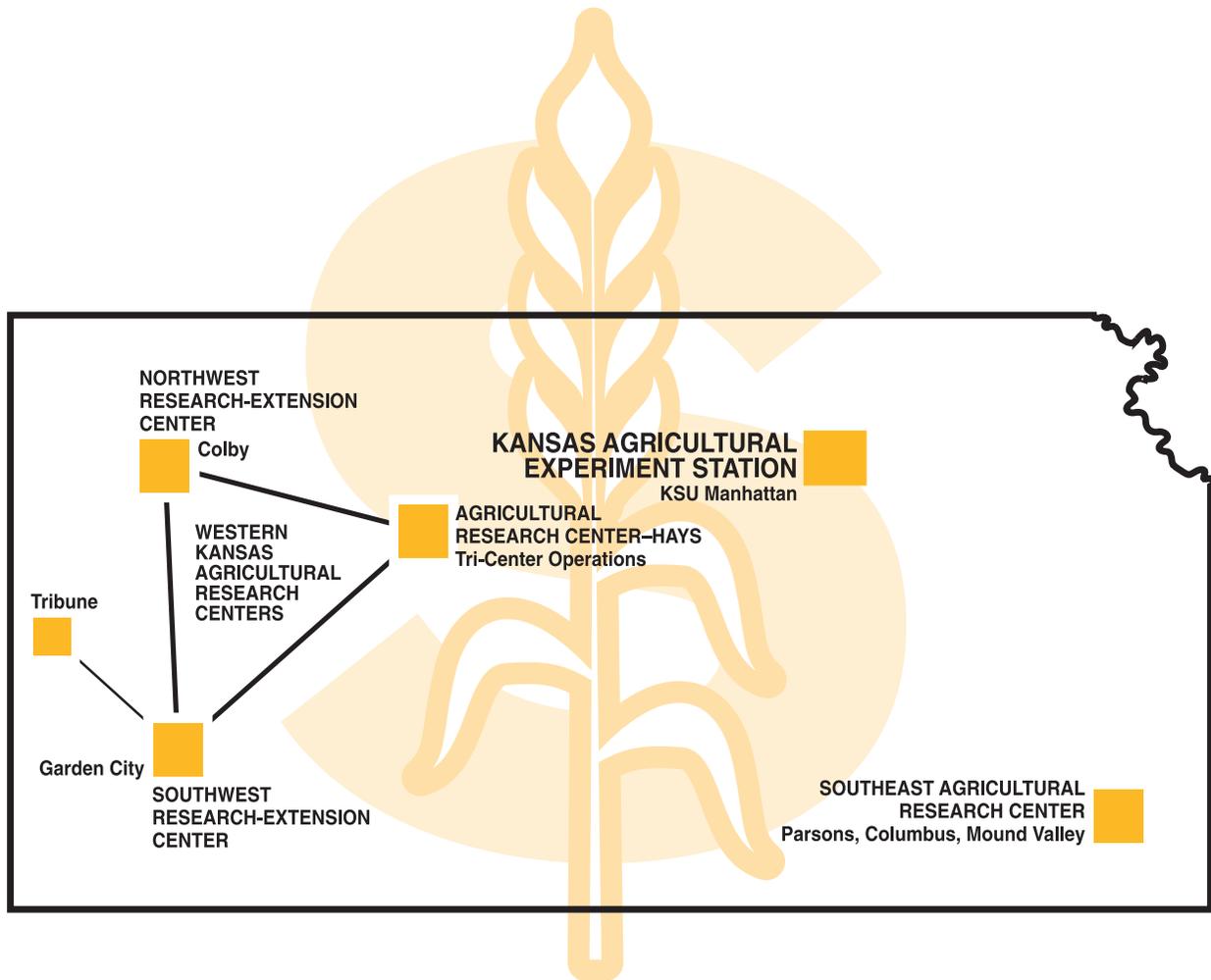


Economic Issues with Value-Enhanced Corn



Agricultural Industry Competitiveness

Enhance the value of Kansas Agricultural goods

Corn is the dominant feed grain of the Great Plains. The United States is generally a low average cost, high-volume producer of corn. Consequently, advancements in corn breeding have focused on increasing yields and plant hardiness to help maintain this strategy. More recently, advances in technology and increased competition has caused a focus on differentiation. Overall low cost leadership and differentiation are the two generic strategies most often used by firms when building a competitive strategy (Porter).

The term “mass customization” has been used to describe how firms might be able to produce customized products for different market segments. Regardless, firms using such a competitive strategy will need to operate at the lowest average cost if they are to succeed in marketing products to these customized market segments. A competitive strategy that requires a firm to focus on particular market niches and provide differentiated products requires tremendous coordination, from identification of end-user needs to selection of genetic traits that may satisfy these needs profitably.

What is the role of corn in the 21st century? Recent development of “value-enhanced corn hybrids,” which are marketed directly to industrial millers and livestock feeders, may provide economic incentives for producers and help diversify market price or production risk.

Economic Traits of the Corn Industry

Corn is the number one field crop produced in the United States in terms of both acreage and value. The United States is the largest producer and exporter of corn worldwide. Corn is also important to the state of Kansas as a feed and cash crop, accounting for 2.85 million Kansas acres and \$817 million of crop value in 1998. Kansas is the eighth largest corn

producing state in the nation (Kansas Agricultural Statistics Service). Figure 1 illustrates U.S. and Kansas corn production for marketing years 1981 to 1999.

