Overview of Production, Nutrient Profile, Physical Characteristics, and Quality Assessment of "New Generation" DDGS

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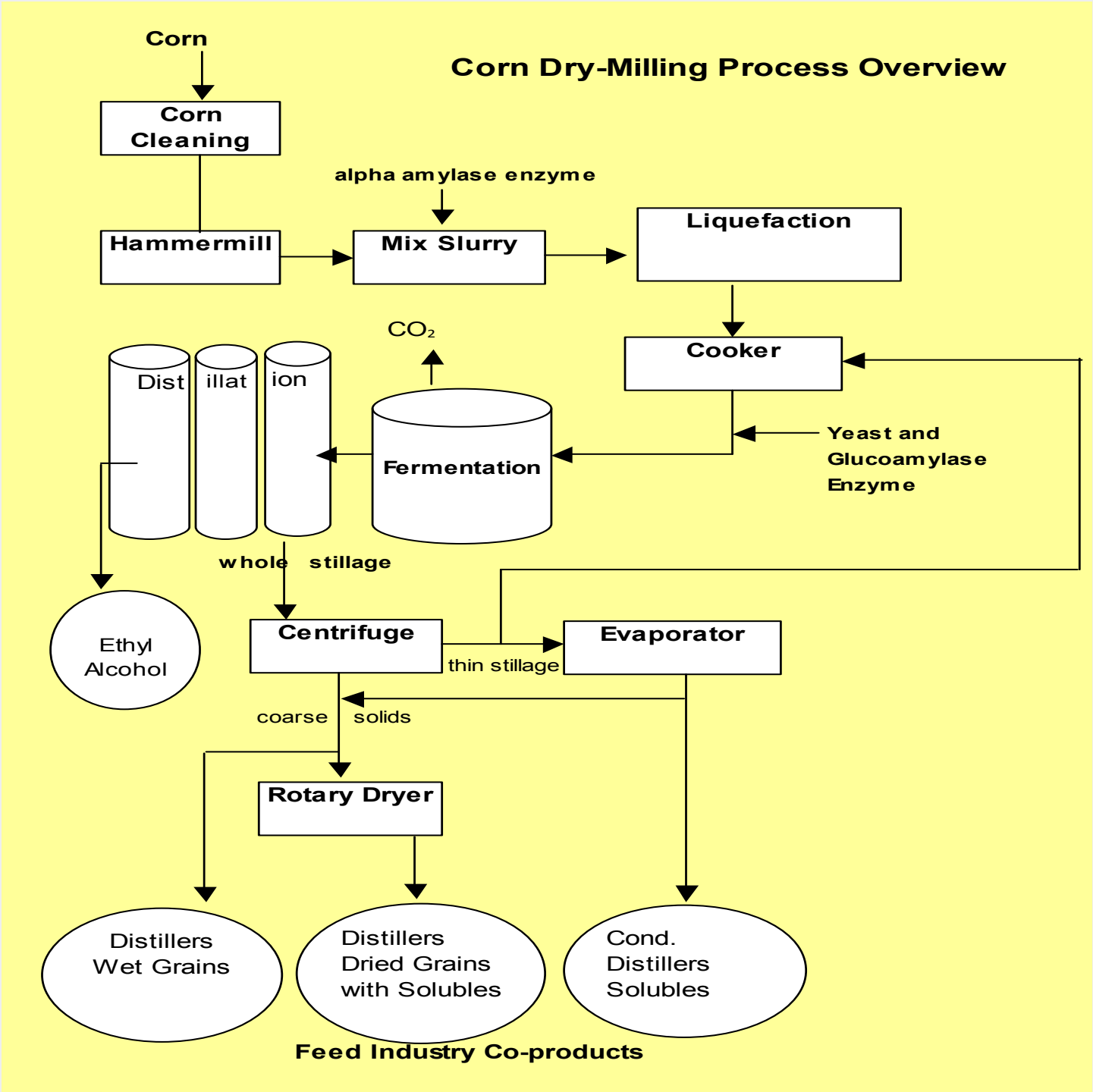
What is DDGS?

- Co-product of the dry-milling ethanol industry
  - Corn (maize) DDGS - Midwestern US
  - Wheat DDGS - Canada
  - Sorghum (milo) DDGS - Great Plains US
  - Barley DDGS
  - Rye DDGS
- DDGS is nutritionally DIFFERENT than other grain co-products

Comparison of Nutrient Composition (Dry Matter Basis) of "New Generation" DDGS to Corn Gluten Feed, Corn Gluten Meal, Corn Germ Meal, and Brewer's Dried Grains

	"New Generation" DDGS (UM)	Corn Gluten Feed (NRC)	Corn Gluten Meal (NRC)	Corn Germ Meal (Feedstuffs)	Brewer's Dried Grains (NRC)
Protein, %	30.6	23.9	66.9	22.2	28.8
Fat, %	***10.7***	3.3	3.2	1.1	7.9
NDF, %	43.6	37.0	9.7	No data	52.9
DE, kcal/kg	***4011***	3322	4694	No data	2283
ME, kcal/kg	***3827***	2894	4256	3222	2130
Lys, %	0.83	0.70	1.13	1.00	1.17
Met, %	0.55	0.39	1.59	0.67	0.49
Thr, %	1.13	0.82	2.31	1.22	1.03
Trp, %	0.24	0.08	0.34	0.22	0.28
Ca, %	0.06	0.24	0.06	0.33	0.35
Available P, %	***0.80***	0.54	0.08	0.17	0.21


