

The Use of Distiller's Grains By-products in Livestock and Poultry Diets

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The Keys To Increased DDGS Use Are:

- Understanding the value and limitations of DDGS in livestock and poultry feeds**

- Overcoming the challenges**



DDGS Nutrition

- DDGS is a “package of nutrients”
 - Mid-protein ingredient
 - Like corn, has poor protein quality (amino acid balance) for swine and poultry
 - High fat
 - High available P
 - valuable for monogastrics
 - can result in overfeeding P for ruminants

The Use of DDGS in Dairy Rations





Benefits and Limitations for Lactating Dairy Cows

Benefits

- More protein and energy than corn
- Feed at up to 20% of ration dry matter
- Highly digestible fiber source
 - Fewer digestive upsets
 - Can be a partial forage replacement
- “Golden” DDGS gives best performance
- Highly palatable

Limitations

- Low protein (lysine) quality
 - add other supplements high in lysine
- Manure P excretion increases at high feeding levels
- No effect on milk fat if adequate forage in the ration

The Use of DDGS in Beef Feedlot Rations



Benefits and Limitations for Finishing Feedlot Cattle

Benefits

- More protein and energy than corn
- Feed up to 40% of ration dry matter to replace corn
 - Feed excess protein and P
- Highly digestible fiber source
 - Fewer digestive upsets
- “Golden” DDGS gives best performance
- No effect on carcass yield, quality, or eating characteristics of beef

Limitations

- Need to supplement calcium to achieve proper Ca:P ratio
 - Avoid urinary calculi
- Manure N and P excretion increases at high feeding levels
- Monitor sulfur level of water and diet (< 0.4% ration DM)
 - Avoid polioencephalomalacia

Feeding Value of DDGS for Swine



Benefits and Limitations of Feeding DDGS Diets to Swine

Benefits

- Energy value = corn
- High available P
 - Reduce diet P supplementation
 - May reduce manure P excretion
- Partially replaces some corn, soybean meal, and dicalcium phosphate and reduces diet cost
- Commonly fed at 10% of diet
 - Higher levels can be used if amino acids are supplemented
- Only “golden” DDGS should be used
 - High amino acid digestibility
- Appears to reduce gut health problems due to ileitis
- May increase litter size weaned when fed at high levels to sows
- Increases pig weight gain when fed to sows during lactation

Limitations

- Low protein (lysine) quality
 - add other supplements high in lysine and tryptophan
- Variability in nutrient content and digestibility among sources
- Manure N excretion increases
- Belly firmness and pork fat quality may be reduced at high dietary inclusion rates
- Fine particle size can contribute to flowability problems in bins and feeders
- Difficult to pellet and maintain throughput of pellet mills
- Mycotoxin free grain should be used to produce ethanol and DDGS
- Short-term feed intake may be reduced when feeding high DDGS diets to sows

Effects of Formulating G-F Diets Containing Increasing Levels of DDGS on a Digestible Amino Acid Basis on Growth Performance and Pork Quality



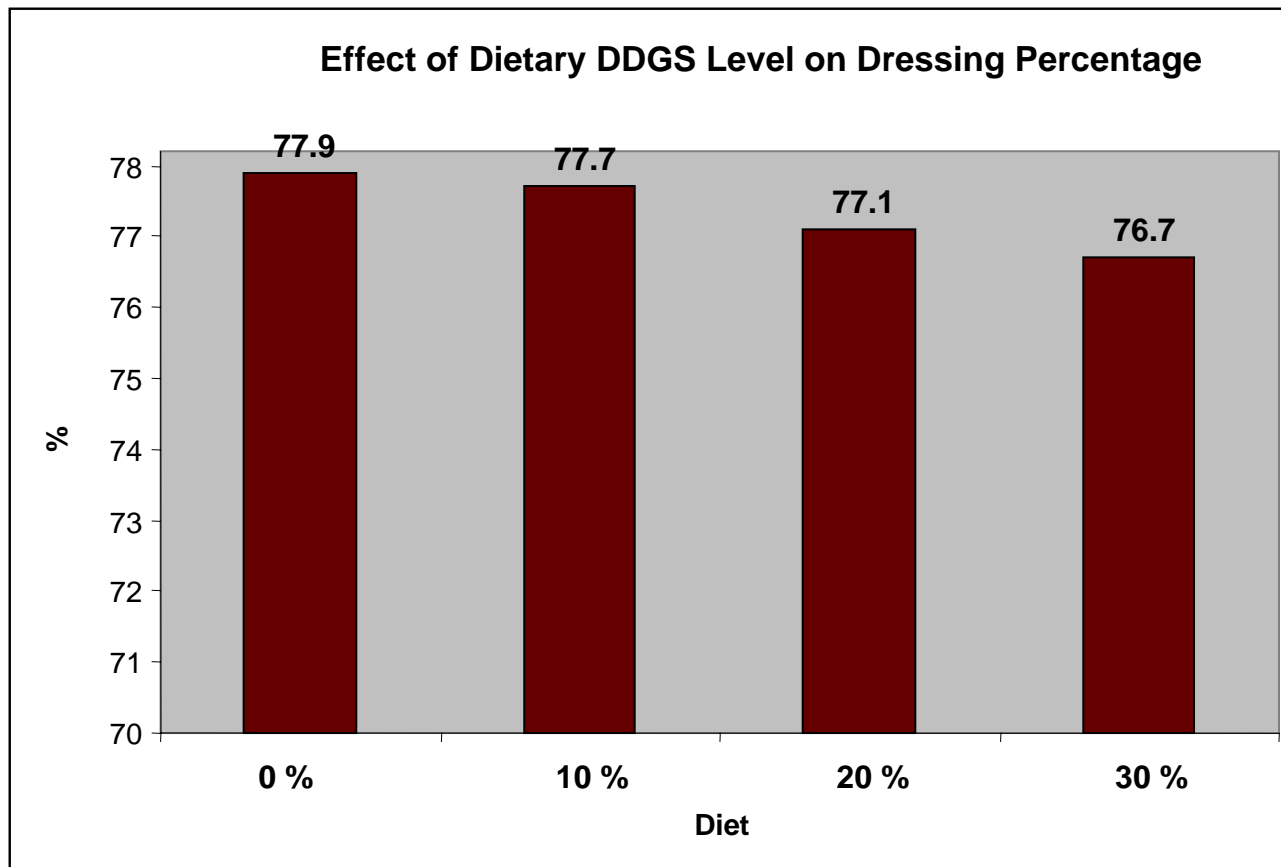
Effect of Formulating G-F Diets on a Digestible Amino Acid Basis, with Increasing Levels of DDGS, on Overall Growth Performance

	0% DDGS	10% DDGS	20% DDGS	30% DDGS
Initial wt., lbs	49.7	50.3	49.7	49.7
Final wt., lbs	252	253	251	250
ADG, lbs/d	2.03	2.03	2.03	2.01
ADFI, lbs/d^a	5.66	5.62	5.49	5.42
F/G^a	2.79	2.76	2.71	2.70

