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Agricultural Outlook Forum

Presented: February 17, 2006

THINKING BIORENEWABLES? THINK CORN!

Julius Schaaf
Corn and Soybean Farmer
Member of the Iowa Corn Promotion Board

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Farmer Director, Iowa Corn Promotion Board

It all starts with a single seed planted into one of the United States greatest assets — fertile soil. Next, the greatest natural nanoprocessors in the corn plant shift into production mode. The internal processors take sunlight, CO₂ from the air, moisture from the air and soil, and nutrients from the soil and convert those seeds to the world's largest renewable resource for feed, fuel, fiber and a whole new carbohydrate economy.

This slide illustrates the composition of a grain of corn. Oil and protein come from the germ. The starch is the driver for the ethanol industry. Gluten Meal is a great feed source. Hull and fiber uses are just now being expanded.

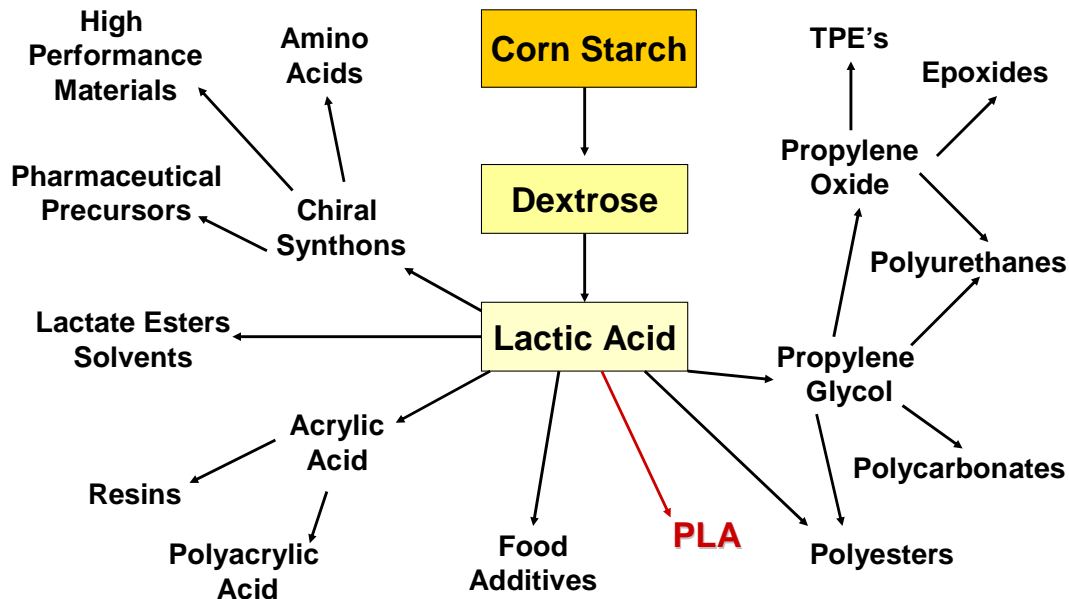
Corn processing is basically divided into wet milling on the left arrow of the slide, and dry milling on the right of the slide. Dry milling is less capital intensive and is the milling process used by most farmer-owned ethanol plants. Large corporate plants use the wet milling process to separate more of the different parts of the corn kernel to add value to the whole process. The separation technology is being added to new dry mill plants and retrofitted to existing plants. The value beyond feed for co-products at the end of the ethanol process is becoming very evident.

Ethanol started out as a “New Use” more than 30 years ago. If it weren't for corn farmers and their checkoff, the ethanol industry would have wilted from its critics. Farmers are naturally optimists, and they had the perseverance to stay with this biorenewable thrust even when well intentioned people in industry and government viewed it with disinterest.

In the past 30 years, corn use for ethanol has grown from just 10 million bushels to a projected 1.57 Billion bushels this year. In Iowa alone, ethanol production from corn now has 6,000 grower investors — in fact, more than one out of every ten Iowa corn growers is an investor. Its benefits to the broader state economy include 3,700 jobs, a \$2.6 million increase in local tax bases, and an additional \$841 million in revenues, according to an analysis by economists at Iowa State University. .

Looking more specifically at ethanol's economic impact on Iowa's corn growers, ethanol production is adding \$2.40 worth of value to every bushel processed. We see the results as \$81 million of increased farm-gate income, a statewide improvement in corn basis of 4 to 5 cents, and an improved basis in areas close to the plants of as much as 12 cents per bushel. In addition, the growing supplies of distillers grains from the plants are benefiting Iowa's livestock producers. The boost to rural economies is very evident.

