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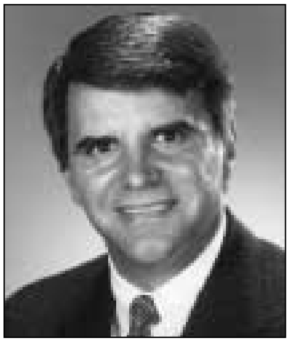
Foreword



Charles F. Conner
President
Corn Refiners
Association, Inc.

The *2001 Corn Annual* focuses on industrial uses and markets for refined corn products. Of the traditional products of the industry—corn starch, sweeteners, oil and feedstuffs—starch has been the leader in industrial applications. In several industrial sectors, the use of starch is well established, but development of new uses and the extension of existing applications continue. Applications for sweeteners are rooted in food manufacturing, but advances in processing technology have opened several opportunities.

By exploring the uses of starch in the established sectors of paper, adhesives and textiles, we hope to convey a better understanding of how starch can advance the production process. The review is also intended to provide an appreciation for product characteristics attributable to starch.

An examination of the current and potential industrial markets for corn starch and corn-derived chemicals shows promising growth for the corn wet milling industry. This market analysis is intended to provide insight to the dynamic of the relationship between supplier and consumer as well as identify the factors that will influence growth.

The corn refining industry continues to be revolutionized by advances in enzyme production and application. Starch, glucose and dextrose are increasingly used as substrates to be converted for use in intermediate products. The purity, reproducibility and reliability of these substrates are crucial to efficient fermentation, extraction and further refining into new products. Many of CRA's member companies have formed strategic alliances with chemical companies as providers of raw material and to offer their expertise in areas of large scale fermentation and separation.

Farmers, scientists, environmentalists and corn refiners have long held on to the vision of a carbohydrate economy; of releasing our dependence on non-renewable resources. In past *Corn Annuals*, we have discussed the opportunities for corn to replace petroleum-based products. This year, we have the chance to provide information on two corn-based innovations that will soon be available to the general public.

Polylactic acid and 3GT are innovations that demonstrate the ability of corn to replace petroleum-based products. The realization of these products being produced on a commercial scale is a tribute to the drive and determination of all those involved in their success.

I would like to take this opportunity to thank all the contributors to the *2001 Corn Annual*. Special thanks to Jeff Cook, this year's CRA chairman, for his perceptive assessment of the challenges that face the refining industry.

I hope you will find the *2001 Corn Annual* a useful source of information about our industry. I invite you to contact us whenever you have questions regarding corn or corn refining.

Introduction

Jeffrey T. Cook
Chairman
President and
Chief Executive Officer
Penford Corporation

Many of the products of the corn wet milling industry, such as corn starch, syrup and oil, are associated with food applications. Since refined corn products are mostly used as ingredients of end products, they tend to be overlooked. Without them, many food items would loose the characteristics we enjoy. Many of these same products play a similar "silent" role in industrial applications. For instance, many of the qualities of the paper you are holding in your hand now can be attributed to the starch used in its production. These include its smooth feel, strength and ink adhesion properties. Over 60 percent of corn starch is used in industrial sectors ranging from paper to mining. On the flip side of the product matrix, less than one percent of all corn sweeteners are used for industrial purposes.

Corn refiners continue to use more corn by developing new product applications and creating new twists on standard products to meet consumer demands. Our industry is dependent on the quantity and quality of corn produced in the U.S. The nation's corn growers produced the second largest corn crop on record last year at 9.968 billion bushels. Corn refiners used nearly 1.4 billion bushels of corn or about 14 percent of the crop. The largest increase in corn usage by wet millers was for ethanol production. Overall, corn usage was up three percent from the year before. Total shipments were up slightly at 56.7 billion pounds with larger increases in exports of high fructose corn syrup (HFCS).

Biotechnology

Last fall, the discovery of StarLink corn, which was not approved for human consumption, in the grain supply resulted in major disruptions throughout the food supply system. Although the U.S. Environmental Protection Agency has confirmed that the wet milling process essentially eliminates

Shipments of Products of the Corn Refining Industry-2000

Starch Products (includes corn starch, modified starch and dextrins)	5,969,553,000
Refinery Products (includes glucose syrup, high fructose syrup, dextrose, corn syrup solids, maltodextrins)	32,857,259,000
High fructose corn syrup—42%	9,817,085,000
High fructose corn syrup—55%+	14,002,280,000
Total HFCS	23,819,365,000
Total - Domestic Basic Products	38,826,812,000
Total - Export Basic Products	2,004,542,000
Corn oil (crude and refined)	1,307,202,000
Corn gluten feed and corn oil meal	10,580,204,000
Corn gluten meal	2,665,579,000
Steepwater	1,269,082,000
TOTAL SHIPMENTS	56,653,421,000

Compiled for the Corn Refiners Association, Inc., by VERIS Consulting, LLC. Statistics represent shipments by members of the association. Shipments are in pounds, commercial weights, and do not include co-products derived from ethanol production.

the Cry9C protein from products for human consumption, member companies were not immune from logistical and market disruptions. While the StarLink issue has been disruptive and costly, it has also forced the entire food chain to reexamine and strengthen its systems for assessing and handling corn derived from biotechnology. At the same time, the U.S. government has taken a number of steps to improve coordination and operation of biotechnology regulation. Despite the difficulties posed by the StarLink incident, the association remains positive about the benefits of biotech corn varieties. Potential developments we look forward to include corn varieties with improved nutrition qualities as well as varieties with improved characteristics for milling.

Export Markets

Corn refiners exported over $1 billion worth of goods last year. Keeping our export markets open and stable is an important responsibility of the association. Two issues in particular are the focus of these efforts: corn gluten feed (CGF) exports to the European Union and high fructose corn syrup exports to Mexico.

For the last forty years, CGF entered the E.U. free of tariff or duty. The European market represents more than 90 percent of all exports of CGF and generates approximately one-half billion dollars for the U.S. balance of trade. In January, the E.U. imposed a retaliatory tariff on imports of CGF in response to U.S. safeguard measures against vital wheat gluten imported from the E.U. The E.U. reacted after a World Trade Organization (WTO) panel found the safeguard measures violated international rules. The retaliatory tariff on CGF will stay in place unless the U.S. safeguard measures are allowed to expire according to schedule on May 31, 2001. The domestic wheat gluten industry has asked for an extension of the safeguard measure, which could result in continuing European duties on corn gluten feed. CRA is working to make sure that no decision is made without full knowledge of consequences to our industry and the potential harm to future trade balances.

Although we gained a favorable ruling from the WTO last year, Mexican antidumping duties on imports of high fructose corn syrup from the U.S. continue to stay in place. The WTO ruled that Mexico violated several WTO rules when it imposed antidumping duties on HFCS nearly five years ago. Mexico did refund provisional antidumping duties paid, but claims it is within its rights under the WTO to maintain the protective measures. CRA will work with the new administration to try to resolve this issue at the WTO and through sweetener negotiations. CRA is also pursuing a remedy through the North American Free Trade Agreement (NAFTA). A NAFTA panel is expected to rule on the case this summer.

The association communicates with and is involved in international decision making bodies. The U.N. Codex Alimentarius

Gregory Thorp

Member Company Products

	Archer Daniels Midland Company	Cargill, Incorporated	Cerestar USA, Inc.	Corn Products International, Inc.	Minnesota Corn Processors	National Starch and Chemical Company	Penford Corporation	Roquette America, Inc.	A. E. Staley Manufacturing Company
STARCH PRODUCTS									
Unmodified, food	•	•	•	•	•	•	•	•	•
Unmodified, industrial	•	•	•	•	•	•	•	•	•
Modified, food	•	•	•	•		•	•	•	•
Modified, industrial	•	•	•	•		•	•	•	•
Dextrins	•		•	•		•		•	•
Cyclodextrins			•					•	
REFINERY PRODUCTS									
Glucose syrups	•	•	•	•	•		•	•	•
Maltodextrins	•		•	•				•	•
Dextrose monohydrate	•		•	•				•	•
Dextrose anhydrous			•	•				•	
HFCS-42	•	•	•	•	•			•	•
HFCS-55	•	•	•	•	•			•	•
Crystalline fructose	•								•
CO-PRODUCTS									
Crude oil	•	•		•					•
Refined oil	•	•		•					
Corn gluten feed	•	•	•	•	•	•	•	•	•
Corn gluten meal	•	•	•	•	•	•	•	•	•
Corn germ or corn germ meal	•	•	•	•	•	•	•	•	•
Steepwater (CFCE)	•	•	•	•	•	•	•	•	•
Carbon dioxide	•	•			•				•
FERMENTATION AND OTHER CHEMICALS									
Citric acid	•	•	•						•
Lactic acid	•	•							
Lysine	•	•							
Tryptophan	•								
Xanthan gum	•								
Erythritol			•						
Sorbitol	•		•	•				•	
Xylitol			•					•	
Mannitol			•					•	
Maltitol			•					•	
Hydrogenated starch hydrolysates			•					•	
Glucose hydrolysates			•					•	
OTHER									
Ethanol, fuel/industrial	•	•			•				•
Ethanol, beverage	•								

Product lists are accurate as of publication date but may change with time.