^a Linear effect of DDGS level

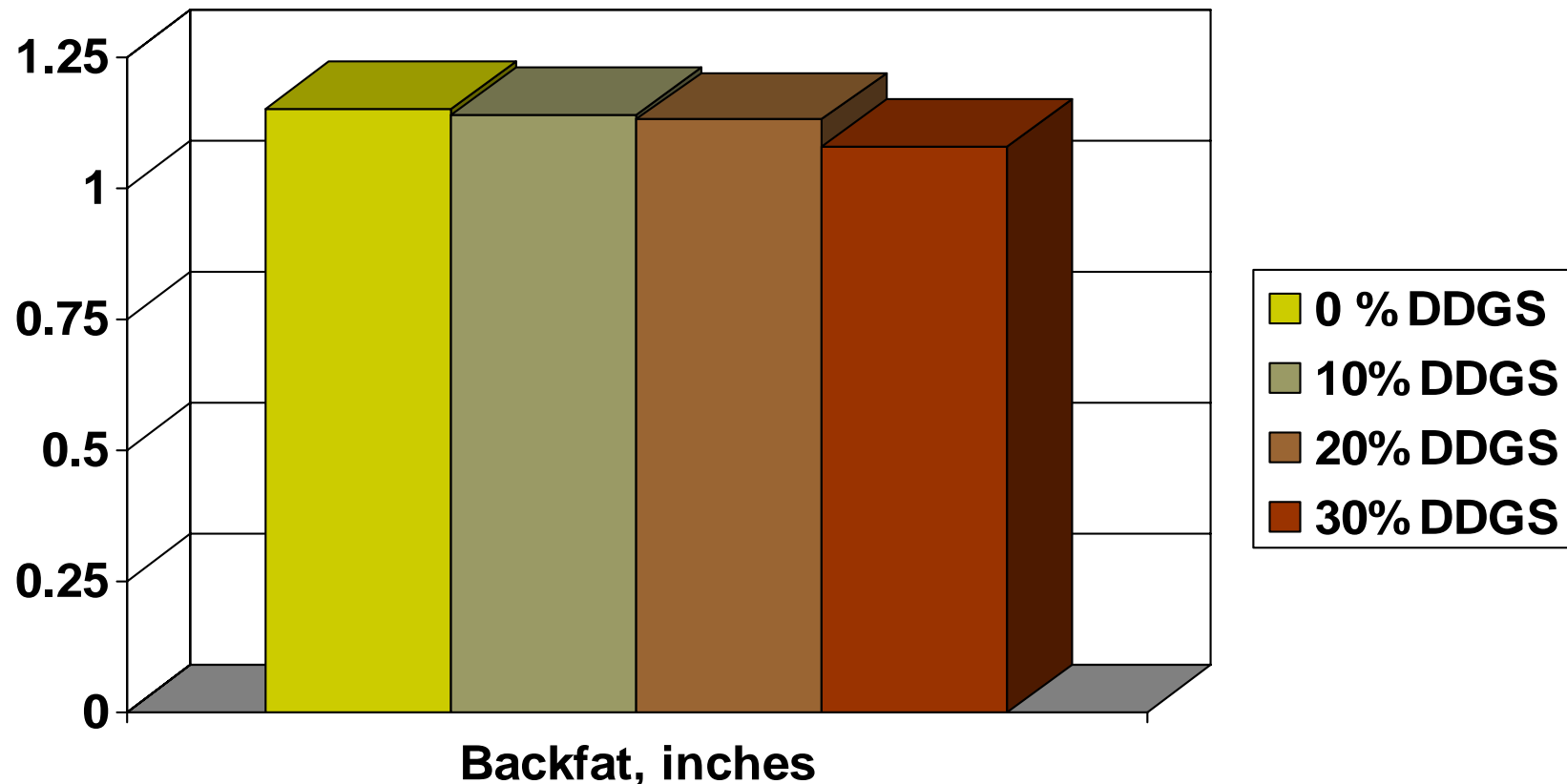
Data from 64 pens, 16 pens/treatment (Xu et al., 2007)

Adding Increasing Levels of DDGS to G-F Diets Slightly Reduces Carcass Yield



Xu et al. (2007)
Linear effect ($P < 0.01$)

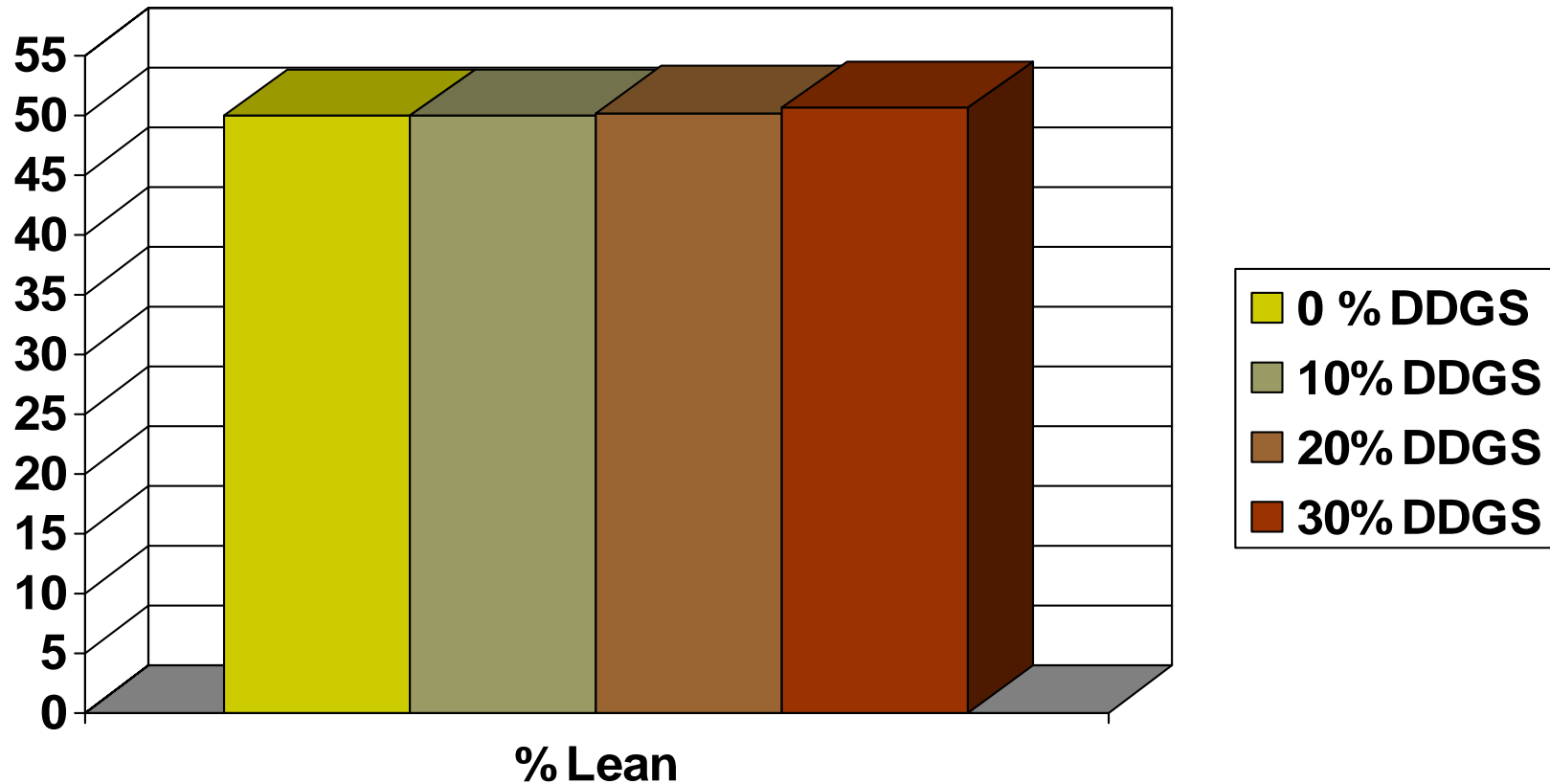
Effects of Dietary DDGS Level on Last Rib Backfat



Xu et al. (2007)

30% DDGS tended to be lower than 0% DDGS ($P = 0.09$)