Corn
Corn Dry-Milling Process Overview
Corn Cleaning
alpha amylase enzyme
Hammermill
Mix Slurry
Liquefaction
Cooker
CO_2
Dist
illat
ion
Fermentation
Yeast and Glucoamylase Enzyme
whole stillage
Ethyl Alcohol
Centrifuge
thin stillage
Evaporator
coarse solids
Rotary Dryer
Distillers Wet Grains
Distillers Dried Grains with Solubles
Cond. Distillers Solubles
Feed Industry Co-products

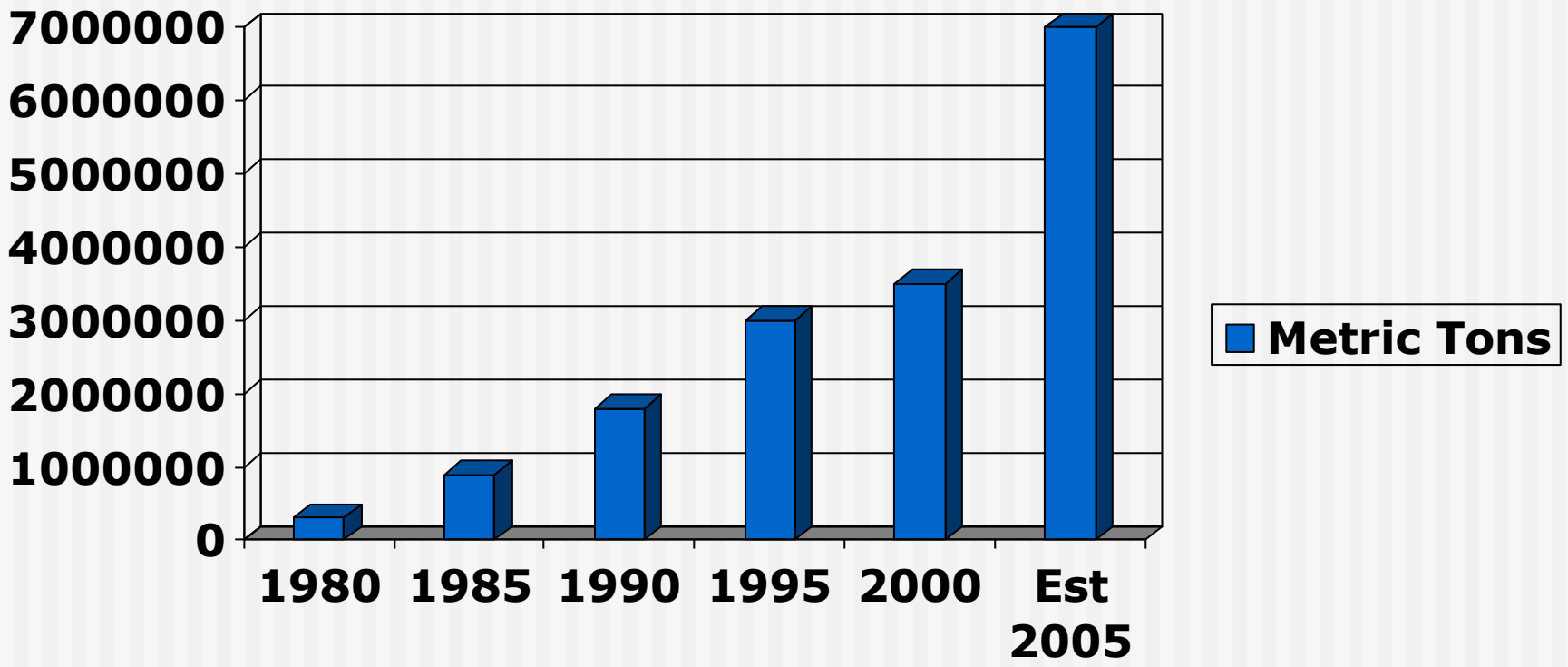
Dry-Milling Average Ethanol Yield Per Bushel (25.4 kg) of Corn

