Feeding Pigs In a Biofuels World; Products and Strategies to Consider

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Agenda

- Current Situation
- Current Options
  - Value of Fat
  - Use of Crystalline Amino Acids
  - Use of Phytase
  - Use of DDGS
  - Use of Glycerin
    - Thanks to Dr Brian Kerr, USDA-ARS

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Agenda

- Future Options
  - Corn Fractionation Technologies
    - Dakota Gold BFRAC™
      - Thanks to Dr. Matt Gibson, Poet Nutrition
    - Renessen Ecorn
      - Thanks to Matt Wolfe, Cargill Animal Nutrition
  - Enzyme Technologies
    - Corn, Soy and DDGS Enzymes
      - Thanks to Dr. Dave Hall, ADM Alliance Nutrition

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Today’s Situation

- The biofuels boom has increased the demand for corn and fat and decreased the supply of soybeans
- As energy costs have increased, the cost of all ingredients has increased
- Cost of feeding a pig wean to finish has increased over $35/head to nearly $80 in the last 3 years

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Value of Fat in Swine Diets

- Trial consisting of moderate fat levels early w/ decreasing levels in late finishing vs high levels throughout growth phase

	Ph 4	Ph 5	Ph 6	Ph 7	Ph 8
St Wt, lb	47	90	140	180	225
Fat lb 1	58	53	32	6	0
Fat lb 2	138	132	112	86	80

- Pig weight and feed conversion measured as a response criteria

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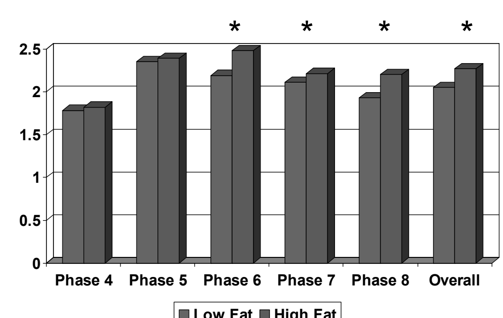
Pig Average Daily Gain



* P<.07

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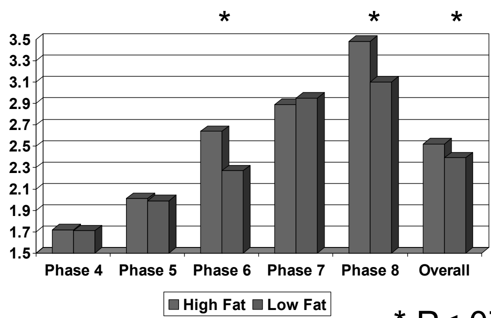
Pig Feed:Gain



* P<.07

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Value of Fat

- Depends on sale weight opportunity and space availability
- Feed cost of high fat ration is $5.93 more if pigs are fed to same day of age. Extra sale weight of 17 lbs is worth $7.65.
  - Net value of fat = $1.72/pig
- If barn availability is loose, and you can let low fat pigs grow to equal weight, 17 lbs = 9 days at no cost and added feed cost to get these pigs to same weight is $5.63
  - Net value of fat = -$0.30/pig

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Value of Fat

- If packer limits your sale weight and barn space is tight you can sell fat fed pigs 9 days early at a value of $1.08 and feed costs are $0.68 higher
  - Net value of fat = $0.40

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Crystalline Amino Acids

- Crystalline lysine, methionine, and threonine are widely available and used in livestock diets
- Can replace significant soybean meal in diets
- Must formulate to the ideal amino acid pattern
- Growing a pig is like building a house, must have proper amount of each building material or you can can’t effectively use any of it

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Crystalline Amino Acids

- Need proper ratio of 10, 8 and 6 ft 2x6’s or you can’t build the house
- Similarly, need proper ratio of lysine, methionine, threonine, tryptophan and isoleusine or you can’t build protein that makes muscle and organs
- Ideal ratio changes as pig grows due to changes in types of proteins deposited