Commission works toward harmonizing international food standards and resolving technical barriers to trade. CRA's involvement with this group focuses on issues surrounding food and feed safety and biotechnology.

Environment

Environmental issues continue to be of major importance to the industry. Our main emphasis has focused on development of environmentally sound products and the impact of environmental regulations. Corn refiners continue to play an important role in developing markets for products that benefit our nation's air quality such as ethanol and to develop new uses of corn to replace petroleum-based products. CRA is actively involved with a wide range of air quality issues that would have a significant impact on the corn refining industry. EPA regulations that are important to the corn refining industry include revised air quality standards for the major pollutants and regulation of industrial combustion sources. CRA is negotiating with EPA Region 7 on the scope of a voluntary air compliance audit program. CRA continues to work closely with industry coalitions and government agencies to develop regulations that achieve environmental protection goals and promote sound economic and industrial growth.

Research

The association and individual members are certainly involved in research toward development of new uses for corn and applications of wet milled products. CRA has a long standing relationship with the National Corn Growers Association to promote and fund such research. The association also supports research to ensure the safety of the U.S. food supply focusing on understanding and reducing the impact of mycotoxins.

Genencor International

As an industry we have many challenges to face. Our industry should enjoy continued growth, and we look forward to meeting the challenge of expanding growth opportunities through product development as well as market development both at home and abroad.

Cargill Dow LLC

Industrial Uses of Refined Corn Products

Refined corn products have thousands of uses. New uses as well as extensions of existing applications are constantly being discovered.

In industrial applications, starch is used more than any other product of the wet milling industry. The use of corn starch in the paper, adhesives and textiles industries is well established. These industrial sectors are also important markets for corn starch. Therefore, this review will concentrate on those areas; and, hopefully, provide the reader with a sense of appreciation for the benefits these products provide to industry and consumers in general.

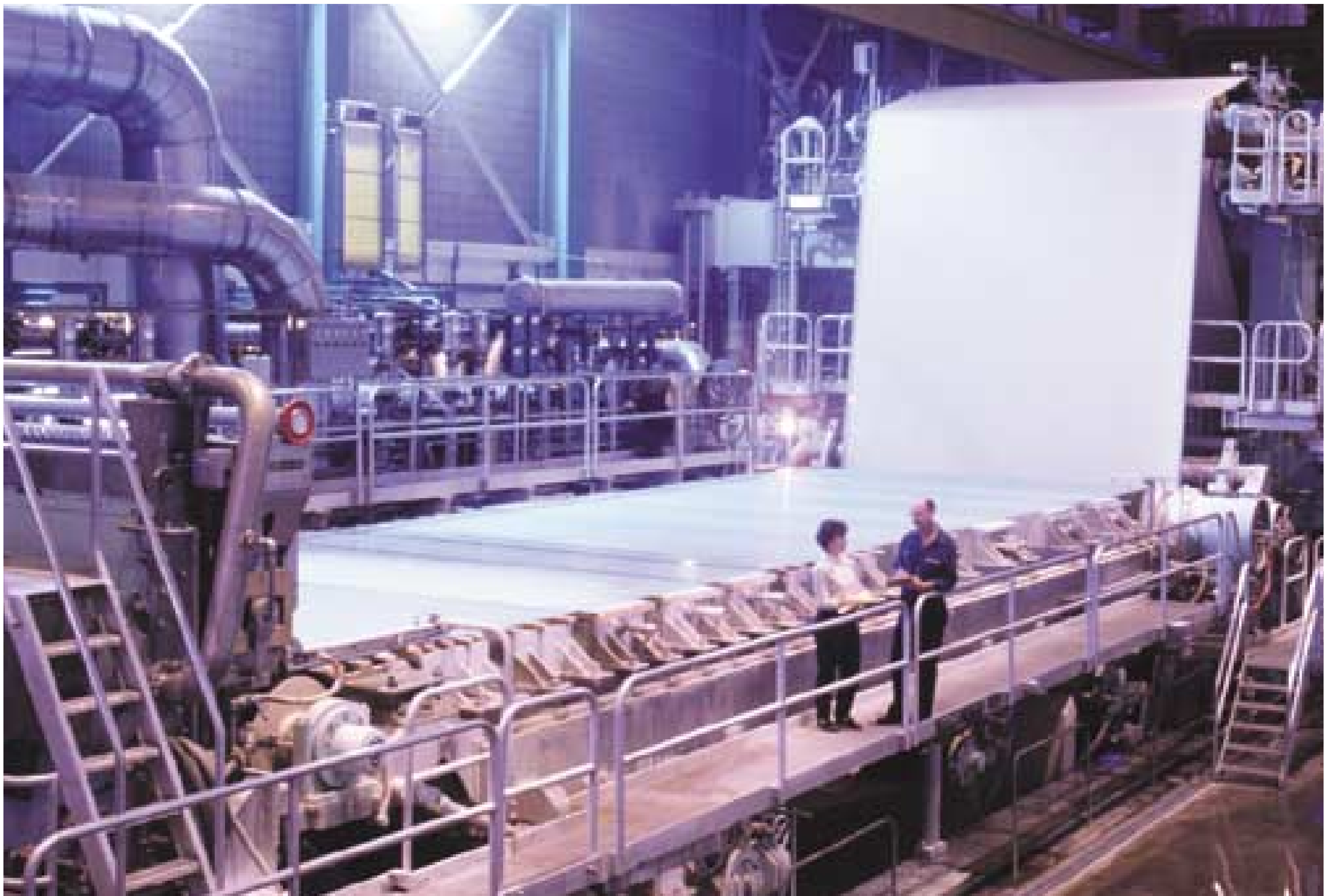
Paper

Starch is one of the paper industry's most important ingredients. In the U.S., over 85 percent of starch used in the paper making process is corn starch. Whether modified or unmodified starch is used depends on the different stages of processing and the desired physical properties of the paper. For example, basic white paper used in the office could be produced with unmodified industrial starch. However, coated papers used to print magazines and high-end publications as well as other specialty papers principally use several different types of modified starches.

Modified starches enjoy a growing role in all aspects of paper production. At one time, it was common practice for paper manufacturers to purchase unmodified starch and then modify it with acid or enzymes at the mill or plant. Although some paper manufacturers continue this practice, many have turned to the technical expertise of starch producers. Starch producers are able to customize starches with reliable functionality for certain machinery and specific qualities of paper.

Pinpointing exactly which types of modified starches are used during the various stages of the paper making process is difficult. Depending on the desired characteristics of the final product, inputs and equipment, any combination of the different starches available could be used.

Starch is used in four major steps of the paper making process: the wet-end, surface sizing, calender stack and coating. The wet-end is the initial step in paper making, where an aqueous slurry is mixed using wood pulp or fiber from recycled paper and fillers. Starch is added to replace the natural binding agents the wood pulp loses during processing. Starch is even more important in making recycled paper products. Recycled fiber is weak and needs the bonding strength starch provides. Starch has the ability to fill in the cavities on the sheet, giving a smoother, more resistant surface.



Stora Enso North America

Stora Enso North America

The slurry is then poured out onto a mesh, where excess liquid drains away, forming an initial sheet. Cationic starches made from dent or waxy corn are often used at this stage. Cationic starches are positively charged so they bind strongly with cellulose fibers, are fully absorbed and retain a variety of fillers. They improve formation, leading to increased drainage, which improves production speeds. Use of cationic starches can also reduce the level of suspended solids in wastewater.

The sheet is smoothed out and dried. It then goes to the size press where the sheet is re-wet and put through two press rolls. Starches used for surface coatings are added at this stage. Treatment at the size press is to increase the surface strength of the paper to achieve a sheet with improved printing properties. Several other important properties are improved by the application of starch at the size press including mullen, fold, tensile, internal bond, water repellence and erasability. Hydroxyethylated starches can be used to develop barrier properties at the size press to reduce the use of coating materials such as wax and polyethylene in the manufacture of food board. These starches, as well as some dextrins, are also used in transparentizing specialized papers.

If high gloss, smoothness and finish are desired qualities of the paper, additional surface sizing is applied at the calender stack. After the paper is dried from the size press, it is rolled at high pressure through a vertical series of pressure rolls to keep the fibers flat. Heavier papers and paperboards are commonly treated at this step to control curl and obtain a smooth, scuff resistant surface for printing.