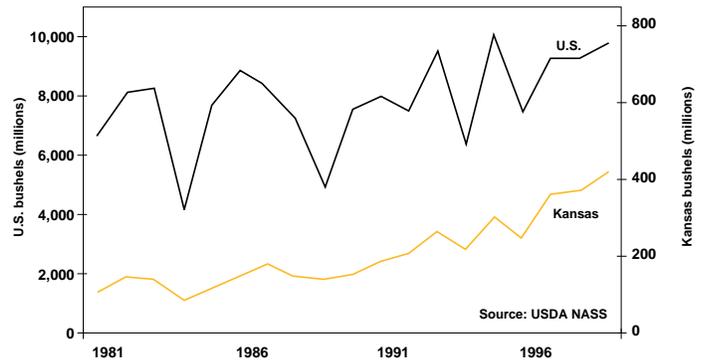


Figure 1. U.S. and Kansas Corn Production

There are more than 3,700 uses for corn, making it one of the most important cereal crops. Broadly defined uses for corn are industrial, human food, and livestock feed. Corn is a primary ingredient in livestock rations and is fed in various forms to account for 85 percent of the grain used in livestock feed. Food processors use corn as a sweetener, food stabilizer, and flour. Industrial uses for corn include adhesives, fuel, and biodegradable plastics.

Feed is the largest market for U.S. corn, accounting for approximately 60 percent of utilization (USDA ERS). In addition, some U.S. corn is exported as livestock feed. The remaining 20 percent of the nation’s crop is processed for numerous food and industrial uses (USDA ERS). Figure 2 depicts utilization of the 1998 corn crop, including the largest food and industrial uses. Figures 3 and 4 depict size of the largest U.S. corn markets since 1981.

Drivers of Change in the Corn Industry

Drivers of change are variables that are thought to strongly influence industry profitability over a 3- to 5-year time

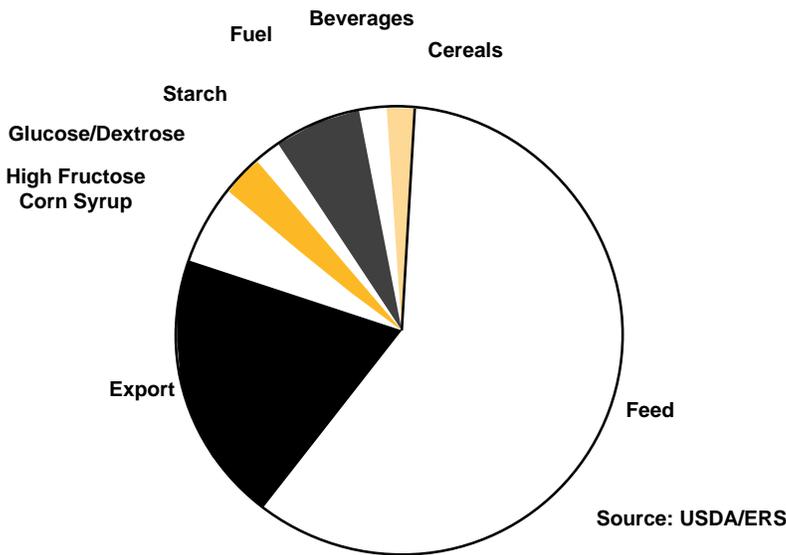


Figure 2. Percentage of U.S. Corn for Feed, Food, and Industrial Use, 1998

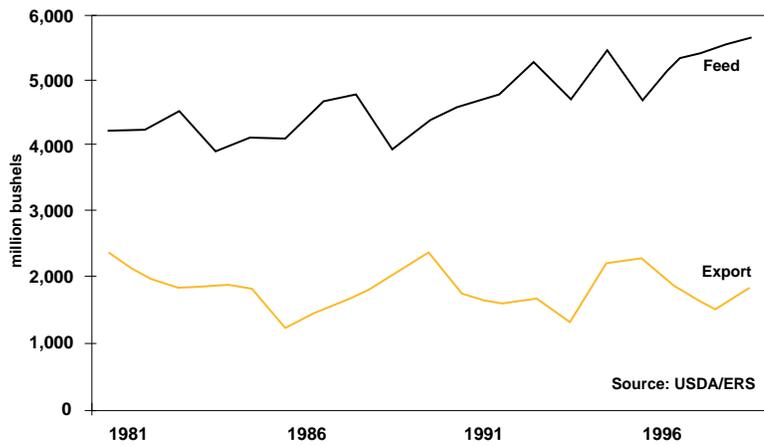


Figure 3. U.S. Corn Feed and Export Use

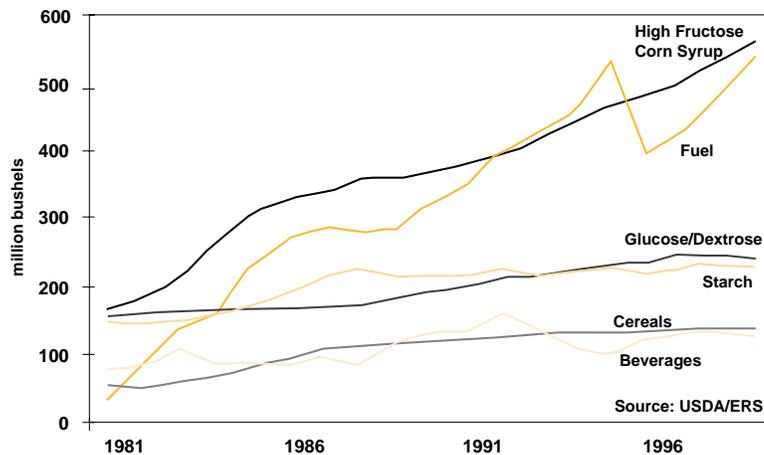


Figure 4. U.S. Corn Crop Food and Industrial Use

horizon. Supply and demand for value-enhanced corn relative to commodity corn is being driven by end-user demands, quality assurance, and consolidation.

End-User Demands

Social and ethical considerations are increasingly important in food marketing. Consumer preferences reflect developing awareness of health and other concerns. Interest in substitutes for petroleum products are expanding due to environmental concerns. Corn is an inexpensive, stable food derivative and can be used in industrial products. Technology has precipitated development of food and industrial uses for corn, which has seen significant growth since 1980.