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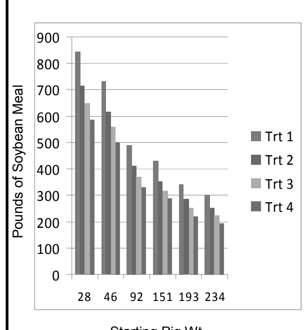
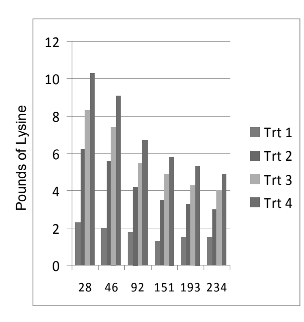
Amino Acid Use Trial





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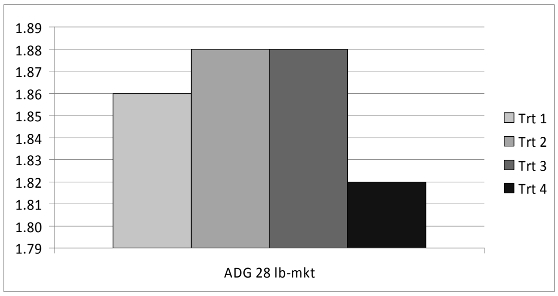
Impact of Crystalline Amino Acid Use on Pig ADG



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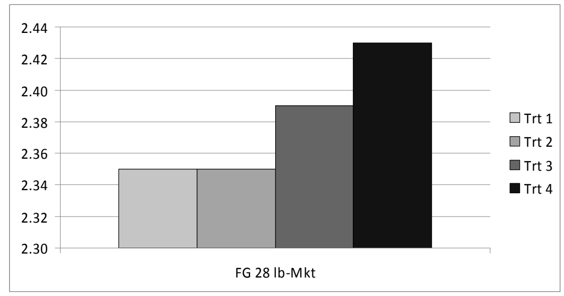
Impact of Crystalline Amino Acid Use on Pig FG



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Amino Acid Trial Conclusions

- ADG and FG not affected by synthetic lysine usage up to 8.5 lb/ton in early grower and 4 lb/ton in late finisher
- Threonine, methionine, and tryptophan must be balanced relative to lysine
- Value of amino acid usage at today's cost is $0.85/pig

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Value of Phytase

- Over 80% of the phosphorus in corn and 60% of the phosphorus in SBM is an indigestible phytate form
- Digestibility can be increased 50% to 70% with use of a phytase enzyme
- Phytase sources of various fungal and bacterial origins are now widely available
- Value of $1.70/pig vs no phytase

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Value of Phytase

- Cost of Monocalcium Phosphate has increased by $200/ton with another $200/ton increase coming in April
- The number of phytase products available has increased and price has decreased
- Traditional phytase usage levels of 300 to 500 FTU/kg final complete feed can now be economically increased to 1000 FTU
- Not all phytase products are created equal

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Current DDGS Strategy

- DDGS used from 25 lb to market in some flows
- Philosophy is that DDGS will only be used where feed cost savings is $\geq$ $1.00/ton due to risk of mycotoxin contamination & ingredient variability
- Formulation method utilized NDF maximum based on size of pig. Loosely based on data from Turlington et al. showing that mid-wt pigs utilize fiber well up to 12% NDF, then next incremental amount decreased total digestability significantly

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DDGS Trial Details

- 10 reps of 30 pigs per pen
- Diets formulation to be iso-caloric, iso-lysinic, and to contain similar minimum ratios of threonine, methionine, and tryptophan to lysine
- Pig weight and feed conversion as a response criteria

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DDGS Trial Design

- Four Dietary Treatments
  - No DDGS Control
  - 50% of Current Level
  - Current Max NDF Inclusion
  - 150% of Current Level
- All Diets Iso-energetic and Iso-Lysineic based on Current Loadings

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Ingredient Nutrient Loadings