- Ethanol 10.2 liters
- DDGS 8.2 kg
- CO_2 8.2 kg

Slide courtesy of Ms. Kelly Davis, CVEC, Benson, MN

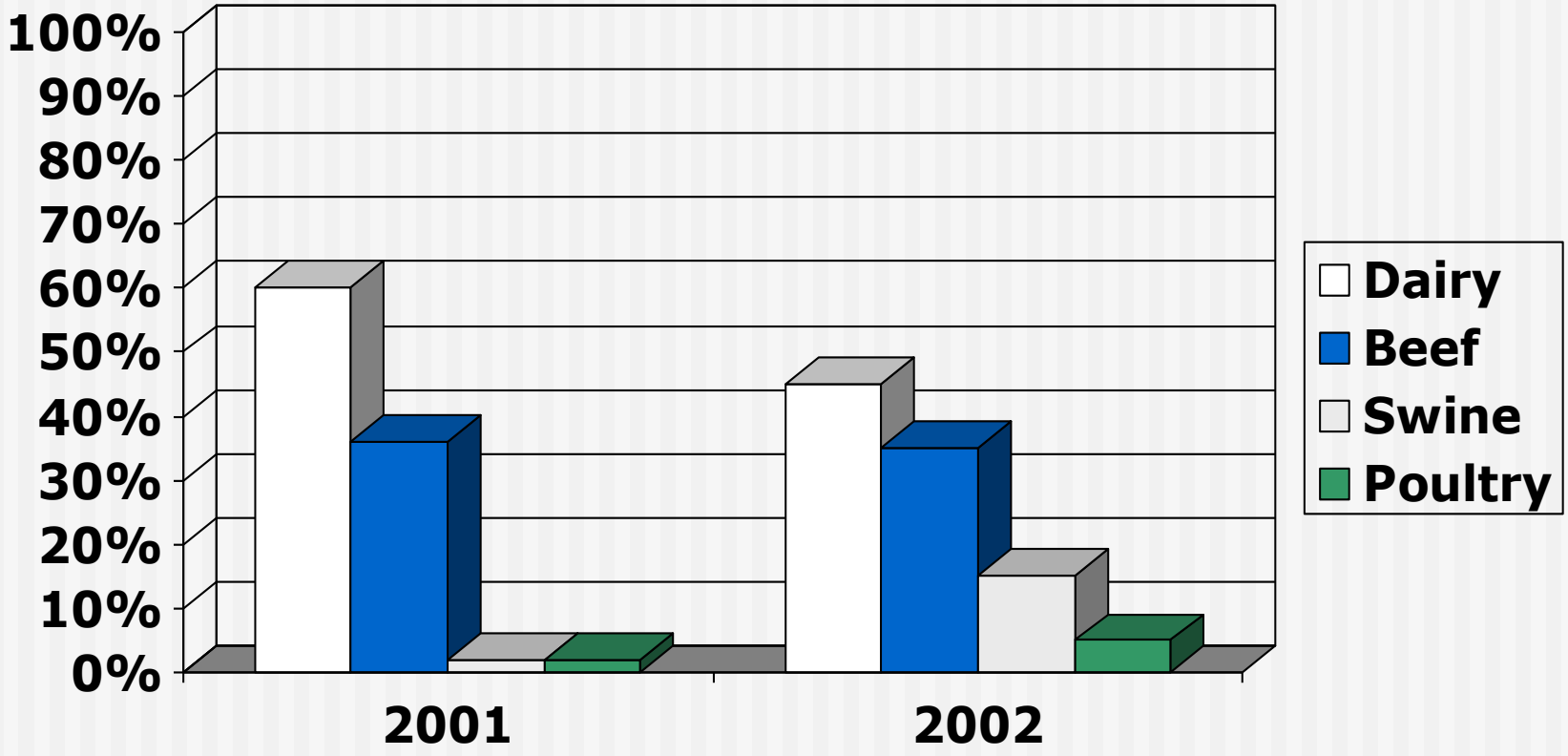
Most Fuel Ethanol Production is in the Western U.S. “Corn Belt”

