Addressing Issues Related to Co-Products of Biofuels

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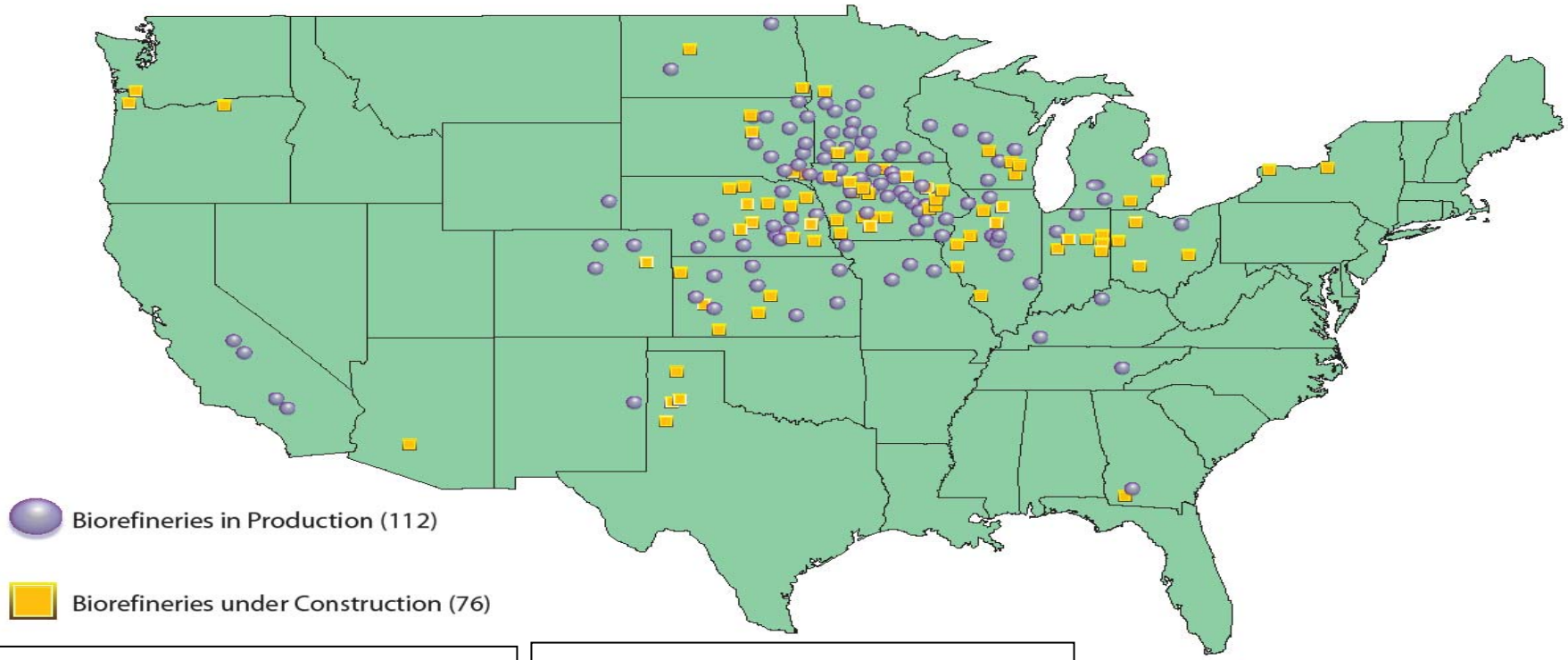
Michigan Agri-Energy Conference
March 13, 2007

U.S. Ethanol Biorefinery Locations



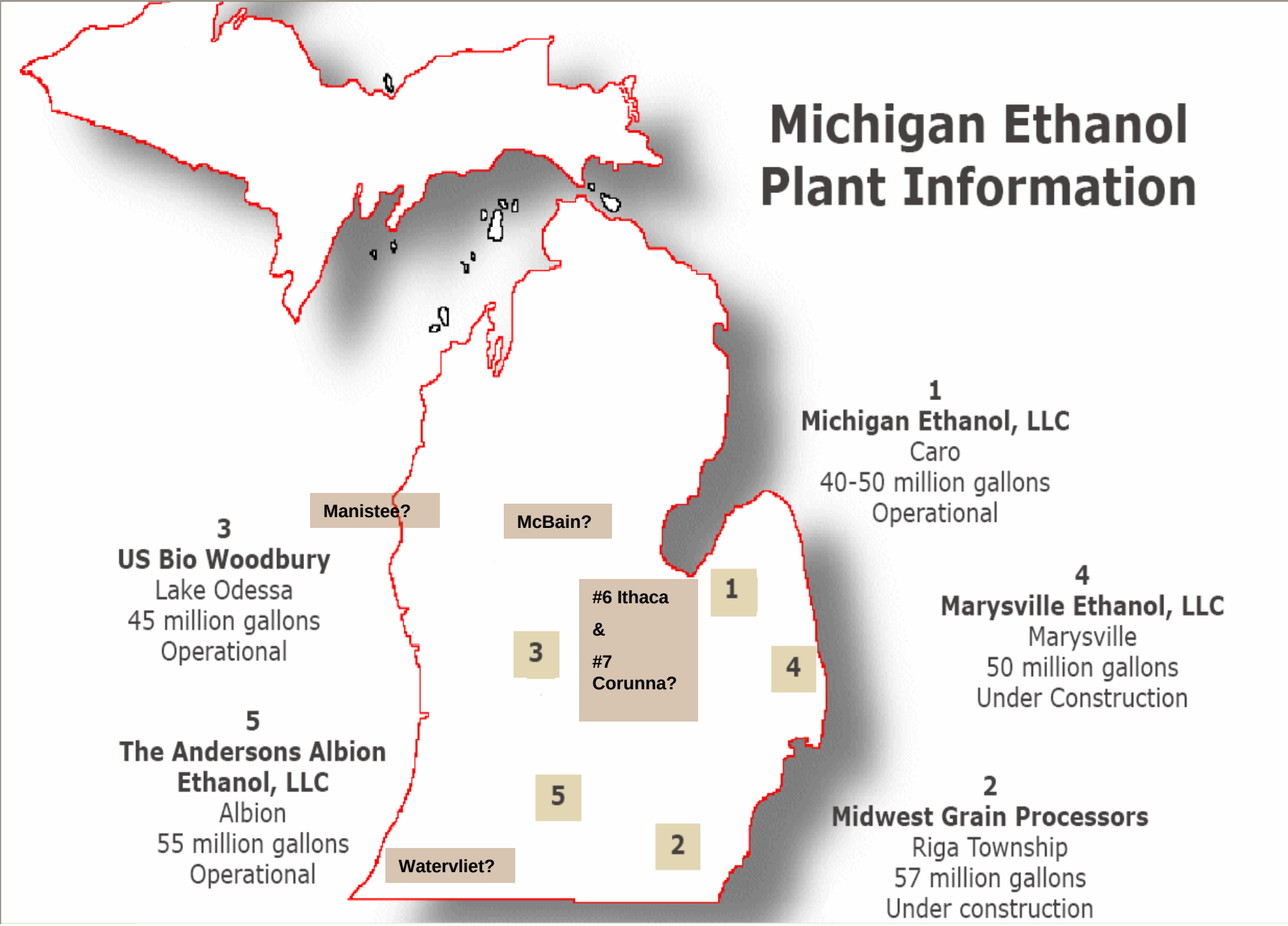
Source: Renewable Fuels Association
1.29.07