	DDGS	Corn	SBM
ME/ % of Corn	1488/96%	1550/100%	1395/90%
NDF	38.37	9.60	8.90
Lysine	.73	.25	3.04
Avail Lys	.387	.166	2.61
Avail TSAA/Ratio	.573/ 1.48	.261/1.57	1.13/.43
Avail Thr/Ratio	.546/1.41	.196/1.18	1.43/.55
Avail Trp/Ratio	.132/.34	.036/.22	.53/.20
Avail P	.704	.04	.26

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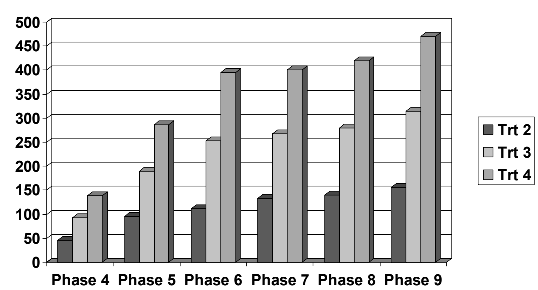
Trial DDGS Levels



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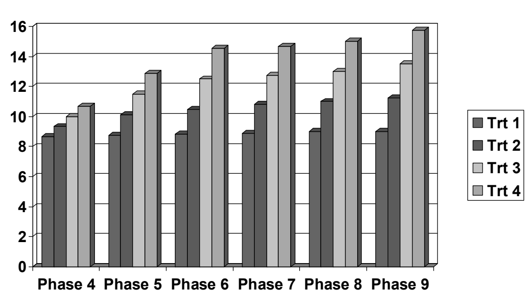
Trial NDF Levels



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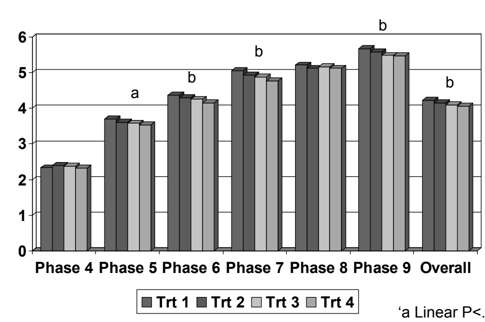
Pig Average Daily Feed Intake



'a Linear P<.10
'b Linear P<.01

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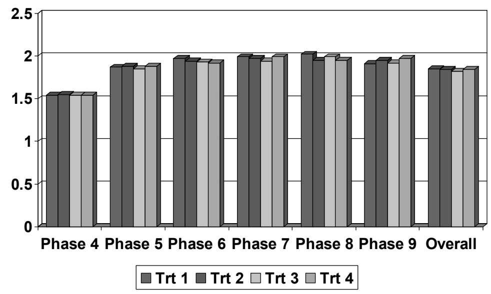
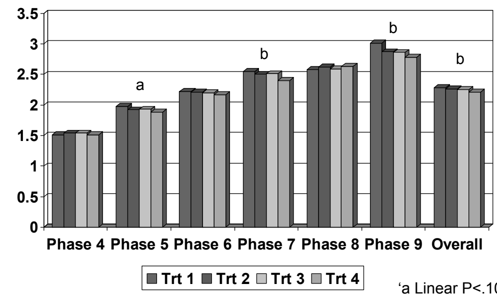
Pig Average Daily Gain



Pig Feed/Gain



‘a Linear P<.10
‘b Linear P<.05

Trial Conclusions

- DDGS levels up to 150 lbs in early grower and 475 lbs in late finishing had no effect on growth rate and improved feed efficiency
- It appears that the new generation DDGS had an energy value greater than 96% the value of corn
- Higher levels may be possible since plateau was not reached in this study
- At these levels would use approximately 100 lb per pig
- This would result in 5,000,000 tons of product used with 100% market share

Summary of Proximate Values

	Count	Mean	Stdev	CV	Range
Moisture	**150**	**10.1**	**1.7**	**16.9**	**6.9 - 14.7**
CP	**150**	**26.1**	**2.3**	**8.9**	**20.2 – 31.0**
Fat	**150**	**9.9**	**2.8**	**28.3**	**3.0 - 13.8**
Fiber	**150**	**6.3**	**1.6**	**24.5**	**4.7 - 23.1**
LYS	**158**	**0.71**	**0.17**	**24.5**	**0.10 – 1.07**

