# Differences in Quality Characteristics Among U.S. DDGS Sources

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## Proximate Analysis and Energy Value Averages and Ranges Among 27 U.S. DDGS Sources (100% Dry Matter Basis)

| Nutrient | Average | Range |
|---|---|---|
| Dry matter, % | 89.3 | 87.3 – 92.4 |
| Crude protein, % | 31.0 | 28.7 – 32.9 |
| Fat, % | 10.6 | 8.8 – 12.4 |
| Fiber, % | 7.2 | 5.4 – 10.4 |
| Ash, % | 6.1 | 3.0 – 9.8 |
| ADF, % | 13.6 | 8.0 – 18.1 |
| Swine DE, kcal/kg | 4053 | 3737 – 4319 |
| Swine ME, kcal/kg | 3790 | 3504 – 4048 |

# Mineral Analysis Averages and Ranges Among 27 U.S. DDGS Sources (100% Dry Matter Basis)

| Nutrient | Average | Range |
|---|---|---|
| Ca, % | 0.08 | 0.02 – 0.12 |
| **P, %** | **0.75** | **0.42 – 0.99** |
| K, % | 0.96 | 0.45 – 1.27 |
| Mg, % | 0.29 | 0.14 – 0.38 |
| S, % | 0.62 | 0.34 – 1.05 |
| Na, % | 0.15 | 0.04 – 0.52 |
| Zn, ppm | 62 | 38 – 105 |
| Mn, ppm | 19 | 9 – 27 |
| Cu, ppm | 6 | 3 – 10 |
| Fe, ppm | 133 | 77 – 239 |

# Amino Acid Analysis Averages and Ranges Among 27 U.S. DDGS Sources (100% Dry Matter Basis)

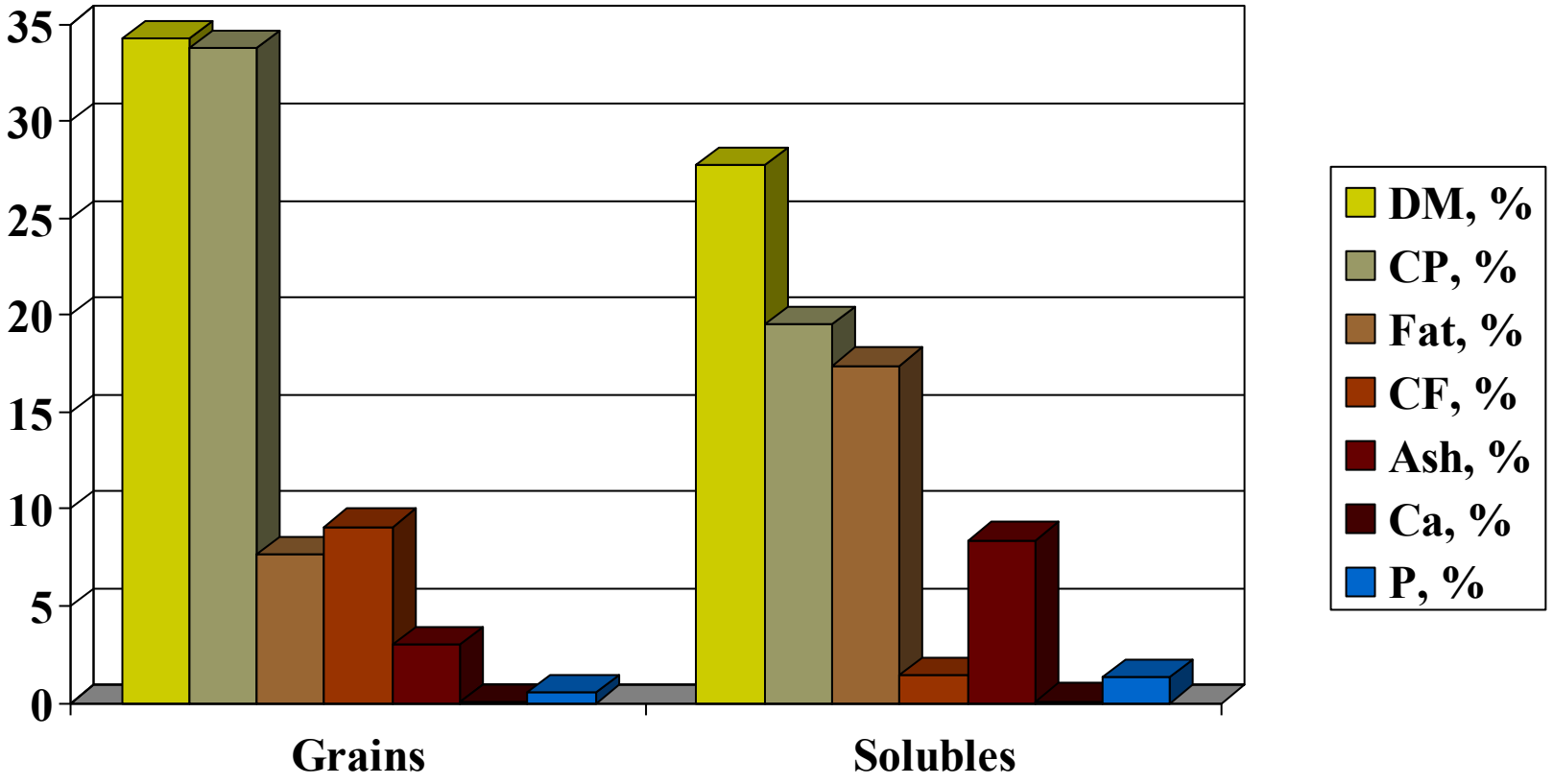
| Nutrient | Average | Range |
|---|---|---|
| Arg, % | 1.31 | 1.01 – 1.48 |
| His, % | 0.84 | 0.71 – 0.98 |
| Ile, % | 1.17 | 1.01 – 1.31 |
| Leu, % | 3.58 | 2.91 – 3.96 |
| **Lys, %** | **0.89** | **0.61 – 1.06** |
| **Met, %** | **0.65** | **0.54 – 0.76** |
| Cys, % | 0.68 | 0.61 – 0.76 |
| Phe, % | 1.51 | 1.36 – 1.72 |
| **Thr, %** | **1.15** | **1.01 – 1.28** |
| **Trp, %** | **0.25** | **0.18 – 0.28** |
| Val, % | 1.58 | 1.31 – 1.80 |