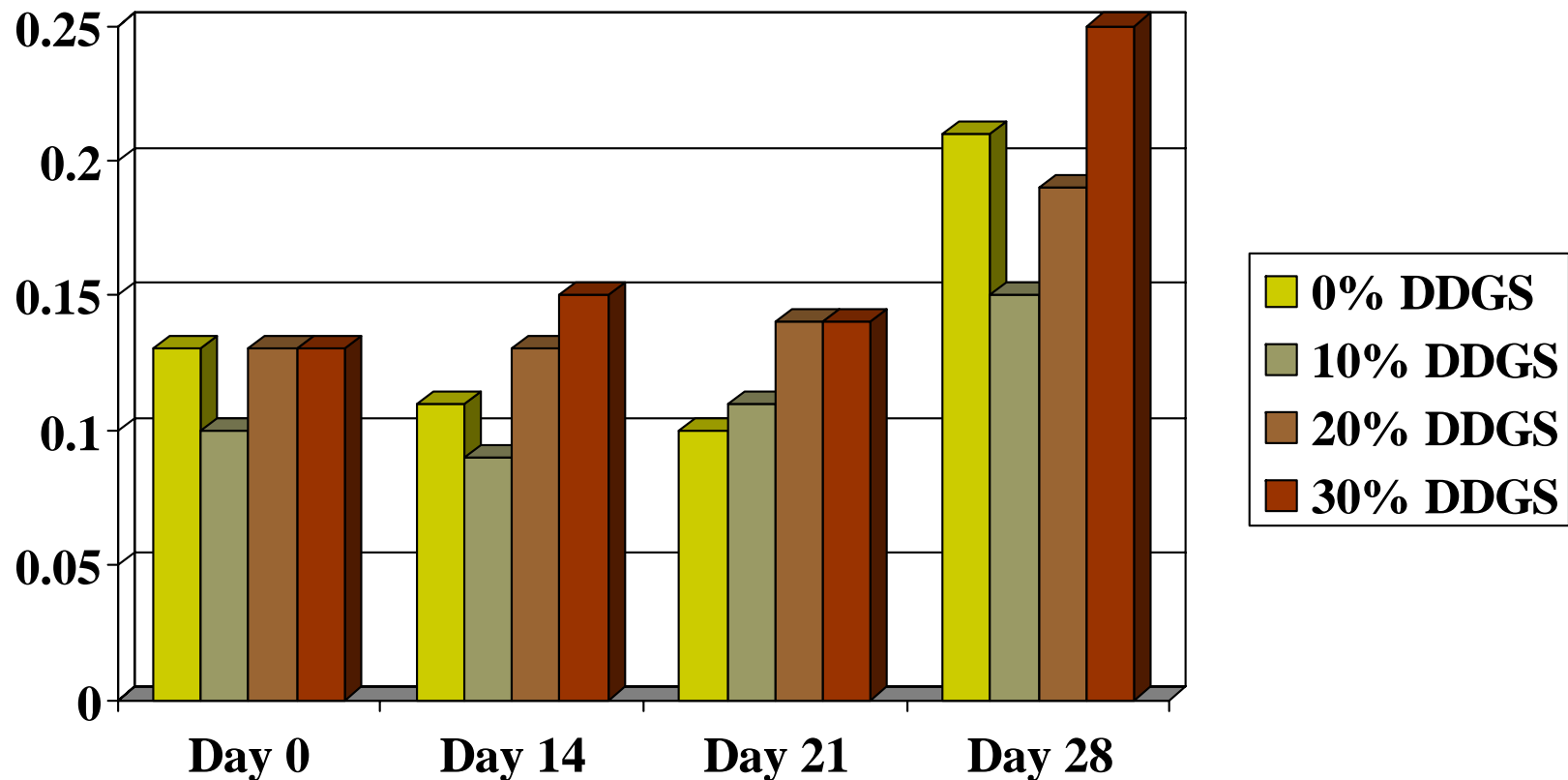
Effects of Dietary DDGS Level on % Carcass Lean



Xu et al. (2007)

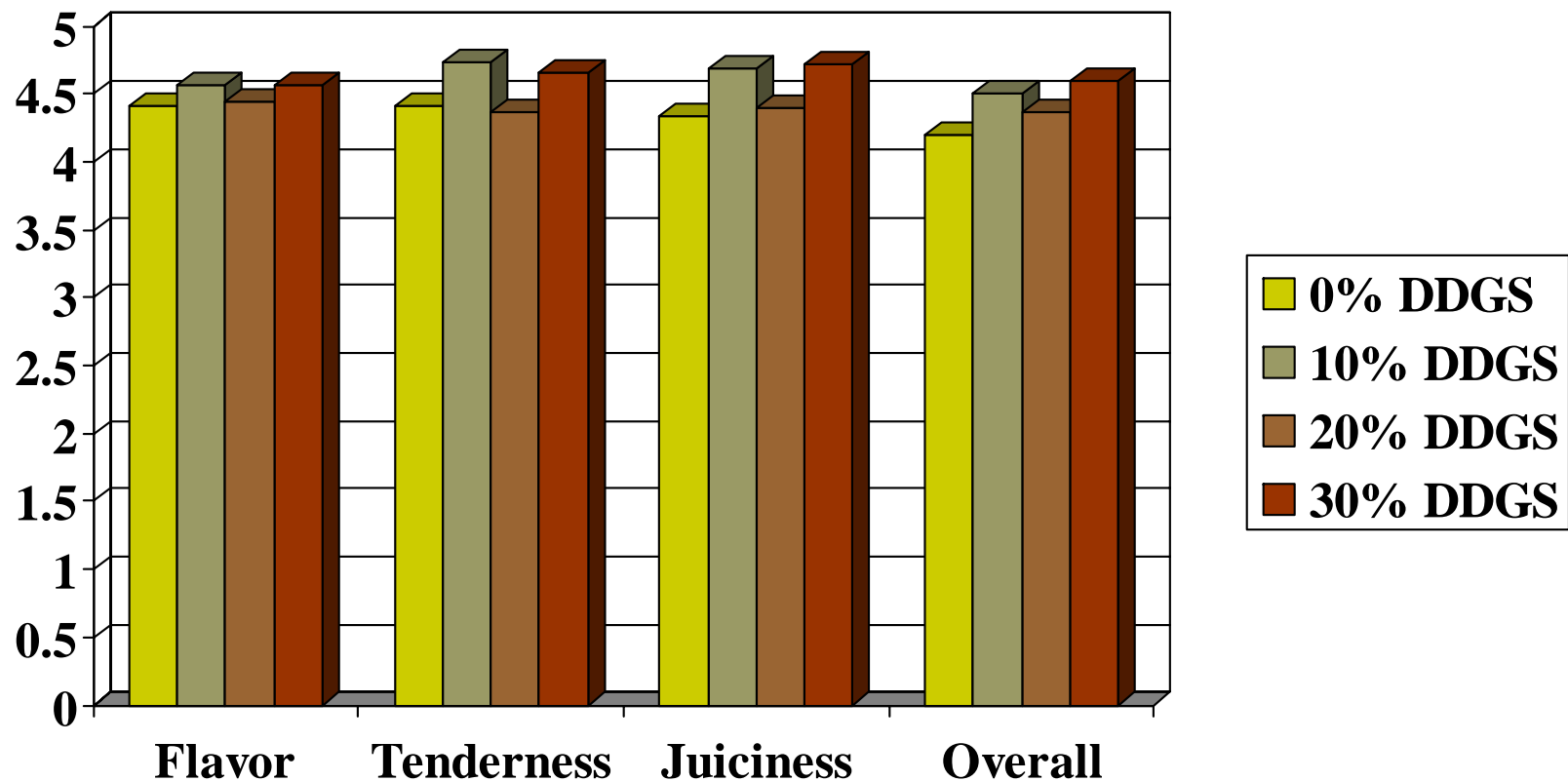
30% DDGS tended to be higher than 0% DDGS (P = 0.11)

Effects of Increasing Dietary DDGS Level on Fat Stability of Pork Loins (TBARS, mg malonaldehyde/kg)