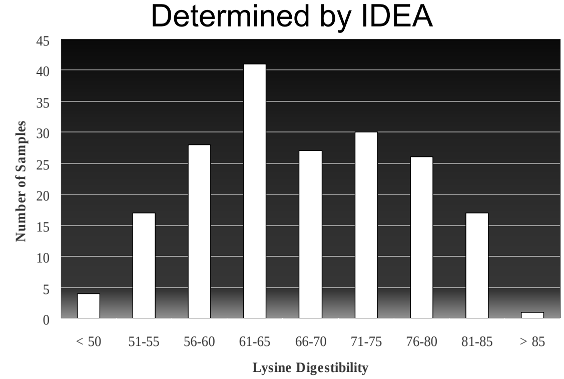
Courtesy of Shannon Peak, NOVUS International

Summary of Digestible Amino Acid Values (Swine)

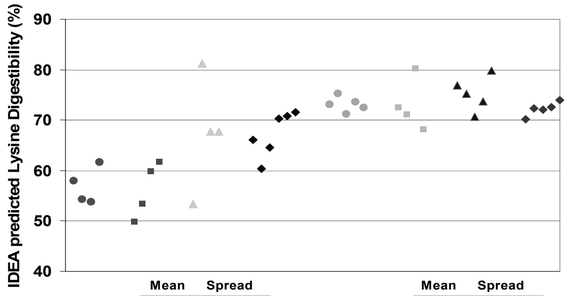
	Count	Mean	Stdev	CV	Range
ARG	**14**	**79 (72)***	**4.6**	**5.9**	**78 – 92**
CYS	**14**	**73 (57)**	**5.5**	**7.5**	**65 - 85**
ILE	**14**	**73 (66)**	**5.4**	**7.4**	**72 – 88**
LEU	**14**	**82 (76)**	**4.7**	**5.8**	**82 – 99**
LYS	**14**	**60 (47)**	**8.7**	**14.5**	**35 – 84**
MET	**14**	**81 (72)**	**4.6**	**5.7**	**79 – 90**
THR	**14**	**70 (55)**	**7.1**	**10.0**	**66 – 83**
TRP	**14**	**73 (50)**	**10.8**	**14.9**	**73 – 95**
VAL	**14**	**72 (63)**	**5.4**	**7.5**	**75 - 89**

*** Values in parenthesis () refer to NRC digestible values for swine.**

Histogram of Lysine Digestibility Values Determined by IDEA



DDGS Supplier Survey



	Mean	Spread		Mean	Spread
Supplier 1	56.9	7.9	Supplier 5	73.1	4.0
Supplier 2	56.3	11.9	Supplier 6	73.1	12.1
Supplier 3	67.5	27.8	Supplier 7	75.3	9.1
Supplier 4	67.2	11.1	Supplier 8	72.2	3.9

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Variability Conclusions

- Large variation with-in and between plants in proximate analysis and amino acid digestibility
- Variation makes it difficult to formulate predictably
- Reasons for variation?
  - Variability of incoming ingredients (corn)
  - Variability of solubles added
  - Variability in drying process
- Novus Idea Test may provide tool for guaranteeing digestibility

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Mycotoxin Concerns

- Mycotoxins concentrated 3 fold by fermentation with no de-activation
- Mycotoxins cause large productivity losses, especially in sows
- This threat limits use in grow-finish pigs and minimizes use in sows

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Pork Fat Quality Concerns

- For the pig, “you are what you eat”
- High levels of unsaturated fatty acids cause soft pork
- Problem magnified in modern high-lean pigs
- Significant problem with bacon slice-ability
- Limits use in many integrated swine operations