North American DDGS Production



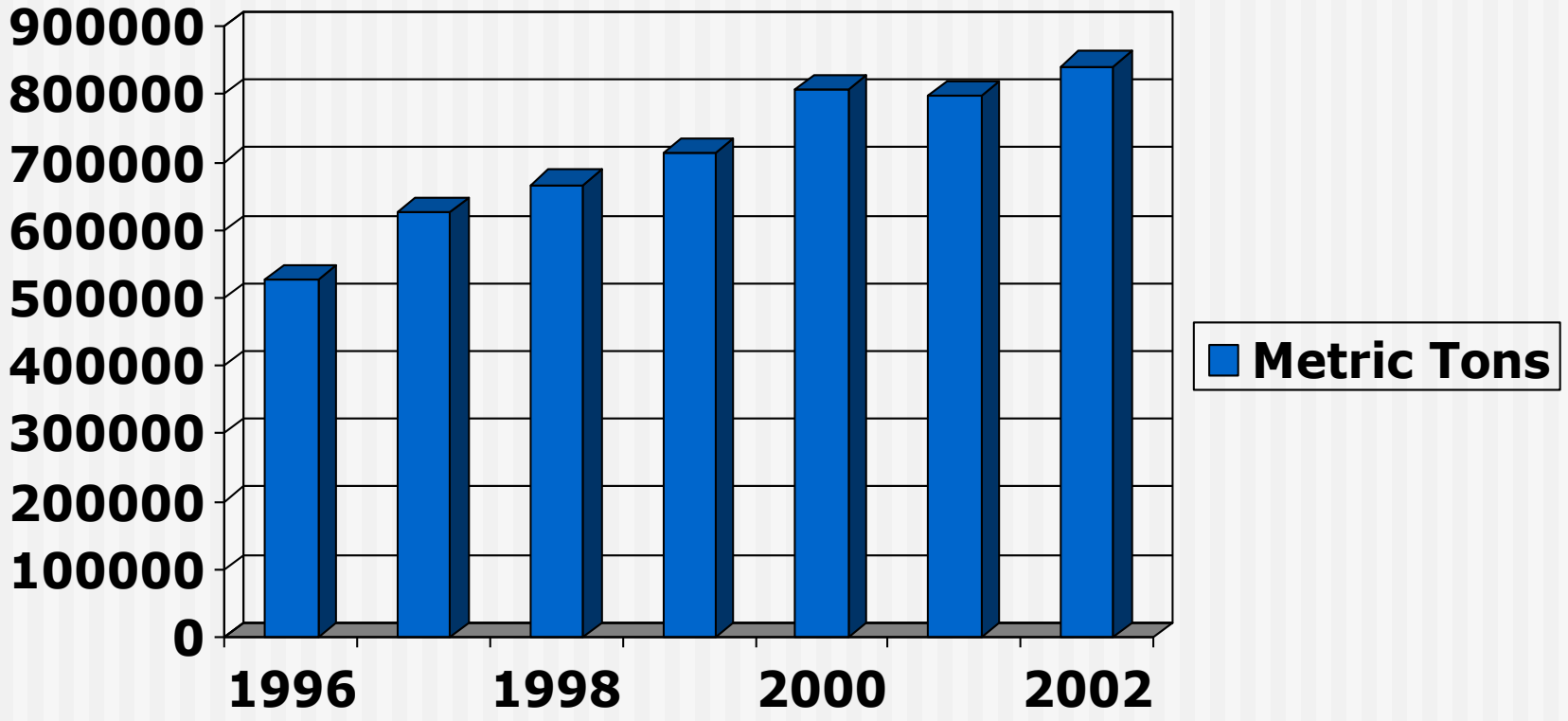
Source: Commodity Specialists Company

Estimated North American DDGS Consumption in 2001 & 2002



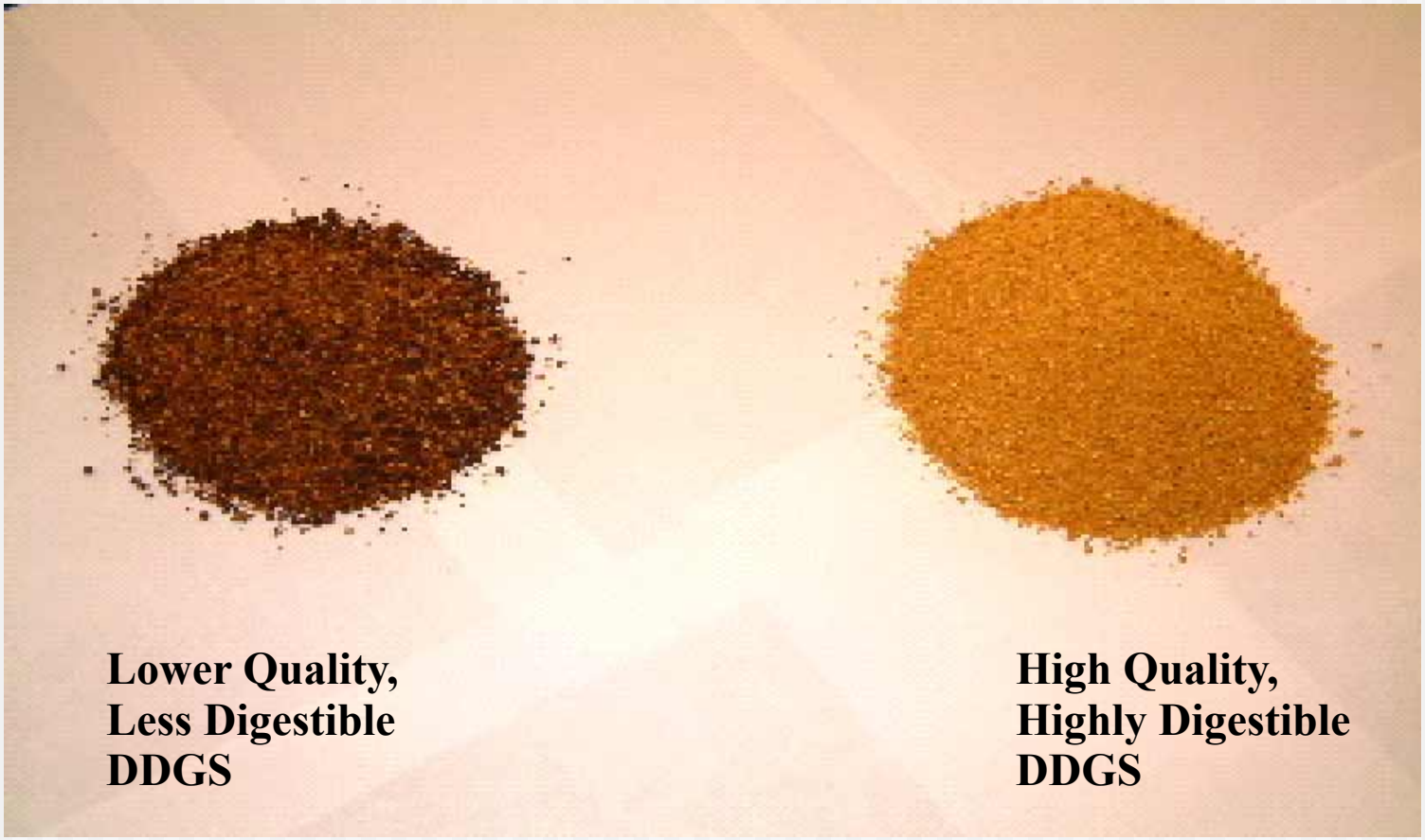
Source: Commodity Specialists Company

North American DDGS Exports



Source: Commodity Specialists Company

“New Generation” vs. “Old Generation” DDGS



Comparison of Proximate Analysis of "New Generation" DDGS vs. NRC (1998) (100% Dry Matter Basis)