A World of Potential



Now let's look at where the carbohydrate economy is taking the world next. Ethanol is only one of many avenues we can explore to replace non-renewable chemicals like petroleum with renewable starch-based products. As you can see, we have many opportunities – this is just a snap shot of the some of the possibilities.

One of the more recent successes of research into biorenewables is the corn-based plastic PLA. Early research was initiated 18 years ago by the Iowa Corn Promotion Board, with additional support from the Nebraska Corn Utilization Board, and the National Corn Growers Association.

Cargill then began work on PLA, which led to construction of the first commercial scale plant at Blair, Nebraska. Full-scale PLA production began in 2001. PLA is now being commercialized in two general areas: in fabrics under the Ingeo trademark and as a resin for packaging and plastics under the NatureWorks trademark.

NatureWorks, now a wholly owned Cargill subsidiary, is currently working with more than fifty companies to introduce PLA-based plastics and packaging in many forms (sheet, film, bottles, jars, rigid food packaging, and service ware) across Europe and in North America, Japan, Korea, Taiwan, Australia and New Zealand.

Ingeo is being introduced in intermediate textile products like yarns and batting and in finished products that include hosiery, apparel, hygienic non-woven products like diapers, fiber-filled products like comforters and futons, and home textiles and furnishings. More than 200 partner companies are involved in this effort, and the geographic reach is even broader than for the resin applications.

Some of the more intriguing applications for PLA include its use in credit, debit, gift, and phone cards, in landscape and plant applications such as fertilizer bags, plant pots, and landscape fabric, and even in the clear plastic sleeves used by florists to protect plants. In Iowa, we now have a company that is making socks from PLA, and in one of the more recent examples of PLA adoption, Walmart began using PLA to package fresh and cut fruits, herbs and vegetables and plans to phase in PLA gift cards, deli trays, salad boxes, and film packaging for baked goods.

Because PLA can be used in so many different products at different levels of adoption, it's very hard to translate this into corn use. One indicator that may give a sense of its potential is the latest estimate from experts in Taiwan that use could require 5 million bushels of corn annually by 2009 to serve a nation of 22.5 million people. If you assume the same level of adoption in much larger countries, the equivalent to 5 mbu use in Taiwan would be 28 million bushels in Japan or 56 million bushels in the United States.

But new uses for corn don't end with PLA. We have maintained an aggressive research program to explore additional new uses. This is not an easy task for a number of reasons. First, the time span for such research is quite long. This work takes many years and depends on strong public-private partnerships to succeed in bringing a new use to market. Also, we've found that a biorenewable product is only sustainable when it has at least equivalent function as the products it is replacing. Most new biorenewable products are reaching or exceeding this standard with the added value of being safer for our environment.

Here are some examples of corn new uses that are moving through the research-commercialization pipeline:

One project to use the corn fiber component more effectively is the polyols work being directed by the National Corn Growers Association, with funding from our corn checkoff dollars and DOE grants. This work involves separating the corn fiber into its component sugars, then converting them into products like propylene glycol, for use in polyester resins, coatings, paints, detergents, cosmetics, and drugs. Annual propylene glycol demand is estimated at 850 million pounds. A second polyol option is ethylene glycol, used in PET and in antifreeze – a 5.6 billion pound market per year.

At the Iowa Corn Promotion Board, we are also funding research with the DOE at Pacific Northwest National Laboratories into the production of isosorbide. Isosorbide would come from the starch portion of the corn kernel and be used as a polymer additive. It has the potential to reduce the amount of petroleum feedstock used in the polymer industry, improve the properties of the plastic, and use an additional 30 million to 40 million bushels of corn per year.

Yes, DaimlerChrysler, Iowa Corn does have a hemi! Hemicellulose fiber, that is. This is another project to convert corn fiber from a dry mill plant into higher value renewable products that include industrial chemicals, plastics, and solvents. This is a joint project with Iowa Corn, Minnesota Corn, Ohio Corn and DOE. By increasing the value of the corn fiber, this project will also improve the overall economics of ethanol production, potentially by increasing the production of ethanol from an acre of corn by 75 gallons.