Feb. 25, 2007 update

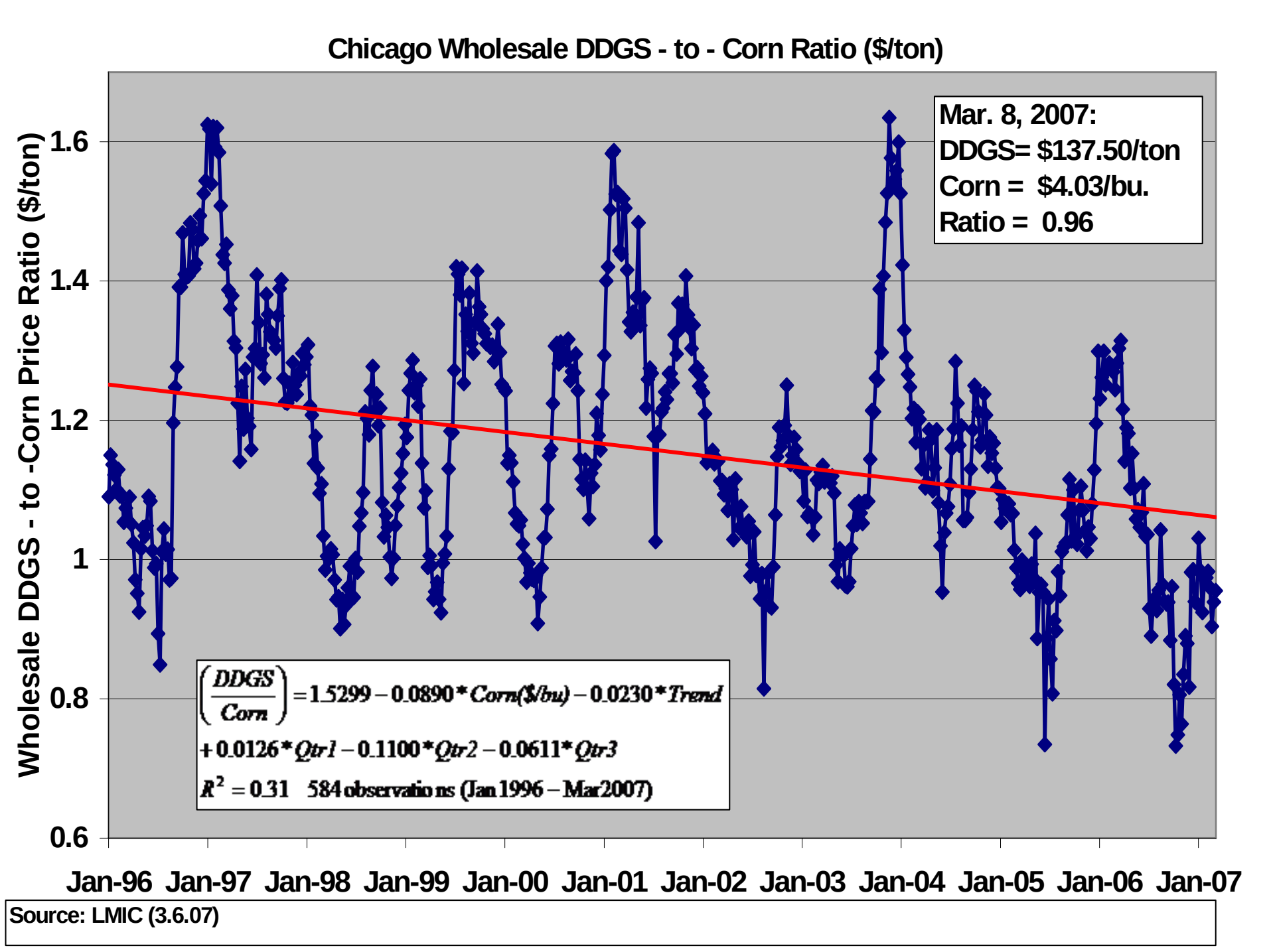
Total operating plants:	114
Under construction:	78
Expansions:	7
Total:	**199**

Capacity (mg/year)