Nutrient	"New Generation" DDGS	NRC (1998)
Dry matter, %	88.9 (1.7)	93.0
Crude protein, %	30.2 (6.4)	29.8
Fat, %	10.9 (7.8)	9.0
Crude fiber, %	8.8 (8.7)	4.8
Ash, %	5.8 (14.7)	No data
NFE, %	44.5 (6.1)	No data
ADF, %	16.2 (28.4)	17.5
NDF, %	42.1 (14.3)	37.2

Values in ( ) are CV's among plants

Comparison of Energy Values of DDGS for Swine (88% DM Basis)

	"New" DDGS Calculated	"New" DDGS Trial avg.	"Old" DDGS Calculated	DDGS NRC (1998)
DE, kcal/kg	3488 Range 3418-3537	3528 Range 2975-4086	3409	3449
ME, kcal/kg	3162 Range 3087-3215	3367 Range 2820-3916	3098	2672

Corn (NRC, 1998): DE (kcal/kg) = 3484
ME (kcal/kg) = 3382

Comparison of Amino Acid Composition of DDGS (88% dry matter basis)

	"New" DDGS	"Old" DDGS	DDGS (NRC, 1998)
Lysine, %	0.75 (17.3)	0.47 (26.5)	0.59
Methionine, %	0.63 (13.6)	0.44 (4.5)	0.48
Threonine, %	0.99 (6.4)	0.86 (7.3)	0.89
Tryptophan, %	0.22 (6.7)	0.17 (19.8)	0.24
Valine, %	1.32 (7.2)	1.22 (2.3)	1.23
Arginine, %	1.06 (9.1)	0.81 (18.7)	1.07
Histidine, %	0.67 (7.8)	0.54 (15.2)	0.65
Leucine, %	3.12 (6.4)	2.61 (12.4)	2.43
Isoleucine, %	0.99 (8.7)	0.88 (9.1)	0.98
Phenylalanine, %	1.29 (6.6)	1.12 (8.1)	1.27

Values in ( ) are CV's among plants

Comparison of Apparent Ileal Digestible Amino Acid Composition of DDGS for Swine (88% dry matter basis)

	"New" DDGS	"Old" DDGS	DDGS (NRC, 1998)
Lysine, %	0.39	0.00	0.27
Methionine, %	0.28	0.21	0.34
Threonine, %	0.55	0.32	0.49
Tryptophan, %	0.13	0.13	0.12
Valine, %	0.81	0.45	0.77
Arginine, %	0.79	0.53	0.77
Histidine, %	0.45	0.26	0.40
Leucine, %	2.26	1.62	1.85
Isoleucine, %	0.63	0.37	0.64
Phenylalanine, %	0.78	0.60	0.96

Comparison of Phosphorus Level and Relative Availability of DDGS for Swine (88% dry matter basis)

	"New" DDGS	"Old" DDGS	DDGS NRC (1998)	Corn NRC (1998)
Total P, %	0.78 Range 0.62-0.87	0.79	0.73	0.25
P Availability, %	90 Range 88-92	No data	77	14
Available P, %	0.70	No data	0.56	0.03

Comparison of Mineral Analysis of "New Generation" DDGS, "Old Generation" DDGS, and NRC (1998) (100% Dry Matter Basis)

Mineral	"New Generation" DDGS	"Old Generation" DDGS	NRC (1998)
Ca, %	0.06 (57.2)	0.44	0.22
P, %	0.89 (11.7)	0.90	0.83
K, %	0.94 (14.0)	0.99	0.90
Mg, %	0.33 (12.1)	0.40	0.20
S, %	0.47 (37.1)	0.51	0.32
Na, %	0.24 (70.5)	0.28	0.27
Zn, ppm	98 (80)	80	86
Mn, ppm	16 (33)	50	26
Cu, ppm	6 (20)	14	61
Fe, ppm	120 (41)	219	276

Values in ( ) are CV's among plants

Comparison of Energy Values of DDGS for Poultry (88% DM Basis)

	"New Generation" DDGS	NRC (1994)
AME, kcal/kg	2260 Range 2090-2418	2480
TME, kcal/kg	2850 Range 2650 - 3082	3097

Source: Noll and Parsons. 2003. Unpublished data.

True Digestible Amino Acid Levels of Corn DDGS for Poultry (5 Sources)

Amino acid	True Dig. Amino Acid, %	Average	Digestibility Coefficient, %	Average
Methionine	0.35 – 0.53	0.43	86 - 90	88
Cystine	0.28 – 0.57	0.40	66 - 85	76
Lysine	0.37 – 0.74	0.53	59 - 83	71
Arginine	0.73 – 1.18	0.93	80 - 90	86
Tryptophan	0.14 – 0.21	0.18	76 - 87	82
Threonine	0.61 – 0.92	0.74	67 - 81	75

Source: Noll and Parsons. 2003. Unpublished data.