# Comparison of Nutrient Composition of Golden DDGS to Other "DDGS Sources" (100% Dry Matter Basis)

| | Golden Corn DDGS | Solulac | Badger State Ethanol | ADM - Peoria | Extruded DDGS/Soy (XDS Plus) | AGP Pelleted |
|---|---|---|---|---|---|---|
| Protein, % | 31.82 | 29.32 | 31.62 | 30.12 | 34.44 | 27.0 |
| Fat, % | 11.32 | 3.52 | 15.25 | 8.96 | 13.33 | 9.00 |
| Crude fiber, % | 6.25 | 7.90 | No data | 7.77 | 7.78 | 15.10 |
| ADF, % | 12.37 | 11.80 | 17.91 | 20.95 | 14.44 | No data |
| Ash, % | 6.93 | 5.29 | 4.58 | 7.30 | 5.56 | 4.28 |
| DE, kcal/kg* | 4053 | 3808 | No data | 3796 | No data | No data |
| ME, kcal/kg* | 3781 | 3577 | No data | 3560 | 3749 | No data |
| Lys, % | 0.92 | 0.61 | 0.90 | 0.83 | 1.67 | No data |
| Met, % | 0.62 | 0.54 | 0.54 | 0.66 | 0.61 | No data |
| Thr, % | 1.17 | 1.01 | 1.04 | 1.13 | 2.50 | No data |
| Trp, % | 0.25 | 0.18 | 0.23 | 0.25 | 0.39 | No data |
| Ca, % | 0.07 | 0.12 | 0.06 | 0.51 | 0.22 | 0.17 |
| P, % | 0.77 | 0.78 | 0.89 | 0.68 | 0.72 | 0.62 |

*Calculated energy values for

# Comparison of the Nutrient Content of Corn Distiller's Grains and Corn Condensed Distiller's Solubles



# Variability of Results from AOAC Approved Testing 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 |

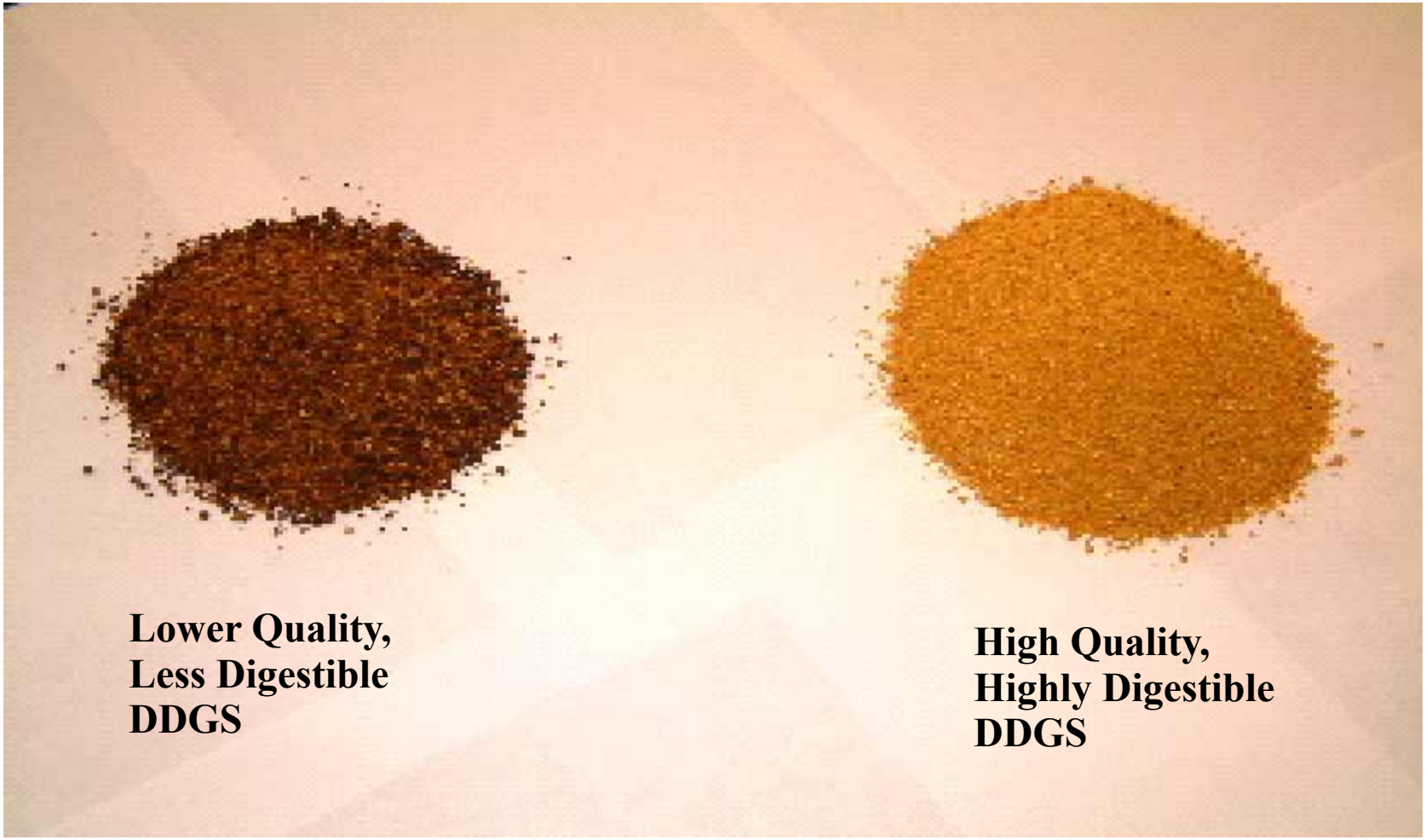
# Quality Assessment of "New Generation" DDGS

- Color
- Smell
- Bulk density
- Particle size
- NIR
- Mycotoxins
- Fat stability

# Corn DDGS Color and Smell are Indicators of Amino Acid Digestibility for Monogastrics

- **Color varies among sources**
  - ranges from dark to golden **(Cromwell et al., 1993)**
  - golden color of corn DDGS is correlated with higher amino acid digestibility in swine and poultry
- **Smell varies among sources**
  - ranges from burnt or smoky to sweet and fermented **(Cromwell et al., 1993)**
  - golden DDGS has a sweet, fermented smell
  - smell may affect palatability