Finally, a priority to corn farmers nationwide is the mapping of the corn genome. This will open new doors for functionality studies to examine what further added input traits (drought resistant, new and safer herbicide resistance, insect resistant, better plant health in general) can be added. Output traits will be wide open. The nano machinery within the corn plant can churn out an unlimited amount of new

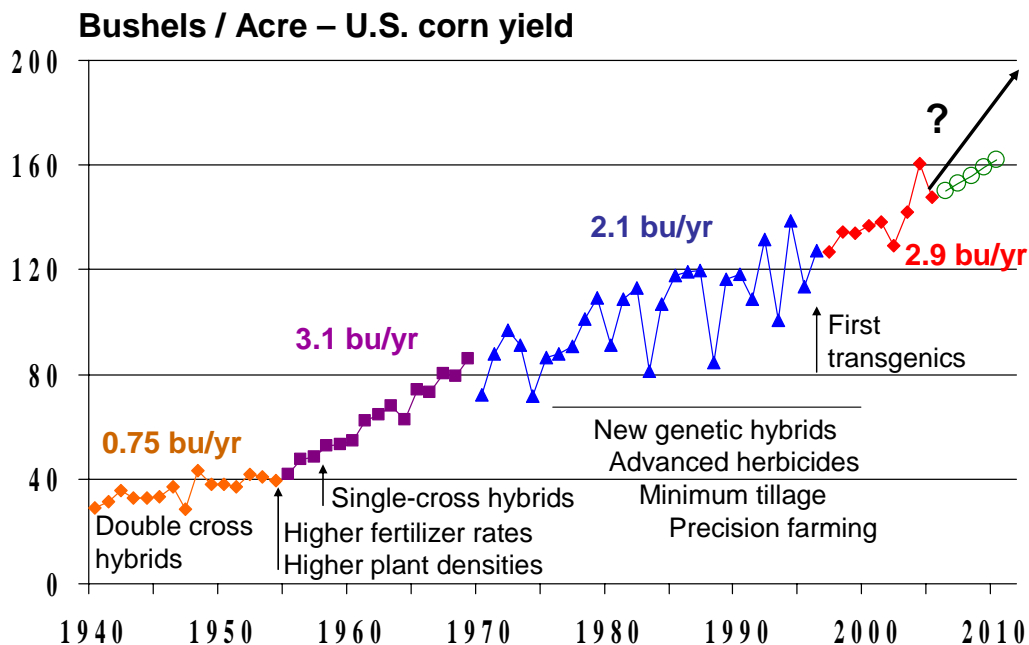
products when so directed by advancements in bioengineering. Iowa Corn has trait research underway but in this project more than any other, no one can do the job alone.

One question that arises in the push for new uses for corn: Will there be enough corn to meet all the demands?

First, it's important to recognize that the conversion of the starch in corn to whatever use still leaves a high protein feed co-product. So the development of many value-added products also results in increased supplies of feed ingredients to support livestock production – and our experience in Iowa ethanol production is that this distillers grain is being readily adopted into feed rations.

Second, corn yield trends are advancing at ever higher rates and will get a big boost from genetic research that will unlock even higher yield potential. (See graph below). Improved genetics are having effects already. It's not by chance that although 2005 was the 20th driest year on record, corn yields were the second highest ever.

U.S. Corn Yield Trend



Source: NASS

There are additional factors that contribute to the supply side of the corn equation – factors like the expansion of significant corn production into areas where corn wasn't always a viable crop (such as the Dakotas) and the potential for changes in the crop rotation, perhaps to a follow one year of an alternate crop with two years of corn. Finally, we must recognize that corn is not the only potential feedstock for some of these products.

In closing, it is obvious why this carbohydrate future is so important to an Iowa farmer. At the Iowa Corn Promotion Board, one of our missions is to move farmers up the value chain and improve profitability back to the farm gate. Will our efforts create a shortage of corn? I don't think we'll see a corn shortage – but hopefully, we will see a shortage of corn at depressed prices that don't return a profit to the grower. As the demand emerges, our nation's farmers will push production to meet that demand. If the U.S. and the world demand biorenewable products, we will meet their needs at all levels.