Comparison of Phosphorus Level and Relative Availability of DDGS for Poultry
(88% dry matter basis)

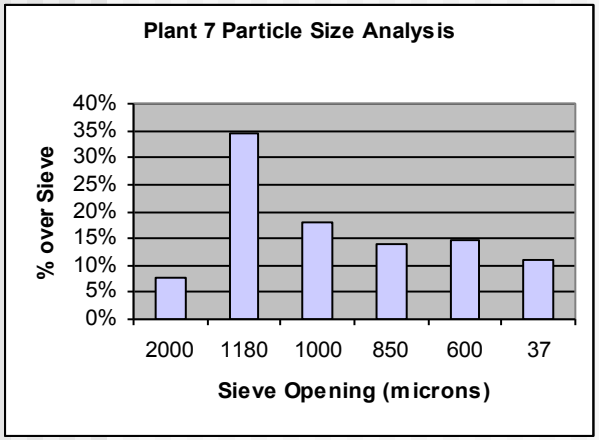
	"New Generation" DDGS	NRC (1994)
Total P, %	0.74	0.72
P Availability, %	61 Range 54 - 68	54
Available P, %	0.45	0.39

Source: 2003 Lumpkins, Dale, and Batal, University of Georgia. Abstract.

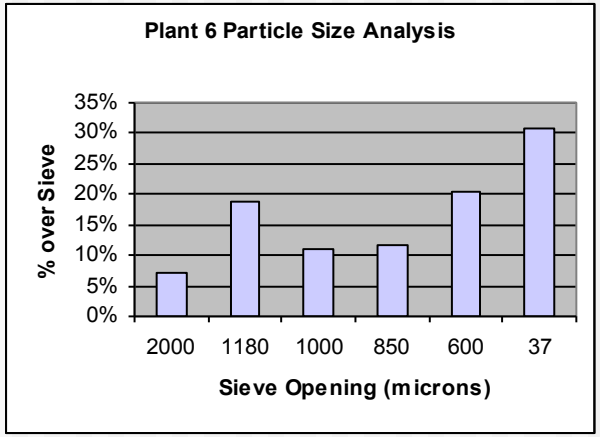
Physical Characteristics of "New Generation" DDGS

- Bulk density (16 "new generation" plants)
  - 35.7± 2.79 lbs/ft^3
  - Range 30.8 to 39.3 lbs/ft^3
- Particle size (16 "new generation" plants)
  - 1282± 305 microns
  - Range 612 to 2125 microns

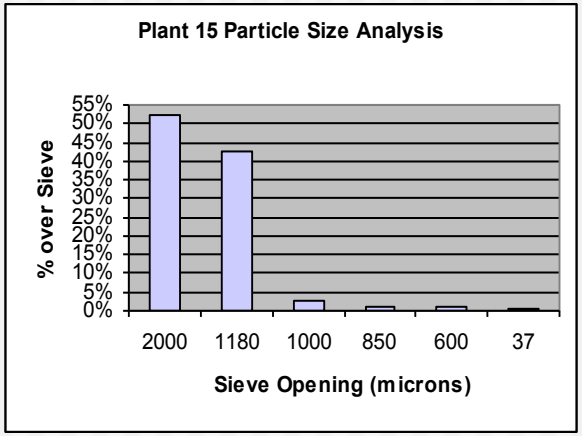
Examples of Particle Size Distribution of "New Generation" DDGS



Typical



Lowest Avg. Particle Size



Highest Avg. Particle Size

Quality Assessment of “New Generation” DDGS

- NIR
- Smell
- Color
- Mycotoxins
- Fat stability

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

DDGS Color and Smell

- Color varies among sources
  - ranges from dark to golden **(Cromwell et al., 1993)**
  - “new generation” DDGS is more golden and color is less variable
  - golden color 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)**
  - “new generation” DDGS has a sweet, fermented smell
  - smell may affect palatability