# Color Extremes of DDGS



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

# Samples of Golden Corn DDGS from Various Midwestern U.S. Ethanol Plants

VeraSun - Aurora, SD

CVEC - Benson, MN

Al-Corn - Claremont, MN

MGP – Lakota, IA

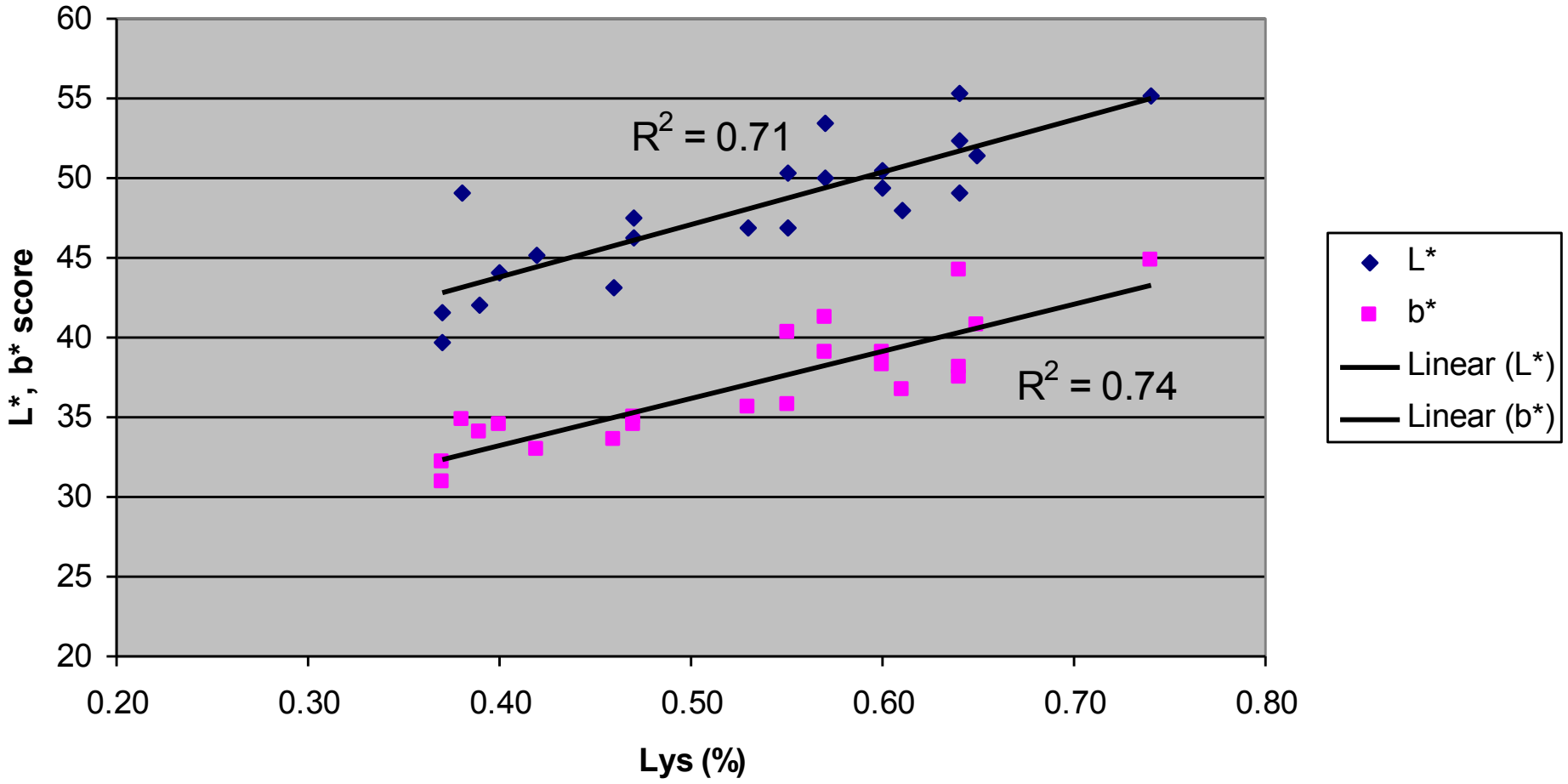
CMEC - Little Falls, MN