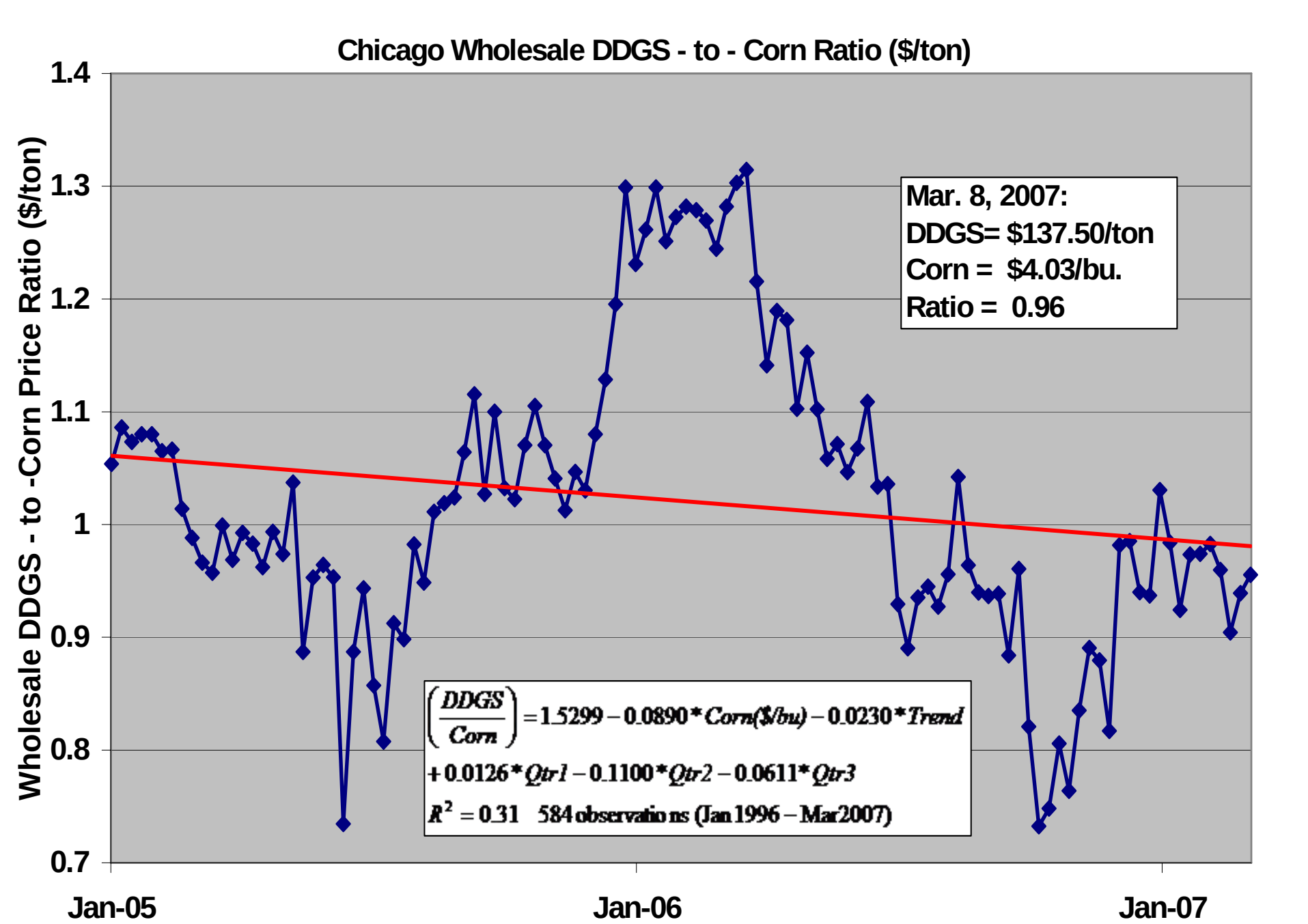
Current	5,633.4
Under Construction & Expansion	6,194.9
Total Capacity:	**11,828.3**



Source: MI Corn Grower's (as of August 2006) http://www.micorn.org/downloads/MiEthanolPlantsAug06.pdf



Source: LMIC (3.6.07)



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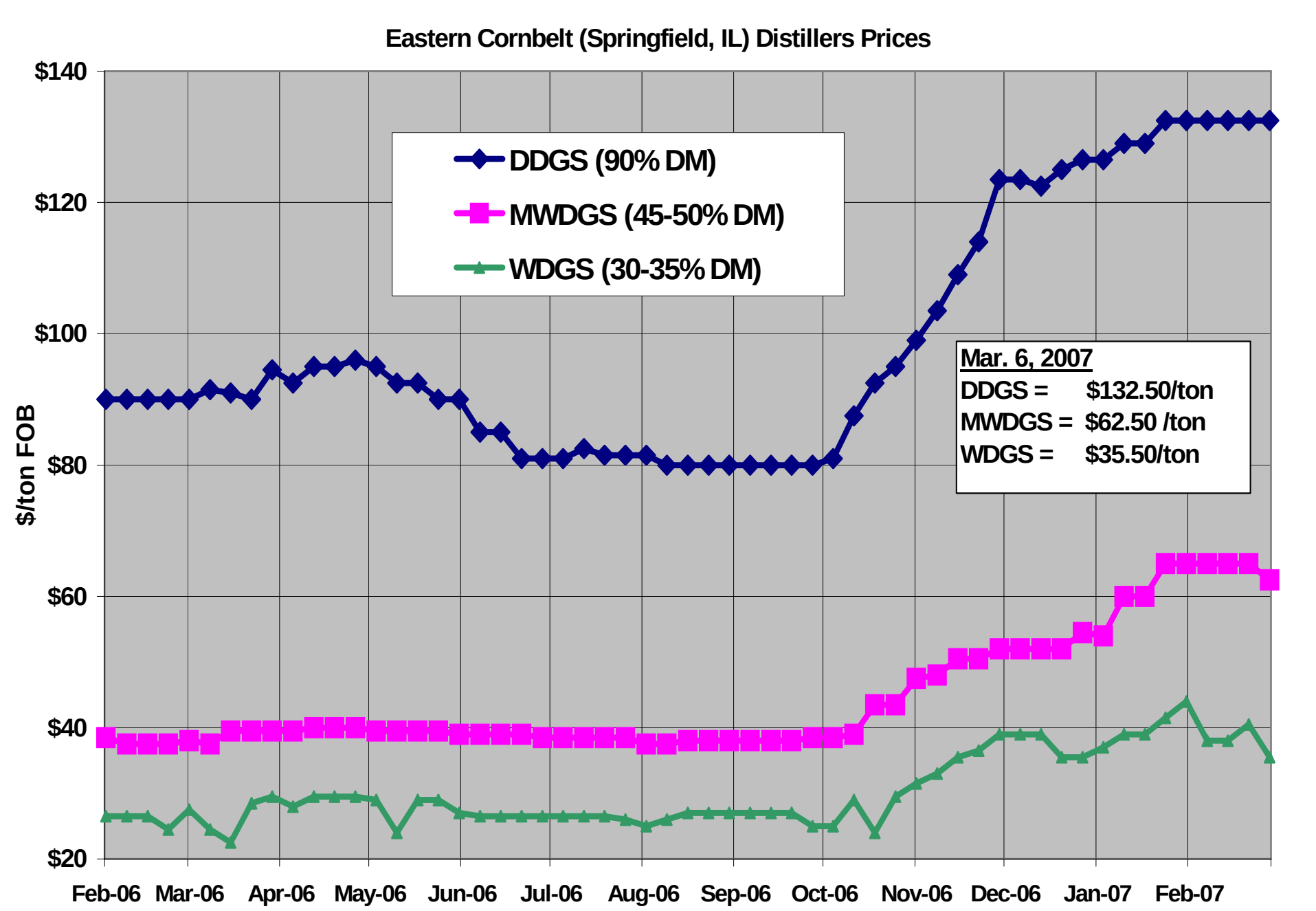
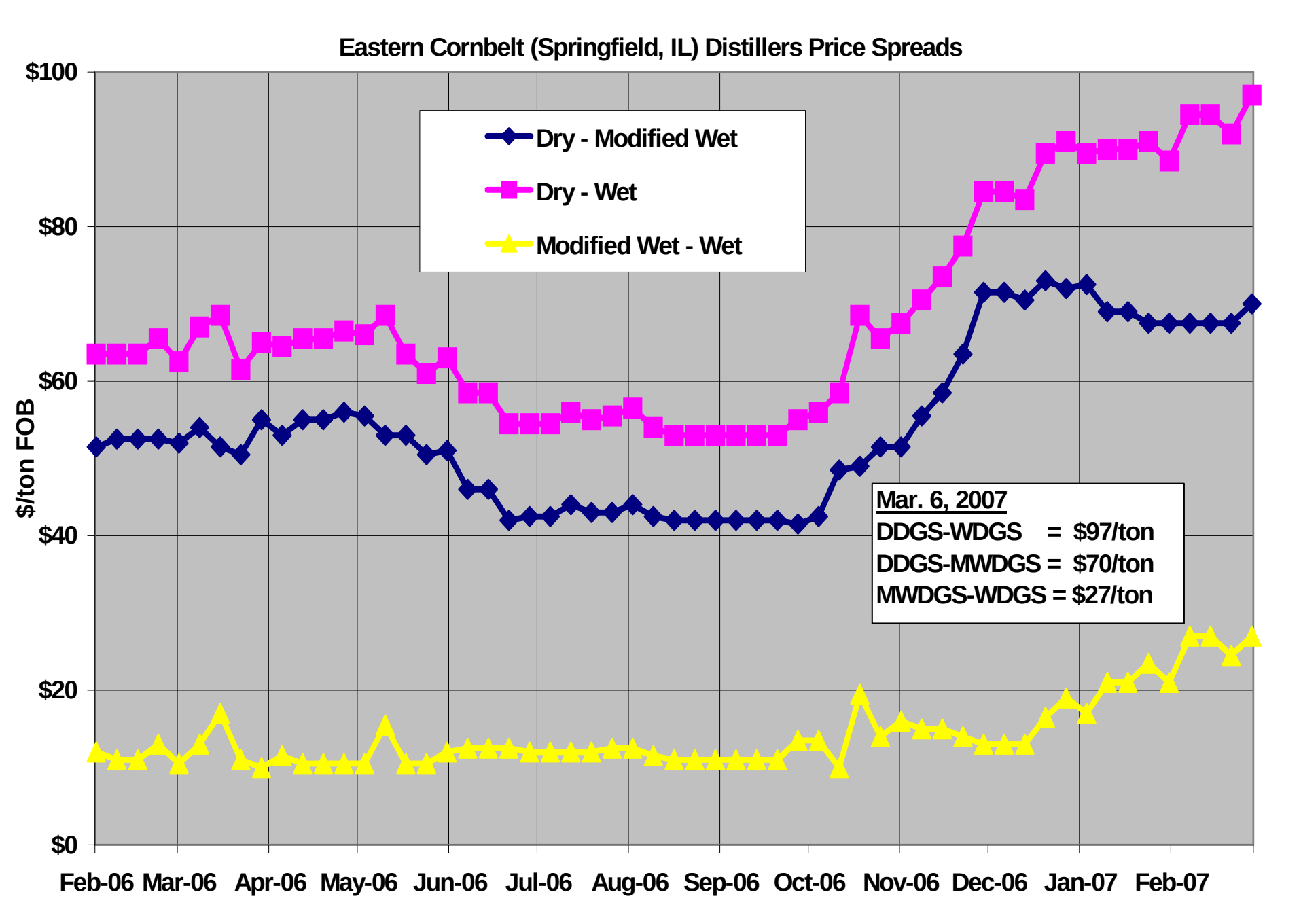


