

# Grain storage, management and grading for the future

*AAGIWA Meeting  
April 26, 2010*

*Charles Hurburgh, Professor  
Agricultural and Biosystems Engineering  
Iowa State University*



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## Outline

- Challenges facing grain handling – 2009 example
- Processing and biofuels – the new driver for the market
- Planning for future professionals in grain related careers – the KSU-GEAPS program
- Official Services in a domestic market

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## Corn Crop Summary Quantity and Quality

- Quantity above trendline
- Quality
  - Wet: >20%M, Much greater ECB
  - Light: Test Weight ~ 52 lb/bu, no increase
  - Low protein: <7.5% (15%M)
  - Storage time: ~50% of normal
  - Damage: ~ 3-5%, normal = 1-2%

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## Wet Corn!



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## Soybean Crop Summary: Quantity and Quality

- Quantity above trendline
- Quality
  - Wet: >14% M, some much greater (20%)
  - Somewhat low protein: <35% (13%M)
  - Hard to process wet soybeans

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## Soybean Drying Anyone?



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## Weather Events and Quality

- West: Reasonable planting dates
- North and East: Progressively later
- Reduced heat units over summer
  - Delayed development rates but total good
  - Assured wet corn but...
- Warm late Aug, early Sep.
  - Brought crops along (Could have been worse!!)
  - Cost 2-3 lbs of test weight

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## Weather Events and Quality

- Then November in October!
  - Put the brakes on drydown
  - Created wet soybeans
  - 20-30% corn
- Then October in November
  - Bailed out the soybeans (field or bin)
  - Some help to the corn (~20-23%)
- Now May in March and April

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News Photo – media are watching [www.kimt.com](http://www.kimt.com)

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## “Sac to Grundy” storm

- August 9, 2009
- Travelled ~150 miles; 900,000 acres
- Hail swath ~10 miles wide; middle 3 miles (~30%) had 100% damage



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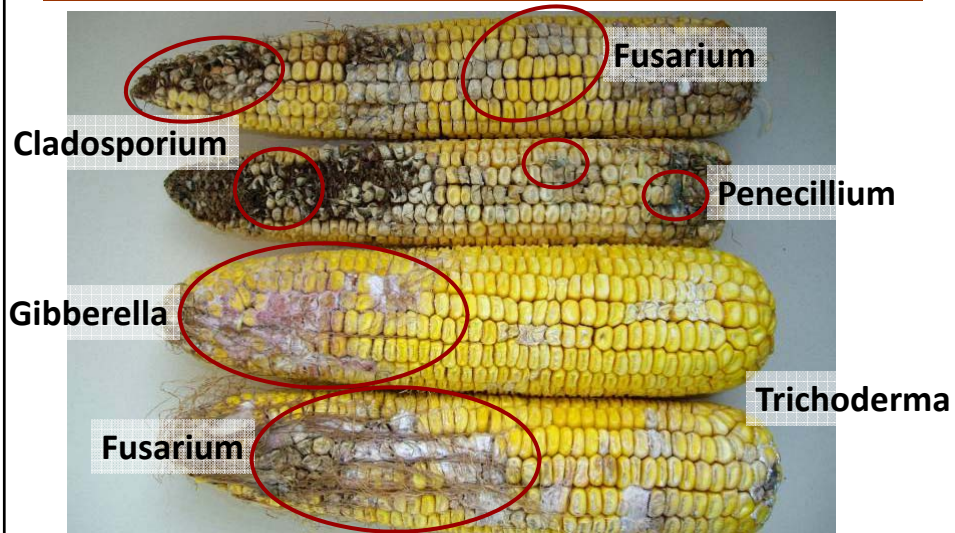
## Hail damage, Sac County, 8-09-2009



Photos courtesy: Mark Licht, ISU Extension

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## Ear rot assessments – percent severity; rot present



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## Ear Rot Summary

	Mean	Ear rot*
<b><i>Hail samples (N=63)</i></b>		
Ear rot severity (%)	11.3	Fusarium, Gibberella
<b><i>Background samples (N=26)</i></b>		
Ear rot severity (%)	3.2	Cladosporium
* Predominant ear rots present		