Agri-Energy - Luverne, MN

LSCP - Marcus, IA

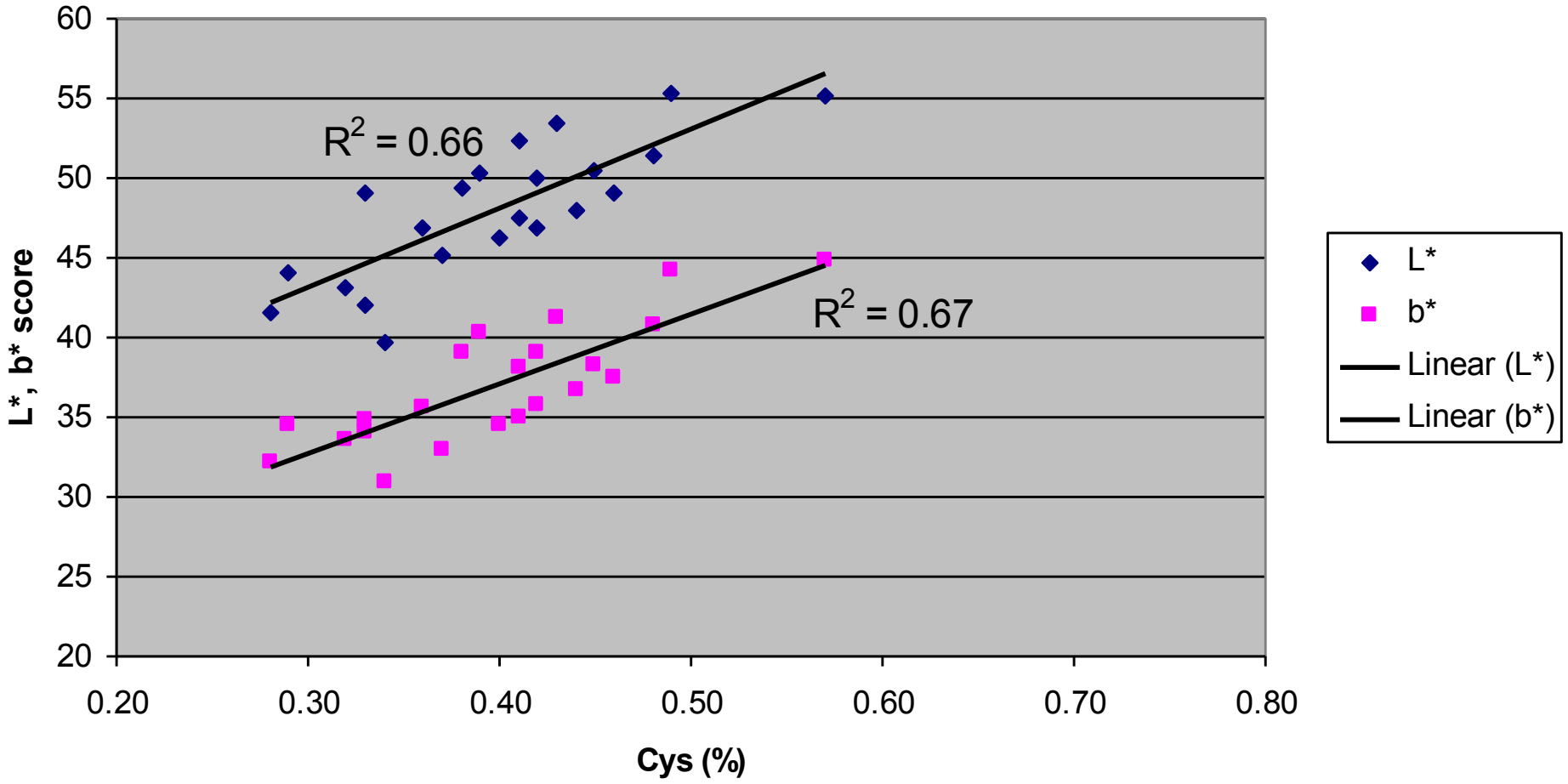
DENCO – Morris, MN

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



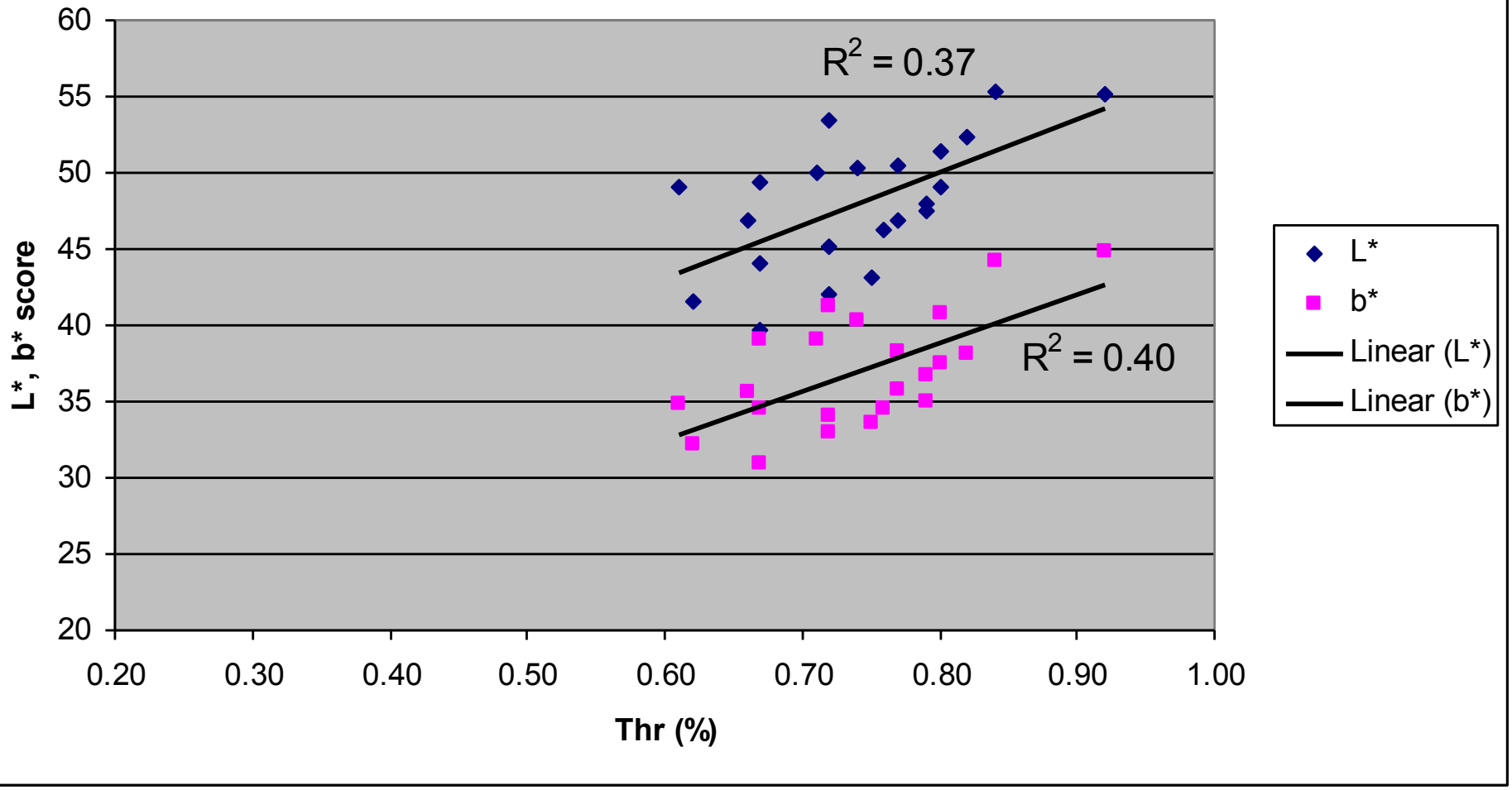

Source: Dr. Sally Noll (2003)

## Fig. 2. Regression of digestible cys (%) and color (L*, b*)




Source: Dr. Sally Noll (2003)