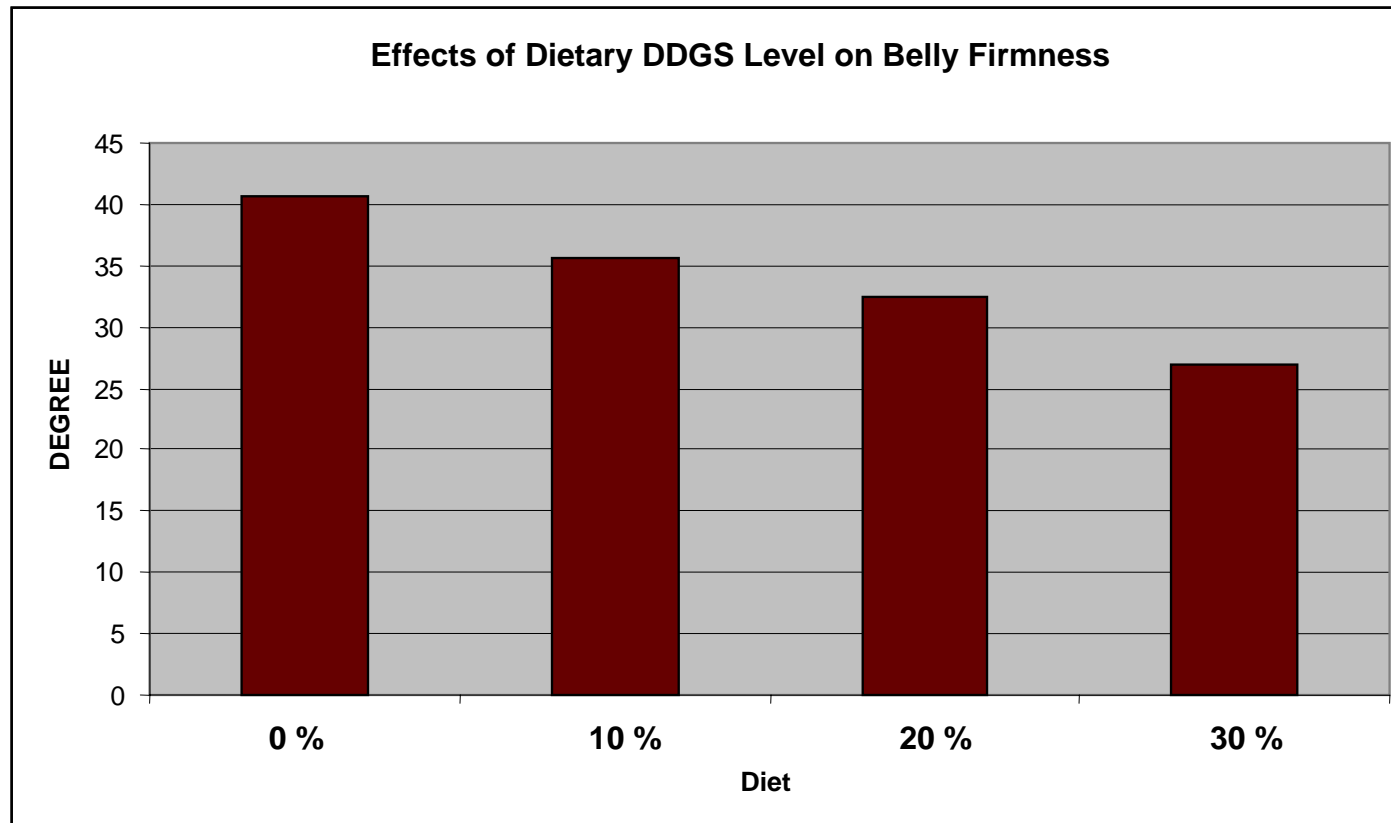
No significant differences among dietary treatments.

Effects of Increasing Dietary DDGS Level on Eating Characteristics of Pork Loins



No significant differences among dietary treatments.

Adding Increasing Levels of DDGS to G-F Diets Linearly Reduces Belly Firmness



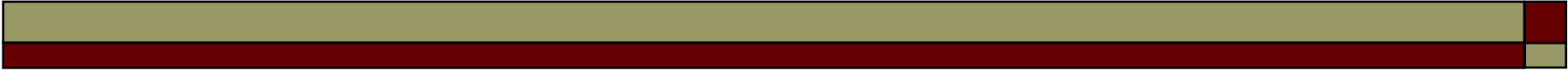
Xu et al. (2007)

Summary of Effects of Feeding DDGS on Pork Quality

- Diets containing 10% DDGS will provide the same ADG as pigs fed typical corn-SBM diets
 - Diets formulated on a total lysine basis
 - Diets formulated on a digestible amino acid basis

- If >10% DDGS is added to G-F diets, diets should be formulated on a digestible amino acid basis to achieve good performance.

- Feed intake may decline with increasing levels of DDGS in the diet
 - Unclear why different studies show different feed intake responses
 - Diets containing >10% DDGS may result in improved feed efficiency



Summary of Effects of Feeding DDGS on Pork Quality

- Carcass yield is slightly linearly reduced with increasing dietary DDGS levels
 - No difference in % lean
 - No difference in backfat
 - May be due to increased viscera weight from increased dietary fiber?
- Backfat thickness is unaffected, and may be slightly reduced, with increasing dietary levels of DDGS
- Bellies will be less firm as higher dietary levels of DDGS are fed
- Belly thickness may or may not be affected by increasing dietary DDGS levels
- No concern about reduced shelf life and fat oxidation in loins under typical retail storage conditions for at least 28 days.
- Muscle quality and eating characteristics are generally unaffected by feeding diets containing increasing levels of DDGS

Use of DDGS in Poultry Diets





Benefits and Limitations for Poultry

Benefits

- Good energy and amino acid source when limited to < 15% of the diet
- Source of highly available P
 - Reduce manure P
- May improve egg yolk and skin color (xanthophyll)
- Source of “unidentified growth factors”?
- “Golden” DDGS gives best performance
- Highly palatable

Limitations

- Energy value ~ 84% of corn
- Low protein quality
 - add other supplements high in lys, arg, trp
- Sources high in sodium may increase litter moisture if adjustments to dietary salt levels are not made

Relative Value of DDGS Differs Depending on Species

	Feed	Dollars/ ton
Assumptions:	Dairy Lactation	\$114.24
•Corn \$2.00 / bu	Poultry Finisher	\$100.09
•SBM \$175.00 / ton	Layer Diet	\$104.66
•Urea \$360.00 / ton	Swine G-F Diet	\$96.34
•Non-ruminant diets corn/SBM	Beef Feedlot	\$108.00
•Ruminant diets typical diets with competing by-products.		

Source: Tilstra, Land O' Lakes



Nutritionists make the decisions on feed ingredient use

- Decisions are based on:
 - Price relative to competing ingredients
 - Corn
 - Soybean meal
 - Dicalcium phosphate
 - Consistency of supply
 - Ability to source and manage quality
 - Physical characteristics
 - Particle size and flowability
 - Bulk density
 - Ability to pellet
 - Risk of mycotoxins
 - Product consistency/variability



What Are the Issues/Challenges?

1. By-product variability
 - a. nutrient content
 - b. nutrient digestibility
 - c. physical characteristics
2. Feeding value of new corn distiller's by-products
3. Lack of a quality grading system
 - a. difficult sourcing to obtain desired quality and price
4. Lack of standardized testing procedures
5. Need for quality management and certification
6. Need a high degree of
 - a. research
 - b. education
 - c. technical support
7. Presence of quality contaminants?



1. By-Product Variability

- Nutrient content
- Nutrient digestibility
 - Color (amino acid digestibility)
- Physical characteristics
 - Particle size
 - Bulk density

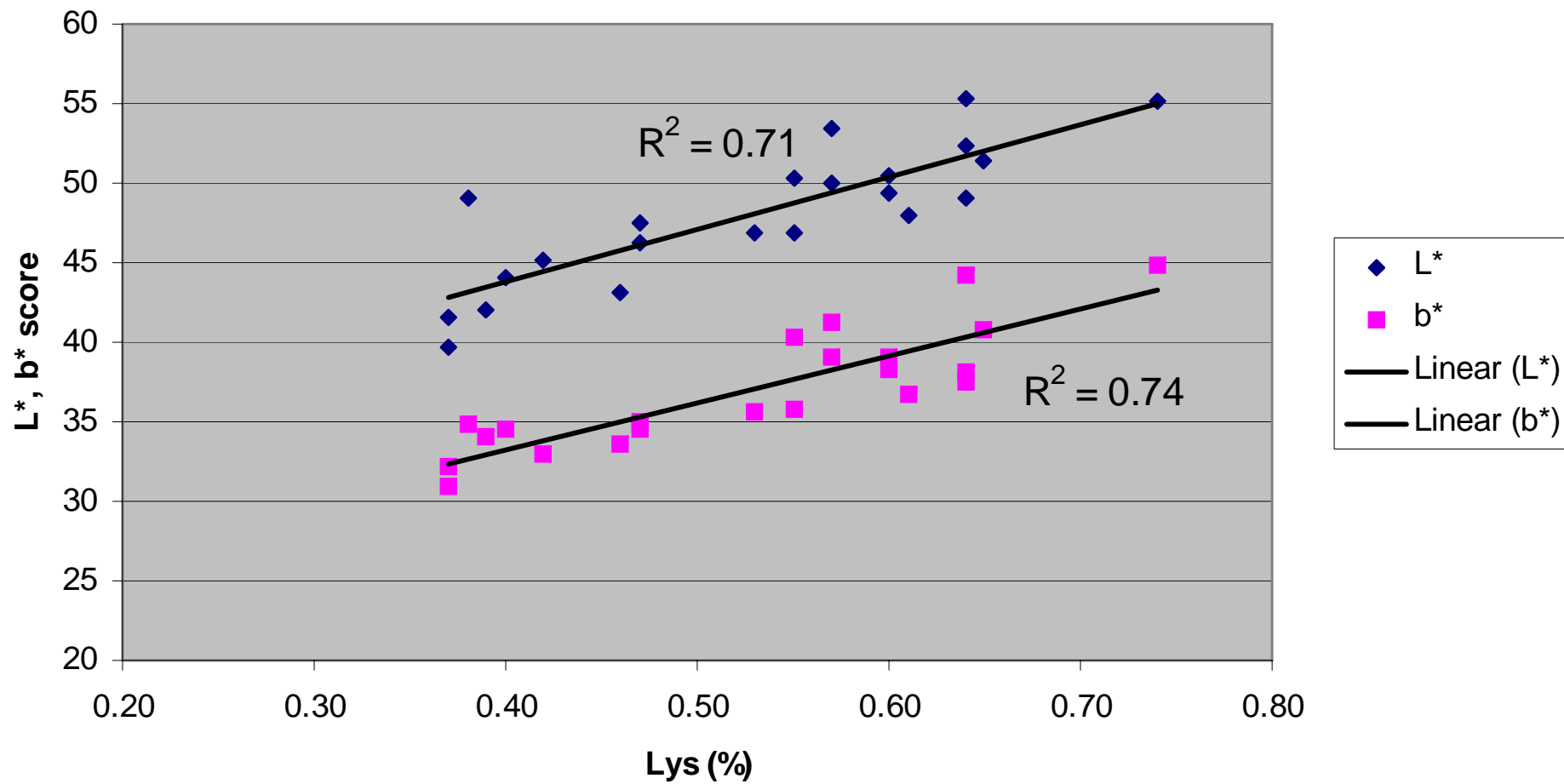
Averages, Coefficients of Variation, and Ranges of Selected Nutrients Among 32 U.S. DDGS Sources (100% Dry Matter Basis)