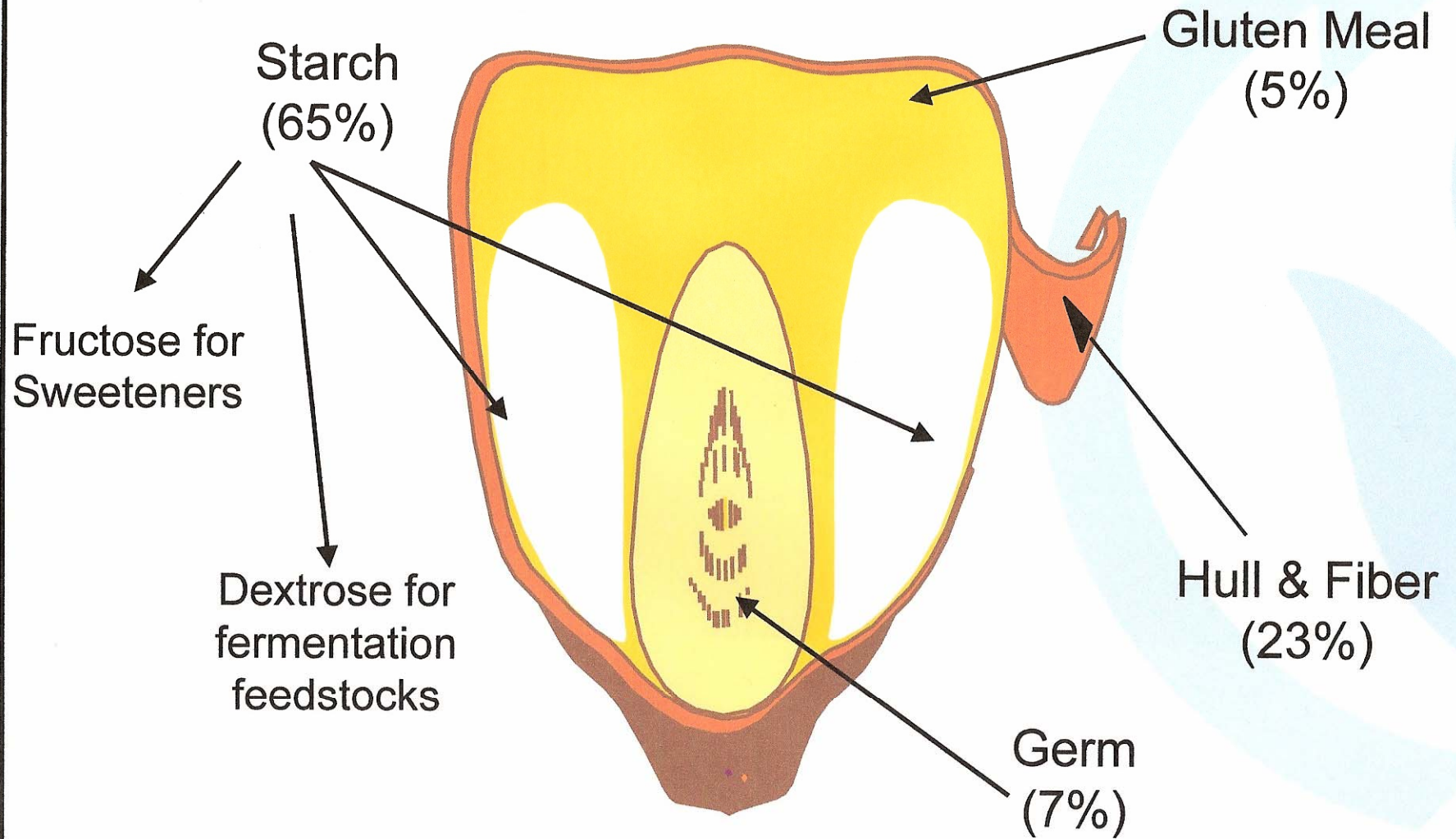


**Thinking
Biorenewables?**

Think Corn!