Source: Livestock Marketing Information Center and USDA-AMS; Last updated 3/6/2007



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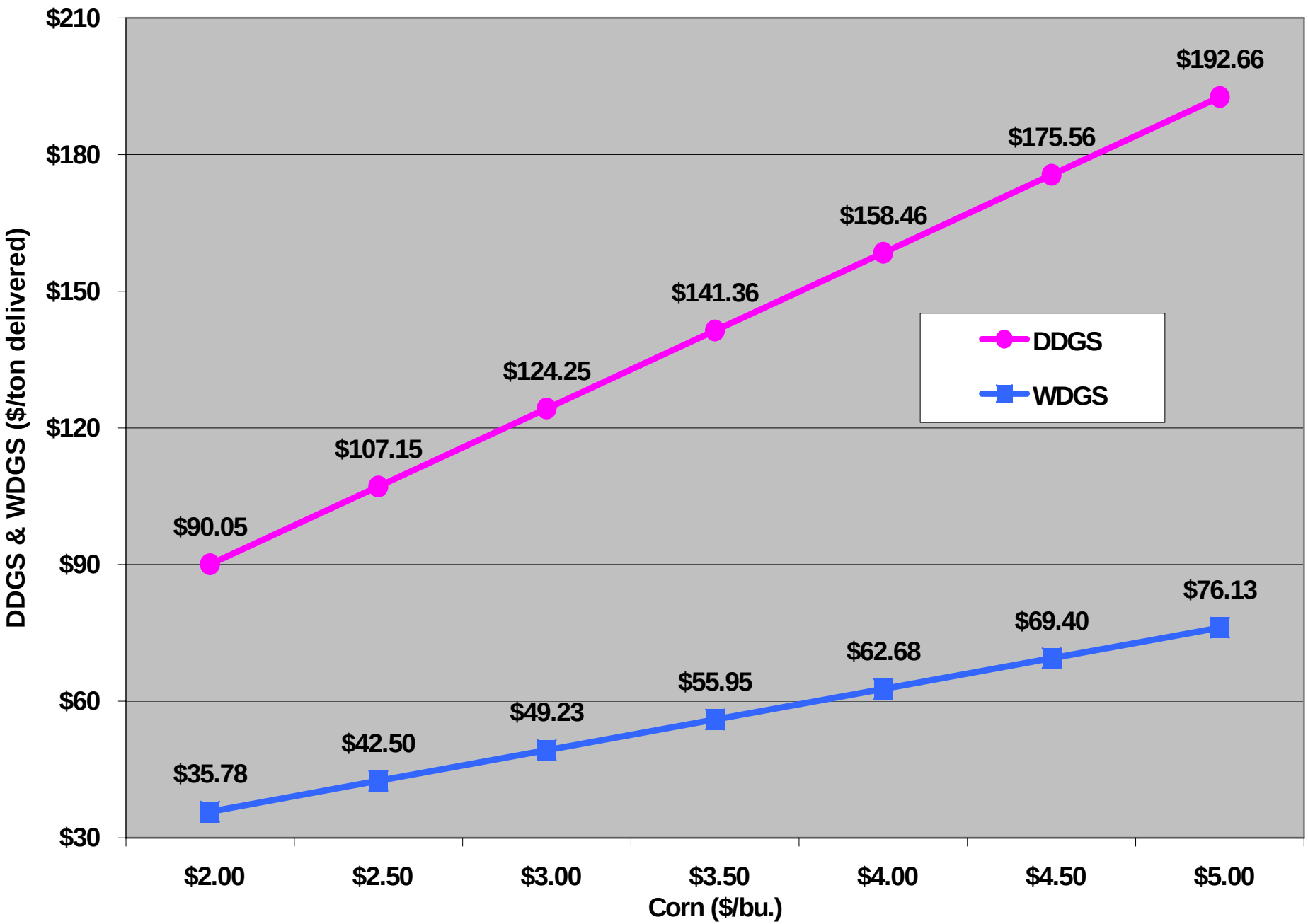
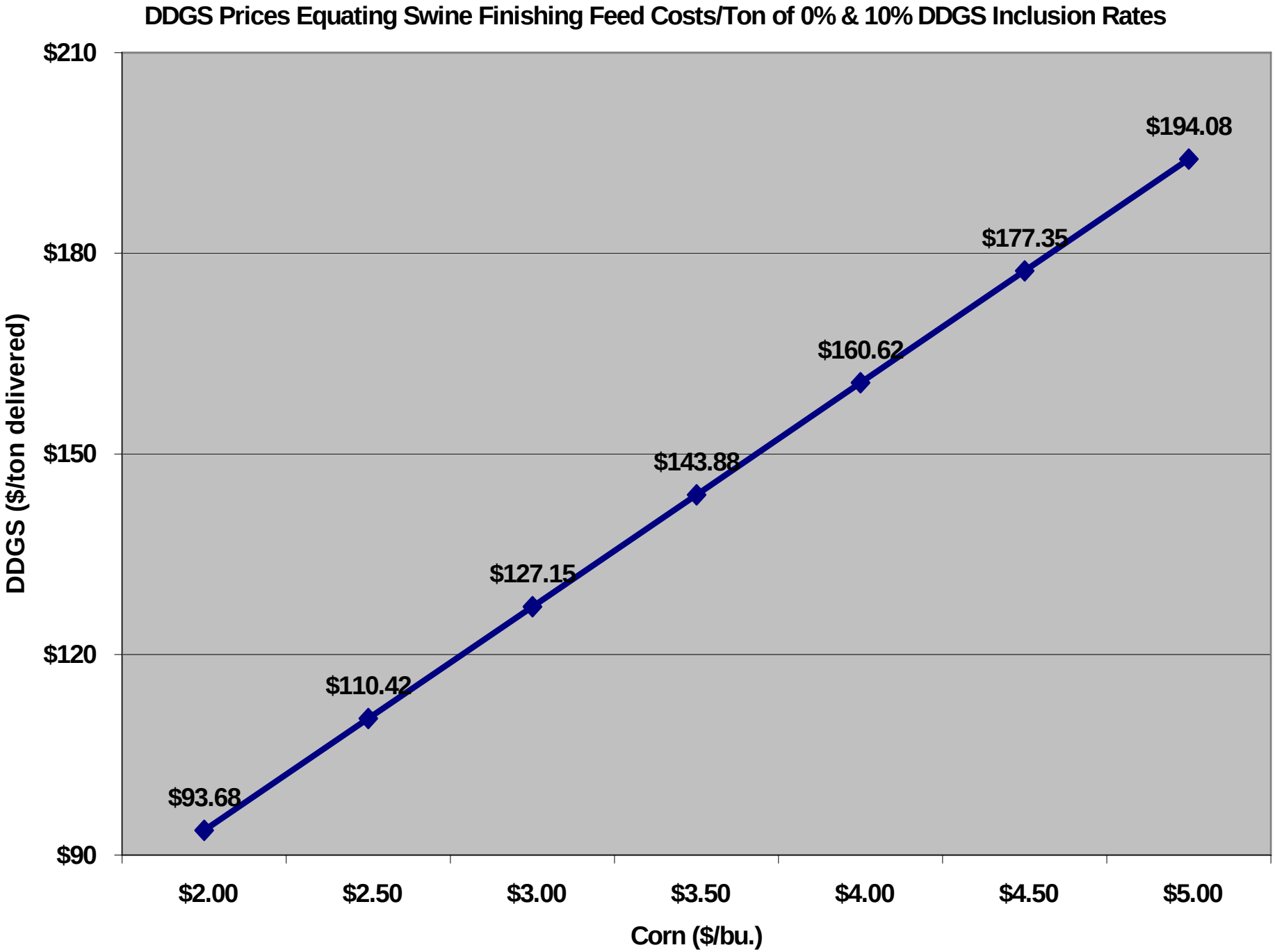

DDGS & WDGS Prices Equating Cattle Finishing Feed Costs of 0% and 40% Inclusion Rates
DDGS & WDGS ($/ton delivered)
$210
$180
$150
$120
$90
$60
$30
$2.00
$2.50
$3.00
$3.50
$4.00
$4.50
$5.00
Corn ($/bu.)
DDGS
WDGS
$90.05
$107.15
$124.25
$141.36
$158.46
$175.56
$192.66
$35.78
$42.50
$49.23
$55.95
$62.68
$69.40
$76.13


DDGS Prices Equating Swine Finishing Feed Costs/Ton of 0% & 10% DDGS Inclusion Rates
$210
$180
$150
$120
$90
DDGS ($/ton delivered)
$194.08
$177.35
$160.62
$143.88
$127.15
$110.42
$93.68
$2.00
$2.50
$3.00
$3.50
$4.00
$4.50
$5.00
Corn ($/bu.)

Lean Hog Price Increase Evaluation

Live Hog ($/cwt) Increase: DDGS = 0% DDGS with $2.50 corn							
DDGS ($/ton)	DDGS Inclusion	Corn ($/bu.) $ 3.00	$ 3.50	$ 4.00	$ 4.50	$ 5.00
$ -	10%	$ 0.15	$ 1.82	$ 3.48	$ 5.14	$ 6.80
$ -	20%	$ (1.59)	$ (0.15)	$ 1.28	$ 2.72	$ 4.15
$ 125	10%	$ 1.86	$ 3.52	$ 5.19	$ 6.85	$ 8.51
$ 125	20%	$ 1.83	$ 3.27	$ 4.70	$ 6.13	$ 7.57
$ 150	10%	NA	NA	$ 5.53	$ 7.19	$ 8.85
$ 150	20%	NA	NA	$ 5.38	$ 6.82	$ 8.25

Assumptions: SBM=$200/ton, 3.2 F/G ratio, all prices are “delivered prices,” and including DDGS results in no changes in carcass composition, days on feed, total feed intake, or changes in manure handling costs. Also assumes no change in other inputs (e.g., feeder pig price).