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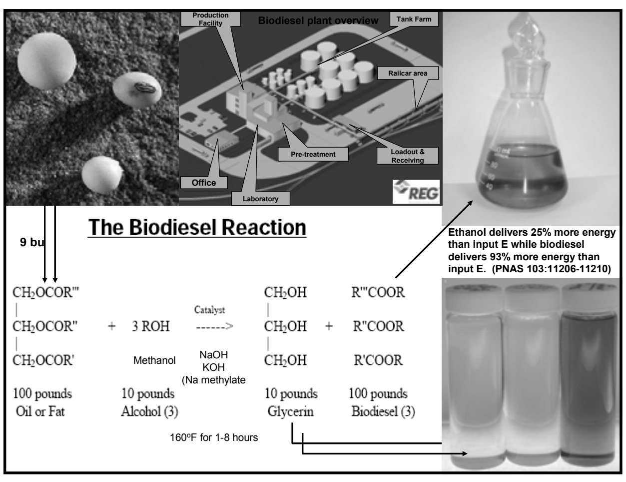
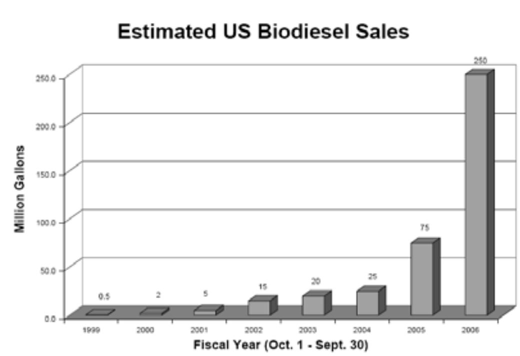
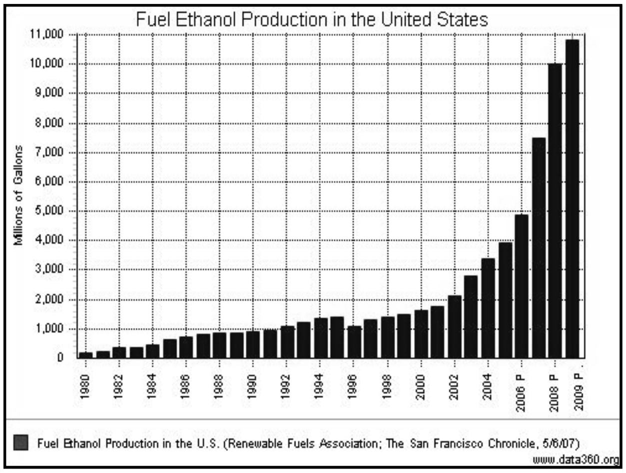




www.NBB.org



Refined Glycerin

- US Consumption (2004)
  - Personal Care/Oral Care — 83 KMT
  - Food/Beverage — 47 KMT
  - Pharmaceutical — 15 KMT
  - Tobacco — 23 KMT
  - Other — 36 KMT

TOTAL = 204 KMT

(current supply 243 KMT!)

Courtesy SRI Consulting – CEH Handbook

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Glycerin in Swine Diets

- **Mourot et al., 1994 (Livest. Prod. Sci. 38:237-244)**
  - Crude glycerol (Cl^- free) 0 or 5% of the diet to 36 to 102 kg pigs. (10 pigs/trt)
  - No effect on growth performance (slight drop in gain and feed efficiency), carcass characteristics, or plasma glycerol.
  - **Drip loss was reduced by 0.51% units while cooking loss was reduced by 3.8% units due to glycerol supplementation. (No change in SM pH.)**
  - Glycerol did not affect total lipid content of BF, SM, or liver tissue.
    - Glycerol increased the proportion of oleic acid (18:1) in the BF at the expense of linoleic (18:2) and linolenic (18:3) acids, and consequently decreased the unsaturation index of fat.

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Glycerin in Swine Diets

Kijora et al., 1997 / J. Anim. Physiol. Anim. Nutr. 77: 127-138

- Pigs from 26.9 to 99.3 kg were fed diets containing 0 or 10% glycerol.
- No change in pig performance due to dietary glycerol.
- Small numerical changes in: ↓% muscle, ↑BF, ↑pH, ↑flesh color, and ↑marbling.
- There was no change in total unsaturated FA in pigs fed glycerol. Reduced incorporation of polyenic acids relative to other unsaturated FA (oleic increased, albeit not significant).

