,000 |
| House-Autry Mills, Inc. | Four Oaks | N.C. | 12,000 |
| J. R. Short Milling Co. | Kankakee | Ill. | 50,000 |
| King Milling Co. | King | N.C. | 12,000 |
| Lakeside Mills, Inc. | Rutherfordton | N.C. | 12,000 |
| | Seven Springs | N.C. | 12,000 |
| Midstate Mills, Inc. | Newton | N.C. | 12,000 |
| Morrison Milling Co. | Denton | Texas | 12,000 |
| New Hope Mills | Moravia | N.Y. | 12,000 |
| North State Milling Co. Inc. | Greensboro | N.C. | 12,000 |
| Nunn Milling Co., Inc. | Evansville | Ind. | 12,000 |
| Pioneer Flour Mills | San Antonio | Texas | 6,000 |
| Quaker Oats Co. | Cedar Rapids | Iowa | 36,000 |
| | St. Joseph | Mo. | 12,000 |
| Scott's Auburn Mills, Inc. | Auburn | Ky. | 6,000 |
| Shawnee Milling Co. | Shawnee | Okla. | 6,000 |
| Southeastern Mills, Inc. | Rome | Ga. | 12,000 |
| The Attala Co. | Kosciusko | Miss. | 12,000 |
| UNOI Grain Mill | Seaford | Del. | 6,000 |
| Weisenberger Mills, Inc. | Midway | Ky. | 12,000 |
| White Lily Foods Co. | Knoxville | Tenn. | 12,000 |
| Wilkins-Rogers, Inc. | Ellicott City | Md. | 12,000 |
| Wilson's Corn Products, Inc. | Rochester | Ind. | 12,000 |

*Source: Milling and Baking Annual 2002; Sparks 2003.*

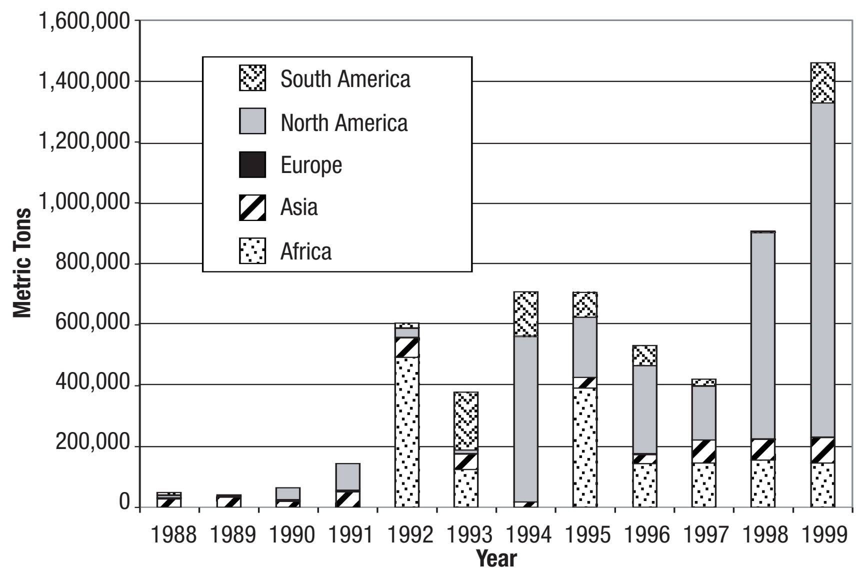
E. Volume of U.S. white corn imported by country, 1988-1999