Quality Assurance

Value can be added to differentiated products only if quality traits (e.g., oil, amylose content) can be preserved in the market channel. Identity preservation is regarded as a primary challenge to the development of value-enhanced grains (Crum and Fink). However, since corn is a homogeneous product, preserving traits through the market chain increases costs. Identity preservation changes traditional corn handling, storage, and processing. A survey of grain handlers conducted by *Feedstuffs* magazine found that country elevator managers handling VEC corn spent more than \$500,000 retooling their operations and anticipate an additional cost of \$300,000 over the next 5 years. The additional costs translate into an extra \$0.02 per bushel per month charge for grain storage (Muirhead).

Consolidation

Seed companies require extensive resources to develop technology. Vertical (e.g., grain handler and processor) and horizontal (e.g., chemical and seed firm) integration has occurred. New licensing agreements, mergers, acquisitions, and joint ventures have taken place. Seed companies have developed relationships with chemical and other agricultural

science firms, creating new “life sciences” businesses. These companies are developing markets for identity-preserved products (Hammes). Consolidation also has occurred in grain processing and handling. Firms coordinate to reduce average costs through large volume.

Vertical coordination between producers and end-users in the form of contracts or vertical integration is continually increasing (Boland and Barton). Since 1990, reductions in government involvement in agricultural markets (e.g., the FAIR Act) have increased the risk exposure of producers to price variation from supply and demand conditions, which has precipitated the use of risk management tools such as contracts and vertical integration (Martinez). In 1997, an estimated 34 percent of total U.S. farm output was contracted relative to 30.5 percent in 1990 (Martinez, USDA ERS).

Economic Traits of Value-Enhanced Corn

Value-enhanced corn (VEC) is “corn with particular quality characteristics that add end-user value” (U.S. Grains Council). VEC can potentially increase end-user profitability, thereby creating an economic incentive relative to commodity corn at the farm level. Growth in value-enhanced crop acreage has been steady, and is estimated to account for 5 to 5.6 percent of the 1999 U.S. corn crop (U.S. Grains Council, 1999). Table 1 summarizes value-enhanced corn acres from that report.

End-Users of Corn

End-users of corn include livestock producer-feeders, feed manufacturers, wet corn millers, dry corn millers, and alkaline corn processors. Different end-users utilize corn through various methods and desire corn properties specific to their individual uses. The ability to procure these properties in raw corn adds value to the end-user through increased profits. End-user needs are derived from consumers of products containing corn and other manufacturers using corn derivatives. The

Table 1. U.S. Value-Enhanced Corn Trends from U.S. Grains Council Report

	U.S. Acreage (1,000)				Price Premium Range
	1996	1997	1998	1999	
White	575	550	725	775	\$0.45 - 0.60
Waxy	400	420	500	525	\$0.25 - 0.30
Yellow Food Grade	800	800	1,000	1,000	\$0.02 - 0.25
High Oil	400	700	900	1,250	\$0.20 - 0.30
Nutritionally Dense	140	140	140	240	\$0.10 - 0.20
High Amylose	35	35	35	45	\$1.20 +
Blue	n.r. ^a	n.r.	n.r.	n.r.	n.r.
Organic	n.r.	n.r.	n.r.	n.r.	n.r.

^an.r. denotes not reported

Source: U.S. Grains Council

end-user’s ability to obtain value determines the extent of economic incentives available to producers. End-users evaluate value-enhanced corn by studying traits and assigning value based on benefits compared to commodity corn. Most often, evaluation is carried to the level of specific commercial seed hybrids.

Value-enhanced corn is defined in terms of traits and components. Traits are the value-adding characteristics of corn leading to differentiated product marketing (e.g., waxy, nutritionally dense, high oil). Components are the specific value-adding attributes of corn creating traits (e.g., starch content, oil content, protein). Note that a trait may have more than one component. For instance, nutritionally dense corn (trait) may have multiple components, such as increased protein levels, altered levels of amino acids, and elevated oil content.

Livestock Feeders

Feeders value corn traits that create substitutability for more expensive feedstuffs or feed additives. Specific value-enhanced corn traits of interest to feeders include increased oil content (energy), modified fatty acid ratios, cholesterol-reducing properties, elevated protein levels, increased essential amino acids, and improved use of amino acids. On-farm feeding is considered a potential market for VEC because it may potentially add value to the producer’s livestock enterprise. The development of larger, specialized livestock and poultry opera-

tions has also created market opportunities for producers to supply VEC. Kansas is a major beef producing state, as well as having dairy, swine and poultry production. Figure 5 describes cattle on feed, milk cows, hogs, and poultry January 1 inventories for the state of Kansas.

Feed Manufacturers

Feed manufacturers supply a variety of feed products including complete ration feeds and nutrient supplements. They produce feed formulated for non-limiting nutrients while minimizing variability in nutritional composition. Furthermore, manufacturers must deliver products at the lowest cost for livestock production and value corn traits which meet the needs of feeders. Commercial feed production in Kansas has been stable since 1981 as shown in Figure 6.

Wet Millers

The wet milling process separates corn into its basic components (e.g., starch, sugar, oil) which can then be used for a variety of food and industrial uses. The corn component desired depends on the end use. Residual components (those not used in the end product) are worth less to the wet miller and are often sold for feed. To minimize costs, millers seek to maximize the extractable level of a given component (Sprague and Dudley). This increases the usable portion of raw corn and the value of that corn. Corn traits (not to be confused with components) desired by wet millers are those which increase extractable levels of components. Altered component levels and component purity or quality are value-enhanced traits. Traits affecting physical kernel attributes are also important for minimizing process costs.

Wet mills are generally large-scale operations and are devoted to producing one product. Corn sweeteners (high fructose corn syrup, dextrose), ethanol, and high grade starch products are examples of wet mill outputs. Some mills are closed cooperatives and contract only with members (e.g., Minnesota Corn Processors). Other major wet millers are large private firms (e.g., Cargill, A.E. Staley, Archer Daniels Midland, and National Starch Corporation).

