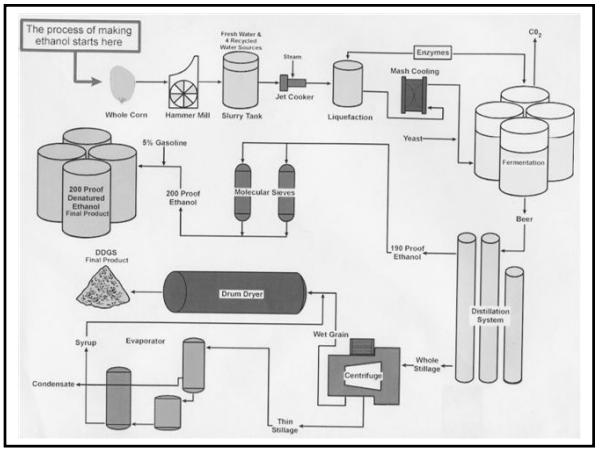
ETHANOL

The Good, the Bad, and the Ugly!

Reminders....

- **Lab this week and next week: AGAD21**
- **Bring a calculator and your NRC tables to lab**
- http://www.ansc.purdue.edu/swineclass/



Background

- **Indiana, Midwest, Eastern Cornbelt**
- **Benefits**
  - **Added value to corn**
  - **Job creation**
  - **State revenues**
- **Who potentially benefits most**
  - **Corn growers**
  - **Beef producers?**
  - **Dairy producers?**

Current and Proposed Ethanol Plants

- **Dry grind vs. wet milling – 2.8 gal/bu**
- **108 plants in operation = 5.16 billion gal.**
  - **1.84 billion bushels of corn**
  - **32.2 billion pounds of DDGS**
- **82 plants under construction = 5.52 bil. gal**
  - **1.97 billion bushels of corn**
  - **34.5 billion lbs of DDGS**
- **Combined 10.67 billion gal. by end of 2007**
  - **3.8 billion bushels of corn**
  - **66.7 billion lbs of DDGS**

What are the Uses of the by-products

- **Landfills**
- **Crop fertilizer - pelletized**
- **Further refinement**
  - **Pyrolysis**
  - **Gasification**
  - **Component fractionation**
  - **Industrial**
- **Co-fire in power plants**
- **Livestock Feed**
  - **Domestic**
  - **International**

How Much DDGS can the US Livestock Industry Use?

100% of the livestock category using DDGS at current recommended levels

Slaughter Cattle	18.25 billion lbs
Beef Cows	20.34 billion lbs
Dairy Cows	16.75 billion lbs
Heifers and calves	18.20 billion lbs
Cattle Total	73.54 billion lbs
Swine	17.58 billion lbs
Broilers and Turkeys	6.02 billion lbs
Grand Total	97.14 billion lbs

** Estimated 66.7 billion lbs produced by the end of 2007 **

Indiana Proposed Ethanol Plants

- Dry grind – possible fractionation
- Estimated 1.4-1.9M tons DDGS
- Typical inclusion rates
  - Beef & Dairy 20%
  - Swine 10%
  - Poultry 5%
- USDA Ag Statistics, 2006
- Maximum IN utilization: 1.33M tons (70-90.5%)
- Realistic utilization in Indiana: 30-50%

SBM vs DDGS

- DDGS contains 57% of the protein of SBM
  - (27.3/47.5)
- DDGS contains 28% of the total lysine of SBM
  - (.84/3.02)
- DDGS contains 20% of the available lysine
  - (.52/2.57)
- This is why it replaces a greater percentage of Corn in the diet than SBM in monogastric diets

SBM vs DDGS

- Swine Example – 10% DDGS in WF
- Pig consumes about 110 lb of SBM and 565 lb Corn from weaning to market
- DDGS could replace about 2.42 lb SBM / Pig
- DDGS could replace about 36.7 lb Corn / Pig
- In Indiana = 4.2 million bushels of corn
- In Indiana = 7,744 ton SBM

Handling, Storage & Transportation

- Wet system - frequent delivery of wet DGs
  - Flat storage
  - Cost of transporting water
  - 3 - 7 day shelf-life
  - Ensiling (corn stover, silage, soyhulls, straw)