Nutrient	Average	Range
Dry matter, %	89.3	87.3 – 92.4
Crude protein, %	30.9 (4.7)	28.7 – 32.9
Crude fat, %	10.7 (16.4)	8.8 – 12.4
Crude fiber, %	7.2 (18.0)	5.4 – 10.4
Ash, %	6.0 (26.6)	3.0 – 9.8
Swine ME, kcal/kg	3810 (3.5)	3504 – 4048
Lysine, %	0.90 (11.4)	0.61 – 1.06
Phosphorus, %	0.75 (19.4)	0.42 – 0.99

DDGS Varies Nutrient Content and Digestibility, Color, and Particle Size Among U.S. Sources

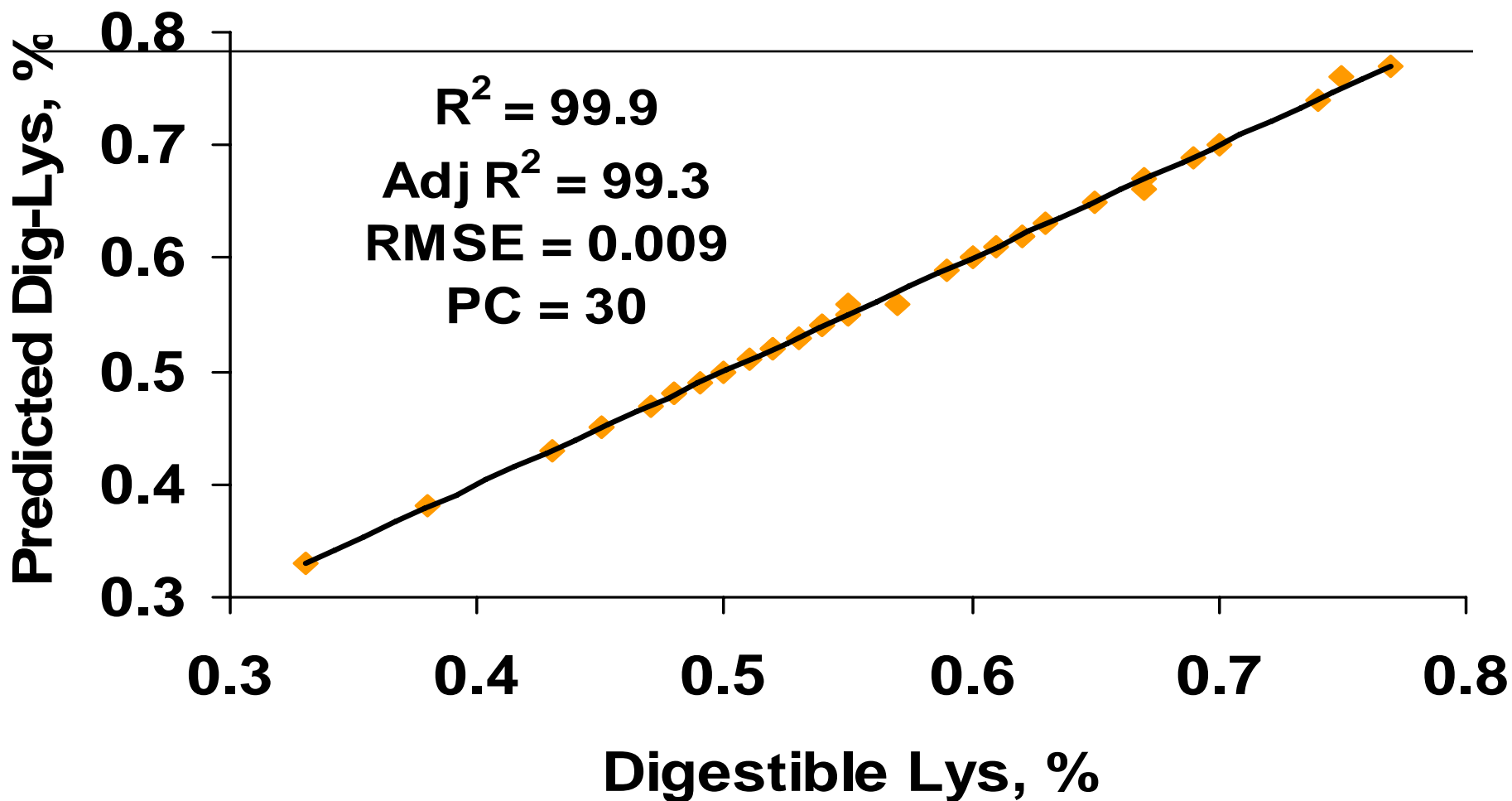


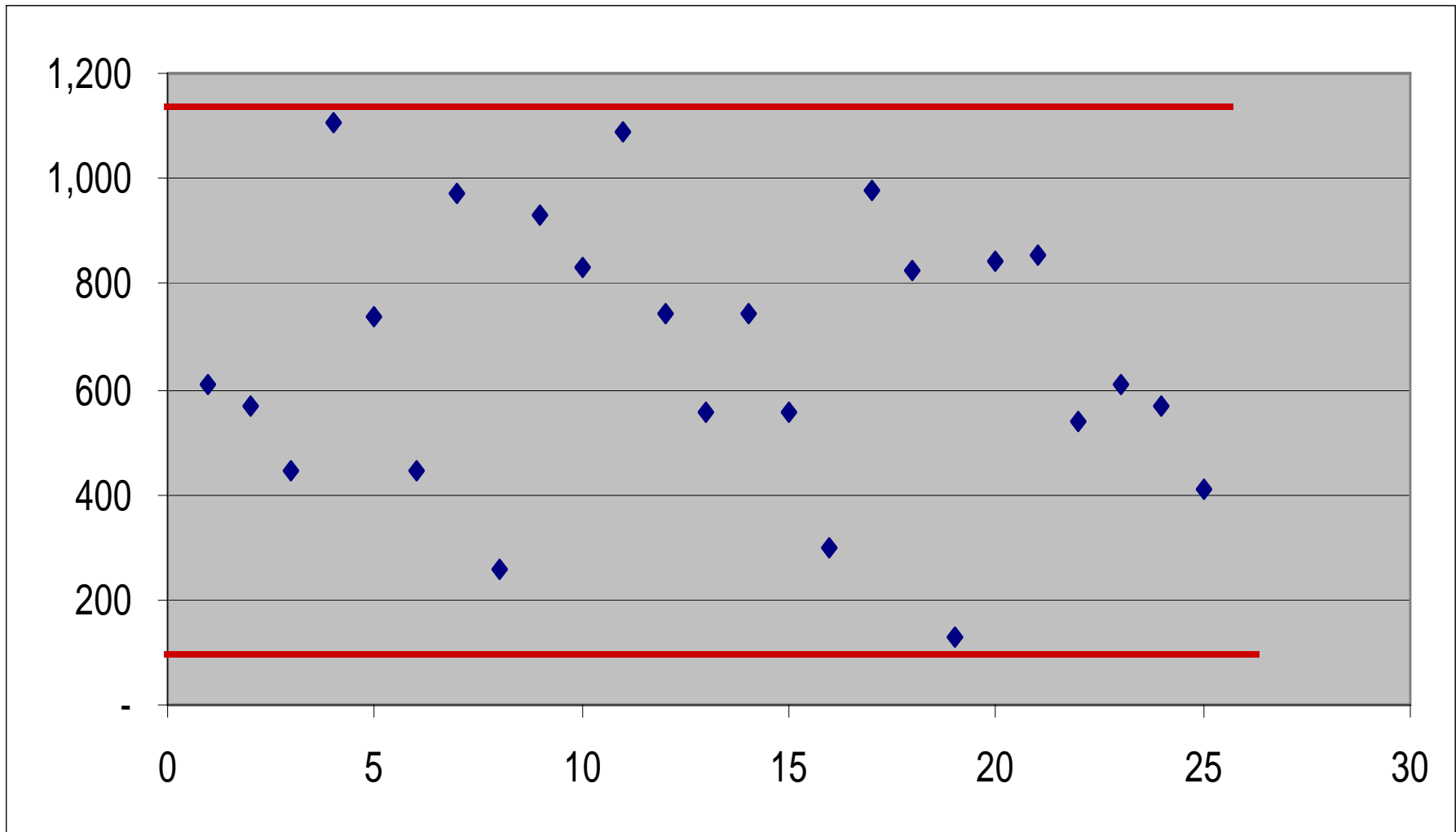
Fig. 1. Regression of digestible lys (%) and color (L*, b*)