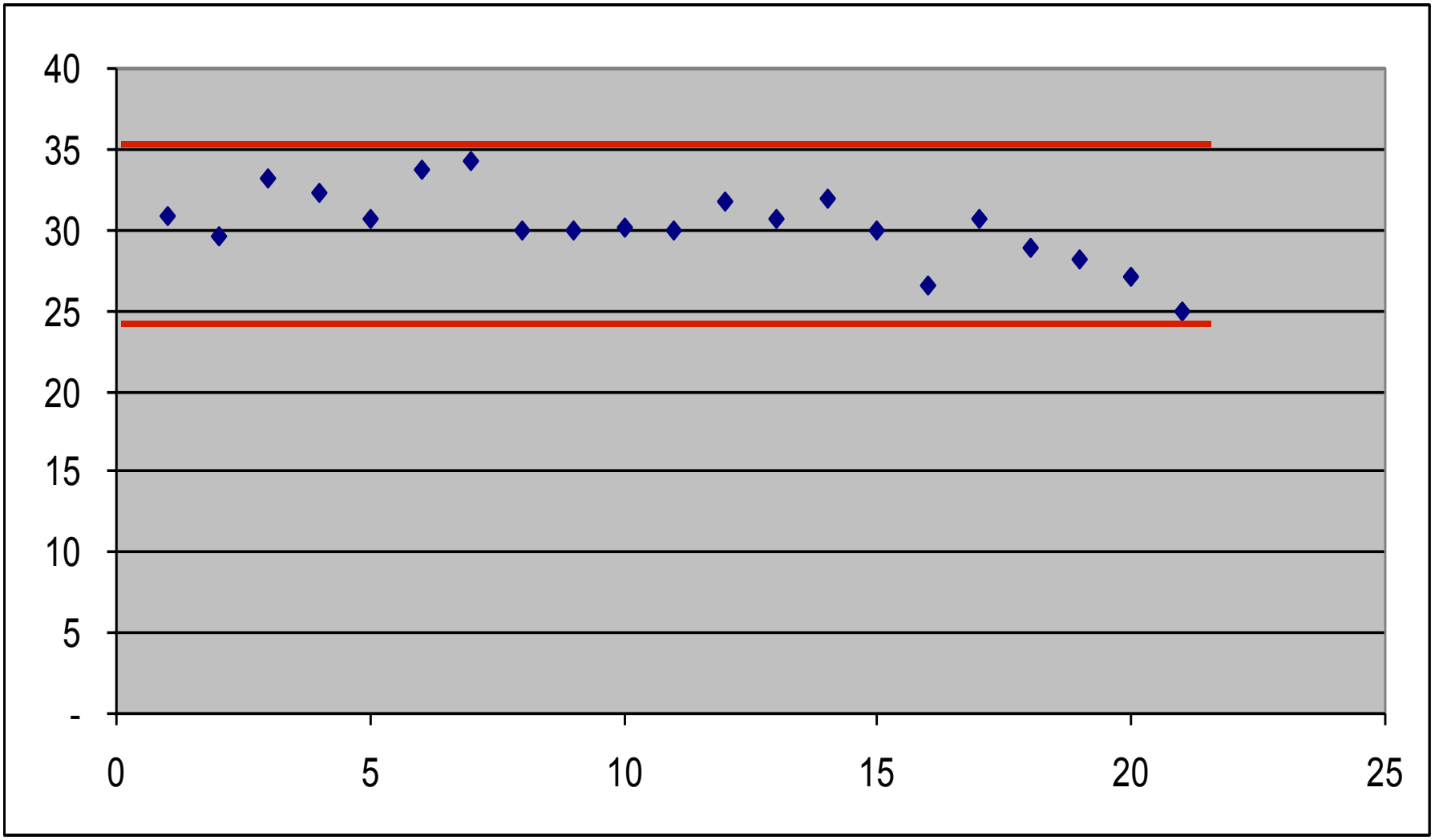
**Fig. 3. Regression of digestible thr (%) and color (L*, b*)**