- DDGS
  - Bridging in bins and rail cars (BN, UP)
  - Separation
  - Particle size ≤ 400 microns
  - Pellets (limited to 5 - 7% inclusion rate)

New Fractionation Processes will change DDGS and it's nutritional value

- Degerming
  - Press the oil to human or Bio-diesel
  - Reduces oil and may reduce P
- Dehulling
  - Reduces fiber
- Separation post-fermentation
  - Fiber and/or oil removed
- Syrup levels used and fractioning or recycling

Comparison of Conventional DDGS and Fractionated Products

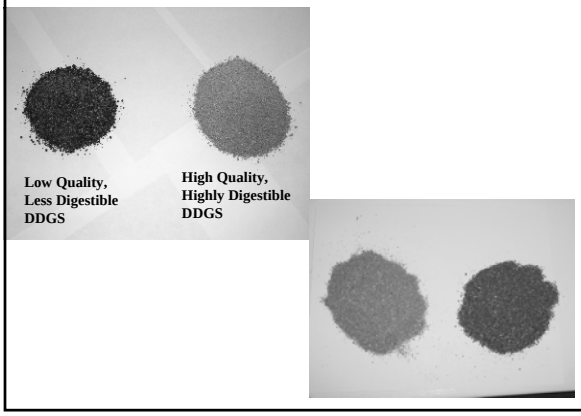
Conventional		Fractionation Process
Ethanol	2.8 gal	2.8 gal
DDGS	17 lb	7 lb
Germ	---	4 lb
Fiber/ hull	---	4 lb
Corn Oil	(2 lb)	2 lb

Dakota Gold Product Profiles
(As Fed)

	DDGS	DDGS -HP	Corn Germ	Dakota Bran[b]
CP	26.6	43.0	15.6	13.7
Lys	0.89	1.19	0.82	?
M+C	1.25	1.81	0.74	?
Thre	1.01	1.63	0.57	?
Tryp	0.28	0.36	0.20	?
Fat	9.7	3.0	17.8	8.1
Fiber	6.1	6.9	5.1	5.0?
ME[a]	1647	1695	1844	???
Phos	0.79	0.37	1.40	0.61

[a] Corn ME = 1505
[b] only 52% DM

Effect of Processing Method on DDGS Quality



How is DDGS Quality Defined?

- Color?
  - Subjective measure
- Nutrient availability to livestock?
- End-use, different measures?
- Who should do this, the industry?
- ????????

Variations in Distillers Dried Grains w/solubles from 4 New Generation Plants

Swine Digestibility

- Protein 58.1 – 78.6%
- Lysine 51.3 – 75.7%
- Threonine 67.8 – 83.7%
- Tryptophan 41.4 – 71.6%
- Methionine 76.4 – 87.8%

- Phosphorus
  - .77 - .90% Tot.P vs Corn at .28% Tot.P (15% Dig.)
  - 35-85% Digestible (Stein, 2006)

- Stein et al., 2004

Rapid Lab Tests

- One-Step pepsin digest – $R^2 = 0.52$
- Two-Step pepsin-pancreatin digest – $R^2 = 0.79$
- Color – $R^2 = 0.53$-0.67
- KOH Solubility – $R^2 = 0.47$
- Furosine – $R^2 = 0.71$
- Reactive lysine – $R^2 = 0.66$

- IDEA Value (Novus) vs. True Lys Dig. (Poultry) – $R^2 = 0.88$

Stein, Pahm, and Pedersen, 2005

Use of DDGS in Beef and Dairy

Animal Performance, Co-Product Quality & Nutrient Management

- Historical use has been WDG by feedlots (proj. 25-30% of by-product)
- Excess N, P & S
  - Amino acid imbalance
  - Environmental implications
- Limited data across species
  - ADG, G/F, repro., longevity
  - Fiber digestibility, milk quality, immune function.
  - Carcass composition, marbling, FA profile

Potential Use of DDGS in Beef

- Beef industry will prefer to used the dry product
- Research is clear concerning the utilization of DDGS in feedlot diets
  - Max. of 40% DM intake
  - Greater than 25% may decrease marbling
- Product may be used in cow, creep, and heifer development diets
  - May help with low quality fiber source digestion

Potential Use of DDGS in Beef

- DG inclusion will alter Ca:P ratio
  - Feedlot diets - urinary calculi (water belly)
  - MUST add calcium to diets (Ca:P at least 1.1:1)
  - P excretion will increase (nutrient management issue)
  - SULFUR!!!