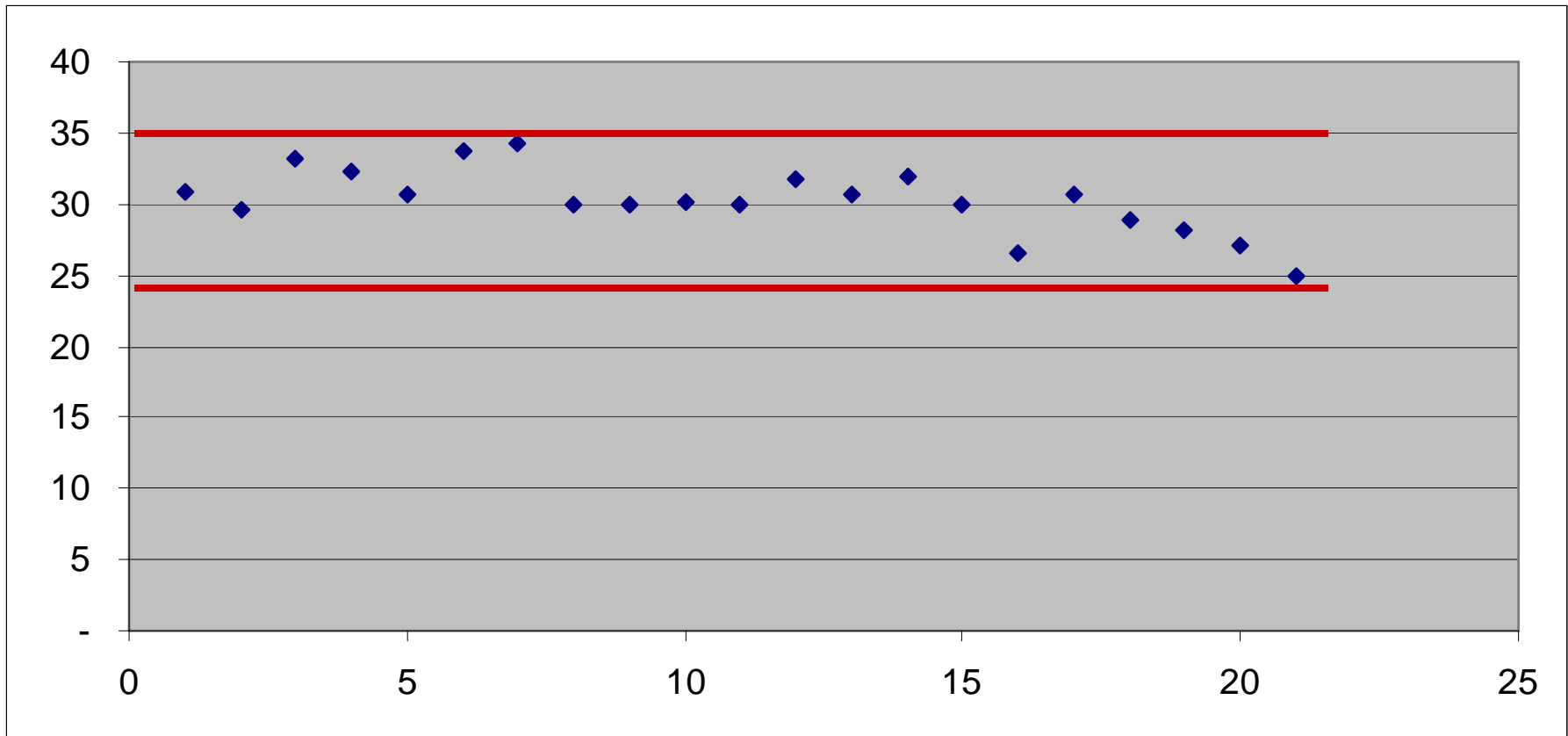
Source: Dr. Sally Noll (2003)

