



*Fueling America Through Renewable Resources*

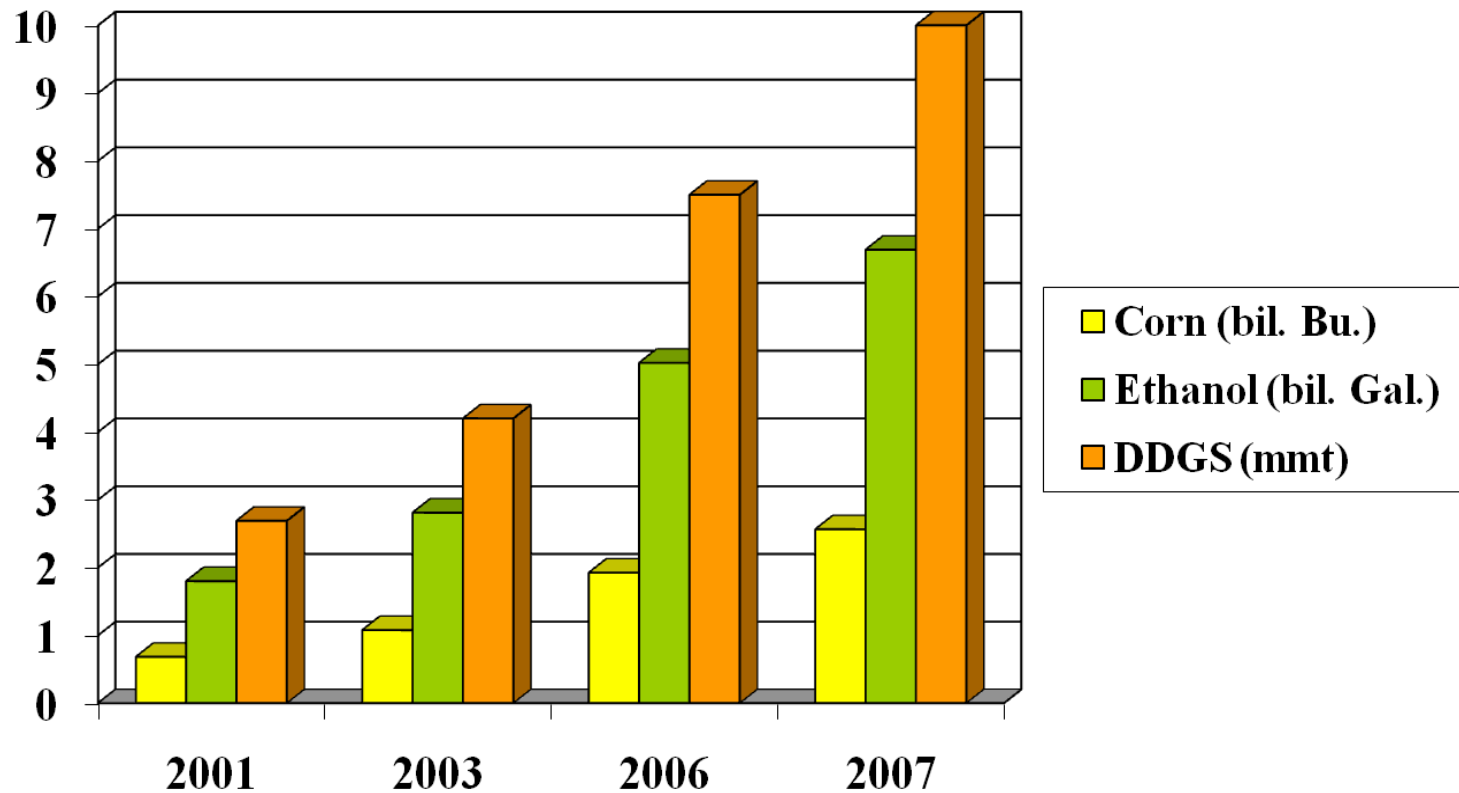
# **ECONOMIC VALUE OF ETHANOL CO-PRODUCTS IN SWINE DIETS: EVALUATING PROFITABILITY OF CORN FRACTIONATION TECHNIQUES**