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Iowa Grain Quality Initiative  
[www.iowagrains.org](http://www.iowagrains.org)

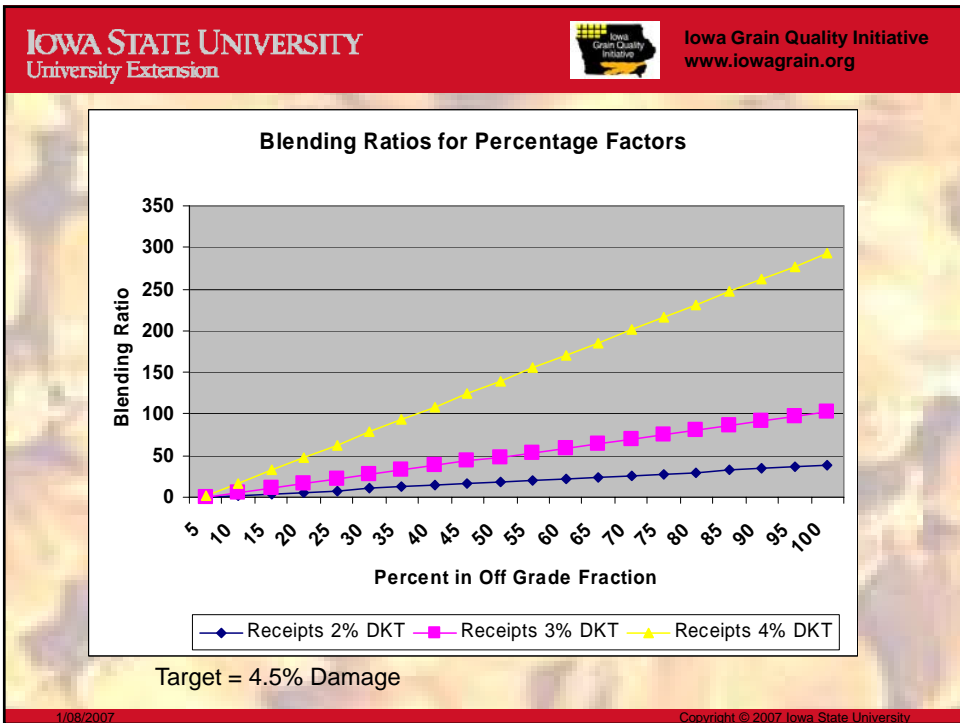
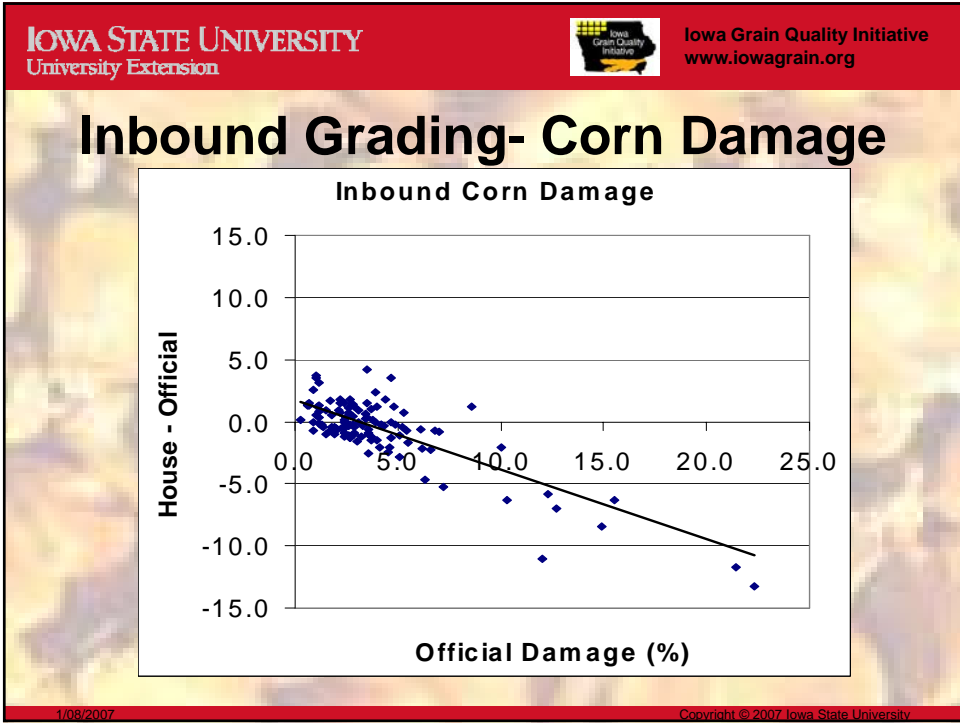
### Maximum storage time (months) for corn and soybeans\*