Dairy Cattle Feeding

- Young Calves – up to 50% of the grain mix
- Older calves – could be greater than 50%

- Max. of 20% DMI in Lactation Rations
- Check particle size of final ration to ensure adequate effective fiber
- Balance for RUP and RDP
- Determine Fat, P, and Mycotoxin levels of purchased distillers products

Ruminate Potential Problems

- Storage
- Transportation
- Upper limits for cow and creep diets
- Reproductive efficiencies
- Variation of co-products
- P and S content
- N and P Excretion
- Fat level
- Effective fiber
- Long term issues

Ensiling Storage DDGS

- Many small producers
  - Can't utilize semi-load lots of wet co-product
  - Need a longer term storage method
- 100% wet co-product
  - Will bust ag bag seams
    - Need a "diluter" for density and nitrogen (CP)
  - pH is low – should store in airtight structure
- Potential "diluters"
  - Corn silage, corn stalks, straw, soyhulls, hay

Use of DDGS in Swine and Poultry

Feeding DDGS to Poultry

Dry product only

Broilers – 5-7.5% typical, 10% max.

Layers – 10% could be used, 15% in non-peak production

Turkeys – 5-15% inclusions

Pig GF Performance fed DDGS

DDGS,%	0*	10	20	30
ADG, lb/d	1.90[a]	1.89[a]	1.80[b]	1.78[b]
G:F	0.377[a]	0.377[a]	0.365[ab]	0.360[b]
Carcass wt.	189.0[a]	191.1[a]	177.5[b]	177.2[b]
Dressing %	73.37[a]	73.03[a]	71.50[b]	71.74[b]
Loin, mm[a]	56.5	54	54.2	51.8
Belly Thickness	3.15[a]	3.00[ab]	2.84[ab]	2.71[a]
Adj. Belly firm.	25.9[a]	23.8[ab]	25.4[a]	22.4[b]
Belly IV value	66.8[a]	68.6[b]	70.6[c]	72.0[c]

* 4-1.5% Soy Oil Control, balanced on total AA Whitney et al., 2001,Univ. MN and SDSU

Recent Research

- Cook et al., 2005 (Grow-finish)
  - No effect on ADG up to 30% DDGS
  - Feed Eff. Decreased above 10% DDGS
  - 30% DDGS decreased FI
  - Mortality linearly decreased from 6% to less than 2%
  - Carcass yield linearly decreased
- Gourley et al., 2005 (Grow-finish)
  - No effect on ADG and ADFI up to 29% DDGS
  - G:F Decreased above 7.3% DDGS
  - Carcass yield linearly decreased
  - Iodine value increased from 66 to 73 as DDGS increased to 22 and 29%

Recent Research

- Decreased Carcass yield will Decrease DDGS value in swine
  - For each 10% inclusion in the diet carcass yield went down 0.6%
  - That is 1.6 lb of lost carcass wt. at 10% inclusion
  - $1.05/pig lost income at 10% inclusion
  - At 10% inclusion 1 ton of DDGS could be fed to 33 pigs for all of grow-finish = $34.65/ton lower value of DDGS to swine!

Poultry and Swine Feed Manufacturing Issues with DDGS

- Flow rates
- Bridging- bad with high inclusion rates
- Particle size
- Separation/settling issues
- Pelletability – "molasses balls" Gummed dies, fines
- Sodium content – Poultry
- Mycotoxins – become concentrated

Swine Feeding Issues

- Reproductive performance (sows and boars)?
  - Any effects on sow longevity?
  - Effects on fatty acid composition of milk?
- Feeding level during high energy demands of lactation and Paylean feeding?