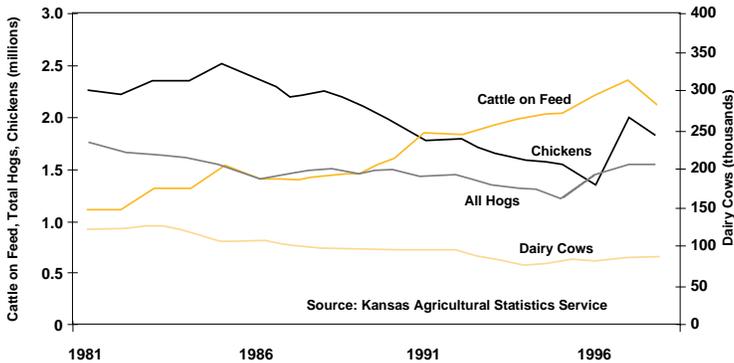


Figure 5. Kansas January 1 Inventories of Cattle on Feed, Hogs, Chickens, and Dairy Cows

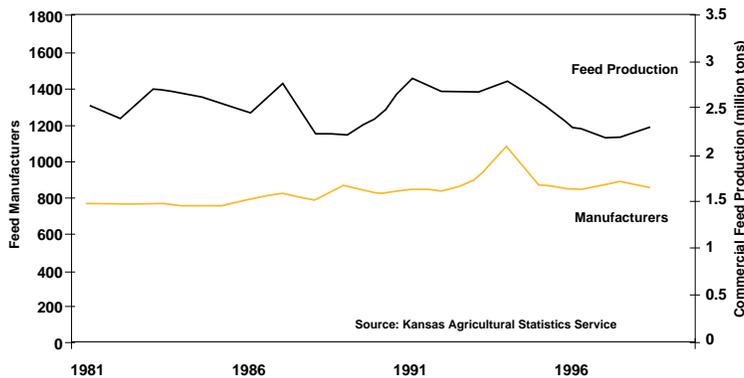


Figure 6. Kansas Feed Manufacturers and Commercial Feed Production

Dry Millers

Dry millers vary greatly in size and outputs. Dry mill outputs range from industrial grade derivatives (starches for building materials, corrugating, adhesives, etc.) to finished food products (corn starch, breakfast cereals, pancake, etc.). Therefore, different mills may desire different corn traits. The dry milling process yields products of various sizes and nutritional contents. The main products rendered are hominy (a food product), corn oil, grits, meal, and flour. Altering the relative yields of these products allows specialization by a mill.

Alkaline Processors

The basis of alkaline processing is cooking corn in a lime-water solution, then grinding it for flour. Alkaline processors mainly produce tortillas, tortilla chips, corn chips, and similar products. Color and finished-product quality are primary concerns for corn procurement. Some specific corn properties important for alkaline processing are resistant to mold and insects, uniform kernel size, uniform kernel hardness, absence of stress-cracks, and ease of pericarp removal.

Demand for Mexican food and tortilla processing has promoted growth in U.S. alkaline processing. In 1997, the U.S. tortilla industry used 796 million pounds of corn flour. In addition, Mexican specialty processors utilized 25.4 million pounds of corn flour and 30.4 million pounds of raw corn in 1997. California and Texas are the top two tortilla producing states (U.S. Department of Commerce).

Overview of Value-Enhanced Corn Products

There are two methods through which value-enhanced corn can increase returns to the end user, and hence, provide economic incentives to producers. The first method is to alter levels of specific components in corn by maximizing corn components and associated profit potential or minimizing the amount of corn used for the same value. The second method is to improve process-

ing properties. Processing properties may add value by minimizing costs of producing products from corn (Eckhoff). Table 2 is a summary of commercially available value-enhanced corn products and markets which may provide economic incentives for Kansas producers. Figures were obtained from a telephone survey of Kansas district sales managers and seed representatives in the summer of 1999.

White Corn

Pure white kernel color is the distinguishing trait of white corn. White corn is dry milled or alkaline processed to produce high quality, light colored flour for food use. Some white corn is used in food grade starch and paper. Processors of white corn desire pure white color, large, uniform kernels, and high specific gravity, as well as other basic attributes for processing efficiency. Typically, 30 to 40 percent of the white corn produced in the United States is exported. Mexico is the major importer, accounting for 56 percent of all U.S. exports in 1998 (USDA ERS). There were approximately 45,000 white corn acres in Kansas in 1999.

High Oil Corn

High oil corn (HOC) has an increased kernel oil component. Typical commercial corn hybrids contain 4 to 5 percent oil, while common high-oil hybrids produce from six to more than nine percent oil content. Advantages of higher oil content

Table 2. Summary of Value-Enhanced Products in Kansas

	Primary Markets			Produced in Kansas?	Estimated 1999 Acres
	Food	Feed	Industrial		
White	X		X	X	45000
Waxy	X		X	X	<5,000
Yellow Food Grade	X			X	50,000 ^a
High Oil		X		X	25000
Nutritionally Dense		X		X	<5,000
High Amylose			X		0
Blue	X				0
Organic	X	X		X	n.a. ^b

^aLittle or none marketed as identity-preserved

^bn.a. denotes information not available

in corn for livestock feeders may include increased energy, increased quality protein, increased limiting amino acids, reduced feed dust, and improved nutritional uniformity. The primary market for high oil corn is livestock feed, as a substitute for feed additives and more expensive feedstuffs. HOC is grown throughout the corn belt. There were approximately 25,000 acres of HOC in Kansas in 1999.