Corn temperature ° F	Corn, soybeans moisture content						24% N/A
	13%, 11%	14%, 12%	15%, 13%	16%, 14%	17%, 15%	18%, 16%	
40	150	61	29.0	15.0	9.4	6.1	<b>1.3</b>
50	84	34	16.0	8.9	5.3	3.4	<b>0.5</b>
60	47	19	9.2	5.0	3.0	1.9	<b>0.3</b>
70	26	11	5.2	2.8	1.7	1.1	<b>0.2</b>
80	15	6	2.9	1.6	0.9	0.9	<b>0.06</b>

\*Based on 0.5% maximum dry matter loss—calculated on the basis of USDA research at Iowa State University. Corresponds to one grade number loss; 2-3% pts in damaged seeds. Soybeans approximated at 2% lower moisture than corn.

1/08/2007



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www.iowagrains.org

## Inbound Grading




The bit of the barley from the first name in grain moisture testing

### Moisture AND Test Weight

- 0.1% Moisture = 1-3 cents/bu
- +/- 0.3% vs GIPSA
- More than just once a year

### Test Weight

- +/- 0.5 lb/bu vs GIPSA
- 1 lb/bu = 1.5% inventory error
- Cup? Training or worse than meter!

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## Volumetric Measurement of Grain Quantity

Source of error	Estimated maximum ( $\pm 2SD$ )	Squared Error
Stretch of tape ( $\pm 1$ in/50 ft)	0.2%	0.04
Level fill depth estimation ( $\pm 6$ in/50 ft)	1.0%	1.00
Average test weight ( $\pm 1$ lb/bu)	2.0%	4.00
Moisture ( $\pm 1\%$ M)	1.2%	1.44
Pack factor	1.0%	1.00
		<b>7.48</b>
Estimated maximum overall error	2.7% ( $= (7.48)^{1/2}$ )	

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# Inbound Grading Particle Based Factors

Must use a divider on samples. Sampling is important.  
Check the division by weight.  
Compare 5-10 samples vs GIPSA; +/- 0.2 – 0.5%  
depending on amount.

Remember: Some of these are dockage!

Toxins – no division!  
Full sample grind

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June 14, 2005

GEAPS North Central Regional  
Conference, Ames, Iowa



**WEST CENTRAL**

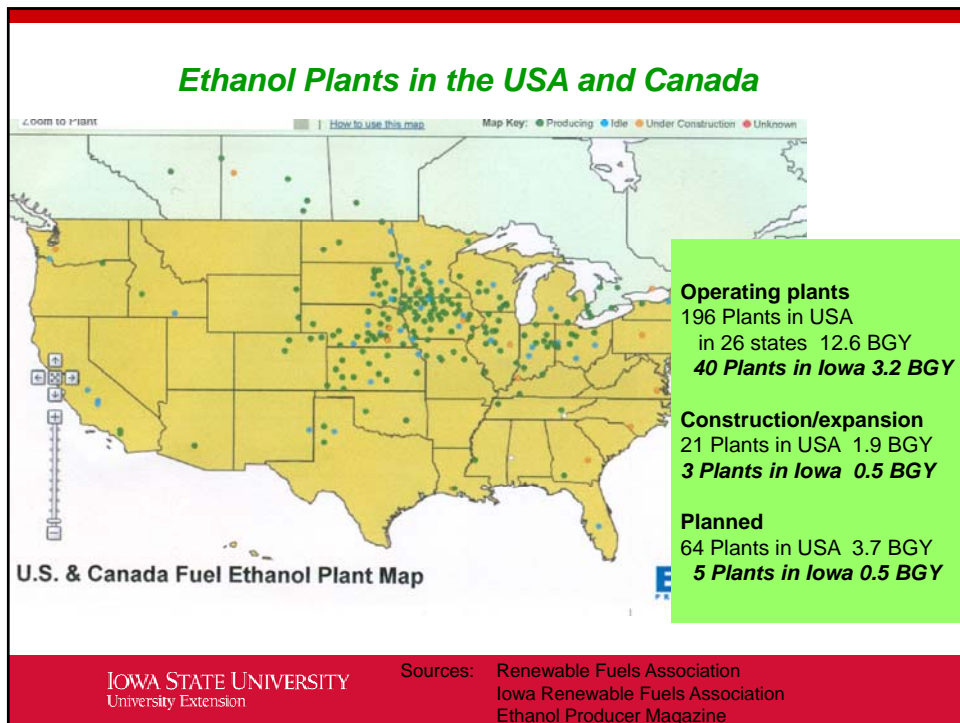
*In business to exceed customer expectations*