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# OVERVIEW

## U.S. Ethanol & DDGS Outlook



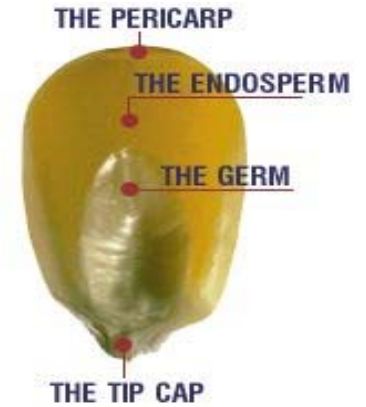
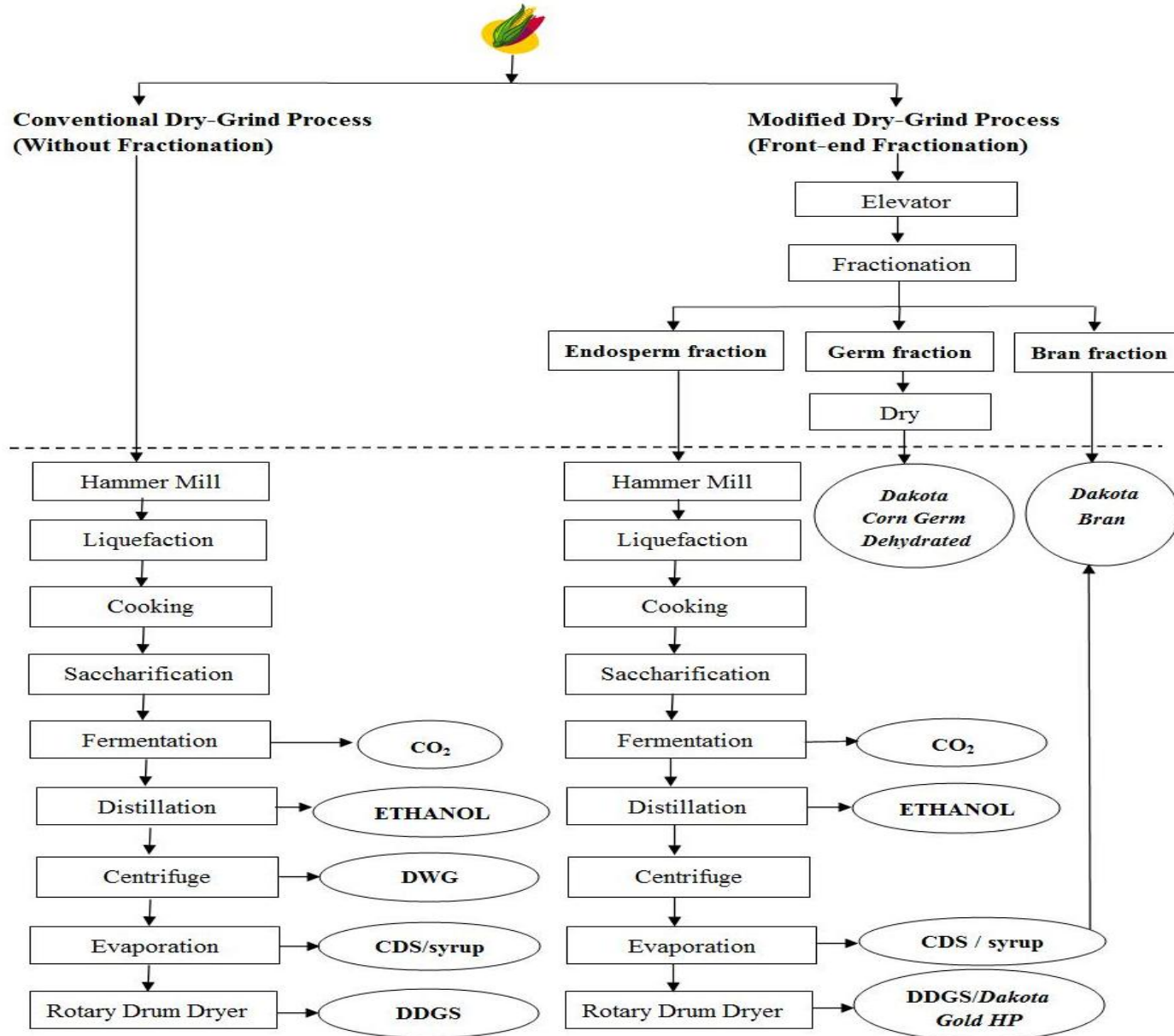
Data Source: U.S. Energy Information Administration / RFA