Prediction of Digestible Lysine from Front Face Fluorescence in DDGS





**Variation in Particle Size Among DDGS Samples Representing
25 U.S. Ethanol Plants
1/05**

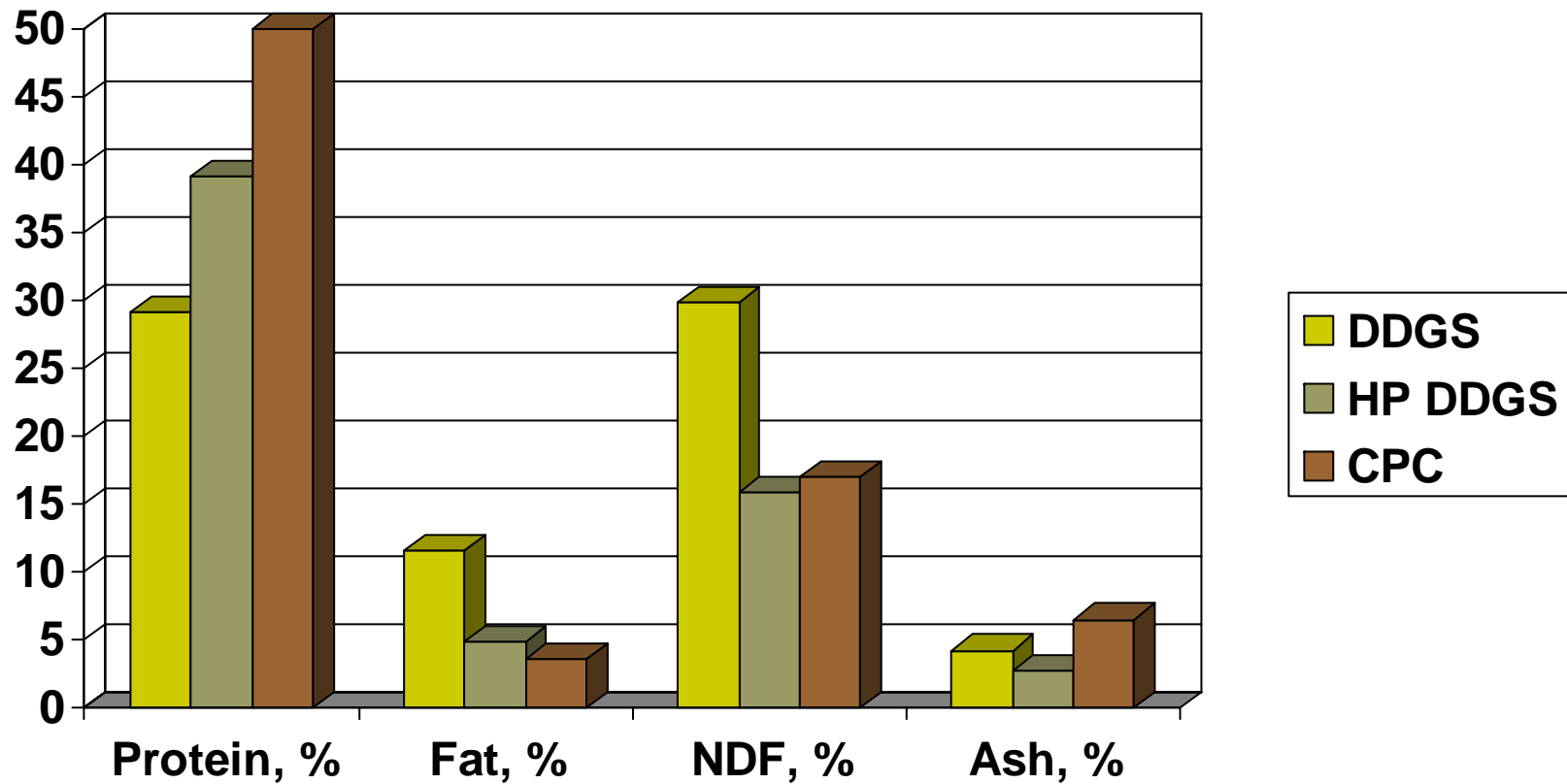


**Variation in Bulk Density (Lbs/Cubic Ft.) Among DDGS
Samples Representing 25 U.S. Ethanol Plants
1/05**

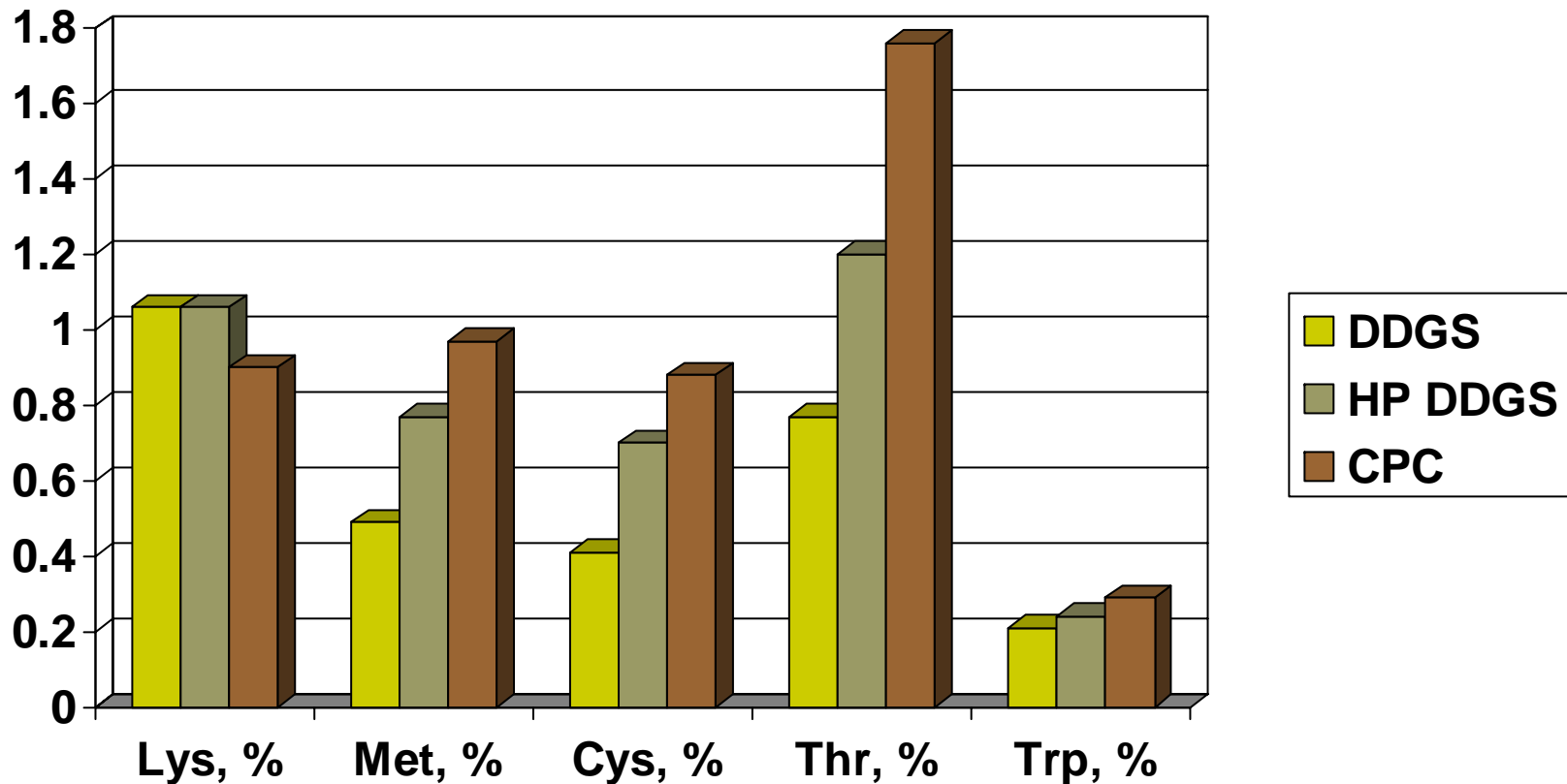


2. Understanding new corn distiller's by-products

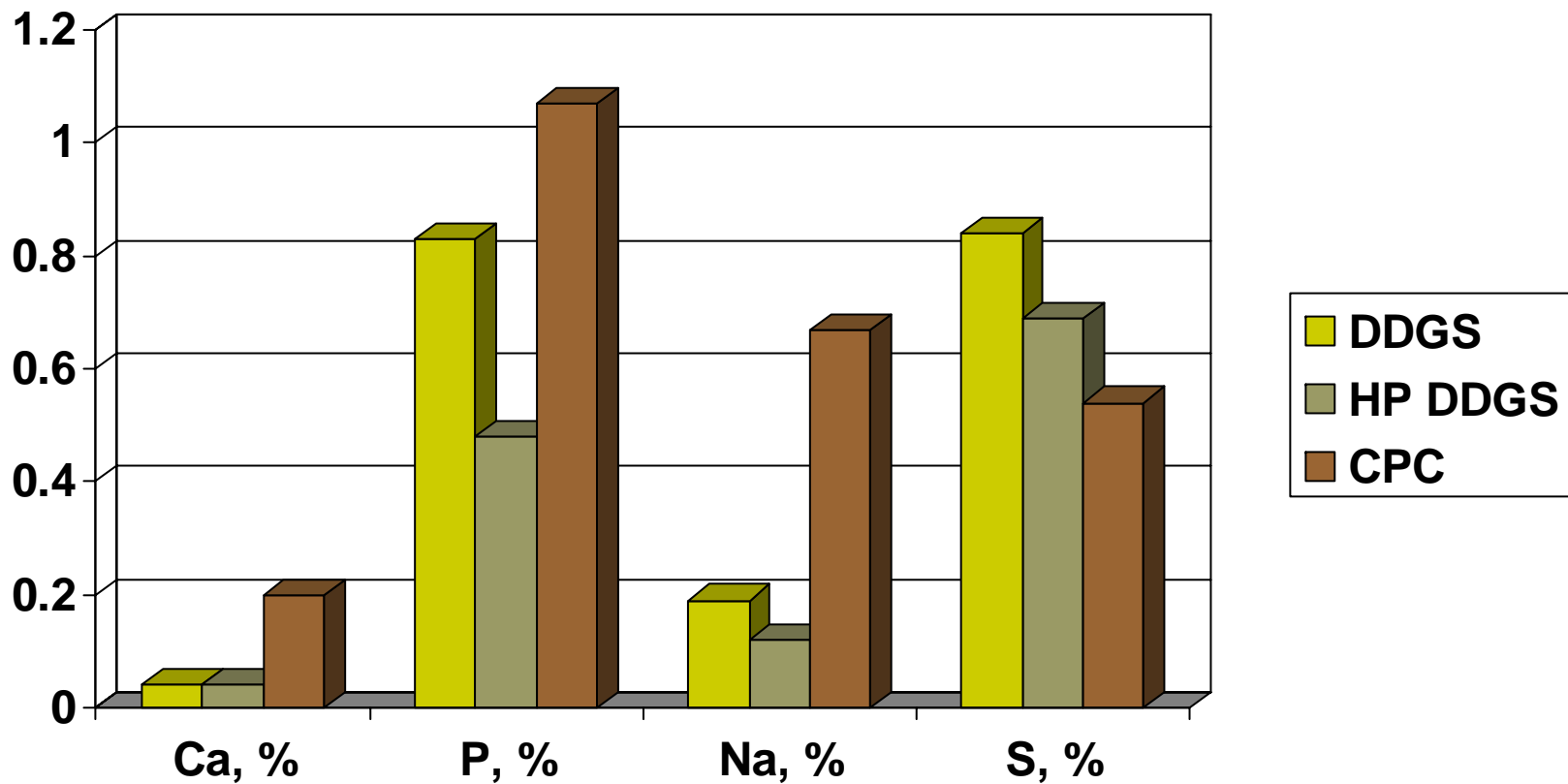
Comparison of Nutrient Content of Dakota Gold DDGS with High Protein Dakota Gold and Corn Protein Concentrate (100% DM Basis)