Waxy Corn

Waxy corn kernels have no amylose component in their starch, but possess 100 percent amylopectin (the waxy component), whereas commodity corn has approximately 72 percent amylopectin. For corn to be identified as waxy, it must contain 95 percent or more waxy kernels as determined by a chemical test. Waxy corn has a variety of uses in food, paper, textiles, corrugating, adhesives, and as livestock feed. Future growth potential is positive for food and industrial uses (Sprague and Dudley). There is also a significant export market for waxy corn in Europe and Asia. For example, Japan imported nearly 50,000 metric tons of yellow waxy corn in 1998. Waxy corn starch is produced by wet milling, and there are three major millers of waxy corn: National Starch and Chemical Company, A.E. Staley Company, and American Maize Products. The U.S. Grains Council estimates 70 percent of waxy corn is grown under contract, 10 percent is fed, and 20 percent is sold on the open market. There were approximately 5,000 acres planted in Kansas in 1999.

Food-Grade Yellow Corn

Food-grade corn has improved properties for milling and production of food products. There are different kinds of food corn, but the most common traits are white cob (absence of red glumes), absence of dents, easy pericarp removal, and hard endosperm. Food-grade yellow corn meets the more specific needs of food processors for easier milling. However, food-grade yellow corn is not exclusively grown for a

specific use, so supply and demand varies depending upon the existing quality of commodity corn. Many commercially grown yellow dent hybrids have food grade traits. However, most of this corn is not identity preserved and is sold as commodity corn. There were approximately 50,000 acres of yellow food-grade corn planted in Kansas in 1999. However, little or none is segregated and marketed through an identity-preserved channel.

Nutritionally Dense Corn

Nutritionally dense corn has superior feed value due to higher levels of key nutrients (e.g., protein, increased amino acids). Much of the nutritionally dense corn is fed on-farm, where it adds value to the livestock enterprise. Since the market for feed is large, most seed companies are working on specialty feed corn traits. Individual seed companies focus on different improvements so there is a variety of products. Less than 1,000 acres of nutritionally dense corn were planted in Kansas in 1999.

Organic Corn

Organic corn is any corn hybrid produced under organic cultivation methods. Organic corn is marketed to food processors or fed in organic livestock production. Organic cultivation of crops does not have a simple universal definition (Lampkin). The USDA defines organic farming as “a production system which avoids or largely excludes the use of synthetically compounded fertilizers, pesticides, growth regulators, and livestock feed additives. To the maximum extent feasible, organic farming systems rely on crop rotations, crop residues, animal manures, legumes, green manures, off-farm organic wastes, and aspects of biological pest control to maintain soil productivity and tilth, to supply plant nutrients and control insects, weeds, and other pests.” This definition covers common management practices of organic producers, but not all of the principles associated with organic production. There are little data on organic corn acreage in Kansas.

High Amylose Corn

High amylose corn has more than 27 percent amylose which is one of the two types of starch compounds found in corn. There are two classes of commercially available high amylose hybrids: class V hybrids, which yield 55 to 60 percent amylose and class VII hybrids, which yield 70 to 80 percent amylose. High amylose corn is wet milled to produce high-amylose flour, which can be used in food, paper, textiles, corrugation, and adhesives. The flexible chemical structure of amylose makes corn flour a possible substitute in numerous products. Currently, there are two main U.S. firms that contract and process high amylose corn: National Starch and Chemical Company and American Maize Products Company. Processing and acreage is concentrated in east central Illinois and west central Indiana (Hallauer). There is little or no high amylose corn acreage in Kansas at the present time.

Blue Corn

As the name suggests, blue corn produces completely blue kernels and blue flour/food products when processed. Blue corn is processed for use in tortillas, pancake mixes, cornbread mixes, corn chips, and cereal due to high protein, soft endosperm, and milling properties. However, color is the trait which creates value for blue corn. Blue corn production is concentrated in the southwest United States. There is little or no blue corn acreage in Kansas at the present time.

New Developments in Value-Enhanced Corn

Product development in the seed industry is moving quickly. There are a number of products “in the pipeline” with potential to add value. The following products are not yet widely adapted for commercial production.

Low-Phytate Corn

Low-phytate corn is corn with decreased phytic acid, which increases phosphorus utilization and lowers phos-

phorus in non-ruminant animal manure. Low-phytate corn hybrids available contain 84 percent digestible phosphorus; three times that of conventional corn. Phosphorus is an essential nutrient for growth, but may be harmful to the environment in surface water runoff. To maintain proper nutrition, feeders supplement inorganic phosphorus into the diet. Feeders may add phytase enzyme to their feed which may increase phosphorus use to around 42 percent but phytase may not be cost-effective for all producers (Boland, Preckel, and Foster).

High Starch Corn

High starch corn yields more starch when processed. Common corn cultivars are composed of four to five percent oil and yields around 66 percent starch (dry matter basis) when wet milled. Commercial hybrids vary in starch yield, and some corn is identified as “high starch” (Sprague). However, there is interest in developing true high-starch hybrids. The goal is a cultivar with approximately 3 percent oil, 5 percent protein, and a 3 to 4 percent increase in starch yield. Increased starch yield lowers costs for producing products from corn starch. There has been expanded interest in corn starch for use in ethanol production. A 1 percent increase in corn starch is associated with an approximate 1 percent increase in ethanol yield.

High-Lysine Corn

High-lysine corn has improved protein quality because of higher levels of lysine, a constituent of protein. Lysine and tryptophan are two amino acid constituents of proteins necessary in non-ruminant animal diets. Lysine levels in corn are not enough to meet the requirements of non-ruminants and consequently, synthetic lysine supplements or other feedstuffs are added to feed rations. Reducing the need for expensive supplements or increasing the amount of corn used in feed rations creates value for high-lysine corn. High-lysine hybrids generally yield (bushels/acre) 7 to 10 percent lower than commer-

cial hybrids due to possible cross pollination and other factors. The opaque-2 gene, which produces high-lysine, also produces a softer, chalky endosperm, which cracks easier during harvest and is more susceptible to rots and molds. Nearly all high-lysine corn is expected to be fed on-farm.