# OVERVIEW

## Dry Milling is the most preferred ethanol process today

- Typical co-products → DDGS and CO<sub>2</sub>
- Challenges with DDGS → nutrition profile, high fiber content reduces use in non-ruminants.
- New dry milling technologies → focus on improving inputs, processes, environment and co-products.
- Corn Fractionation → additional new feed co-products
  - Benefits → higher ethanol yield, improved nutrient profile of co-products, greater energy savings, environment friendly process.

# FRACTIONATION





# PROBLEM STATEMENT

- Historically, DDGS is a more popular feed ingredient in ruminant diets than non-ruminant diets.
- Concerns about feeding DDGS and germ to swine
  - High fiber content
  - Low protein
  - High oil content
- Urgent need to understand economic value of different types of DDGS in the market (conventional vs. new)
- Economic analysis of fractionation technology and its effect on the nutritional profile of its co-products is important.

# MODELS & METHODS

## Linear Programming Model for Diet Cost

- Objective → Impute the economic value of DDGS and germ as ingredients of swine diets.
- Model → Feed ration model, in the form of a constrained cost minimization linear program (LP).
- Constraints → Upper and lower bounds on nutrients specific to the growth stage of the pig.
- Data:
  - Iowa DDGS → Big River Resources Ethanol plant, Iowa
  - Fractionated DDGS & Germ → Poet plant, South Dakota

# MODELS & METHODS

## Ethanol Plant Model in EXCEL

- Objective → Evaluate profitability of corn fractionation technique
- Model → Economic model of 50 MGY ethanol plant with and without fractionation technology
- Revenue → Ethanol, DDGS, Bran and Germ
- Costs → Corn cost, operating cost
- Data required → Yield and prices, amount of corn required, operating cost.
- Data source → FWS Technologies, Winnepeg, Canada.<sub>7</sub>

## Data for 50 MGY Ethanol Plant Model

	Without Fractionation	With Fractionation
Annual Ethanol Capacity (MGY)	<b>50,000,000</b>	<b>55,000,000</b>
Corn Required (bushels)	<b>17,857,143</b>	<b>20,676,692</b>
Operating Cost (\$/gallon)	<b>\$0.61</b>	<b>\$0.53</b>
Iowa DDGS Yield (lbs/bu)	<b>17.4</b>	
Fractionated DDGS Yield (lbs/bu)		<b>12.5</b>
Bran Yield (lbs/bu)		<b>3.4</b>
Germ Yield (lbs/bu)		<b>4.4</b>



# Co-products Data

	Units	Iowa DDGS	Fractionated DDGS	Germ
ME (kcal/lb)	kcal/lb	1775	1687	1828
Crude Protein	%	29.1	41.0	15.7
App. Dig. Lysine	%	0.51	0.70	0.47
App. Dig. Meth+Cys	%	0.85	1.72	0.46
App. Dig. Threonine	%	0.73	1.16	0.30
App. Dig. Tryptophan	%	0.15	0.27	0.13
App. Dig. Isoleucine	%	0.75	1.16	0.23
App. Dig. Valine	%	0.98	1.57	0.43
Calcium	%	0.03	0.01	0.02
Phosphorous	%	0.81	0.35	1.28
Digestible Phosphorous	%	0.49	0.28	0.77
Crude Fiber	%	6.20	6.67	5.10