Starch is an important component of coating formulations to improve the printing and optical properties of paper. During the coating process, pigments, additives and binders are added to impart physical properties such as whiteness, brightness, gloss and opacity. Starches are used as the adhesive for paper coating colors. They act as co-binders for the latexes and proteins commonly used in coatings.

Adhesives

Starches and dextrins are used for a variety of adhesive applications, particularly when bonding paper to itself or to other materials. Unmodified starch and dextrins are frequently employed in combination with modified starches and other ingredients such as borax, caustic soda, salts and resins to produce adhesives with varying properties.

The corrugated board industry is one of the largest markets for starch-based adhesives. After pulp, starch is the largest input. Corrugated board is made by adhering linerboard to paper that

has been fluted. First, flat paper is fluted by passing through two corrugating rolls where the teeth of the rolls form zig-zags. As the fluted paper emerges from the nip of the corrugating rolls, adhesive is applied to the tips of the flutes. Then both linerboards are brought into contact with the flutes. Heat and pressure are added to strengthen the bond. Most corrugators use unmodified industrial starch as the base of the adhesive. The adhesive is mixed at the plant according to equipment and process specifications.

Processing speeds can be improved by the addition of carrier starches. Regulation of the amount of adhesive applied to the flute tips is critical to the successful production of high-quality corrugated board. Carrier starches can be used in combination with unmodified starch to improve the consistency and flow of the adhesive, which permits the machinery to run at the desired meter. High amylose starches used for this purpose also form strong water-resistant bonds.

Paper bag manufacture typically uses both dextrin-based and unmodified starch-based adhesives. Paper bags are made by first producing a tube, which is cut into segments and then sealed at one end. Applying a seam of adhesive to one edge of the paper and contacting it with the opposite edge forms the tubes. Seam pastes made with dextrins develop a strong bond quickly to permit high-speed operation. After the tube is cut into specified lengths, the bottom is sealed. Bottom paste is normally made from unmodified starch for its textural qualities. Multiwall bags are formed similarly, but the various plies must be adhered together before the tube is formed. The adhesive used for this purpose is similar to seam paste.

Some of the other main uses for dextrin and starch-based adhesives are carton/case sealing, tube winding, bottle labeling, flat gumming and leather pasting. Starches and dextrins are also used in adhesives for envelope seams, poster and school pastes.

Textiles

The textile industry uses starch in warp-sizing and finishing operations. In the warp-sizing operation, a protective coating is applied to the yarn to enable it to withstand the abrasive action of the weaving process. This is designed to minimize breaks

and shedding, which result in costly reductions in weaving efficiency and defects in the fabric. Oxidized, hydroxyethylated and other modified starches are used depending on the type of yarn and the requirements of the specific mill operation. Cationic starches are frequently used to spin continuous filament glass yarn because they attract to the fiber. Starch protects the delicate fibers from abrasion during subsequent processing.

Textile finishes are applied to impart or enhance desirable properties such as crease-resistance, shrink-resistance, softness, hand, draping properties, etc. Dextrins, modified and unmodified starches are used as sizing or weighting agents to produce desired hand. They can be used alone or in conjunction with thermosetting resins. Fabrics that are subject to washing are frequently finished with modified starch-resin mixtures to improve hand. Modified starches provide film clarity, which contributes to the brightness and sparkle of colored fabrics, and film flexibility, which ensures smoothness to the touch.

The textile printing process requires thickeners for the dyes used. Modified starches are frequently used in dye paste formulation to provide good dispersion, controlled transfer of the design to the cloth and good color value. Dextrins can also be used as standardizing agents for textile dyes.

Building Materials

Modified and unmodified starches are used as thickeners and binders in building products, such as walljoint compounds, floor leveling compounds and tile grouts. They can also be used to partially replace polyvinyl acetate and cellulosics in spray textured coatings. Acid-modified starch is typically used in the manufacture of gypsum board for drywall construction. In paints

and coatings, starches and dextrins function as binders, rheology modifiers, dispersants, flocculants, film formers, and as gloss agents.

Other Industrial Uses of Starches and Dextrins

Dextrins and starches can serve as die mold release agents, green strength additives, fillers and binders, and can be used as anti-cracking additives maintaining even distribution of liquids and solids in foundry and ceramic applications.

Dextrins and starches act as liquid or dry binders in items such as salt blocks and other function blocks, tablets and bars. They are also used as binders or fillers for functional coatings on items like garden seeds. Certain modified starches can be used in soaps and detergents as fillers and binders.

Cationic and other modified starches are used in wastewater treatment and chemical processing operations as flocculants, precipitants and rheology modifiers.

The mining industry uses starches and dextrins as foam control agents to improve the efficiency of certain ore separation processes.

Industrial Uses of Sweeteners

Starch and dextrins capture the majority of industrial uses, but corn sweeteners also play important roles in industrial applications. In some cases, they are used in addition to starches and dextrins, but the properties they provide the end product are very different.

Glucose and dextrose are used in adhesives to improve stability, provide flow control and prevent wrapping.

Sweeteners are used as humectants in air fresheners and tobacco. They are used in wallboard as humectants to control water release and prevent brittle edges.

Sweeteners can be used in the manufacture of tiles and bricks to reduce cracking by regulating the migration of water during

Cerestar USA, Inc.

drying. They reduce brittleness and deformation of the brick or tile. They are also used to retard setting in concrete.

Glucose and dextrose are used in resin manufacture as modifiers and plasticizers. Glucose is used as a stabilizer in the production of urea and formaldehyde resins. It also gives the resins tack after cold pressing and adds to the pot life.

Glucose is used in the tanning process in the leather industry as a weighting material and for pliability. It also prevents shoe polish from caking and also helps give a better and quicker shine.

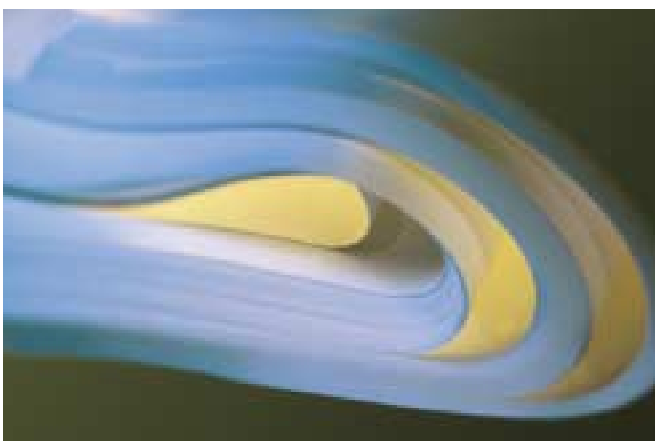
In addition, sweeteners can be used as binders in the production of chip board, as reducing agents in metal treatment and as diluents for standardizing dyes.

Industrial Markets for Starch and Corn-derived Chemicals

Corrine Gangloff is the Director of Public Relations at The Freedonia Group, Inc., a leading international business research company. For over 15 years, Freedonia has been providing the wet milling industry with accurate forecasts and market analyses.

Demand in the U.S. for industrial starch and corn-derived chemicals (excluding ethanol) is projected to increase over 3 percent per year to 8.6 billion pounds in 2004. In value terms, the market will expand 5.5 percent annually to $3.3 billion. The majority of the market in both value and volume terms will continue to be industrial starch used by the paper and board industry. The food and beverage market is the only other market, which accounted for at least ten percent of 1999 total demand in value terms. The fastest growing market will be the chemical industry, largely due to the imminent commercialization of polylactic acid (PLA), which uses lactic acid as a feedstock.

The overall industrial starch and corn chemical outlook is mixed, though generally favorable. The strongest growth opportunities lie in the chemicals and animal feed markets. PLA production will drive growth in the chemical markets, along with the prospects for corn-derived versions of established products such as butanol. The animal feed market will register strong gains based on the continuing use of lysine as a feed supplement and the greater use of other amino acids including threonine and tryptophan.



Stora Enso North America

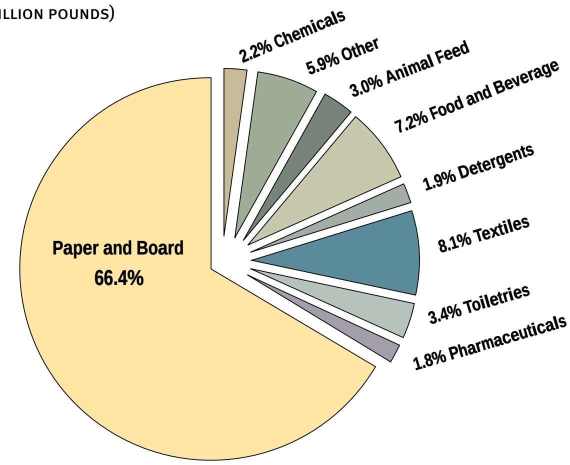
For the anticipated growth in each of these markets to come to fruition, though, critical variables must fall into place. Corn supplies and prices must remain favorable for chemicals using corn as a feedstock to be economically competitive, and major corn chemical producers must remain committed to mass production to capitalize on the advantages presented by vertical integration and economies of scale. Recent increases in crude petroleum prices should also boost interest in corn-derived products, especially as more attention is given to the country's widening trade deficit in petroleum.