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

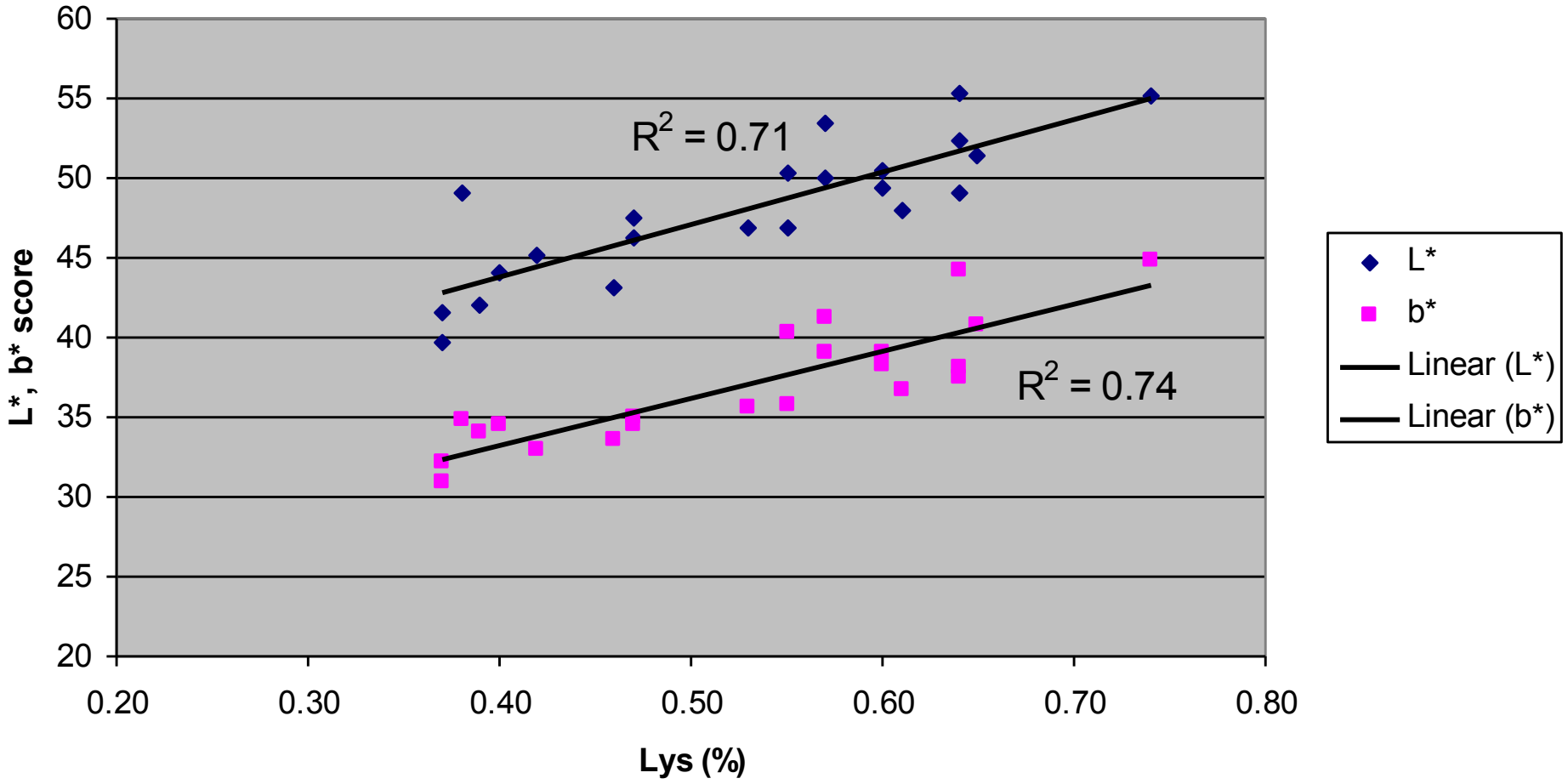


Fig. 2. Regression of digestible cys (%) and color (L*, b*)