| | *1988* | *1989* | *1990* | *1991* | *1992* | *1993* | *1994* | *1995* | *1996* | *1997* | *1998* | *1999* |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Mexico | 9,422 | 3,968 | 36,865 | 48,567 | 24,105 | 3,200 | 484,661 | 195,056 | 253,670 | 100,152 | 599,807 | 1,019,609 |
| Japan | 28,609 | 33,912 | 19,200 | 51,869 | 65,257 | 50,448 | 17,451 | 35,993 | 31,090 | 49,886 | 34,823 | 84,049 |
| South Korea | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1,016 |
| Philippines | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 26,391 | 34,950 | 0 |
| Canada | 0 | 0 | 0 | 0 | 0 | 0 | 4,623 | 0 | 0 | 0 | 30,963 | 4,166 |
| Belgium | 0 | 0 | 2,617 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Italy | 0 | 0 | 0 | | 0 | 0 | 0 | 0 | 1,499 | 0 | 0 | 0 |
| Netherlands | 2,694 | 2,678 | 2,550 | 2,692 | 533 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Colombia | 9,538 | 0 | 0 | 0 | 13,793 | 27,942 | 38,762 | 24,995 | 9,500 | 21,590 | 3,962 | 132,588 |
| Costa Rica | 0 | 0 | 0 | 0 | 5,512 | 0 | 0 | 0 | 10,998 | 7,620 | 11,125 | 29,849 |
| EL Salvador | 0 | 0 | 0 | 24,359 | 0 | 0 | 38,941 | 0 | 15,570 | 26,721 | 9,906 | 27,457 |
| Grenada | 0 | 0 | 0 | 0 | 330 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Guatemala | 0 | 0 | 2,753 | 0 | 0 | 0 | 2,997 | 0 | 7,315 | 5,512 | 15,011 | 16,815 |
| Honduras | 0 | 0 | 0 | 14,453 | 0 | 9,600 | 6,782 | 2,743 | 2,896 | 36,932 | 10,998 | 0 |
| Nicaragua | 0 | 0 | 0 | 0 | 0 | 0 | 5,487 | 0 | 0 | 0 | 0 | 0 |
| Venezuela | 0 | 0 | 0 | 0 | 2,998 | 162,903 | 108,261 | 57,483 | 56,998 | 0 | 0 | 0 |
| Cameroon | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2,896 | 0 | 0 |
| Cape Verde | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 5,004 | 7,329 | 3,861 | 0 |
| Ghana | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 32,029 | 0 | 0 |
| Kenya | 0 | 0 | 0 | 0 | 117,430 | 43,132 | 0 | 0 | 0 | 83,668 | 124,384 | 0 |
| Malawi | 0 | 0 | 0 | 0 | 2,693 | 0 | 0 | 3,099 | 0 | 0 | 0 | 0 |
| Mozambique | 0 | 0 | 0 | 0 | 24,868 | 0 | 0 | 0 | 0 | 0 | 0 | 21,996 |
| Namibia | 0 | 0 | 0 | 0 | 0 | 29,034 | 0 | 0 | 0 | 0 | 0 | 0 |
| Rwanda | 0 | 0 | 0 | 0 | 0 | 10,796 | 0 | 0 | 0 | 0 | 0 | 0 |
| South Africa | 0 | 0 | 0 | 0 | 218,759 | 31,905 | 0 | 387,497 | 137,668 | 0 | 26,238 | 0 |
| Tanzania | 0 | 0 | 0 | 0 | 0 | 9,907 | 0 | 0 | 0 | 19,202 | 0 | 99,492 |
| Zimbabwe | 0 | 0 | 0 | 0 | 128,911 | 0 | 0 | 0 | 0 | 0 | 0 | 24,206 |
| Total Metric Tons | 50,263 | 40,558 | 63,985 | 141,940 | 605,189 | 378,867 | 707,965 | 706,866 | 532,208 | 419,928 | 906,028 | 1,461,243 |
| Total Bushels[a] | 1,978,747 | 1,596,682 | 2,518,952 | 5,587,874 | 23,824,994 | 14,915,182 | 27,871,065 | 27,827,800 | 20,951,889 | 16,531,666 | 35,668,381 | 57,526,006 |

[a]Bushels conversion was done by multiplying metric tons by 2,204.6 to convert to pounds and then dividing by 56 to convert to a bushels basis.

*Source: Boland 2000.*

F. Continents importing U.S. white corn, 1988-1999




*Source: USDA.*