Paper & Board

Paper and board production is far and away the largest market for industrial starch and other corn-derived chemicals. In 1999, the paper and board market accounted for about two-thirds of total volume demand and slightly more than half of demand in value terms. Starch is the dominant corn-based product in paper and board production, accounting for practically the entirety of demand. Well over 80 percent of the industrial corn starch volume consumed in the U.S. is used in paper and board production. Although starch derived from other carbohydrates is used in the paper and board industry, corn is the dominant starch raw material due to its low cost, ready availability and perception within the paper industry that corn starches offer superior performance characteristics.

INDUSTRIAL CORN STARCH & OTHER CORN CHEMICAL MARKETS BY VOLUME, 1999

(7.4 billion pounds)



Corn starch is used in virtually all paper and board products, and the vast majority of industrial starch is used in paper and board production. As such, the tone for industrial starch demand in the U.S. is set by the performance of the U.S. paper and board industry. The paper and board market is the largest user of both native and modified starches. In paper and board applications, starch is used as a sizing and coating agent, a binding and strengthening agent and in adhesives. Paperboard packaging

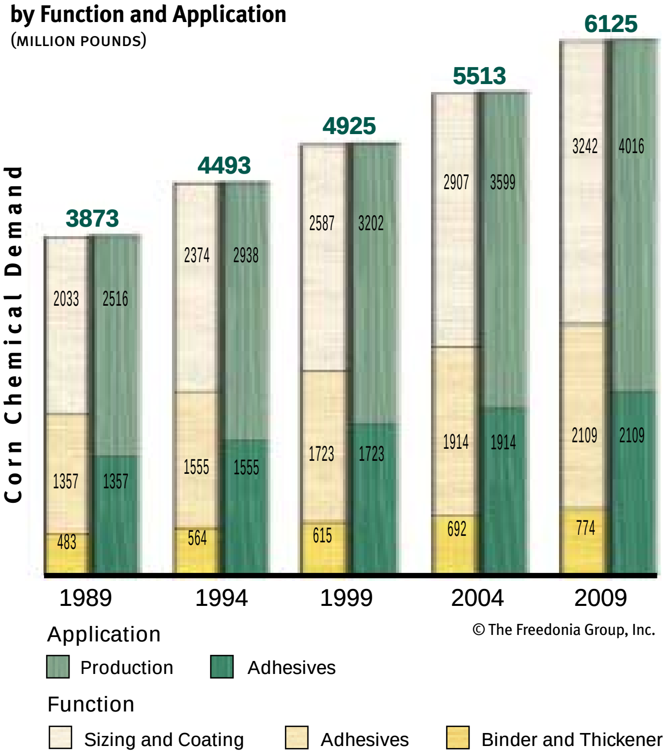

Gregory Thorp

accounts for most adhesive use of starch, but starch is also used in adhesives for envelopes and certain rewettable applications.

Demand for corn chemicals will essentially track paper and board production levels, although growth will be slightly stronger due to the somewhat faster growth rates for corrugated paperboard production.

PAPER & BOARD MARKET FOR STARCH CORN CHEMICALS

by Function and Application
(MILLION POUNDS)



More than 65 percent of the starch used in paper and board applications is used at the wet and dry ends of the production process, serving mainly as sizing and coating agents. The remainder is used in adhesives, mostly in the production of paperboard boxes. At one time, unmodified starch accounted for most of the starch used by the paper and board industry. By 1999, modified starches accounted for a slight majority, and will continue to expand their share of the starch segment.

Much of the competition for starches in the paper and board market is between the various types of starch themselves, although synthetic polymers compete with starch as well. The paper and board industry is fiercely competitive, as papermakers seek advantages over competitors in terms of both costs and product quality. Unmodified starch offers the advantage of low price with capable performance, while modified starches and synthetic polymers typically offer stronger performance at additional cost.

Gains for starch in the paper and board market will be led by modified starches, as papermakers have gradually moved toward greater use of modified starches which often offer stronger performance characteristics than native starch, but at lower cost than some synthetic polymer alternatives. Additionally, the growing use of recycled fibers in paper production will require greater usage of starch, as recycled fiber gets progressively weaker with reuse. Moreover, environmental regulations applicable to the paper industry will lead papermakers to seek safe ingredients such as starch when cost and performance allow.

Genencor International

Chemicals

The imminent commercialization of a number of key corn-derived chemicals, including polylactic acid and butanol, is expected to more than triple the size of the chemicals market by the end of the first decade of the 21st century. This will be contingent upon a number of variables, including the continued abundance of U.S. corn harvests, continued technological advances which will make chemicals using carbohydrate feedstocks more competitive with petrochemically derived products, and a volatile petroleum market which may prompt chemical producers to gravitate to corn-based processes.

Demand for starch and other corn-derived chemicals as intermediates in chemical applications will increase a healthy 13.4 percent per year, to 310 million pounds in 2004. In value terms, the market will expand over 22 percent annually. Gains will result predominantly from the introduction of polylactic acid which is expected to make a strong showing as a raw material for use in plastic and fiber production. Producers, such as Dow Cargill Polymers, hope that PLA will be a strong competitor in such applications as carpets, food containers and packaging.

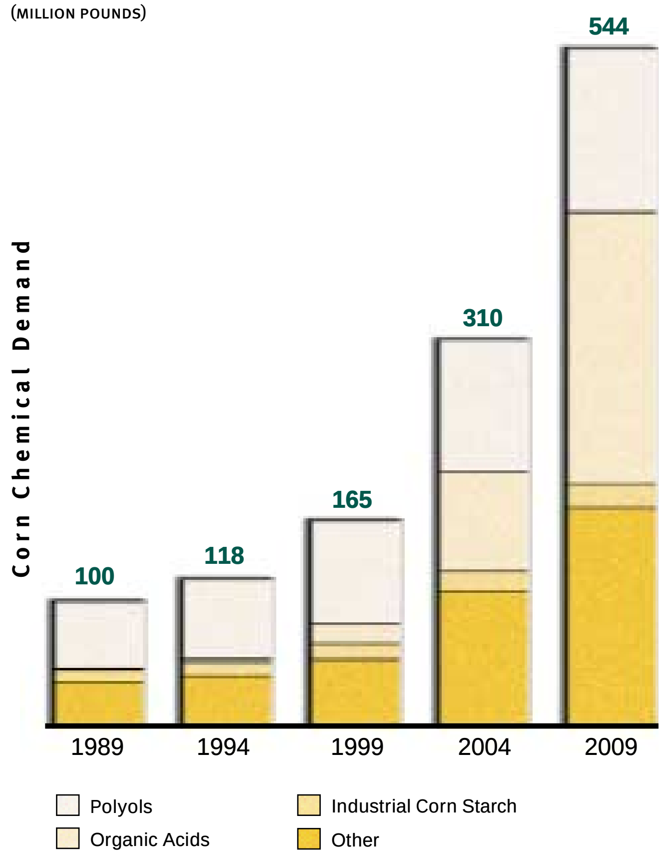
Cargill Dow LLC

Another contributor to these expected advances is the anticipated increased production of chemicals, such as butanol, which have heretofore been derived from petrochemicals.

In addition to new growth opportunities in the chemicals market, there are also a number of established uses for corn-derived products. Sorbitol is the main raw material used in the production of ascorbic acid (vitamin C). Gluconic and citric acids are used as chelating agents and pH regulators, as is lactic acid. Lactic acid is also used as a descaling agent and in electronics chemicals.