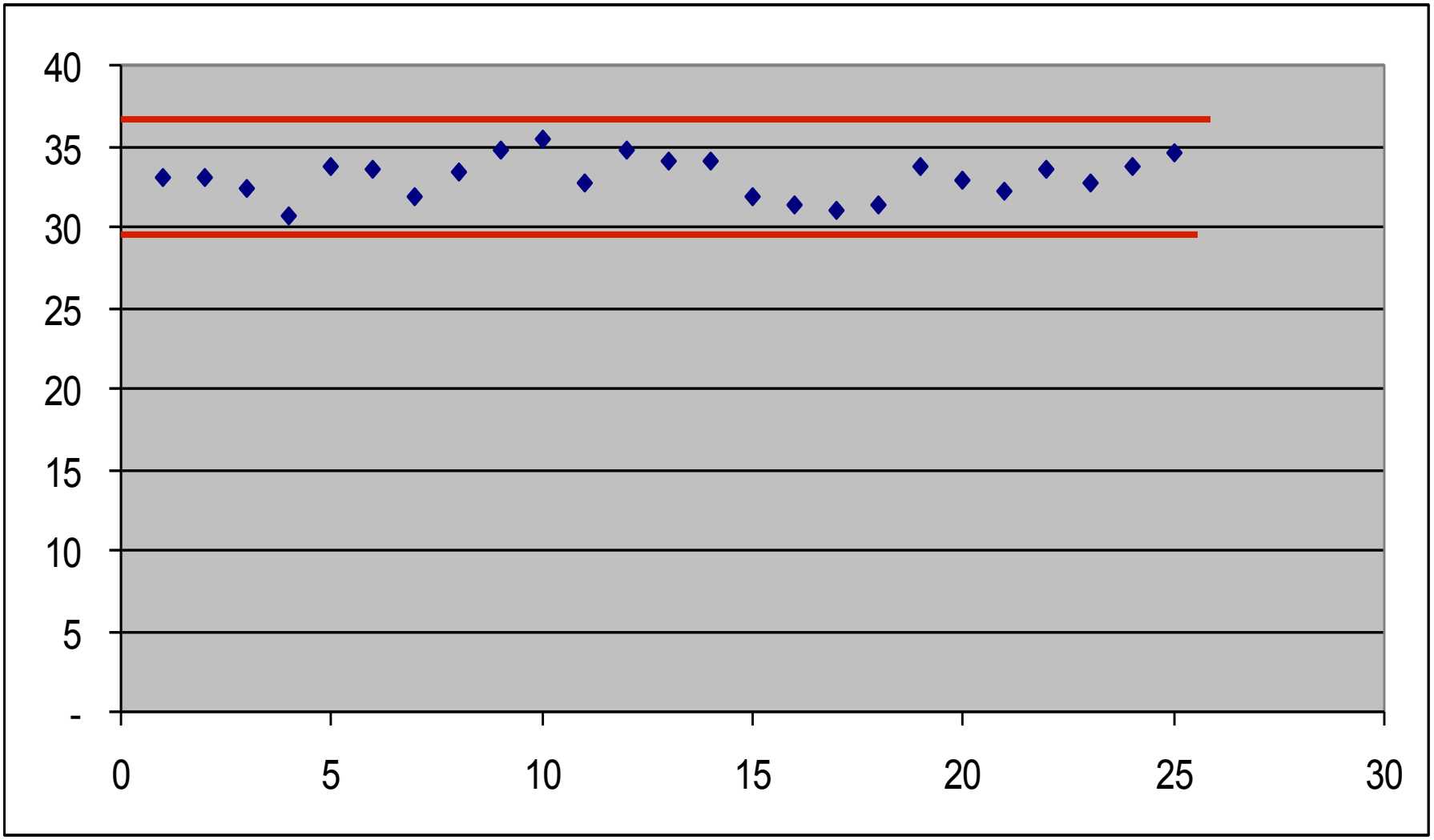

Source: Dr. Sally Noll (2003)

# Variability (CV, %) of Selected Nutrients Among U.S. DDGS Sources vs. U.S. Soybean Meal Sources

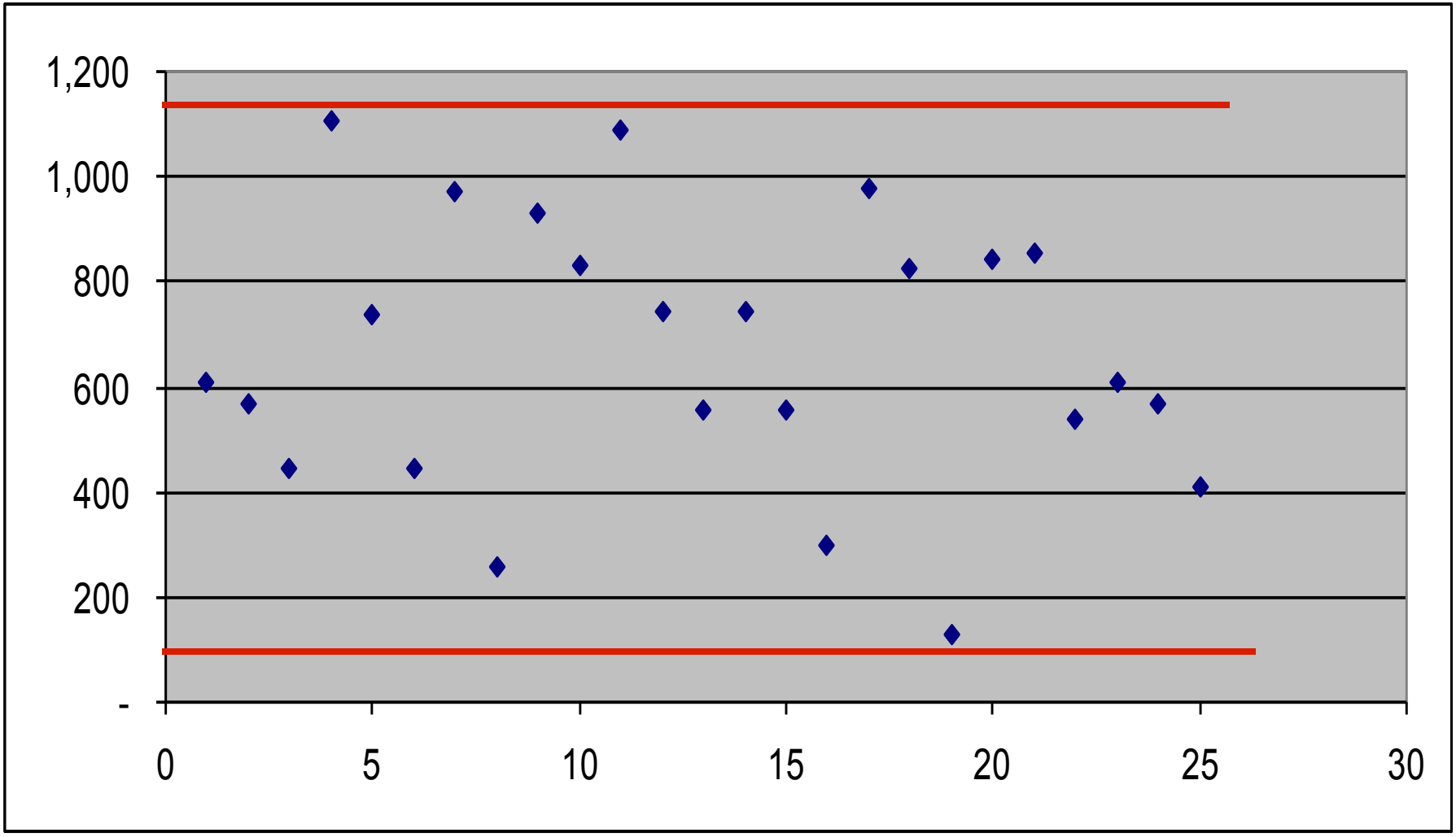
| Nutrient | DDGS | Soybean Meal |
|---|---|---|
| Crude protein | 4.5 | 2.3 |
| Crude fat | 17.1 | 30.9 |
| Crude fiber | 18.9 | 9.5 |
| Ash | 27.2 | 6.6 |
| Lysine | 12.1 | 3.0 |
| Methionine | 8.5 | 5.3 |
| Threonine | 5.8 | 4.2 |
| Tryptophan | 12.0 | 7.3 |
| Calcium | 117.5 | 25.8 |
| Phosphorus | 19.4 | 9.1 |