# RESULTS

## Linear Programming Model for Diet Cost

	Iowa DDGS			Fractionated DDGS			Germ		
	<i>Max. %</i>	<i>Shadow Value</i>	<i>Diet Cost</i>	<i>Max. %</i>	<i>Shadow Value</i>	<i>Diet Cost</i>	<i>Max. %</i>	<i>Shadow Value</i>	<i>Diet Cost</i>
<i>Grower 1</i>	26.95	\$158.57	\$156.80	14.08	\$144.84	\$159.42	35.86	\$137.47	\$157.70
<i>Grower 2</i>	27.92	\$158.57	\$149.51	13.08	\$157.49	\$153.22	37.66	\$137.47	\$151.35
<i>Finisher 1</i>	28.65	\$158.57	\$140.98	9.79	\$186.92	\$146.86	25.03	\$136.13	\$145.32
<i>Finisher 2 w/o Paylean-9®</i>	19.23	\$158.57	\$138.52	6.57	\$186.92	\$142.36	8.27	\$157.26	\$143.64
<i>Finisher 2 w/ Paylean-9®</i>	26.62	\$164.10	\$168.11	16.92	\$186.92	\$168.72	21.01	\$137.47	\$175.06
<i>Gestating Sow</i>	9.66	\$182.31	\$138.16	0.90	\$209.50	\$143.40	32.25	\$157.87	\$131.47

# Results: Ethanol Plant Model in EXCEL

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<b>Annual Totals</b>	<b>W/O Fractionation</b>	<b>With Fractionation</b>
Ethanol	<b>\$100,000,000</b>	<b>\$110,000,000</b>
Iowa DDGS	<b>\$18,332,143</b>	
Fractionated DDGS		<b>\$13,928,665</b>
Bran		<b>\$2,284,750</b>
Germ		<b>\$4,608,093</b>
<b>Total Revenues</b>	<b>\$118,332,143</b>	<b>\$130,821,507</b>
Corn Cost	<b>\$59,464,286</b>	<b>\$68,853,384</b>
Operating Costs	<b>\$30,500,000</b>	<b>\$29,150,000</b>
<b>Total Costs</b>	<b>\$89,964,286</b>	<b>\$98,003,384</b>
<b>EBITDA</b>	<b>\$28,367,857</b>	<b>\$32,818,123</b>
<i>Increased Net Income from Fractionation Technique = \$4,450,266</i>		
<i>Present Value (PV) of Increased Annual Revenue = \$38,945,481</i>		

# SUMMARY

- Low maximum optimal inclusion rates of Fractionated DDGS because:
  - Higher app. dig. lysine content than Iowa DDGS
  - Good amino acid profile
  - Lower energy value
- Despite low inclusion levels, shadow values of fractionated DDGS is comparable to that of Iowa DDGS.
- Lower diet cost with Iowa DDGS because the high inclusion rates replaces more corn, and phosphorus in the diet.
- High inclusion rates of Germ because of its high energy value.



# SUMMARY

- Fractionation technology more profitable than conventional technique as a result of greater ethanol yield and higher revenue from co-products.
- **Conclusion** → Despite lower inclusion levels, Fractionated DDGS has higher economic value than Iowa DDGS and should increase net revenue for the ethanol plant producers.