CHEMICAL MARKET FOR CORN CHEMICALS

(MILLION POUNDS)



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Corn for Grain: Yield and Production

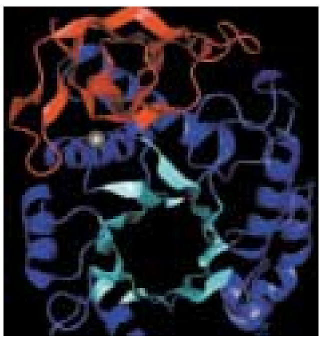
State	AREA HARVESTED (Thousand Acres)			YIELD (Bushel Per Acre)			PRODUCTION (Thousand Bushels)		
	1998	1999	2000	1998	1999	2000	1998	1999	2000
AL	200	200	165	63.0	103.0	65.0	12,600	20,600	10,725
AZ	30	30	33	175.0	195.0	196.0	5,250	5,850	6,468
AR	215	100	175	100.0	130.0	130.0	21,500	13,000	22,750
CA	245	185	235	160.0	170.0	170.0	39,200	31,450	39,950
CO	1,070	1,120	1,180	145.0	142.0	127.0	155,150	159,040	149,860
DE	155	154	156	100.0	89.0	162.0	15,500	13,706	25,272
FL	55	40	28	62.0	93.0	75.0	3,410	3,720	2,100
GA	265	300	300	85.0	103.0	107.0	22,525	30,900	32,100
ID	52	55	57	150.0	155.0	160.0	7,800	8,525	9,120
IL	10,450	10,650	11,050	141.0	140.0	151.0	1,473,450	1,491,000	1,668,550
IN	5,550	5,670	5,550	137.0	132.0	147.0	760,350	748,440	815,850
IA	12,200	11,800	12,000	145.0	149.0	145.0	1,769,000	1,758,200	1,740,000
KS	2,850	2,980	3,200	147.0	141.0	130.0	418,950	420,180	416,000
KY	1,180	1,180	1,230	115.0	105.0	130.0	135,700	123,900	159,900
LA	540	330	370	81.0	121.0	116.0	43,740	39,930	42,920
MD	400	360	405	109.0	93.0	155.0	43,600	33,480	62,775
MI	2,050	1,950	1,970	111.0	130.0	124.0	227,550	253,500	244,280
MN	6,750	6,600	6,600	153.0	150.0	145.0	1,032,750	990,000	957,000
MS	500	310	385	86.0	117.0	100.0	43,000	36,270	38,500
MO	2,500	2,550	2,770	114.0	97.0	143.0	285,000	247,350	396,110
MT	18	18	18	115.0	110.0	140.0	2,070	1,980	2,520
NE	8,550	8,300	8,050	145.0	139.0	126.0	1,239,750	1,153,700	1,014,300
NJ	98	60	75	92.0	37.0	134.0	9,016	2,220	10,050
NM	85	83	73	165.0	180.0	160.0	14,025	14,940	11,680
NY	580	590	480	114.0	101.0	98.0	66,120	59,590	47,040
NC	770	640	650	70.0	80.0	116.0	53,900	51,200	75,400
ND	825	655	930	107.0	117.0	112.0	88,275	76,635	104,160
OH	3,340	3,200	3,300	141.0	126.0	147.0	470,940	403,200	485,100
OK	220	280	270	130.0	145.0	140.0	28,600	44,950	37,800
OR	33	30	29	190.0	175.0	180.0	6,270	5,250	5,220
PA	1,050	880	1,080	111.0	70.0	127.0	116,550	61,600	137,160
SC	275	275	280	40.0	70.0	65.0	11,000	19,250	18,200
SD	3,550	3,250	3,850	121.0	113.0	112.0	429,550	367,250	431,200
TN	620	570	590	96.0	102.0	114.0	59,520	58,140	67,260
TX	1,850	1,770	1,900	100.0	129.0	124.0	185,000	228,330	235,600
UT	24	20	21	141.0	143.0	144.0	3,384	2,860	3,024
VA	300	280	330	84.0	78.0	146.0	25,200	21,840	48,180
WA	100	100	100	190.0	180.0	185.0	19,000	18,000	18,500
WV	34	20	35	80.0	65.0	130.0	2,720	1,300	4,550
WI	2,950	2,850	2,750	137.0	143.0	132.0	404,150	407,550	363,000
WY	60	52	62	127.0	118.0	132.0	7,620	6,136	8,184
USA	**72,589**	**70,487**	**72,732**	**134.4**	**138.8**	**137.1**	**9,758,685**	**9,430,612**	**9,968,358**

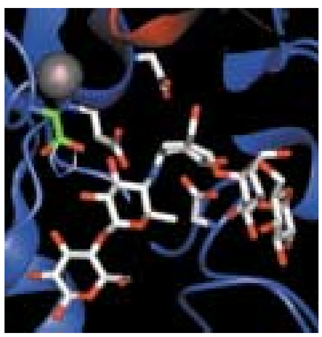
CT, ME, MA, NH, RI, VT Not estimated. Source: USDA - National Agricultural Statistics Service

The Enzyme Advantage

Mike Knauf is director of marketing and product management of grain processing enzymes for Genencor International. Mike earned his undergraduate and graduate degrees from the University of California at Davis in biochemistry and food science, respectively. He has been with Genencor since 1986, focusing his work on enzyme applications.

Enzyme technology has been described as having "enabled" modern corn refining. Enzyme developers are working closely with corn refiners to develop low cost, environmentally sound corn-derived products and processes to enable future market growth. Already, new and expanded product platforms in energy, food, nutrition and biomaterials markets are possible through innovative enzyme technology.





Genencor International

Prior to the introduction of "acid-enzyme" technology more than five decades ago, corn refiners used acid conversion techniques to hydrolyze starch to smaller molecules like glucose, maltose, oligosaccharides and dextrins. The acid hydrolysis process is harsh; heat and hydrogen ions efficiently disrupt starch granules, hydrolyzing both glucosyl ∝-1,4 and ∝-1,6 bonds that form the starch chain. However, acid treatment had severe environmental as well as product quality and functionality shortcomings. Commercial success of corn syrups in the pre-enzyme era suffered from low purity, high salt content, undesirable byproducts and unacceptable color. Markets for primary refined corn products were limited to starches, modified starches and a limited range of crude corn syrups.

That was then, this is now...

The 1960s and 1970s witnessed significant and successful transfer of technology from enzyme developers to corn refiners. With the introduction of high temperature liquefaction processes that utilize thermostable ∝-amylase, high dextrose saccharification with purified glucoamylase, and glucose isomerase-catalyzed production of fructose, both the corn refining industry and the enzyme industry were poised for growth. By the mid-1980s, enabling enzyme technologies, combined with other technologies necessary to consistently deliver high quality corn syrups at competitive costs, were introduced.

Enzymatic hydrolysis can be accomplished under much milder conditions. Thankfully, advances in filtration, fractionation, ion exchange, process control and carbon treatment have paralleled the many advances in enzyme technology. As a result, corn refiners are able to deliver a plethora of desirable value-added corn syrups to their customers (See Figure 1). From the early 1980s to 2000, corn sweetener production increased by more than 50%, high fructose corn syrup (HFCS) production doubled and U.S. ethanol production increased by an order of magnitude.

Biotechnology's Role

Advances in enzyme discovery and genetic engineering techniques in the 1980s and 1990s led to a series of innovative enzyme products. Enzyme developers utilize many of the same biotechnology techniques that have been used to develop new drugs. Genetic engineering of enzyme production organisms effectively reduced enzyme production costs and helped corn refiners stay competitive in their markets. The discovery and development of starch debranching enzymes called pullulanases allowed processors to target—and achieve—higher dextrose levels in the saccharification step. A few percentage points of additional sweetness made for higher quality products to compete with other sweeteners. Product development cycle times for new enzymes shrunk: second and third generation thermostable ∝-amylases were introduced to the market one

Genencor International

Cargill Dow LLC

after the other in the late 1990s. These improved enzymes were protein engineered to liquefy starch without stabilizing chemicals under pH conditions that are more in tune with subsequent saccharification steps. Significant overall cost improvements were achieved through reduced formation of unwanted byproducts, improved product yield and lower ion exchange costs. At the same time, improved enzyme immobilization technologies drove down isomerization (i.e., fructose production) costs.

As a result of these innovative new enzyme products, the cost of enzymes in dextrose, ethanol and fructose production processes ended the 20th century at about half the cost level of a little more than a decade earlier. Additional process cost savings were delivered by improved enzymes: ion exchange savings were realized due to reduced ion addition, fractionation steps were simplified or removed due to achievement of higher peak dextrose in saccharification, and more concentrated glucose isomerase products enabled increased fructose production without investment in new isomerization columns. Availability of lower cost, higher purity glucose also enabled improved production and purification of microbial fermentation products. Dextrose and glucose syrups are a preferred carbon source for production of value-added specialty biochemicals such as amino acids, sugar alcohols, organic acids, antibiotics and enzymes. Small increases in glucose yield in the corn refinery can have a big commercial impact downstream.