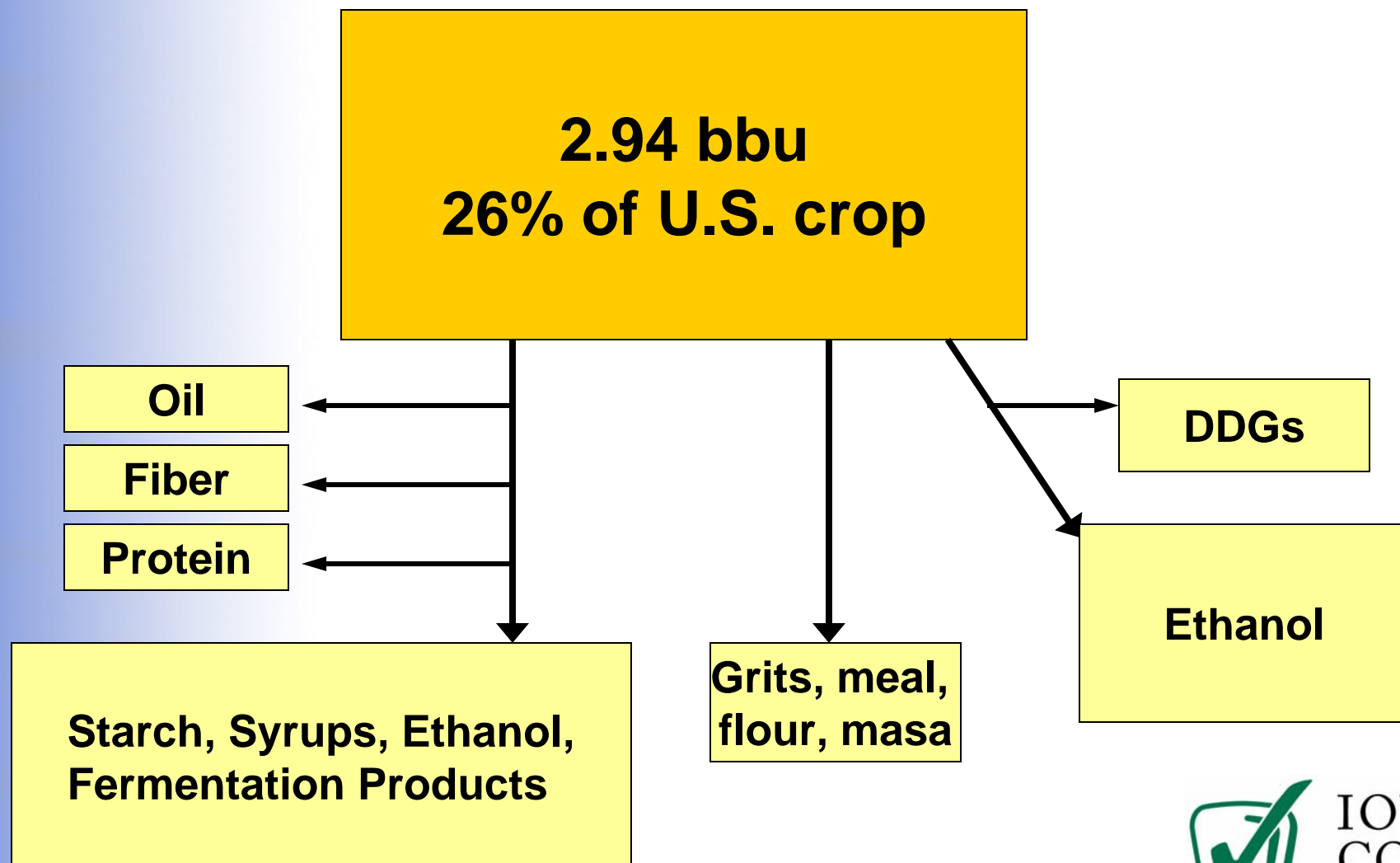
Julius Schaaf, Farmer Director
Iowa Corn Promotion Board