DGS Market Access

- 2003-04 NASS DGS Survey: 721 IA & MN Producers & 25 Ethanol Plants
- Ethanol Plants (2004)
  - 30% had minimum order for DGS; avg. min = 9.8 tons
  - DGS sales agreements:

Monthly		Quarterly		6-Month		Yearly	
2002	2003	2002	2003	2002	2003	2002	2003
10%	15%	10%	13%	9%	12%	NA	20%

Spot		Clock		No Contract	
2002	2003	2002	2003	2002	2003
38%	18%	11%	10%	19%	13%

NASS report accessed 1/25/07 at: http://www.nass.usda.gov/Statistics_by_State/Iowa/Links/2004_national_dg.pdf

Past NASS DGS Survey: Ethanol Plants (2004)

Transportation of DDGS, 2003

Paid by Plant	% Plants Using Transport Mode	% Product Hauled by Transport Mode	Average Miles Hauled	Average Transport Costs/Ton
Rail	100	16	1,550	30
Truck	67	10	82	4
Paid by Buyer				
Rail	50	16	1,812	40
Truck	100	58	133	7

Transportation of WDGS, 2003

Paid by Plant	% Plants Using Transport Mode	% Product Hauled by Transport Mode	Average Miles Hauled	Average Transport Costs/Ton
Rail	0			
Truck	100	23	61	4
Paid by Buyer				
Rail	0			
Truck	100	77	60	4

NASS report accessed 1/25/07 at: http://www.nass.usda.gov/Statistics_by_State/Iowa/Links/2004_national_dg.pdf

DGS Feed Market Existence

- Plant Response to Rising Natural Gas
  - Switch from DDGS to WDGS???
  - Burn DDGS ???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Potential Usage of DGS in Michigan

	MSU Estimate			
	Diet, %	# Head	Tons/yr (thousand)	Bu/yr (million)
Dairy	15	561,600	455.5	16.3
Beef	27.5	381,000	303.4	10.8
Hogs	17.5	1,954,000	119.3	4.3
Poultry	17.5	14,810,000	106.8	3.8
Horses	5	150,000	27.4	1.0
Sheep	15	88,000	14.5	.5
Total			1,026.7	36.7

Estimated 2007-2008 production= 32.8

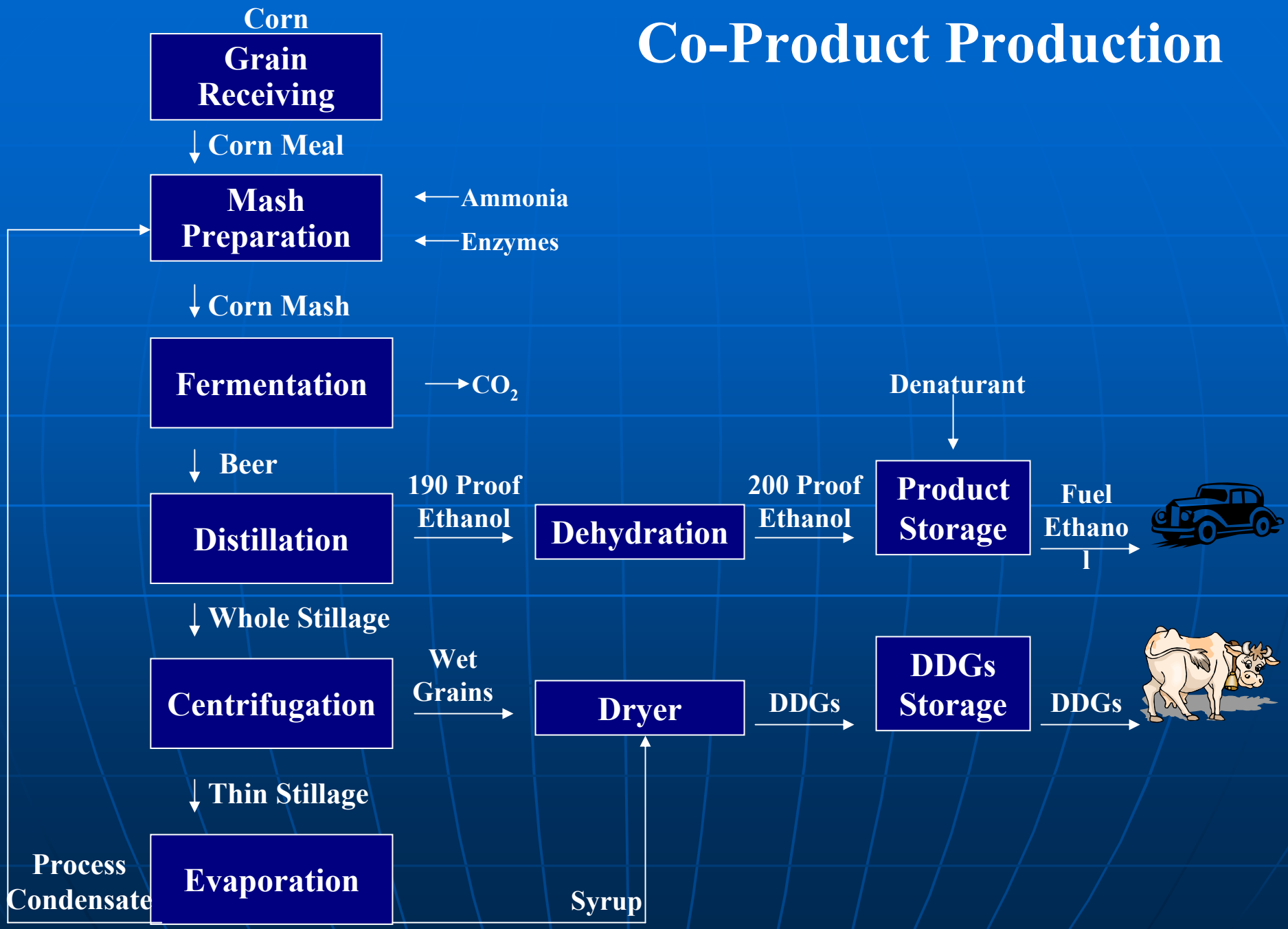
Product Yield From Corn

Corn	
Starch	61.0%
Corn oil	3.8%
Protein	8.0%
Fiber	11.2%
Moisture	16.0%

Wet-milling, lb/bu	
Starch	31.5
Gluten feed	12.5
Gluten meal	2.5
Corn oil	1.6

Dry-milling, lb/bu	
Ethanol (2.7 gal)	21.6
DDGS	18.0
CO_2	18.0

Co-Product Production



Nutrient Content of Corn Distiller's Grains and Distiller's Solubles on (100% DM Basis).