- Grain Bids
- Grain Commentary
- Our Locations
- About WCC
- Career Opportunities
- Weather
- Account Login
- Agronomy
- Feed
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- Questions?
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*A dozen reasons West Central makes a smart business partner...*

- \*Outstanding Growers
- \*Central Iowa locations
- \*Corporate Values
- \*Professional attitudes
- \*Partnering track record
- \*Commitment to research
- \*Cooperative structure
- \*Financial strength
- \*High value facilities
- \*Multiple locations
- \*Smart computer conn
- \*Our corporate mission

**ISO 9001**  
**BUREAU VERITAS**  
Certification



## Iowa Ethanol Production, Corn Usage

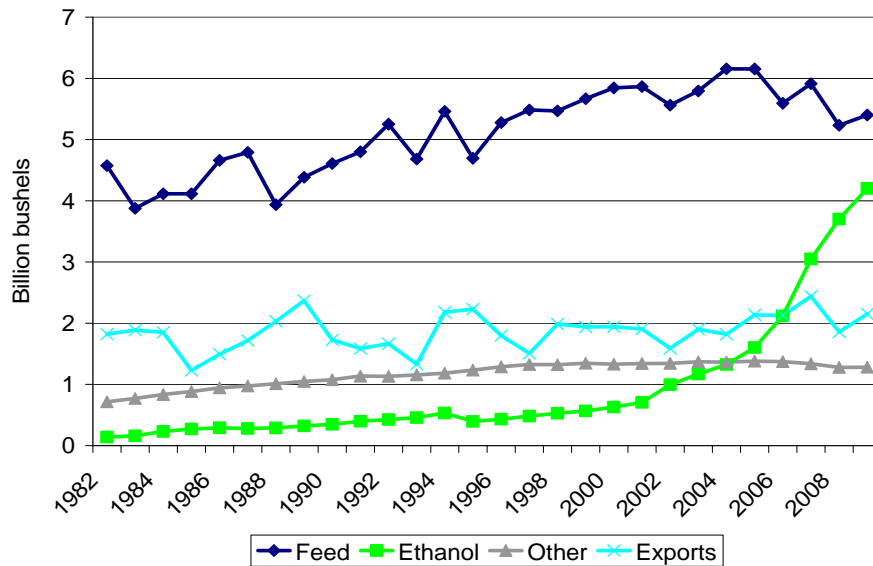
Summary Statistics	n	Ethanol Produced mil gal/yr	Corn Used mil bu/yr	DGS 000 tons/yr
Current Dry-grind Plants	25	1,646	593	4,975
Plants, expansions under construction	13	1,110	397	3,370
Wet Mills	6	865	320	2,641
Nearby, Iowa Draw**	6	402	144	1,220
<b>Subtotal</b>	<b>50</b>	<b>4,023</b>	<b>1,454 ~65%</b>	<b>12,206</b>
<b>ALL USA</b>	<b>196</b>	<b>~12,500</b>	<b>~5,000 ~30-40%</b>	<b>~40,000+</b>

\*Operating at rated capacity.

\*\*Plants in bordering counties of other states with 50% use assigned to Iowa corn.