Bartlet and Schneider / UFOP-Schriften Heft 17, 2002, pp. 15-36

- Pigs weighing 34 kg were fed 0, 5, 10, and 15% pure glycerol.
- Wheat, barley, SBM, corn starch based diet.
- Prececal digestibility of glycerol was marginally affected.
  - 99.3, 98.5, and 97.6% for 5, 10, and 15% glycerol, respectively.
- **A decrease in the ME of glycerol as the level increased.**
  - **4177, 3436, and 2524 kcal/kg for 5, 10, and 15% pure glycerol, respectively.**

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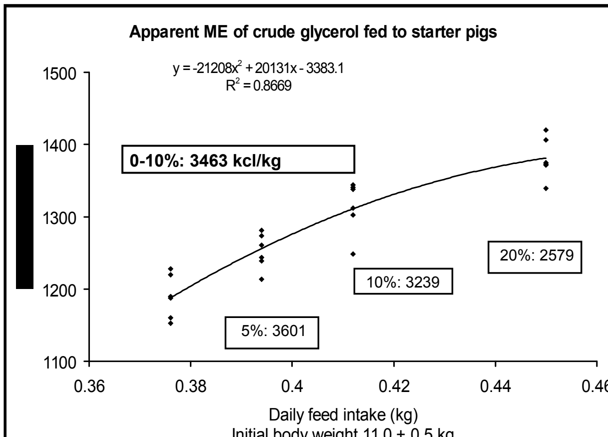
Energy Determination in Swine

ARS/ISU

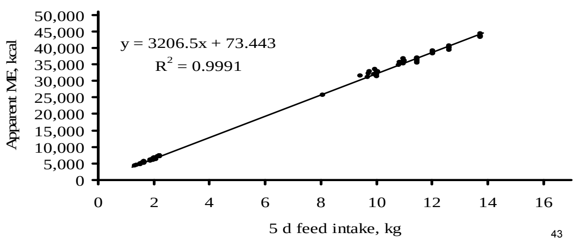
- Pigs adapted to metabolism cages, dietary treatments, and feeding regimens for 10 d prior to initiation of collection.
- Total fecal and aliquot urinary collection for 6 d.
- Pigs fed on a graded scale relative to crude glycerin consumption.
- Energy determination of feces and urine by bomb calorimetry.
- 86.95% glycerin, 9.63% water, 0.028% methanol, 3.13% NaCl, 0.29% total FA



Crude Glycerin ME summary – Swine

- **E1 (11.0 – 15.9 kg, 24 ♂) (0-3164 basal ME, 5, & 10%): 3,463 kcal/kg**
- ***E3 (8.6 – 11.2 kg, 24 ♂) (0-3211 basal ME & 10%): 3,177kcal/kg***
- ***E4 (11.3 – 13.3 kg, 24 ♂) (0-3247 basal ME & 10%): 3,544 kcal/kg***

- **E2 (109.2 – 125.4 kg, 24 ♀) (0-3175 basal ME, 5, 10, & 20%): 3,088 kcal/kg**
- ***E5 (99.9 – 102.7 kg, 24 ♀) (0-3254 basal ME & 10%): 3,352 kcal/kg***



Evaluation of Crude Glycerin in GF Pigs

ARS/ISU

- Pigs (96) allotted to pens based on body weight and gender.
- Corn-SBM diets supplemented with 0, 5, and 10% crude glycerol.
- Pigs allowed free access to feed and water.
- 84.51% glycerol, 12.24% water, 0.318% methanol, 2.93% NaCl, 0% total FA.
- Pig performance, carcass composition, and meat quality assessment.