During this same period, innovations by enzyme developers have led to promising new niche products made from corn:

- New enzymes enable cost-effective production of cyclodextrins to serve new markets in flavor and fragrance encapsulation;

CORN: Food and Industrial Uses

Year	HFCS	Glucose and Dextrose	Starch	Fuel Alcohol	Beverage Alcohol	Cereals and Other Products	Total
1985	327	169	190	271	83	93	1,133
1986	338	171	214	290	85	109	1,207
1987	358	173	226	279	77	113	1,226
1988	361	182	223	287	107	114	1,274
1989	368	193	230	321	109	115	1,336
1990	379	200	232	349	80	114	1,354
1991	392	210	237	398	81	116	1,434
1992	414	214	238	426	83	117	1,493
1993	442	223	244	458	83	118	1,568
1994	465	231	226	533	100	118	1,672
1995	482	237	219	396	125	133	1,592
1996	504	246	229	429	130	135	1,672
1997	513	229	246	481	133	182	1,784
1998	531	219	240	526	127	184	1,827
1999	540	222	251	566	130	185	1,894
2000	550	220	255	615	130	190	1,960

In million bushels
Source: USDA - Economic Research Service. Year beginning Sept. 1.

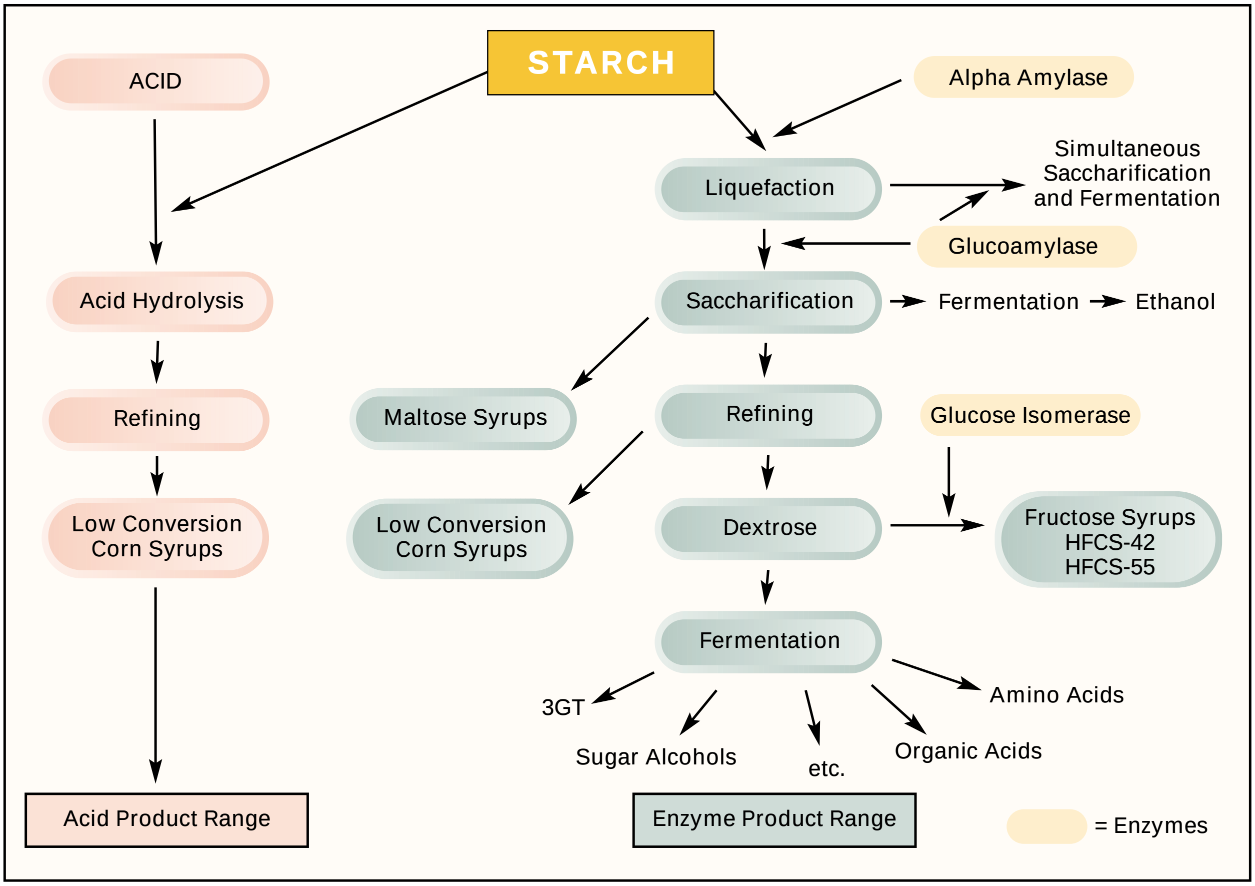


Figure 1: Many products can be made using enzymatic processes

- Very high maltose syrups are made possible through combinations of maltogenic enzymes and starch debranchers;
- An efficient new enzymatic process generates gluconic acid; and
- Transglucosidases produce isomaltooligosaccharide (IMO) syrups with interesting functional and nutritional properties.

Advancing Renewable Resources

Starting in 1996, the U.S. Department of Energy teamed with U.S. industry, including the Corn Refiners Association (CRA), National Corn Growers Association (NCGA), several CRA member companies and Genencor International to develop a vision document for a sustainable economy, entitled "Plant/Crop-Based Renewable Resources 2020: A Vision to Enhance U.S. Economic Security Through Renewable Plant/Crop-Based Resource Use." This effort was followed by publication of "The Technology Roadmap for Plant/Crop-Based Renewable Resources 2020." Among the research areas given a high-priority ranking was "Advanced (bio)catalysts for monomeric and polymeric conversions." Clearly, enzyme biocatalysts will provide technology that enables new uses for corn and its increasing role for U.S. economic security.

The CRA, NCGA and enzyme developers have also been supporting and working on new biomass processing technologies to achieve the milestones established in the Technology Roadmap. The U.S. Department of Energy (DOE) has sponsored separate subcontracts, through the National Renewable Energy Laboratory (NREL), with two enzyme companies to develop cellulose-hydrolyzing enzymes. Including cost-share, over $30 million will be invested in cellulase research and development by DOE/NREL, Genencor International and Novozymes. Corn stover is a leading cellulosic biomass candidate. The goal is to achieve a significant reduction in cellulase cost, which will contribute to the future commercial viability of cellulose hydrolysis.

Branching out to develop new value-added uses for dextrose, Genencor International's metabolic pathway engineering expertise is being used to develop a new fermentation route to ascorbic acid (Vitamin C). A fruitful collaboration between DuPont and Genencor International enables the production of polyester from corn (see 3GT, Figure 1). Add in Cargill

Dow's plans to commercialize corn-derived polylactic acid fibers and plastics, and an exciting new corn-derived biomaterials market has been born. (see Organic Acids, Figure 1).

Enzyme technology has also impacted the animal feed industry. Upgrading nutritional quality and removing anti-nutritional factors from feed components, enzymes have improved barley and wheat-based feeds, for example. Corn processing co-products such as gluten meal and fiber can also be improved enzymatically.

The enzyme industry has been a capable and willing partner with the corn processing industry. However, as corn syrup and HFCS markets showed increasing signs of maturity throughout the 1990s and into the new century, corn refiners and the companies that develop and produce grain processing enzymes face some serious challenges and questions:

- How can enzyme producers continue to add value to corn refiners?
- Which new enzyme products should be developed?
- What new corn-derived products will lead the way to renewed industry growth?
- How long will it take for markets to develop interesting new biochemicals and biomaterials made possible by novel enzyme technology?
- Can corn refiners adopt new enzyme technology at the pace enzyme technology can be developed?
- What role will corn-derived products play in a more sustainable, renewable carbohydrate economy?

In order to come up with the best answers to these questions, corn refiners and enzyme companies have recognized the need for sustained commitment to and investment in enzyme technology. Innovating at the speed required by the competitive marketplace—and allowed by the technology—requires novel collaborative approaches. For example, enzyme technology transfer is aided by expert in-plant technical services that are best provided by partner-suppliers. Enzyme awareness and education programs for refinery personnel are in place. Research and development collaborations target the next new enzyme products that will lead to cost-saving process improvements to keep the industry competitive. And we are working together—and with the chemical industry—to identify and develop new markets for refined corn products.

The future of the corn refining and enzyme industries is bright. Together, we've come a long way in a short time. Together, we will innovate our way to continued growth and prosperity.