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## Corn Use



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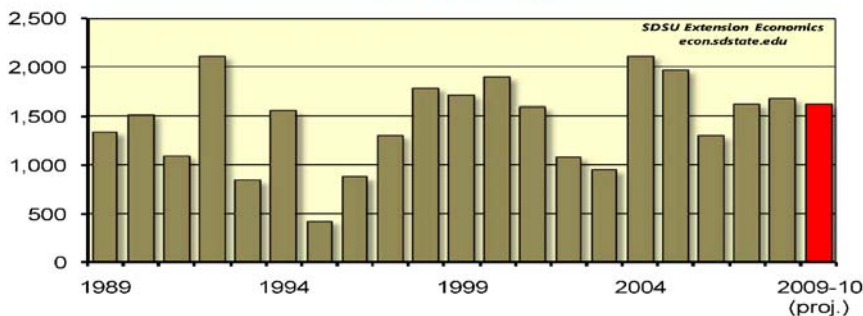


Source: USDA

## Are We Running Out of Corn?

South Dakota  
Cooperative Extension Service

### U.S. Corn Ending Stocks (million bushels)



Sources: USDA - National Ag Statistics Service and Economic Research Service

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## Typical Ethanol Corn Specs

- Base US Grade #2 Yellow Corn
- Moisture limit: 17% (a few take 18%)
- Test Weight low limit: 54 lb/bu
- Damage limit: 10% max (discount from 5%)
- Broken Corn: 12% max
- Toxins: <1/3 FDA guidance/action level
  - **Mostly a truck market**

Source: Hardy et al 2006.

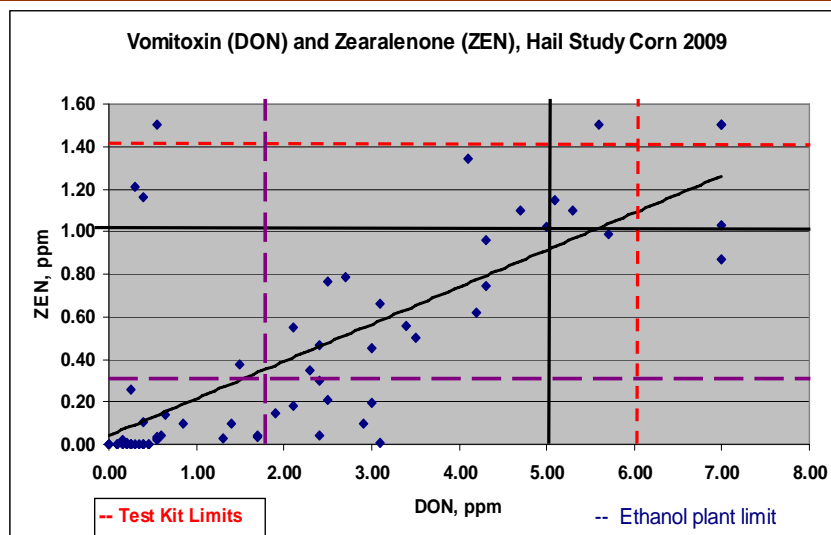
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## Ethanol – Important Factors

- Toxins!!
- Damage – interferes; stuck fermenters
- Protein – low; oil- low
- BCFM – Maybe if toxins present
- Moisture over 18 – mess in tanks; less dry matter in fermenters.
- Corn temp in drying – deactivates natural enzymes over 85C (~160F).

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## DON and ZEN in hail/nonhail samples



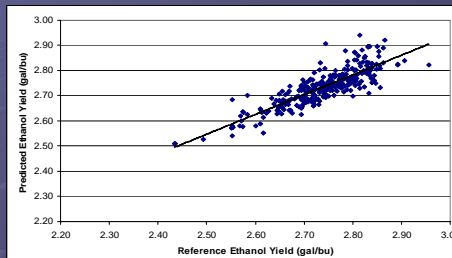
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## Supply Chain Agronomics: Ethanol Yield

- 0.1 gal/bu =  
\$6,000,000/yr  
(100 mgy plant)



Protein, Oil and Density measured by  
Near-Infrared; about 1 minute/sample

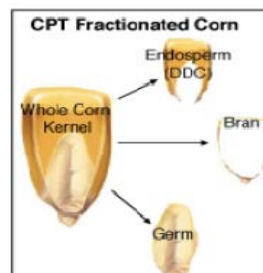


Predicted ethanol yield against reference ethanol yield  
for final Protein-Oil-Density equation

Component	Final Equation Coefficients
B0	3.23
Protein	-0.062
Oil	-0.030
Density	0.104

## Food, Feed and Fuel

- How many units of protein, oil, amino acids, glucose, etc will 200 bu corn give, 250 bu, 300 bu?
- We have a distribution issue.  
Not a total quantity issue.  
Supply chain management.  
Biodiesel is not a grain use  
Uses oil only.