Risk Factors with Value-Enhanced Corn

There are two kinds of risk in producing crops: production risk and marketing risk. Production risk for producing value-enhanced corn includes producing a crop that meets the quality standards of the buyer and is profitable to grow (e.g., sufficient yields). Marketing risk is the ability to market the value-enhanced trait to gain economic profits.

Production Risks

There are special considerations in production risk management for VEC. Commodity corn has been developed for performance in the field. Many of the VEC trade agronomic performance for additional traits. Soil preparation, crop monitoring, and crop protection costs may be different from commodity corn. In addition, many VEC products also have higher seed costs to compensate for research and development. Yields, ease of harvesting, and susceptibility to weather, pest, and disease pressure are all production risk factors. There also may be risks associated with crop rotations, equipment needs, finance needs, or other production factors. Economic incentives are only available if quality can be harvested, stored, and preserved in an identity-preserved market channel. Crop diversification is a primary method to minimize risk while evaluating VEC potential. Production risk for VEC is described below.

White corn hybrids may yield 5 percent lower than yellow dent corn due to breeding complexity (Hallauer). Food-enhanced and nutrient traits are bred into existing commercial lines or already exist in those lines and thus, there are no performance or management considerations for producing food grade yellow corn.

The TopCross® system, developed by DuPont, represents most commercially available high oil corn technology. In this system, a typical inbred hybrid is crossed in the field with a high oil inbred containing 20 percent or more oil to produce a field content in the 6 to 9 percent range. This is accomplished through 90 to 93 percent male-sterile females which will produce the crop and 7 to 10 percent pollinator plants, which produce little or no seed but pollinate the entire field. To compensate for the reduction in productive plants, seed companies have suggested increasing planting populations (and hence, increased seed cost per acre). Research in Kansas has shown about an 8 percent yield drag with high oil hybrids

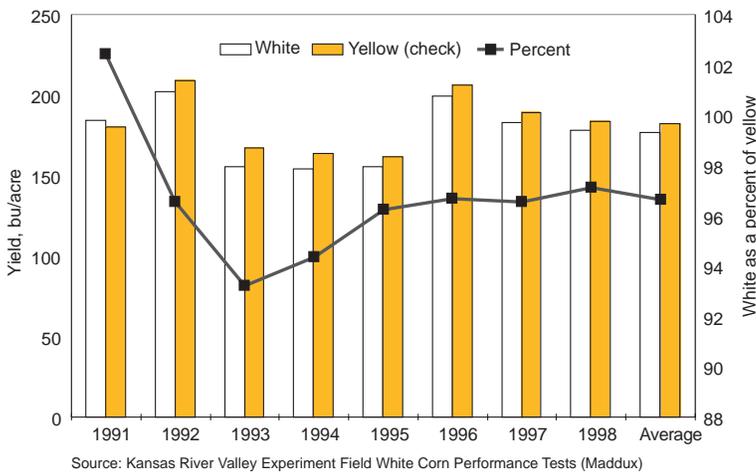


Figure 7. White and Yellow Corn Yields in Northeast Kansas

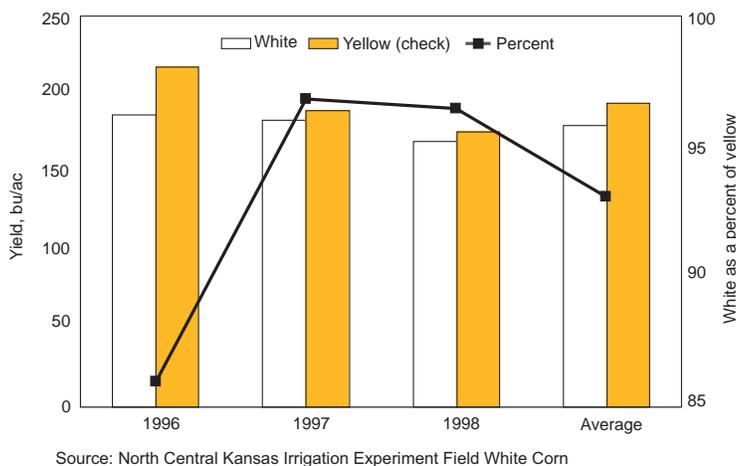


Figure 8. White and Yellow Corn Yields in North Central Kansas

compared to conventional yellow corn (Staggenborg, Maddux, and Gordon).

Waxy corn yields are similar to commercially available corn hybrids. The primary risk associated with growing waxy corn is maintaining 95 percent waxy grain. Waxy corn seed contains approximately 97 percent waxy kernels. This means production requires careful management to prevent pollen contamination from other corn.

High-amylose corn hybrids yield 20 to 35 percent lower than conventional hybrids due to germination and emergence concerns. Due to the method in which high amylose is produced, pollination is critical as high amylose fields require protection from contamination by non-high amylose corn pollen. Organic farming requires intense management and often results in much lower yields due to insect and weed damage.

Blue corn was isolated from Native American corn cultivars. Many of the blue corn cultivars have relative maturities above 115 days and are open-pollinated. Water must be managed carefully to control growth. Fertility management is also different, as the crop is “hilled”, by burying four to six inches of the plant during growth.

Market Price Risks

Markets of non-commodity crops such as VEC often experience greater volatility in supply, demand, and prices than commodity markets. Economic incentives may vary between contracts and over time. The U.S. Grains Council surveyed 3,233 corn producers in the Corn Belt (46 percent response rate). Several findings were noted that have an effect on market price risk: 1) drying, storage, and delivery, 2) entry and exit from year-to-year, 3) contracts, and 4) lack of markets.