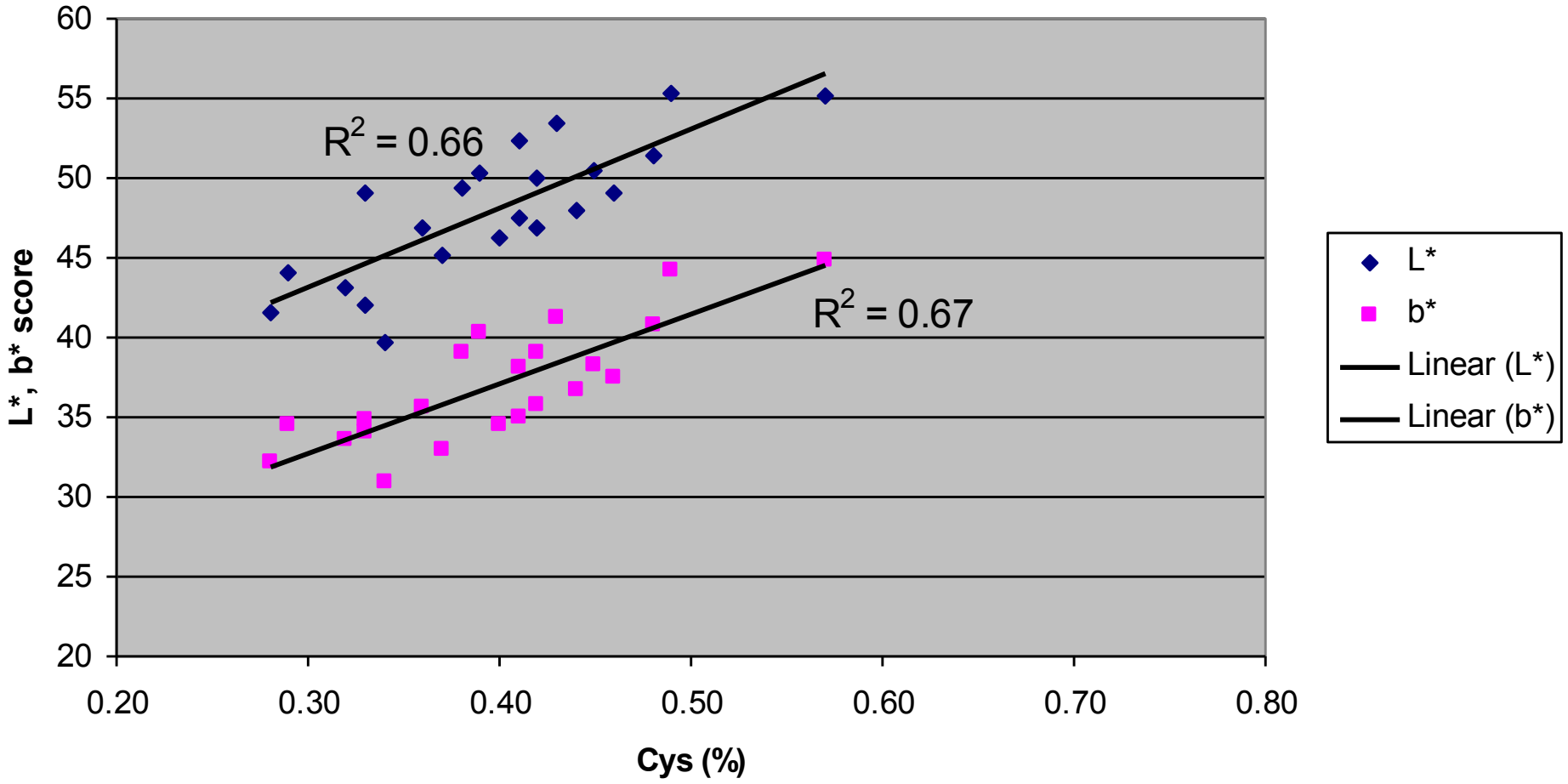
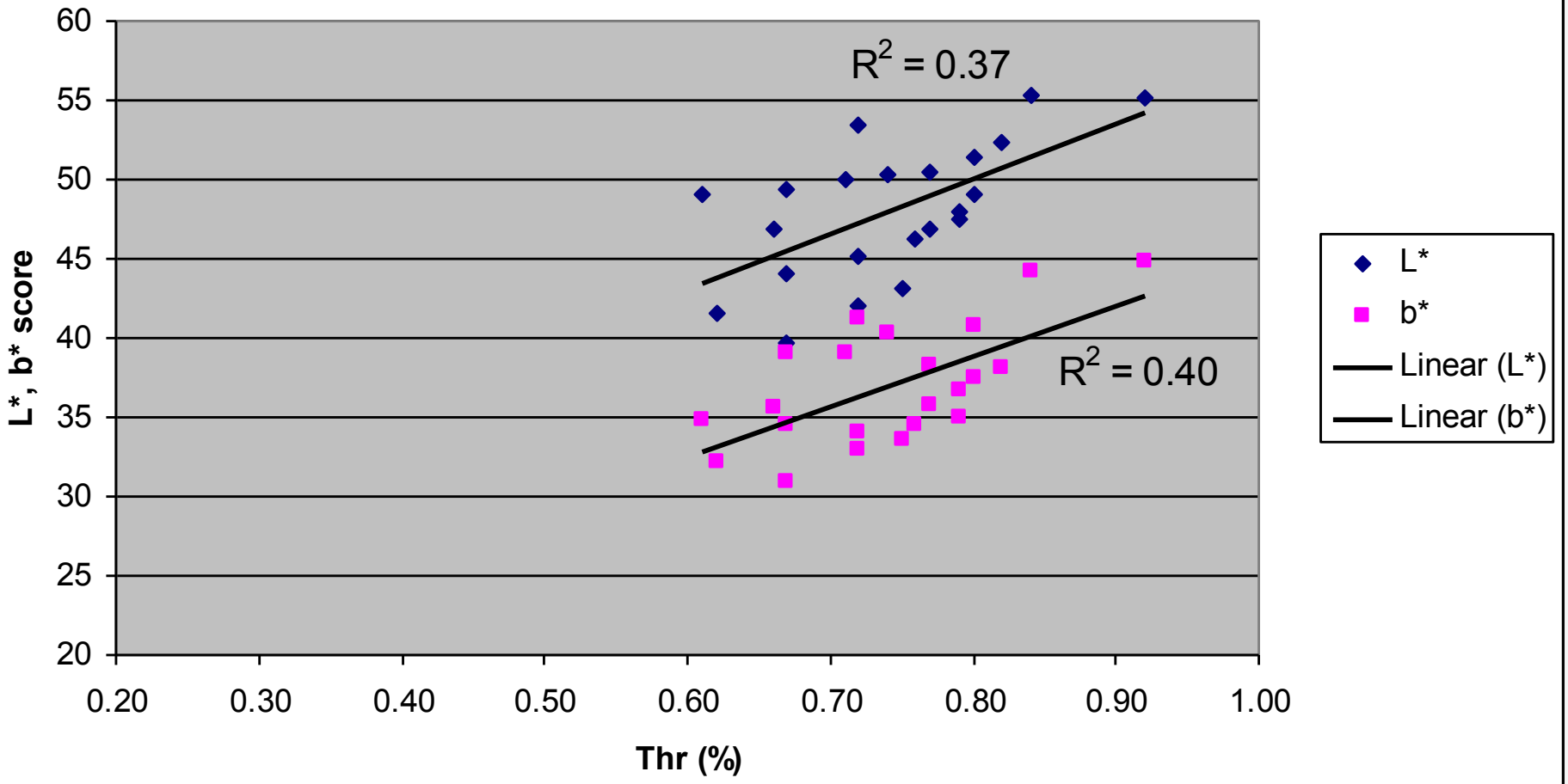


Fig. 3. Regression of digestible thr (%) and color (L*, b*)



Mycotoxins

- Incidence of mycotoxin contamination in “new generation” DDGS 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

- Very little data
- DDGS
  - monitored during transit and storage
  - 16 weeks
  - 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