# THANK YOU!



## QUESTIONS?

# Price Information for the Models

## For the Ethanol Plant Model

Corn (\$/bushel)	<b>\$3.33</b>
Iowa DDGS (\$/ton)	<b>\$118.00</b>
Fract. DDGS (\$/ton)	<b>\$107.78</b>
Bran (\$/ton)	<b>\$65.00</b>
Germ (\$/ton)	<b>\$101.30</b>
Ethanol (\$/gallon)	<b>\$2.00</b>

## For the LP Model (\$/lb)

DDGS	<b>\$0.06</b>
Corn	<b>\$0.06</b>
SBM	<b>\$0.13</b>
Limestone	<b>\$0.05</b>
DiCalPhos	<b>\$0.28</b>
Vitpremix	<b>\$0.85</b>
Lysine HCL	<b>\$0.99</b>
DL Meth	<b>\$1.30</b>
Grease	<b>\$0.24</b>
Lthreonine	<b>\$1.17</b>
Ltryptophan	<b>\$22.50</b>
Paylean®	<b>\$26.00</b>

# Ethanol Plant Model in EXCEL (at highest sow diet prices)



<b>Annual Totals</b>	<b>W/O Fractionation</b>	<b>With Fractionation</b>
Ethanol	<b>\$100,000,000</b>	<b>\$110,000,000</b>
Iowa DDGS	<b>\$18,332,143</b>	
Frac. DDGS (at 135.6 \$/ton)		<b>\$17,523,452</b>
Bran		<b>\$2,284,750</b>
Germ (at 102.2 \$/ton)		<b>\$4,648,066</b>
<b>Total Revenues</b>	<b>\$118,332,143</b>	<b>\$134,456,268</b>
Corn Cost	<b>\$59,464,286</b>	<b>\$68,853,384</b>
Operating Costs	<b>\$30,500,000</b>	<b>\$29,150,000</b>
<b>Total Costs</b>	<b>\$89,964,286</b>	<b>\$98,003,384</b>
<b>EBITDA</b>	<b>\$28,367,857</b>	<b>\$36,452,884</b>
<i>Increased Net Income from Fractionation Technique = \$8,085,027</i>		
<i>Present Value (PV) of Increased Annual Revenue = \$70,754,257</i>		



## Price Information for the Models

### Ethanol plant model results at current market price

Corn (\$/bushel)	<b>\$4.50</b>
Iowa DDGS (\$/ton)	<b>\$170.00</b>
Fract. DDGS (\$/ton)	<b>\$220.00</b>
Bran (\$/ton)	<b>\$75.00</b>
Germ (\$/ton)	<b>\$160.00</b>
Ethanol (\$/gallon)	<b>\$2.00</b>

# Ethanol Plant Model in EXCEL (at current market prices)



<b>Annual Totals</b>	<b>W/O Fractionation</b>	<b>With Fractionation</b>
Ethanol	<b>\$100,000,000</b>	<b>\$110,000,000</b>
Iowa DDGS (at 170 \$/ton)	<b>\$26,410,714</b>	
Frac. DDGS (at 220 \$/ton)		<b>\$28,430,380</b>
Bran (at 75 \$/ton)		<b>\$2,636,250</b>
Germ (at 160 \$/ton)		<b>\$7,278,240</b>
<b>Total Revenues</b>	<b>\$126,410,714</b>	<b>\$148,344,870</b>
Corn Cost (at 4.50 \$/bu)	<b>\$80,357,144</b>	<b>\$93,045,114</b>
Operating Costs	<b>\$30,500,000</b>	<b>\$29,150,000</b>
<b>Total Costs</b>	<b>\$110,857,144</b>	<b>\$122,195,114</b>
<b>EBITDA</b>	<b>\$15,553,571</b>	<b>\$26,149,756</b>
<i>Increased Net Income from Fractionation Technique = \$10,596,185</i>		
<i>Present Value (PV) of Increased Annual Revenue = \$92,730,076</i>		

## Weight Information for Phase Diets

<b>Growth Phase</b>	<b>Weight of Pig</b>
Grower 1	(45-95 lbs)
Grower 2	(95-155 lbs)
Finisher 1	(155-205 lbs)
Finisher 2	(205-260 lbs)
Gestating Sow	(300-500 lbs)