Corn as the Feedstock





Corn Processing 2006

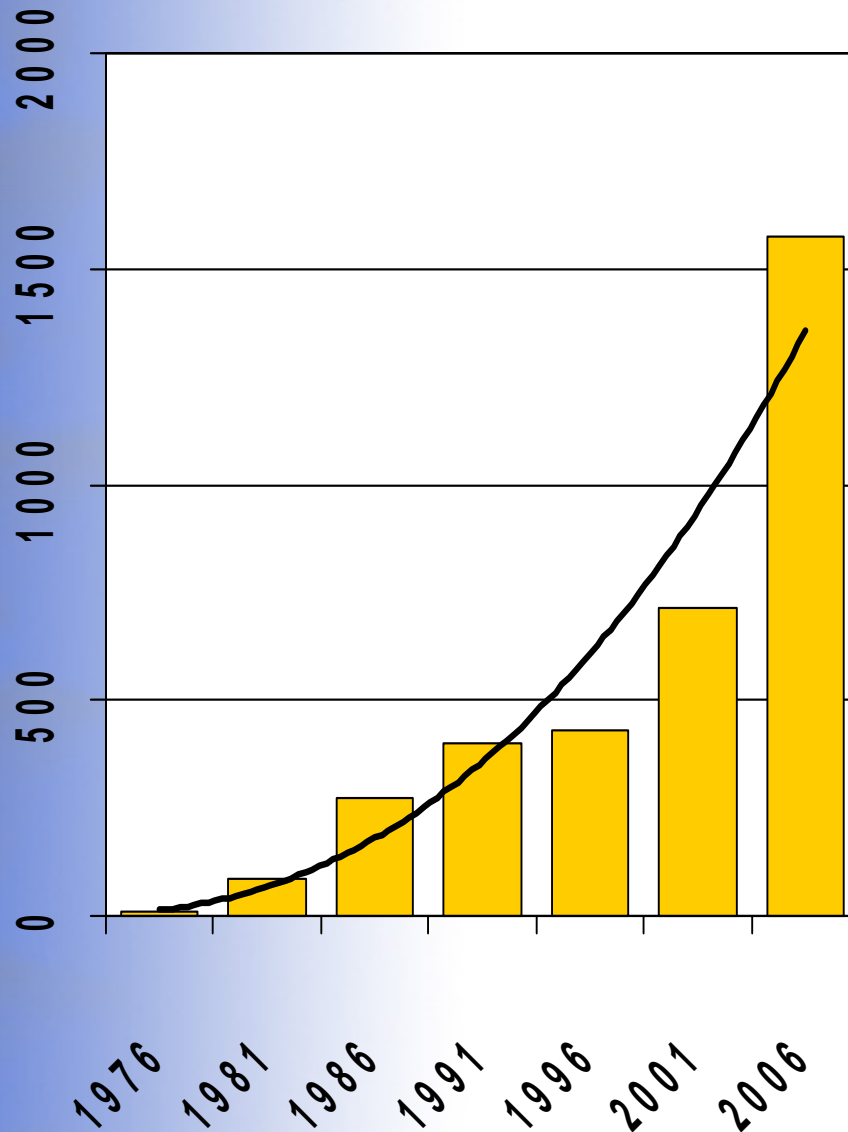


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Ethanol is just the start

Corn Use for Ethanol



Benefits in Iowa

- 3,700 jobs
- 6,000+ farmer investors
- \$2.6 million increase in local tax base
- \$841 million in revenue