Crude Glycerin in Growing Pigs

performance and carcass scan

ARS/ISU

Criterion	0%	5%	10%	SE	P
ADG, g/d	905	913	906	15.7	0.93
ADFI, g/d	2333	2385	2400	52.4	0.65
G:F	0.386	0.382	0.376	0.003	0.13
scanBF, mm	18.8	21.0	20.7	0.8	0.14
scanLEA, cm^2	48.6	49.0	46.6	0.9	0.12
scan% FFL, carcass	52.9	52.5	51.7	0.4	0.14

Eight pens/trt, 4 pigs/pen, 8.0 to 133.2 kg BW, 138 d trial. Lammers et al., 2007

Glycerol in Swine Diet

- Concerns
  - Shipping cost- Liquid ingredient 10-12% H2O
  - Need heated liquid tank for mill application
  - Other compounds in product may limit use
    - Potassium
    - Sulfate
    - Methanol (FDA limit of 150 ppm in diet and range is 25 to 2000 ppm in analyzed samples

Glycerol in Swine Diet

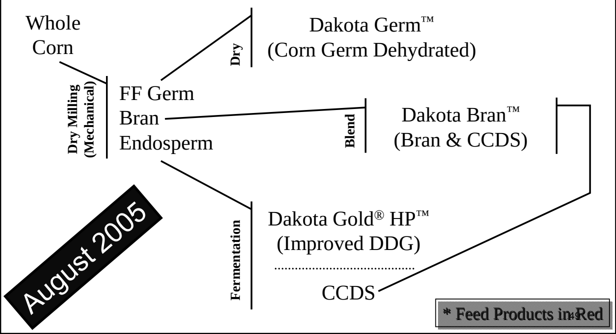
- Conclusions
  - Glycerol provides a highly available energy source for pigs and poultry
  - Energy 1450 – 1500 kcal/lb or roughly equivalent to corn
  - Supplementation up to 10% has little to no impact on performance, carcass composition, or meat quality

Bio-refinery Concept

Generally, "Up-Front" Corn Processing

(Pre-Fermentation)

Broin Process Flow:
Ingredient Origin*



* Feed Products in Red

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Bio-Refining Products
Nutrient Profiles*

	DG-HP	CGD
CP	43.0	17.5
EE	4.3	20.2
LYS	1.43	0.84
MET	1.21	0.31
THR	1.64	0.60
Phos	0.54	1.66

* Selected Nutrients
Complete Profile available

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Energy Nutrition[1]
ME-S Values, kcal/kg[2]

Ingredient	NRC	DGRA
Corn	3,842	3,864
DDG/S	3,032	3,940
Dakota Gold HP	-	4,049
Corn Germ Dehy	-	4,540

[1] U MO
[2] DMB

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Other Processes
In Start-up Phase

Solaris™ Products*
- ProBran™
- NutraFiber™
- Germ
- Energia™
- Glutenol™
- Glutenol XP™

* from HydroMilling™ process
www.QTITech.com
www.CornVP.com

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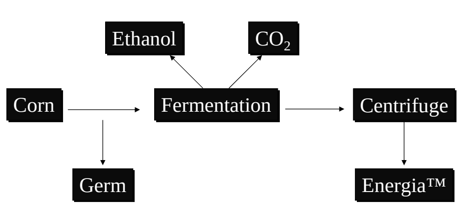
HydroMilling™
Phase I



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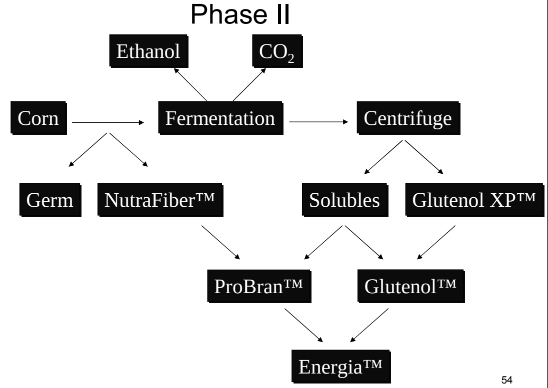
HydroMilling™
Phase II



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HydroMilling™

Ingredient Nutrients*

	DM	CP	Fat	Fiber
Germ	97	17.5	45.0	6.0
NutraFiber™	90	6.8	1.5	17.1
ProBran™	90	9.5	2.0	16.0
Glutenol™	90	45.0	3.3	3.8
Energia™	90	30.0	2.5	8.2