Drying, Storage, and Delivery

Almost 65 percent of the respondents dry and store VEC on-farm. However, almost 90 percent have on-farm drying and storage facilities for approximately two-thirds of an average crop. Almost 40

percent use continuous flow, 35 percent dry in-bin with heat, 15 percent dry in-bin with air only, and 10 percent use batch dryers. There was great variability in drying costs. One-third indicated that low-temperature drying costs were \$0.02 or less per bushel while 30 percent reported drying costs of more than \$0.08 per bushel. Clearly, storage costs are an important aspect of VEC. On-farm segregation costs had similar variability. Almost 20 percent indicated that segregation costs were \$.04 or less per bushel. However, the remaining 80 percent indicated costs greater than \$0.04 per bushel. Finally, almost half the producers required at least a \$0.08 per bushel delivery charge. It should also be noted that premium expectations have become lower over time, which suggests that supply is increasing or the production cost structure has declined (i.e., lower management costs, etc.).

Entry and Exit

Production of VEC is increasing. In 1995, approximately 5 percent had produced VEC compared to 12 percent in 1999. However, there is great entry and exit from year-to-year. Of the respondents in the USGC survey, almost 30 percent planted VEC for the first time in 1999. Less than 12 percent grew VEC in 1998 and not in 1999. These are comparable to figures reported in past years. Those who have continuously grown VEC since 1995 (12 percent of respondents) have increased VEC acreage by more than 75 percent since that year. Thus, it is apparent that a small percentage of producers have been able to “learn to manage” VEC and have increased acreage significantly over the past 5 years. Previous experience, premiums paid, and feed value were most frequently cited as reasons to plant VEC. Satisfaction with returns from their current commodity corn hybrid and lack of premiums were cited as two most frequent reasons for not continuing to produce VEC. Other reasons included lack of local markets, segregation and delivery constraints, and extra management effort. This

entry and exit can also be seen in premium expectations which were quite variable among producers.

Contracts

Approximately 50 percent of the VEC is grown under contract. However, this varied by VEC. All high-amylose corn is contracted relative to 75 percent for waxy corn, 64 percent for white corn, 52 percent for food-grade corn, and 40 percent for high-oil corn. Marketing contracts were most often used.

Lack of Markets

Lack of markets was most frequently cited as a constraint for producing additional VEC. To reduce average costs and obtain maximum value for processing VEC, processors are likely to purchase corn from producers surrounding their immediate facility. Thus, proximity to an industrial miller or processor is likely to be important in determining whether a producer plants VEC. For feed crops such as high-oil corn, producers are likely to grow their own or purchase from a local market.

Almost 45 percent of the 110 grain elevators surveyed by the U.S. Grains Council in 1999 reported purchasing VEC compared to 20 percent in 1996. High-oil corn was segregated by 34 percent of these elevators (relative to only 9 percent in 1996) while less than 10 percent handled waxy, white, or other VEC. High-oil corn has the greatest potential growth increase. Average premiums paid for high-oil corn decreased for the second year, suggesting that supply has increased through increased acreage or reduced yield losses due to greater management experience and elite hybrid development. Technologies were used by 25 percent of the elevators to test for composition (e.g., oil percentage). These elevators were purchasing 41 percent of all VEC volume. Forty percent reported plans to modify their existing system to handle segregated corn. The most significant impediment to VEC markets was that the costs were too great

relative to returns. Other reasons included small volumes, lack of contact with end-users, and a “commodity” mindset.

Other Issues

Premiums for VEC may change from year-to-year depending upon three factors. First, the quality of commodity corn changes from year-to-year. Thus, the benefit-cost trade-off of using a VEC vis-a-vis commodity corn may not be as great in years of poor quality. Second, the supply of VEC is increasing which reduces other costs such as management or segregation and thus, lowers the economic incentives. Finally, as supply increases in response to demand, these incentives will decrease so that prices will be equated to the market price plus any additional costs incurred to maintain quality in order to market through a segregated marketing channel.

Tables 3 to 5 show projected budgets for production of high oil, white, and waxy corn in northeast Kansas. These budgets can be used to compare VEC to commodity corn and determine required economic incentives. Figure 9 gives the necessary premiums to compensate for possible yield losses for high oil, white, and waxy corn based on tables 3 to 5. Although general effects of production considerations may be studied, it is important for individual producers to evaluate VEC production in the context of their own operations.

Implications

Value-enhanced corn is becoming an important component of enhancing income for many Corn Belt producers. Lack of local markets may be a hindrance to increased acres of VEC in Kansas. However, high-oil corn and white corn appear to be options for some Kansas producers given local feed or processing markets. It is likely that there will not be as much VEC production in Kansas relative to other states where there are more markets.

Table 3. Costs/Returns of Producing High Oil Corn vs. Commodity Corn

Variable Expenses per Acre	High Oil	Commodity	Difference (HOC – commodity)
Seed			
Seed Cost/Bag (80,000 kernels)	\$ 116.16	\$ 96.80	\$ 19.36
Seeding Rate per Acre	25,080	22,800	2,280
Total Seed Cost per Acre	\$ 36.42	\$ 27.59	\$ 8.83
Labor	32.40	32.40	0
Herbicide	22.28	22.28	0
Insecticide	16.34	16.34	0
Fertilizer	25.25	25.25	0
Fuel	6.31	6.31	0
Machinery	19.64	19.64	0
Drying	10.80	10.80	0
Miscellaneous	8.00	8.00	0
Interest on Variable Costs	7.98	7.59	0.40
Total Variable Costs	\$ 185.42	\$ 176.20	\$ 9.23
Yield per Acre	102.6	108	-5.4 (5% yield loss)
Price per Bushel	\$ 2.33	\$ 2.33	0
Total Revenue per Acre	\$ 239.06	\$ 251.64	\$ -12.58
Return over Variable Expenses	\$ 53.64	\$ 75.44	\$ -21.81
To Breakeven with Commodity Corn			
Break-even Price at Projected Yield*	\$ 2.54		\$ 0.21
Break-even Yield without Price Premium*	112.0		\$ 4.0