Comparison of Amino Acid Content of Dakota Gold DDGS with High Protein Dakota Gold and Corn Protein Concentrate (100% DM Basis)



Comparison of Mineral Content of Dakota Gold DDGS with High Protein Dakota Gold and Corn Protein Concentrate (100% DM Basis)



Opportunity Costs of Corn By-Products in Swine and Poultry Diets

	DDGS Spec. 1	DDGS Spec. 2	HP DDGS	CPC
Swine	\$80.00	\$78.00	\$51.00	\$61.60
Poultry	\$80.00	\$75.20	\$53.00	\$43.00



Product Flowability

- ❑ Particle size is sometimes too fine
- ❑ Difficult and costly to pellet
- ❑ Minimal cooling or “curing” time before loading
 - ❑ Extensive damage to trucks and rail cars





3. Lack of a Quality Grading System

- ❑ Difficult for buyers to differentiate quality and price
- ❑ Can be as much as \$20-\$30/ton price differential due to quality in the market
- ❑ “What you want isn’t always what you get”

Some of the Nutrient Variability is Due to the Use of Different Approved Laboratory Testing Procedures





4. Lack of Standardized Testing Procedures

- Different labs may use different procedures
 - variable results

- No referee laboratories have been established



Variability of Moisture Content from One DDGS Source Using Approved AOAC Lab Procedures

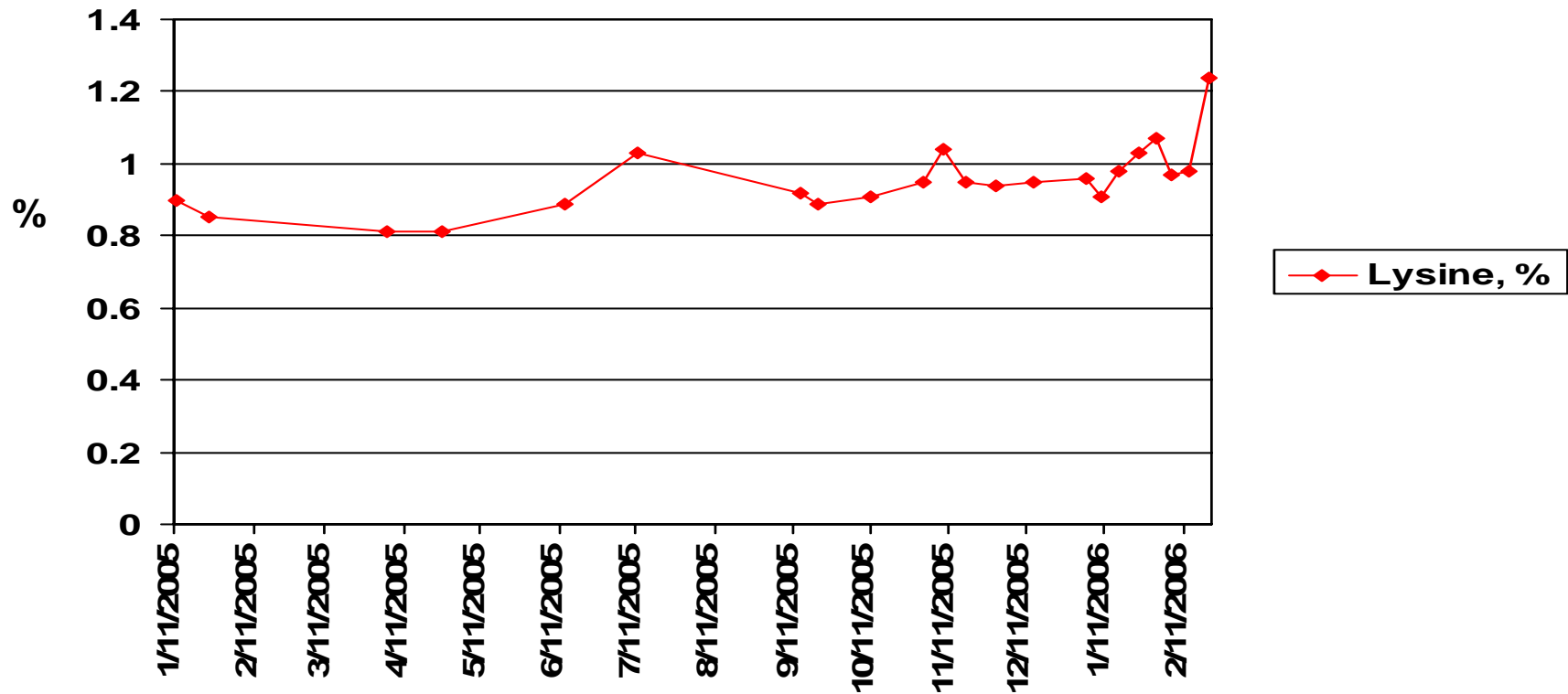
	Moisture (%)
Procedure 1	12.69
Procedure 2	10.48
Procedure 3	10.09
Procedure 4	10.64
Procedure 5	13.30
Procedure 6	12.60



5. Need for Quality Management and Certification

- Paradigm shift in parts of the ethanol industry toward improved DDGS quality and consistency
 - Implementation of DDGS Quality Assurance Programs
 - Many commercial feed mills are ISO 9000:2001 and HAACP Certified
 - EU – International Feed Ingredient Standard
 - GMP Certification
 - Transparency of information about the by-products produced
 - Aggressive sampling and nutrient analysis

Lysine Monitoring - Big River Resources 1/11/05 – 3/6/06 (100% DM Basis)





6. Need a High Degree of Research, Education, and Technical Support

- **Additional research** is needed to improve DDGS acceptance in the feed industry
- **High degree of education and technical support** is required in the market place



7. Quality Contaminants??

- Antimicrobials in ethanol production
 - Used to control bacterial (lactobacillus) contamination
 - Can increase ethanol yield by as much as 25%
 - Which ones are used?
 - Virginiamycin (0.25 to 2.0 ppm)
 - Penicillin (1 g/1000 liters)
 - Unique compared to forms used in animal feeds



7. Quality Contaminants??

- Antimicrobials in ethanol production
 - Virginiamycin
 - Does not affect yeast productivity
 - Does not remain in ethanol after distillation
 - Is destroyed at temperatures $> 93^{\circ}\text{C}$
 - Dryer temperatures range from 93 to 232°C
 - Is destroyed and there are no detectable residues in DDGS



7. Quality Contaminants??

- Antimicrobials in ethanol production
 - Penicillin
 - Most stable at pH 6.0 to 6.4
 - Half life of 14 days when in solution at 24° C
 - Easily inactivated by primary alcohols and some sugars
 - At pH of 4.5 or 9.0, rate of inactivation increases 10-fold
 - At pH 3.2 or 10.5, rate of inactivation increases 100-fold
 - Completely degraded at pH 3 and a temperature of 37° C for 30 minutes
 - No residues in DDGS



7. Quality Contaminants??

□ Mycotoxins

- If contaminated corn is used, concentrations of mycotoxins are concentrated 3x in DDGS
- ELISA tests for mycotoxins may give false positive results

□ Sulfur levels

- Range from 0.31 to 1.93%
- Variation partially due to use of sulfuric acid to clean fermenters



U of M DDGS Web Site

www.ddgs.umn.edu

We have developed a DDGS web site featuring:

- * nutrient profiles and photos of DDGS samples
- * research summaries
 - swine, poultry, dairy, & beef
 - DDGS quality
- * presentations given
- * links to other DDGS related web sites
- * international audiences