Economic Impact on Farmers

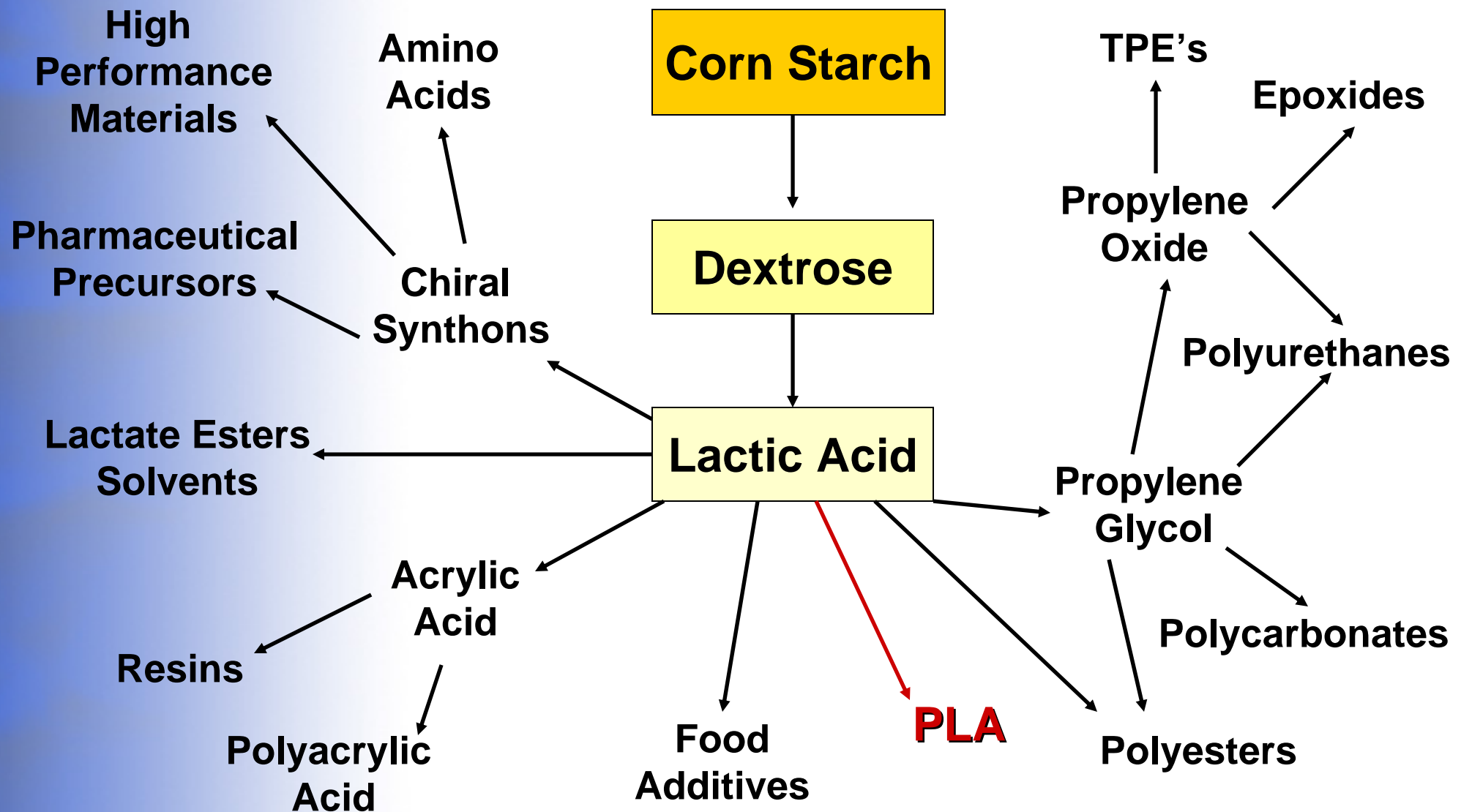
Farmer-Owned Plants

- \$910 million of Iowa corn purchased
- \$81 million additional farm gate income
- Up to 12¢ per bushel increase in value
- \$2.40 value added per bushel processed
- Statewide 4¢ to 5¢ improved basis
- Growing DG supplies benefit Iowa's livestock sector




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A World of Potential



NatureWorks® PLA

- Ingeo™ fiber 
 - brand name for fabric and fiber products made from PLA
- NatureWorks® PLA
 - brand name for resin and packaging made from PLA





Resin and Packaging

- Europe, North America, Japan, Korea, Taiwan, Australia, New Zealand
- Used in
 - Serviceware (bowls, plates, cups, labels)
 - Bottles/jars/preformed packaging
 - Sheet/film
 - Rigid, heat-formed food packaging
- More than 50 companies



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Textiles and Fibers

- Intermediate products
 - Fibers, yarn, filament, battings, nonwoven, woven, knit fabrics
- Apparel, hosiery
- Hygienic non-woven products
- Fiber-filled products
- Furnishings
 - Carpet, upholstered fabrics, home textiles
- 200+ partner companies





Examples

- Conical sleeves for flowers, plants
- Credit, debit, Smart, ID, gift, phone cards
- PLA-cotton blends
 - landscape fabric
 - plant pots
 - fertilizer bags
- Walmart adopting PLA to package produce

The Ultimate...





Corn Use for PLA

- Range of uses
- Varying levels of adoption
- Alternative feedstocks
- PLA use in Taiwan = 5 mbu corn by 2009
- Equivalent use in Japan = 28 mbu
- Equivalent use in U.S. = 56 mbu



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Beyond PLA

- Research/commercialization time spans
- Critical role of public-private partnerships
- Criteria for success
 - Renewable resource
 - Replacing petroleum / other more hazardous products
 - Price competitive
 - Equivalent function or better



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Fiber Utilization/Polyols

- Separate fiber into component sugars
- Propylene glycol used in
 - Polyester resins, coatings, paints
 - Detergents
 - Drugs and cosmetics
 - 850 million pound market per year
- Ethylene glycol used in
 - PET and antifreeze
 - 5.6 billion pound market per year



Isosorbide

- Starch-based plastic additive
- Non-toxic blended material
- Current use mainly pharmaceuticals
- Replace oil, other chemicals in PET plastics, other materials
- Moldable plastics tolerate higher temps
- Market potential for 30-40 mbu corn per year



Hemicellulose

- Fiber ➡ simple sugars ➡ organic acids
- Feedstock for:
 - Industrial chemicals
 - Plastics
 - Solvents
- Advantages
 - Higher value
 - Renewable resource
 - Less price volatility
- Market potential = 40 mbu corn/year