**Does not include cost associated with identity preservation
Adapted from Dhuyvetter*

Table 4. Costs/Returns of Producing White Corn vs. Commodity Corn

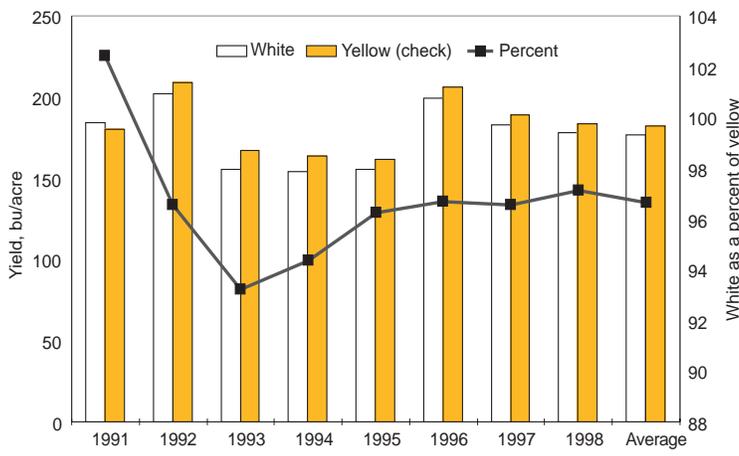
Variable Expenses per Acre	White	Commodity	Difference (white - commodity)
Seed			
Seed Cost/Bag (80,000 kernels)	\$ 106.48	\$ 96.80	\$ 9.68
Seeding Rate per Acre	22,800	22,800	0
Total Seed Cost per Acre	\$ 30.35	\$ 27.59	\$ 2.76
Labor	32.40	32.40	0
Herbicide	22.28	22.28	0
Insecticide	16.34	16.34	0
Fertilizer	25.25	25.25	0
Fuel	6.31	6.31	0
Machinery	19.64	19.64	0
Drying	10.80	10.80	0
Miscellaneous	8.00	8.00	0
Interest on Variable Costs	7.71	7.59	0.12
Total Variable Costs	\$ 179.08	\$ 176.20	\$ 2.88
Yield per Acre	102.6	108	-5.4 (5% yield loss)
Price per Bushel	\$ 2.33	\$ 2.33	0
Total Revenue per Acre	\$ 239.06	\$ 251.64	\$ -12.58
Return over Variable Expenses	\$ 59.98	\$ 75.44	\$ -15.46
To Breakeven with Commodity Corn			
Break-even Price at Projected Yield*	\$ 2.48		\$ 0.15
Break-even Yield without Price Premium*	109.2		\$ 1.2

**Does not include cost associated with identity preservation
Adapted from Dhuyvetter*

Table 5. Costs/Returns of Producing Waxy Corn vs. Commodity Corn

Variable Expenses per Acre	Waxy	Commodity	Difference (waxy-commodity)
Seed			
Seed Cost/Bag (80,000 kernels)	\$ 103.58	\$ 96.80	\$ 6.78
Seeding Rate per Acre	22,800	22,800	0
Total Seed Cost per Acre	\$ 29.52	\$ 27.59	\$ 1.93
Labor	32.40	32.40	0
Herbicide	22.28	22.28	0
Insecticide	16.34	16.34	0
Fertilizer	25.25	25.25	0
Fuel	6.31	6.31	0
Machinery	19.64	19.64	0
Drying	10.80	10.80	0
Miscellaneous	8.00	8.00	0
Interest on Variable Costs	7.67	7.59	0.09
Total Variable Costs	\$ 178.21	\$ 176.20	\$ 2.02
Yield per Acre	108	108	0 (no yield loss)
Price per Bushel	\$ 2.33	\$ 2.33	0
Total Revenue per Acre	\$ 251.64	\$ 251.64	\$ 0.00
Return over Variable Expenses	\$ 73.43	\$ 75.44	\$ -2.02
To Breakeven with Commodity Corn			
Break-even Price at Projected Yield*	\$ 2.35		\$ 0.02
Break-even Yield without Price Premium*	108.9		\$ 0.9

*Does not include cost associated with identity preservation
Adapted from Dhuyvetter



Source: Kansas River Valley Experiment Field White Corn Performance Tests (Maddux)
Figure 9. Economic Incentives Needed for Possible Yield Loss

Key Questions and Answers

What are key success factors for the adoption of value-enhanced corn? The value added by a specific value-enhanced trait must be greater than the cost of bringing that trait to the end-user. There has to be economic incentives for each level of the value chain to have a successful value-enhanced corn market. Some of the

most common factors for success include: 1) incentives large enough to cover large research and development costs of seed development and have value left for everyone else, 2) reliable supplies, both year-to-year and on a 12-month basis, 3) consistent delivery of desired traits, 4) ability to measure quality attributes accurately, and 5) ability to store and preserve quality through the marketing system.

Will there always be premiums for VEC products? Not necessarily. As end-users and producers adopt value-enhanced technology, competition will increase and drive profit margins down. Costs for identity preservation and agronomic performance concerns may slow the maturing process of the VEC markets. However, early adopters of this technology may receive greater economic incentives. Relative to commodity corn, there will be premiums, but in the long run, these will be equal to the additional costs for segregation and other costs associated with identity-preservation.

What value-enhanced corns are grown in Kansas? White corn, contracted for food processing, accounts for the largest acreage and is concentrated in the eastern half of the state. There are approximately 45,000 Kansas acres of white corn. Value enhanced feed traits are popular throughout the state. High oil is the most popular feed trait, with approximately 25,000 acres.

What value-enhanced corn has the most potential in Kansas? Approximately 75 percent of the U.S. wet- and dry-milling capacity is in Illinois or within 100 miles of its borders. However, alkaline processing is primarily located in the south and western United States. There are opportunities for these markets available in Kansas, but feed is the market with the most volume, and therefore, the most potential.

What effect will the genetically modified organism (GMO) controversy have on VEC? Most of the current value enhanced traits have been isolated through conventional breeding techniques, and thus, most VEC is **not** genetically modified. Value-enhanced corns may be affected by non-GMO policies through the inability to improve agronomic performance of VEC with genetic modification because of market effects.

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