Nutrient	Distiller's Grains	Distiller's Solubles
C. protein, %	33.5	18.5
Crude fat, %	9.0	15.7
Crude fiber, %	9.5	2.5
Ash, %	3.0	8.4
Ca, %	0.04	0.06
P, %	0.54	1.28


Agri-Energy LLC
Luverne, MN


Al-Corn Clean Fuel
Claremont, MN


Central Minnesota Ethanol Coop
Little Falls, MN


Chippewa Valley Ethanol Co LLLP
Benson, MN


Corn Plus Coop
Winnebago, MN


Heartland Corn Products
Winthrop, MN


Minnesota Energy
Buffalo Lake, MN


Morris Ag Energy /
Diversified Energy Co (DENCO)
Morris, MN


Adkins Energy LLC
Lena, IL


Archer Daniels Midland
Peoria, IL


Lincolnland Agri-Energy LLC
Palestine, IL


MGP Ingredients Inc
Pekin, IL


New Energy Corp
South Bend, IN


Golden Grain Energy LLC
New Hampton, IA


Grain Processing Corp
Muscatine, IA


Little Sioux Corn Processors
Marcus, IA


Midwest Grain Processors Coop
Lakota, IA


Quad-County Corn Processors
Galva, IA


Tall Corn Ethanol LLC
Coon Rapids, IA


Commonwealth Agri-Energy LLC
Hopkinsville, KY

Variation in Nutrient Content

	DM	CP	Fat	ADF	Fiber	TDN	Ash
Average	89.2	30.9	10.8	12.2	7.2	86.5	6.0
Range	86.2-92.4	28.3-33.9	3.5-12.8	0-21.0	5.4-10.6	78.7-89.0	3.0-9.8
Caro, MI	89.6	32.6	11.0	12.8	7.4	86.6	6.08
Requirement/ max the diet	----	12.0	6.0	----	----	----	----
40% of diet	35.7	12.4	4.3	4.9	2.9	34.6	2.4

34 samples, Shurson, 2006

Variation in Mineral Content

	Ca	P	K	Mg	S	Na	Cl	Zn	Mn	Cu	Fe
Average	.07	.77	1.0	.30	.68	.18	.09	62	19	6	127
Range	.02-.51	.42-1.06	.45-1.33	.14-.45	.34-1.93	.01-.52	0-.36	38-128	9-27	3-13	77-239
Caro, MI	.02	.99	1.06	.38	.89	.16	.18	93	15	6	96
Required	.50	.27	.65	.10	.10	.08	----	30	40	8	50
40% of diet	.03	.31	.40	.12	.27	.07	.04	25	8	2	51

Ca-Cl=% of diet; Zn-Fe= ppm

34 samples , Shurson, 2006

General Limitations

- Variation in nutrient content
- High phosphorus levels
- Amino acid imbalance
- Cost
- Reduced intakes at high inclusion levels
- High trans-fat content
  - Suppresses gene expression for fat synthesis in mammary gland

General Limitations (con't)

- Manure volume
- Low energy content
- Nutritionists
- High sulfur content
- Mycotoxins
  - Vomitoxin
  - Zearelonone
- Antibiotic residues

Product Handling & Storage

- Can be mixed with other feedstuffs and ensiled
  - 70:30 Wet DGS: Soybean hulls
  - 50:50 Wet DGS: Corn silage
- Storage length
  - Dry 60-90 d
  - Wet 5-14 d
- Shrinkage
  - Dry = 2-5% Shrink
  - Wet = 10-50% Shrink

WDGS is difficult to store alone in silage bags

Storage of Wet DGS

	Spoilage	Recovery
• Covered bunker silo	3-4 in.	91.5%
• Uncovered bunker silo	12 in.	90.4%

- Some red and white mold
- Temperature
  - > 200 °F when it leaves the plant
  - May be 100 °F upon arrival at the farm

Iowa, 2006

Sulfur Requirements

Requirement .15% diet DM

Maximum tolerable concentration .40% of diet DM

Chronic toxicity

↓ DMI

↓ Growth

↓ Reduced copper status

Acute toxicity

Polioencephalomalacia

Restlessness, diarrhea, muscular twitching, dyspnea, death

Effects of High S Containing DGS on Dietary S Levels

- Basal diet of 80% corn, 15% corn silage and 5% supplement
  - Dietary S level = .13%
- Replace 40% of corn with DGS (1% S)
  - Contribute .4% to total diet
- Total dietary sulfur level= .48%
- With 1% S in DGS, maximum inclusion rate should be 30%

Effects of DGS S Levels on Dietary S Content[a] (% DM)

	S Content of DGS, %		
Dietary inclusion rate, % DM	.60	.80	1.0
20	.21	.25	.29
30	.27	.33	.37
40	.33	.41	.49

[a] Basal diet contains 15% corn silage, .3% urea, and corn

[b] Doesn't account for S intake from water

ADD Calcium!!!!

- The Ca to P ratio will be altered with inclusion of DGS
  - DGS is a high P feedstuff
  - Risk of urinary calculi
- Add calcium to the diet
  - Limestone is relatively inexpensive

Supplemental Calcium Carbonate Required To Maintain Ca:P Ratio (% DM)

	P Content of DGS, %		
Dietary DGS Inclusion Rate, % DM	.60	.80	1.0
20	.88	.99	1.11
30	.93	1.10	1.28
40	.98	1.22	1.45

Consultant Recommendations

- **Consultant A**
  - Recommends only feeding wet product
  - Dry DGS limits intake
  - 10-30% inclusion rate
- **Consultant B**
  - Prefers wet DGS unless Dry is priced lower than corn
  - Inclusion rate limited by S and fat content

Feeding Recommendations For Distillers Grains (Beef)

- **Protein Source (1-3 lb/d)** **6-15%**
- **Energy Source (4-9 lb/d)** **20-40%(maybe more)**
- **Mineral Balance (Ca:P),**
  - **Add limestone**
  - **Ca:P> 1.1**
- **Does Not Replace All Roughage Sources**
- **Monitor S Content of DGS**
  - **Maximum allowable level = .4%**
  - **Feeding 40 % DGS that has 1% S is risky!!!!**
- **Prefer Wet Over Dry DGS**