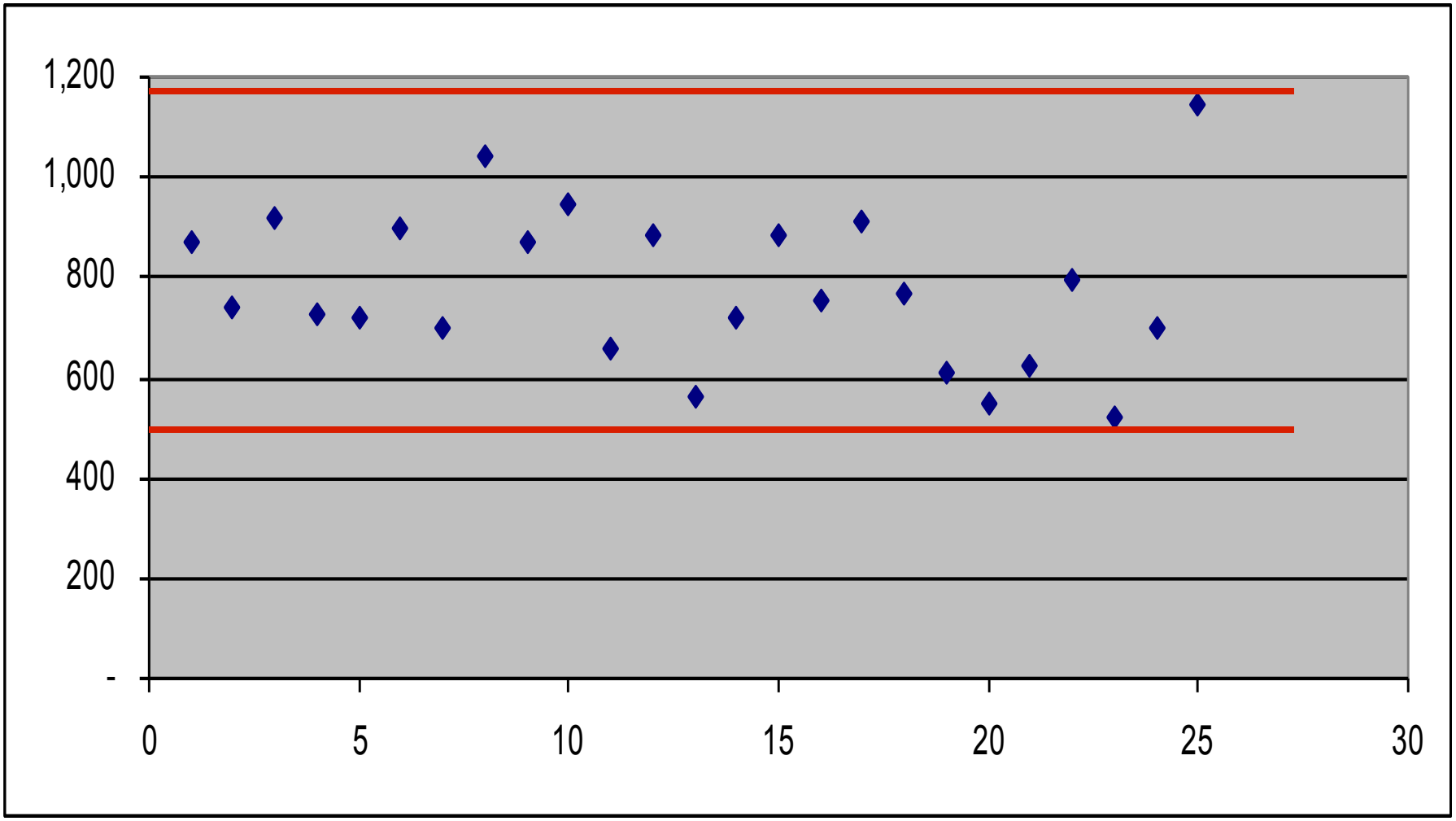

**Variation in Bulk Density (Lbs/Cubic Ft.) Among DDGS Samples Representing 25 U.S. Ethanol Plants**




**Variation in Bulk Density (Lbs/Cubic Ft.) Among Soybean Meal Samples Representing 6 U.S. Plants**

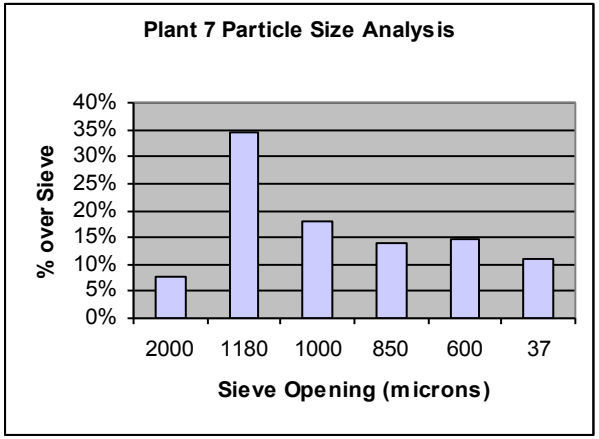



**Variation in Particle Size Among DDGS Samples Representing 25 U.S. Ethanol Plants**

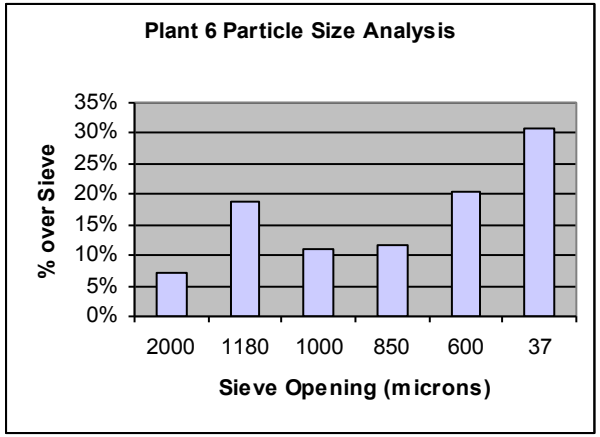



**Variation in Particle Size Among Soybean Meal Samples Representing 6 U.S. Plants**

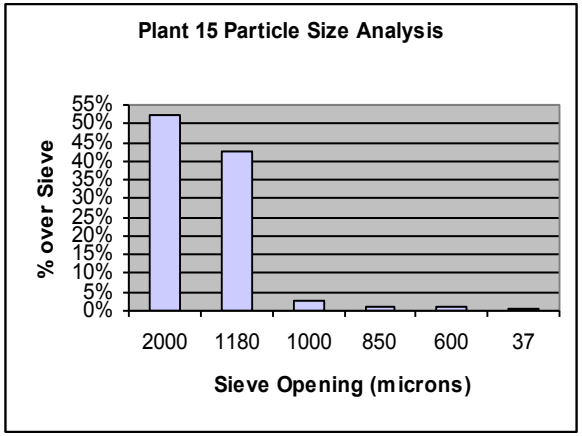
# Examples of Particle Size Distribution of "New Generation" DDGS