* from Pilot Plant Tests

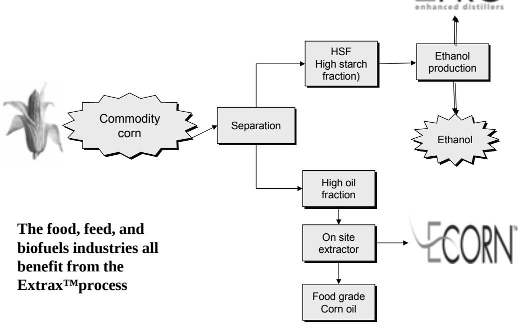
"Oil from Syrup"

Use of Oil

- Bio-diesel (probably...?)
  - Crude
  - Post-Fermentation

Nutrition Issues

- Lower Fat DDG/S
  - 11 % → 5 %
  - Energy will be lower



The food, feed, and biofuels industries all benefit from the Extrax™process

Trial Results

- Conducted 13 commercial trials involving 23,000 + head
- Ecorn™ replaces 100% of the corn in a swine grower finisher ration and achieves similar performance (ADG, ADFI, F:G)
- Carcass results (backfat, % lean, yield) are comparable between Ecorn™ and controls
- Fat iodine values are lowered in Ecorn™ fed pigs

Formulation

- Ecorn™ replaces all of the corn in a grow-finish ration, 25% of the SBM, and 25% of added phosphorus

Example Diets

	100% Ecorn™	**Control**
Corn		1431.0
Ecorn™	1490.0	
SBM	352.4	434.6
Fat	104.6	84.0
Dical	9.4	12.0

Licensing

- Renessen will offer a limited number of licenses for the Extrax™ technology
- Multiple ways to participate
  - Ecorn™ off take agreements
  - Ownership share in Extrax™ facility
  - Purchase of Ecorn™
  - Ethanol plant ownership of Extrax™ enabled facility

The need of exogenous enzyme

- NSP(non-starch, non-digestible polysaccharides)
  - Retards endogenous enzyme access to feed nutrients.
    - High viscosity
  - Inhibits absorption of digested nutrients.
  - Leads to imprecise matching of nutrient specifications to diet specifications (AME variability).
  - Retards uniformity of animal performance.
  - And…
    - High osmolarity (osmotic pressure)
    - Low convectional mobility
    - Low hydrolysis
    - Fast intestinal feed passage

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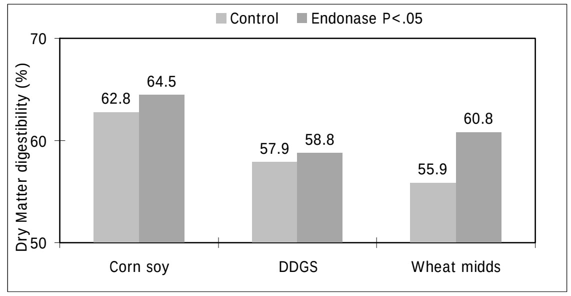
Effect of Endonase (in vitro ileal digesta)



ADM Trials S03601 & S03602

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Effect of Endo-Power β

	Corn-Soy	CS+0.01% Endo-Power β	CS+0.02% Endo-Power β
Initial weight, lb	13.8	13.9	13.8
Final weight, lb	41.8	42.0	42.1
ADG, lb	0.80	0.80	0.81
Feed/Gain*	1.74	1.63	1.67

Kim et. al, JAS (2003) *P<.05 — University of Illinois

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Effect of Endo-Power β on DDGS Spencer et.al, 2006

	Treatment			PSE	P-value
	Corn-soy	+30% DDGS	+30% DDGS + E		
ADG, kg	1.18b	1.19b	1.23a	0.02	0.07
ADFI, kg	1.77a	1.65c	1.73ab	0.03	0.01
FCR	1.50a	1.39c	1.40c	0.01	<0.0001

- 300 pigs (3 treatments x 10 pens x 10 pigs)

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Thank You

- Questions?

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