## What About the Acreage Split?

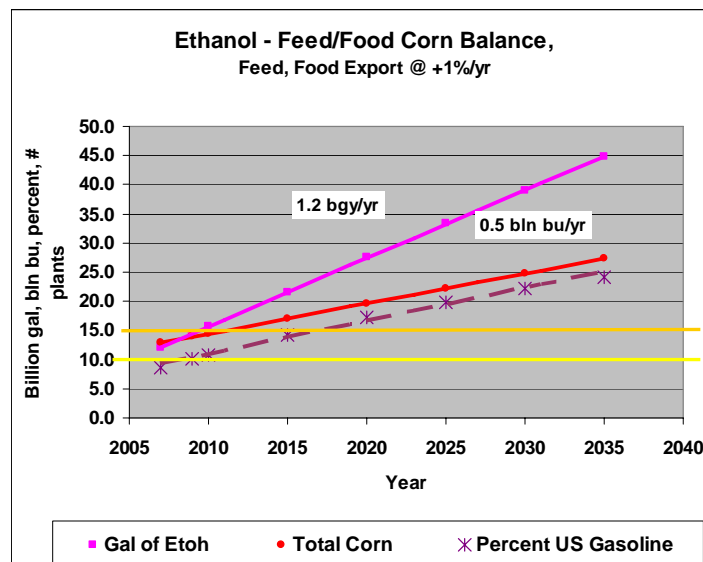
	DDGS (mln ton)	SBM (mln ton)	Protein (mln ton)	Oil (bln lb)	Lysine (bln lb)
2006	17.4	11.3	9.9	9.8	1.14
2007	20.8	9.8	10.1	9.7	1.07

**Issues:** Protein quality (amino acids)  
Energy content (starch, oil)  
Carbon Footprint

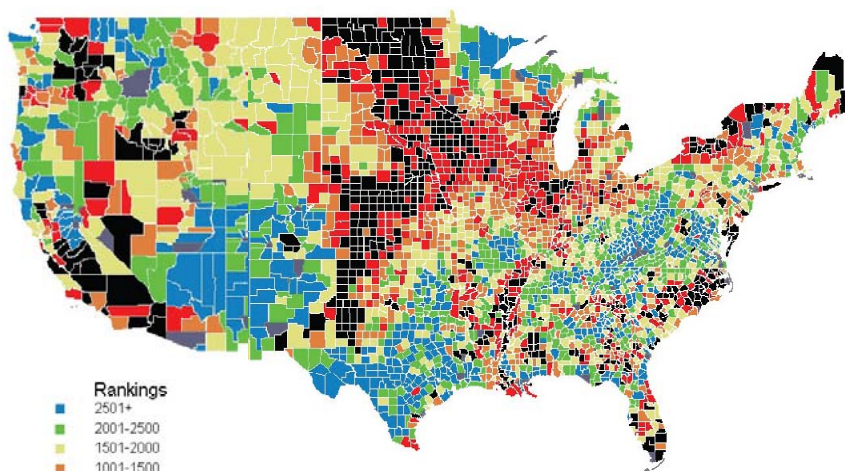
**Solutions:** Fractionation  
Glycerin, Amino Acid transformation  
Yield increase

30 - 40% of starch calories from corn necessary for feed uses.