Typical




Lowest Avg. Particle Size




Highest Avg. Particle Size

# NIR Calibrations for DDGS

| Nutrient | R | Rmsep,% | $R^2$ | CV,% |
|---|---|---|---|---|
| Lysine | 0.89 | 0.064 | .79 | 16.2 |
| Methionine | 0.81 | 0.044 | .66 | 14.2 |
| Threonine | 0.73 | 0.046 | .53 | 6.2 |
| Energy | 0.87 | 37 | .76 | 1.9 |

R = correlation between actual and predicted values
Rmsep = prediction error
$R^2$ = proportion of the total variation explained by calibrations
CV, % = coefficient of variation among DDGS samples

# Mycotoxins

- Incidence of mycotoxin contamination of DDGS from upper Midwest ethanol plants is low
  - Poor quality corn = poor ethanol yields
  - Corn supplied from a relatively small geographic region
  - Corn produced in upper Midwest is generally lower risk for mycotoxins
- Must use thin layer chromatography (TLC) or HPLC for analyzing DDGS
  - ELISA and other methods result in false positives

# Fat Stability of DDGS

- Limited data
- Mexico
  - DDGS monitored during transit and storage for 16 weeks in a commercial feed mill in Jalisco, Mexico
    - Temperature ranged from 2 to 28 degrees C
    - Average high temperature 25 degrees C
    - Average low temperature was 8.4 degrees C
  - No rancidity was detectable

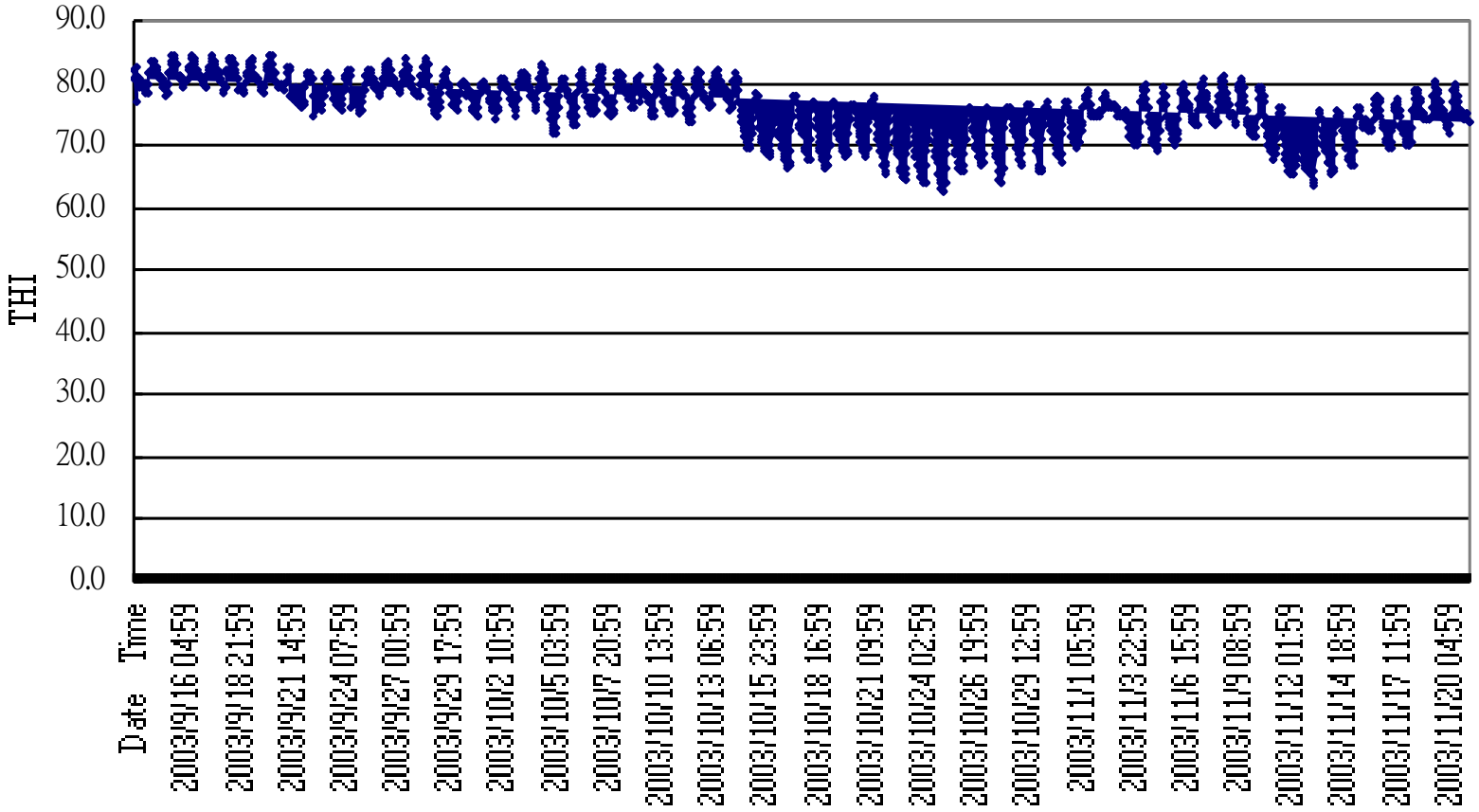
# Fat Stability of DDGS in Taiwan

- Study conducted at Lin-Fong-Ying Dairy Farm
  - a commercial dairy farm located about 20 km south of the Tropic of Cancer
  - DDGS was shipped from Watertown, SD to Taiwan in a 40 ft. container
  - upon arrival in Taiwan, DDGS was re-packaged in 50 kg feed bags with a plastic lining
  - DDGS bags were stored in a covered steel pole barn for 10 weeks during the course of the dairy feeding trial

Dr. Yuan-Kuo Chen discussing DDGS sampling procedures from storage bags with his research assistant.


Inside of the covered, steel pole barn used to store bags of DDGS and other forage and feed ingredients at LFY Dairy.

# Temperature-Humidity-Index (THI) During the Taiwan DDGS Fat Stability Trial



# Fat Stability of DDGS in Taiwan

| Analysis | Week 1 | Week 10 |
|---|---|---|
| Peroxide value, mEq/kg | 0.70 | 0.60 |
| Free fatty acids, % as oleic | 11.2 | 16.2 |

**Peroxide values < 5 mEq/kg are considered acceptable for fat quality and there is no oxidative rancidity.**