U.S. Per Capita Sweetener Consumption (pounds)

Year	Refined Sugar	Corn Sweeteners/Dry Basis				Honey and Edible Syrups	Total Caloric Sweeteners
		HFCS	Glucose	Dextrose	Total		
1985	63.2	44.6	15.9	3.5	63.9	1.5	128.6
1986	60.8	45.1	16.0	3.5	64.6	1.6	127.0
1987	63.1	47.1	16.2	3.6	66.8	1.7	131.6
1988	62.6	48.3	16.4	3.6	68.3	1.5	132.4
1989	62.8	47.5	16.7	3.7	68.0	1.6	132.4
1990	64.8	49.2	17.4	3.8	70.4	1.6	136.8
1991	64.4	50.0	18.2	3.8	72.0	1.6	138.0
1992	64.5	50.6	17.7	3.8	72.0	1.4	137.8
1993	64.1	53.3	17.9	3.8	75.0	1.2	140.4
1994	64.8	55.0	18.1	3.8	76.9	1.3	143.0
1995	64.9	55.2	18.4	3.9	77.5	1.3	143.6
1996	65.3	56.5	18.3	3.9	78.7	1.4	145.3
1997	65.6	59.2	19.8	3.7	82.7	1.3	149.6
1998	65.6	61.4	18.8	3.6	83.9	1.3	150.7
1999	67.0	62.8	18.2	3.5	84.5	1.4	152.8
2000*	65.8	61.6	17.9	3.3	82.9	1.5	150.1

* estimate based on preliminary data. Source: USDA—Economic Research Service

Plastics from Corn—The Vision Becomes Reality

Cargill Dow LLC, a 50:50 joint venture between Cargill Incorporated and Dow Chemical, develops high-performance materials from annually renewable resources. The first result of this venture is a family of fibers and packaging polymers made entirely from corn.

In the center of America's heartland, the next breakthrough in the history of corn refining is under construction … the first world-scale polylactic acid plant developed by Cargill Dow LLC.

The facility, located in Blair, Neb., produces a proprietary polylactic polymer called NatureWorks™ PLA. Made from corn, this new material can be used in everyday items such as clothing, cups, food containers, candy wrappers, as well as home and office furnishings; great news globally for farmers and across industry. Scheduled to be on-stream in 2001, the new manufacturing plant will require 40,000 bushels of local corn per day to meet its global production capacity.

The Cargill Dow facility will be located adjacent to the site of Cargill's existing corn wet milling operation at Blair. The facility will be comprised of two main operational components, a NatureWorks PLA manufacturing line and a lactic acid plant that will utilize dextrose from Cargill's wet milling operation. The manufacturing line will be brought on-stream first and will be operational November 2001. At capacity, it will produce 300 million pounds of NatureWorks PLA per year.

The technology used to create the polymer allows the company to "harvest" the carbon plants, like corn, remove from the air during photosynthesis. This is achieved by tapping into the carbon stored in plant starches, which can be broken down into natural plant sugars. The carbon and other elements in these natural sugars are then used to make plastic through a process of simple fermentation and separation. By replacing petroleum as the feedstock with an annually renewable resource, NatureWorks PLA uses 20 to 50 percent less fossil resources than comparable plastics.

Not only does it use less fossil fuel, PLA also offers environmental benefits through waste management opportunities. NatureWorks products can be composted in municipal composting facilities, thereby providing an alternative means of managing municipal solid waste.

Cargill Dow LLC

NatureWorks PLA is a major step toward the development of more sustainable products. The breakthrough process has a good lifecycle profile, can compete with traditional materials based on cost and performance and will ultimately use a variety of biomass feedstocks, allowing NatureWorks PLA to be produced anywhere in the world using agricultural byproducts. Cargill Dow is partnering with leaders in industry and non-business as it continues to drive toward more sustainable marketing offerings and business systems.


Cargill Dow LLC

Cargill Dow LLC's breakthrough technology has recently earned the company three of industry's most coveted science and technology awards. *Popular Mechanics* and *Industry Week* recognized NatureWorks PLA as one of the most influential developments of the past year. In addition, NatureWorks was named the United State's Department of Energy's Office of Industrial Technologies (OIT) "Technology of the Year." This honor is awarded annually to a technology that demonstrates the potential for improved energy efficiency along with economic and environmental benefits.

Since formally launching its technology in January 2000, Cargill Dow has been actively working with application developers to bring products made from NatureWorks PLA to market. At present, the company has launched numerous packaging and fibers applications globally. The response from the industry has been tremendous and exciting for Cargill Dow, with on-going partnerships and support from numerous leading companies in packaging and fibers.

Fibers applications under development include apparel fabrics made from NatureWorks fibers, as well as blends with wool, rayon and cotton. These fabrics exhibit the comfortable wear and feel of the natural fibers while having the performance, cost, easy care and specialty performance characteristics of


Cargill Dow LLC

Cargill Dow LLC

synthetics such as excellent resiliency, outstanding crimp retention and improved wicking. Additional performance characteristics make PLA fibers useful in non-apparel applications like industrial fabrics, carpet tiles, fiberfill and home furnishings.

In packaging, Cargill Dow teamed up with Biocorp Inc. to launch a clear, cold-drink cup made from NatureWorks PLA available to major venues around the world. In addition, the company has launched an environmentally friendly golf-ball sleeve as well as plastic packaging wrap. PLA's twist retention, deadfold and flavor and aroma barrier properties make a variety of other consumer packaging applications possible including candy wrappers, dairy containers and other food containers possible.

Founded in 1997, Cargill Dow LLC is based in Minnetonka, Minn. It is the first company to offer its customers a family of polymers derived entirely from annually renewable resources with the cost and performance necessary to compete with packaging materials and traditional fibers. The company has achieved this breakthrough by applying its unique technology to the processing of natural plant sugars to create a proprietary polylactide polymer. Future applications of the technology could include use in injection blow molded bottles, foams, emulsions and chemical intermediaries. For more company information, please visit the Cargill Dow Web site at www.cargilldow.com.

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World Corn Production, Consumption and Stocks

Production	1999/00	2000/01
Argentina	17,200	15,000
Brazil	31,600	38,500
Canada	9,096	6,800
China	128,086	105,000
Egypt	5,678	5,800
Hungary	7,000	4,500
India	11,470	12,000
Indonesia	6,200	6,200
Mexico	19,000	18,500
Philippines	4,449	4,300
Romania	10,500	4,000
South Africa	10,584	8,000
Thailand	3,900	4,400
Ukraine	1,700	3,800
Yugoslavia	9,900	5,500
European Union	36,962	38,890
Others	52,773	51,158
United States	239,549	253,208
TOTAL	**605,647**	**585,556**
Consumption		
Brazil	33,150	35,400
Canada	9,359	8,900
China	116,900	120,000
Egypt	10,178	10,300
Hungary	5,014	4,700
India	11,350	12,000
Indonesia	7,300	7,400
Japan	16,317	16,050
Korea, South	8,400	8,300
Malaysia	2,353	2,450
Mexico	23,411	24,300
Romania	9,500	5,450
Russia	1,850	1,800
South Africa	7,981	8,300
Yugoslavia	9,325	8,850
Others	137,961	133,727
United States	192,477	196,987
TOTAL	**602,826**	**604,914**
Ending Stocks		
Brazil	1,000	3,600
China	52,911	32,061
South Africa	2,325	1,275
European Union	3,778	4,542
Others	21,111	15,886
United States	43,628	48,031
TOTAL	**124,753**	**105,395**

Source: USDA, Foreign Agricultural Service
Based on local marketing years in thousands of metric tons.

Renewable Resources Bring Sustainability to DuPont's Newest Polymer Platform

Ian Hudson is the Global Business Director for DuPont Sorona™ 3GT Polymers.

DuPont has been the world's preeminent innovator of polymers and synthetic fibers since Wallace Carothers' discovery of nylon in the 1930s. From there, DuPont scientists went on to develop Teflon® fluoropolymer resins, Lycra® spandex fiber, Kevlar® aramid fiber, Cordura® nylon fiber, Corian® solid surface material and a long list of other brands, many of which have become household names.

DuPont

Along with its expertise in polymers and fibers, DuPont helped to define the modern supply chain, bringing advances in fibers to consumers around the world. Today's "miracle" fabrics are easy to care for and affordable. In short, no one knows the fibers business like DuPont.

Many of these early chemical fiber developments sought to emulate or improve on natural products (nylon for silk and Lycra® for rubber). But as the world awakens to the finite nature of its natural resources, it is becoming abundantly clear that continued reliance on non-renewable petrochemicals is impractical and unrealistic. In addition, some materials simply cannot be produced economically by chemical means. For these reasons, DuPont decided to apply biological science to the production of its newest polymer platform, Sorona™ 3GT polymer and fiber.

DuPont became aware of the unique attributes of 3GT polymers in the early 1940s and research efforts were restarted briefly in the 1960s and the early 1980s. This work was shelved, however, when a low cost route to the key monomer 1,3 propanediol (PDO) was not achieved. In the early 1990s, renewed corporate interest in 3GT was sparked by development of new petrochemical technologies that offered the potential for a less expensive source of PDO. DuPont acquired Degussa's PDO technology in 1998 and is now using that monomer to produce Sorona™ polymer at a 12,000-annual-ton retrofitted PET facility in Kinston, North Carolina. The Kinston unit is the world's first continuous polymerization line dedicated to 3GT polymer.