## Current Trendlines for Corn, Ethanol Prod. and Use



## Best Places to Farm Farm Futures, April 2009



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## Challenges

- **Work force:** Time marches on even for Baby Boomers
- **Integration of Supply Chain:** Everyone affects everyone else.
- **Localization of Markets:** We control our own destiny but....
- **Environmental Impact**
- **Organization/Concentration of Knowledge**

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## The Bigger Picture for Grain Bag to Box

- Production Sustainability and Environmental Stewardship
- Grain Handling and Distribution
- First and Second Processing Steps: Commodity to Product

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## Grain Industry Center Partnership Needs

- Extended education (eg Distance Ed.)
- Direct education/curriculum
- Applications research and problem solving
- Conceptual thinking-idea exchange
- Interpret and respond to regulation/public
- Influence public policy and basic research
- **Whole supply chain**

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## 5-10 Years From Now?

- I will not be here giving this discussion
- How many of you will be here listening?
- Transformed supply chain – by whom?
  
- The knowledge developed in the 1970-1990 period will be organized ...where?
- Concentration into a few programs. Who will support grains?

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## International Center for Grain Operations

GEAPS Strategic Partnership Meeting  
Manhattan, Kansas  
April 12-13, 2010

Dr. Dirk E. Maier  
*Kansas State University*  
Dr. Charles R. Hurburgh  
*Iowa State University*



## GEAPS Goals

- *Core Purpose* is providing members with forums to generate leadership, innovation and excellence in grain industry operations
- Meet *Core Competencies* via professional development and credentialing opportunities
- Achieve vision of being THE Knowledge Resource for the World of Grain Handling Operations

## International Center for Grain Operations

- **Purpose:** The International Center for Grain Operations will serve as the primary partner to the U.S. (North American/ international) grain handling and processing industry in providing a current, complementary and comprehensive knowledge resource for the world of grain operations.
- **Partners:** GEAPS, Grain Handling & Processing Companies, Kansas State University, Iowa State University, Purdue University, USDA-ARS CGAHR, USDA GIPSA Tech Center



## Grain Science & Industry



Shellenberger Hall



Hal Ross Flour Mill



Bioprocessing and Industrial Value-Added Program (BIVAP)



International Grains Program

## GSI North Complex on Kimball Ave

(View from top of East Stadium.)



## O.H. Kruse Feed Mill & Biorefinery Teaching and Research Center

- estimated \$12.5 million project
  - \$2 million lead gift by Mr. Ron Kruse
  - \$0.3 million cash from grain, feed and biofuels industry so far
    - plus >\$2.5-3 million in equipment commitments
  - Seeking \$5.2 million in NBAF relocation funds from State of Kansas
  - Seeking additional \$2.5-3 million cash and equipment from domestic and international grain, feed, biofuels and animal nutrition industry and allied trades



**Project Timeline:**

**Summer 2010 – complete fund raising**

**Fall 2010 – break ground as part of Centennial Celebration**

## International Center for Grain Operations Funding

- Annual funding will support...
    - faculty, staff, students, projects, facilities, operations
  - Annual funding will consist of...
    - expendable funds from grain industry, K-State appropriated funds, extramural funding, future gifts
  - Various options for industry support...
    - Single large endowment of \$20 million will yield annual expendable funds of \$1,000,000 / year
    - 10-15 year commitment of \$1-2 million to build up endowment (50%) and provide annual support funds (50%)
    - ...
- Equipment suppliers have been generous to the KSU projects.

## GEAPS-KSU Distance Education Program Purpose

To organize and provide a professional development curriculum regarding the design and operation of grain handling and processing facilities that meet the seven *GEAPS Core Competencies* and deliver these courses via distance education to grain industry professionals around the globe.



## Official Inspection

- Same personnel transition issues.
- Larger volume means more risk in the system.
  - Propane gas is cheaper than corn.
- Food Safety is coming to commodities
- Standardization programs
  - Not just ethanol plants.
  - Connect with qms, credentialling
  - Know the end user and end-use economics

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## Official Inspection

- A 100 mgy ethanol plant uses about 35MM bu of corn/year. 125-150 trucks/day (300 days).
- A loss of 0.1 gal/bu = \$6,000,000/yr
- A loss of \$2/ton (1%) = \$600,000/yr
- Options:
  - On site service
  - QC program to support house graders.

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## Summary

- The 2009 crop presented quality challenges that may become the norm.
- Quality problems are why the Official System exists.
- Grain based ethanol has a large capacity to grow. ~20-25% of US gas.
- Support education, training, credentials, quality management systems.

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## Where to find us...



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