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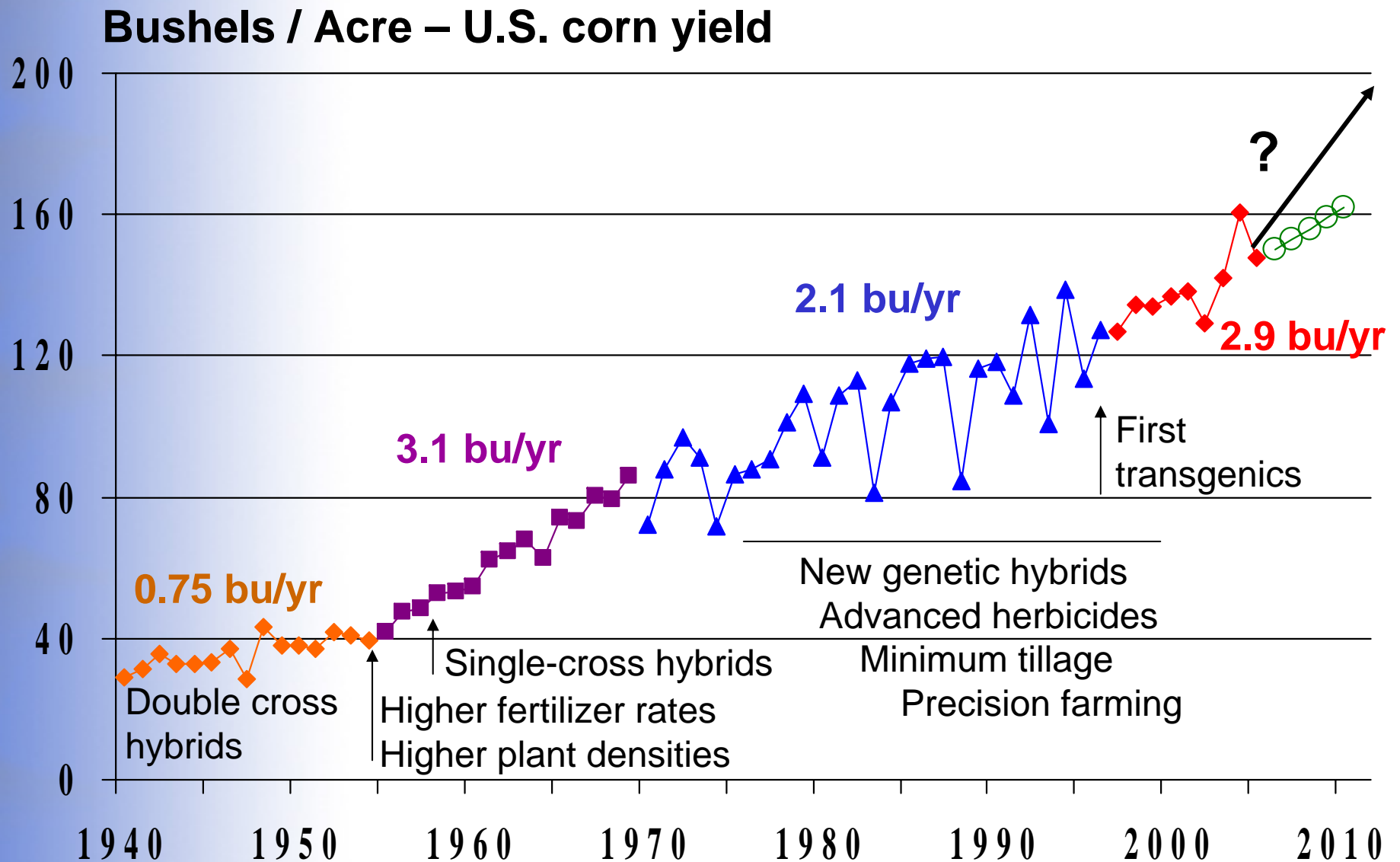
Corn Genome Research

- Essential groundwork before we can develop practical uses
- 60,000 genes in corn (human genome 30,000)
- Biotech, seed companies can follow “map” to develop new traits and benefits
 - Nutrition
 - Yields
 - New products
- No one can do this alone



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U.S. Corn Yield Trend



Source: NASS



Other Supply Factors

- Changes in corn acreage
 - Shift north and west
 - Corn replacing other crops
 - Changes in crop rotation
- It's not just about corn
 - Soybeans / other oilseeds
 - Alternative crops
 - Biomass



Why does it matter?

- Better products for our society and environment
- Increased, diversified demand for crops
- Grower participation in value chain
- Reduced grower reliance on farm program would benefit government, taxpayers, and farmers

The image is a collage featuring corn. On the left, there's a large, detailed cob of red corn with its husk partially peeled back, revealing the kernels. Below it, a smaller cob of yellow corn is shown, also with its husk partially removed. The background is a solid, deep blue. Overlaid on the right side of the image is a faint, semi-transparent graphic of a corn stalk with its leaves and tassel, rendered in a light blue or white color. The overall composition is artistic and celebratory, likely intended for a presentation related to agriculture or a corn-themed event.

Thank you