Swine Feeding Issues

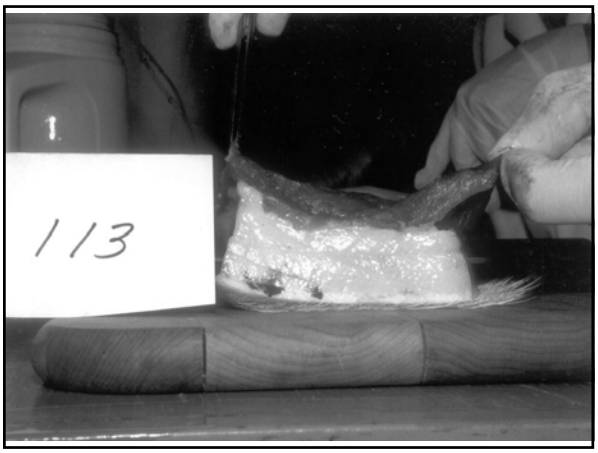
- Ingredient shifts
  - Oil in DDGS displacing animal fat and AV blends?
  - Less need for inorganic P and/or less phytate P available for phytase activity?
- Fiber content and energy availability from fiber
- Heat increment of fiber- summer time feeding

Swine and Poultry Nutrient Excretion Issues with DDGS

- N excretion increases 15-200+%
  - Ammonia emissions?
- P can be managed by decreases MCP/DCP
- Increased DM excretion/Increased solids? Increased Sludge?
- Crust formation? Flies? Ammonia?

DDGS and Pork Quality

- Processing/Handling issues
  - Fat firmness (IV values increase to 75-80)
  - Shelf-life
  - Export marketing- decrease in marbling score
  - Increased problems with processed products
- Potential health issues
  - n-6:n-3
    - n-6 increases drastically (doubles)
  - Fatty acid composition – high linoleic (18:2)



Brat Quality

Possible Body Fat Changes

- **Assume sows are 65 IV points, sold two weeks after farrowing.**
  - **Fed 20% DDGS, now 71.4**
  - **Fed 30% DDGS, now 74.6**
  - **Fed 40% DDGS, now 77.8**
  - **Fed 50% DDGS, now 81.0**
- **Long Term use of DGGS may create a change in CWG FA profiles – reflective of the DDGS fed to slaughter animals!**

Proper Production and Utilization

- **Increase value of co-products**
  - **Mitigate negative environmental effects**
  - **Separate phosphorus, fat, protein, fiber**
- **Potentially make livestock industry**
  - **More competitive**
  - **More attractive**

Recommended Use of DDGS in Swine Diets

- **Swine industry will only use the dry product**

	0% DDGS	5% DDGS	10% DDGS	20% DDGS	40% DDGS
Gestation				XX	XX
Lactation	XX	XX	XX		
Nursery	XX	XX	XX		
Grower			XX	XX	
Finishing	XX	XX	XX	XX	

My Recommendations
Nursery – 0, 5, 10, 15-25%
Grow-finish – 20-30, 15, 0%
Lactation –0-10%
Gestation – 20-30%

Overall Issues with DDGS

- **Product Variation**
- **Handling, Storage, Transportation**
- **Effect on Animal Performance**
- **Effect on Product Quality**
- **Effect on Nutrient Management**
- **Antibiotic contamination**
- **Producer Education**
- **Food vs. Fuel National Policy**

Processing, Handling and Utilization of DDGS – An Integrated Ethanol Co-Product Research and Extension Effort

Phase I Projects with a 9-12 Month Time Horizon

College of Agriculture
Purdue University

Project Objectives

1. **Processing, Handling, Storage and Digestibility of DDGS**
2. **Animal Performance and Product Quality**
3. **Environmental Impact of DDGS Ration Inclusion**

➔ **Phase I: next 9-12 months**
➔ **Phase II: 9 months & beyond**

Final Thoughts

- **Infrastructure does not exist in Indiana**
  - **Handling, storing, distribution**
- **Cost of livestock production could increase**
  - **By-products shipped out of state**
  - **Rising corn price**
  - **Diverting soybean acres to corn**
- **Opportunities for alternative processing / fractionation**

Questions?