Feeding Recommendations For Beef Cows

- Gestation
  - 3-5 lb of dry DGS
  - 8-14 lb wet DGS
- Lactation
  - 6-8 lb dry DGS
  - 17-23 lb wet DGS
- May need to remove P and S from mineral supplements

Summary Tips

- **Overall inclusion level of CDG for dairy cows 15 to 20% of DM.**

  Will depend on:
  - **Milk production level of cows, groups of cows**
  - **Other feeds, forage base of ration; effective-fiber**
  - **Fat content and Fermentability of whole ration (more rumen fermentable rations can not contain as much CDG w/o depressing milk fat test)**
  - **Quality of crude protein: dietary EAA; RUP; RDP; heat-damaged?**
  - **Phosphorus and sulfur content?**

- **For high yielding and early lactation cows:**
  - **Inclusion level for CDG: start at 5 to10% of ration DM**
  - **Proceed with caution ~ monitor milk fat test, MY, feed intake**
  - **Highly fermentable rations (high corn silage, high moist. corn, etc.)**

    as typically fed in Michigan will limit level of CDG

- **Routine lab analyses: analyze, analyze, analyze**

Feeding Recommendations For Swine

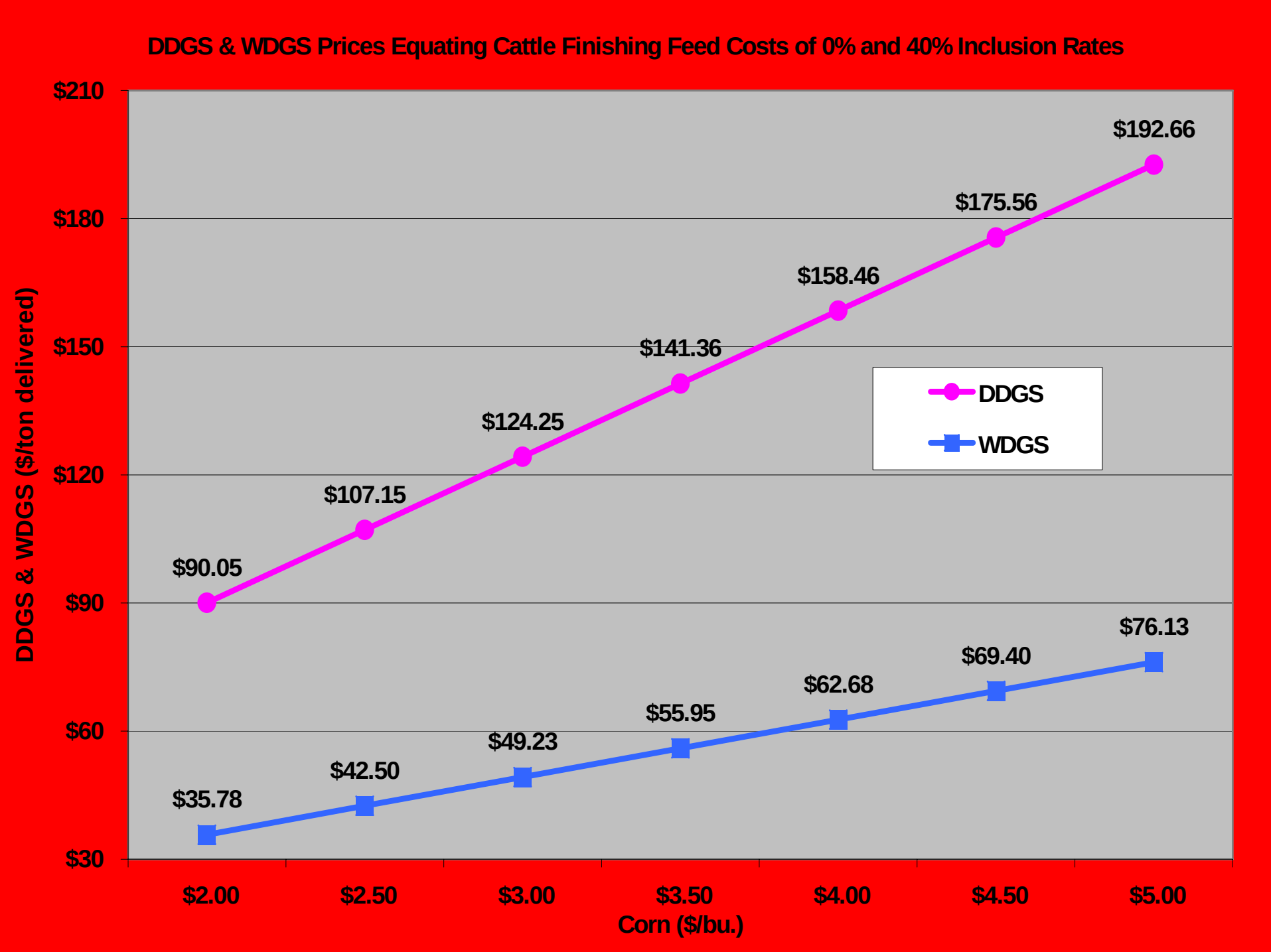
- 20-30% of diet
  - may have belly softness at higher levels
  - DM intake may be reduced at higher levels
  - “ramp to to higher levels”
- Balance on available P
- Monitor amino acid levels
  - lysine, tryptophan, threonine, methionine

Feeding Distillers Grains to Sheep

- Greatest Applications:
  - **Ewes:** High energy and protein contents in DDGS work well to supplement ewe diets especially those based on low quality or mature forages (gestation, lactation).
  - **Lambs:** High energy and protein contents in DDGS can be incorporated into typical growing finishing lamb diets at 20% with no change in growth rate.

Additional Thoughts on Use of Distillers Grains

- **Value relative to corn (DM basis)**
  - **Wet 110-120%**
  - **Dry 100%**
- **Adjust nutrient management plans**
  - **P**
  - **Potential runoff from storage piles**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$35.78
DDGS
WDGS
$2.00
$2.50
$3.00
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$4.00
$4.50
$5.00
Corn ($/bu.)

Summary

- DDGS can offer opportunities for the livestock industries
- Beneficial if plants reduce P, S and/or fat content
- Reduce nutrient variability

Distillers Co-products Will Change In The Future

- Use DGS as feedstock for cellulosic ethanol production
- Use dry DGS as replacement for natural gas
- Remove oil
  - Biodiesel
  - Food/confectionary uses
- Other ?????

DGS is a great feed for livestock but does create some additional environmental challenges!!!

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