At the same time though, DuPont is progressing toward its sustainable business goals – that is, making products in a cost-effective manner while reducing the company's environmental footprint – by perfecting a biological route to PDO production. By 2003, DuPont plans to have in operation a commercial scale bio-PDO plant with an annual capacity of up to 100 million pounds. That plant will use corn-sourced dextrose as its feedstock.

The technology behind this can be traced to the early-90s when DuPont succeeded in genetically engineering a microorganism capable of producing PDO from dextrose. This single microorganism is capable of combining two chemical steps that nature performs independently in separate organisms.

DuPont formed a partnership in 1995 with Genencor International to improve the microorganism to enable economical manufacturing of PDO. By late 1999, the partnership had developed a second-generation organism capable of much higher yield, rate and titer. DuPont and Genencor recently announced that they have expanded their collaboration to continue work on an even more efficient third-generation organism.

This work is producing encouraging results at a pilot bio-PDO plant located at Tate & Lyle's Decatur, Illinois, facility. The company is DuPont's other development partner in the effort. With Tate & Lyle's expertise in fermentation processes, scientists at the site have successfully manufactured the monomer. The timing of this event and progress toward developing the improved

DuPont

microbe, dubbed “COSMO,” or Corn Sugar Metabolizing Organism, bode well for DuPont’s 2003 commercialization plan.

“We are extremely pleased with this development because it offers solid proof that biotechnology can and will deliver far-reaching, transformative benefits in a wide variety of areas,” said Ellen J. Kullman, DuPont group vice president and general manager of DuPont Bio-Based Materials. “Sorona™ is the first in what we believe will be a family of bio-based products with exciting consumer and industrial applications.”

What impact will DuPont’s bioprocess have on the corn wet-milling industry? That’s difficult to foresee. Although site selection is not yet complete, it is expected that DuPont’s first bio-PDO plant will be located adjacent to a wet milling operation in the United States. The plant is being designed to produce up to 100 million pounds of PDO annually. That will require approximately 7 million bushels of corn.

However, the bioprocess is not inextricably tied to corn. Once DuPont’s 3GT polymer, Sorona™, is fully commercialized, it is not inconceivable that additional PDO production capacity might be located closer to customers around the world. In that case, depending on location, other cost-effective sources of starch from local crops would provide feedstocks.

Sorona™ polymer exhibits characteristics that make it highly desirable in fibers applications such as clothing, upholstery and other textiles. Its “comfort stretch” and recovery make it ideal for use in men’s and women’s tailored and casual garments as

CORN: Supply and Disappearance

	SUPPLY				DISAPPEARANCE						ENDING STOCKS		
Year Beginning Sept. 1	Beginning Stocks	Production	Imports	Total	Food, Alcohol and Industrial	Seed	Feed and Residual	Total	Exports	Total Disappear.	Govt. Owned	Privately Owned	Total
1986/87	4,039.5	8,225.8	1.8	12,267.0	1,216.8	16.7	4,659.4	5,892.9	1,492.5	7,385.3	1,443.2	3,438.5	4,881.7
1987/88	4,881.7	7,131.3	3.4	12,016.4	1,234.4	17.2	4,789.2	6,040.9	1,716.4	7,757.3	835.0	3,424.1	4,259.1
1988/89	4,259.1	4,928.7	2.8	9,190.6	1,279.4	18.4	3,936.0	5,234.4	2,025.8	7,260.1	362.5	1,567.9	1,930.4
1989/90	1,930.4	7,532.0	1.9	9,464.3	1,351.1	18.9	4,381.6	5,751.6	2,368.2	8,119.8	233.0	1,111.5	1,344.5
1990/91	1,344.5	7,934.0	3.4	9,281.9	1,405.8	19.3	4,610.9	6,036.1	1,724.6	7,760.7	371.1	1,150.1	1,521.2
1991/92	1,521.2	7,474.8	19.6	9,015.6	1,513.3	20.2	4,797.7	6,331.2	1,584.1	7,915.3	112.5	987.8	1,100.3
1992/93	1,100.3	9,476.7	7.1	10,584.1	1,537.1	18.7	5,252.1	6,807.8	1,663.3	8,471.1	55.5	2,057.5	2,113.0
1993/94	2,113.0	6,337.7	20.8	8,471.5	1,588.5	20.1	4,684.4	6,293.1	1,328.3	7,621.4	44.8	805.3	850.1
1994/95	850.1	10,050.5	9.6	10,910.2	1,696.9	18.3	5,459.7	7,174.9	2,177.5	9,352.4	42.3	1,515.5	1,557.8
1995/96	1,557.8	7,400.1	16.5	8,974.4	1,608.0	20.1	4,692.5	6,320.6	2,227.8	8,548.4	30.4	395.5	425.9
* 1996/97	425.9	9,232.6	13.3	9,671.8	1,693.9	20.3	5,277.0	6,991.2	1,797.4	8,788.6	2.1	881.1	883.2
* 1997/98	883.2	9,206.8	8.8	10,098.8	1,784.4	20.4	5,481.8	7,286.6	1,504.4	8,791.0	4.3	1,303.5	1,307.8
* 1998/99	1,307.8	9,758.7	18.8	11,085.3	1,826.4	19.8	5,471.5	7,317.7	1,980.6	9,298.3	11.6	1,775.4	1,787.0
** 1999/00	1,787.0	9,437.3	14.7	11,232.3	1,893.0	20.3	5,664.2	7,577.5	1,937.3	9,514.8	14.7	1,702.8	1,717.5
** 2000/01	1,717.5	9,968.4	10.0	11,695.9	1,950.5	19.5	5,825.0	7,795.0	1,950.0	9,745.0	15.0	1,935.9	1,950.9

Million Bushels Source: USDA * Preliminary ** Projected well as fleece and intimate apparel. Sorona™ is very soft and can be dyed atmospherically.

Its resilience makes it ideal for automotive upholstery and home textiles. DuPont is also exploring applications in non-wovens, such as diapers, and in packaging films. Sorona™ has excellent barrier characteristics in uses where moisture, odor and taste are important.

Gregory Thorp

As DuPont approaches its 200th anniversary, the company is acutely aware that, in today's fast-moving, global economy, change must be a constant and pervasive operating modality. DuPont is changing in many ways.

For example, the company is committed to operating in a more sustainable manner. In fact, by 2010, DuPont expects to derive 25 percent of its revenues from non-depletable raw materials. It also expects to source 10 percent of its energy needs from renewable energy sources by that time.

Above all, the company is dedicated to adding biology to mathematics, physics and chemistry as its very powerful fourth science. Biotechnology is viewed as an enabling technology that will help to fuel DuPont's sustainable growth across the broad spectrum of markets in which it participates.

DuPont Sorona™ 3GT polymer represents the vanguard of the company's determination to become a major force in bio-based materials.

DuPont is a science company, delivering science-based solutions that make a difference in people's lives in food and nutrition; health care; apparel; home and construction; electronics and transportation. Founded in 1802, the company operates in 70 countries and has 93,000 employees.

Exports of Products From Corn

Product	2000	Units	Value
Corn meal	136,486,597	Kilograms	$34,245,737
Corn starch	88,645,014	Kilograms	$40,683,654
Corn oil, crude	173,781,195	Kilograms	$88,706,142
Corn oil, once refined	25,796,431	Kilograms	$14,309,336
Corn oil, fully refined	233,616,289	Kilograms	$135,255,775
Glucose (dextrose)	55,674,999	Kilograms	$26,446,770
Glucose syrup not containing fructose or containing in the dry state less than 20% fructose	111,453,993	Kilograms	$37,990,796
Glucose syrup with 20-50% fructose	43,345,929	Kilograms	$10,370,452
Chemically pure fructose	48,690,939	Kilograms	$31,952,190
Fructose syrup with 50%+ fructose	235,642,047	Kilograms	$58,859,868
Fructose solids containing more than 50% fructose	39,426,634	Kilograms	$32,267,872
Bran, sharps and other residues	59,242	Metric tons	$7,987,088
Corn gluten feed	5,091,959	Metric tons	$375,028,748
Corn gluten meal	748,416	Metric tons	$215,228,308
Other residues of starch manufacturing	15,432	Metric tons	$2,319,929
Corn oil cake	39,178,717	Kilograms	$3,882,497
Dextrins	22,582,949	Kilograms	$15,900,820
Modified starches derived from corn starch	70,289,294	Kilograms	$53,277,459

Source: U.S. Department of Commerce