Feeding Distillers II: Overcoming Nutritional Challenges

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Distillers – focus of presentation

- Dried Corn Distillers Grains with Solubles (DDGS)
  - New Generation – product from fuel ethanol plants
  - Older product from distilleries – fed to dairy and beef cattle for many years
  - New Generation product uses new technology
    - Much more efficient at converting starch and sugar to ethanol

General: Local production vs market

- Current production, 3 plants ~ 280,000 Mt/yr
- 7 more plants by 2009 = 1,400,000 Mt/yr

(OMAFRA, 2007)

- Potential market (conservative)
  - 342,000 dairy cows @ 2.5kg/d = 312,000 Mt/yr
  - 184,000 dairy heifers @ 1kg/d = 67,000 Mt/yr
  - 465,000 feedlot steers & heifers @ 2 kg/d x 260 d = 242,000 Mt/yr
  - 421,000 sows @0.25 kg/d = 38,500 Mt/yr
  - 2,047,000 G/F pigs @0.20 kg/d x 0.3 x 300 d = 37,000 Mt/yr

Total: = 696, 500 Mt/yr

Note: Ontario Ag Stats 2007. Not counting 381,000 beef cows, 66,000 calves, 235,000 sheep, 213 M chickens and turkeys. Assumes 30% market G/F pigs in Ontario

Sale of dried distillers grains to the livestock industry is a major component of ethanol plant profitability. USDA photos by Dan Campbell

Nutrient profile…

By removing Starch from corn – other nutrients increase 3 x in distillers

Nutrient	CORN, DM basis	DDGS, DM basis
Dry matter, %	89.1	90
Crude protein, %	9.9	↑↑↑ 30.0
ADF,%	3.3	↑↑↑ 22.6
NDF, %	13.4	↑↑↑ 41.1
Ash,%	1.5	↑↑↑ 5.9
Crude Fat,%	3.8	↑↑↑ 12.7
Sugar,%	1.1	3.4*
Starch, %	72.2	↓↓↓↓ 8.9*
NSC,%	73.3	↓↓↓↓ 12.3

Webster and Hoover, 1998

*Better extraction techniques= 2.2%sugar,4.7% starch,Shurson.2005

Difference between Old vs 'New generation' DDGS

Nutrient, DM basis	Old	New Generation
Crude protein, %	28.0	31.8 <= 14%
Crude fat, %	10.3	11.3
Crude fibre, %	11.1	6.3
NEl , Mcal/kg	2.04	2.26 <= 11%
ME poultry, Mcal/kg		
ME swine, Mcal/kg		3.90
ADF, %	19.70	18.4
NDF, %	38.8	35.5
Calcium, %	0.10	0.07
Phosphorous, %	0.80	0.77
Avail.Phosphorous, %		0.70

Shurson et al., 2005, NRC, 1982

Difference between Old and 'New Generation' DDGS – amino acids (cont)

Nutrient, DM basis	Old	New Generation
Lysine, %	0.53	0.85 <= 60%
Methionine, %	0.50	0.72 <= 44%
Threonine, %	0.98	1.13
Tryptophan, %	0.19	0.25
Valine, %	1.38	1.50
Arginine, %	0.92	1.20
Histidine, %	0.61	0.76
Leucine, %	2.97	3.55
Isoleucine, %	1.00	1.02
Phenylalanine,%	1.27	1.47

Nutrient profile of DDGS from 2 Ontario Plants, and 1 from Quebec

Nutrient, DM basis	#1 Source	#2 Source	#3 Source
n =	12	6	supplied
Moisture, %	13.51	10.78	10.72
Crude protein, %	31.57	31.38	29.85
Crude fat, %	11.36	11.71	12.50
ADF, %	18.90	20.23	16.6
NDF, %	36.17	38.46	34.91
ADF-CP, %	4.18	7.43	4.0
Starch, %	2.41	2.22	--
Soluble protein, % CP	11.37	12.49	13.80
UIP, % of CP	66.8*	69.9*	--

* Sources 1,2: AgriFood Labs, 2007 , Source 3: Dairy One Lab. Kleinschmidt et al., 2005 – 63.5-78.0% UIP

Nutrient profile of DDGS from 2 Ontario Plants, and 1 from Quebec

Nutrient, DM basis	#1 Source	#2 Source	#3 Source
n =	12	6	supplied
Calcium, %	< 0.01	< 0.01	0.03
Phosphorous, %	0.89	0.86	0.89
Sodium, %	0.21	0.08	0.24
Potassium, %	1.19	1.12	1.38
Magnesium, %	0.34	0.31	0.33
Sulphur, %	0.96	0.70	0.56
Zinc, ppm	54.4	57.1	59.0
Manganese, ppm	12.4	13.7	14.0
Copper, ppm	4.4	6.0	4.7
Iron,ppm	82.2	82.9	90.0

* Sources 1,2: AgriFood Labs, 2007 , Source 3: Dairy One Lab

So..any problems with feeding distillers?

Challenges

- Quality Assessment Standards
  - Smell
  - Colour
  - Nutrient content
  - Particle size
  - Bulk density
  - Fat stability
  - Mycotoxins

#1. Variability

- Wide variability across Plants: nutrient content, colour
  - Less variability within plants
  - Focus on ethanol

- Reasons for variation
  - Corn source– can vary in CP from 7.8 – 10.0 %, 0.22 to 0.32% lysine and 0.24 – 0.34 % phosphorous
  - Amount of solubles added to final product (25 to 50%) varies between plants

Nutrient value affected by proportion of solubles added – varies across plants (Shurson et al, 2005)

Nutrient, DM basis	Distillers Grains	Distillers solubles
Crude protein, %	33.5	18.5
Crude fat, %	9.0	15.7 < =
Crude fibre, %	9.5	2.5
Ash, %	3.0	8.4
Calcium, %	0.04	0.06
Phosphorous, %	0.54	1.28
Bypass protein,%*	65	20 <=
Lysine, %	1.05	0.68
Methionine, %	0.66	0.27

* Adapted from Trenkle, Iowa State U

Variability! 32 US corn DDGS sources (Shurson et al., 2005)

Nutrient	Average (CV)	Range
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
Cal ME,kcal/kg	3810 (3.5)	3504 – 4048
Lysine, %	0.90 (11.4)	0.61 – 1.06
Arginine, %	1.31 (7.4)	1.01 – 1.48
Tryptophan, %	0.24 (13.7)	0.18 – 0.28
Methionine, %	0.65 (8.4)	0.54 – 0.76
Phosphorous, %	0.75 (19.4)	0.42 – 0.99

General Rule: AVOID > 10 % CV

Purchase from one source……

Ontario analysis DDGS sources, 8 samples from 1 source – more consistent! (DM basis)

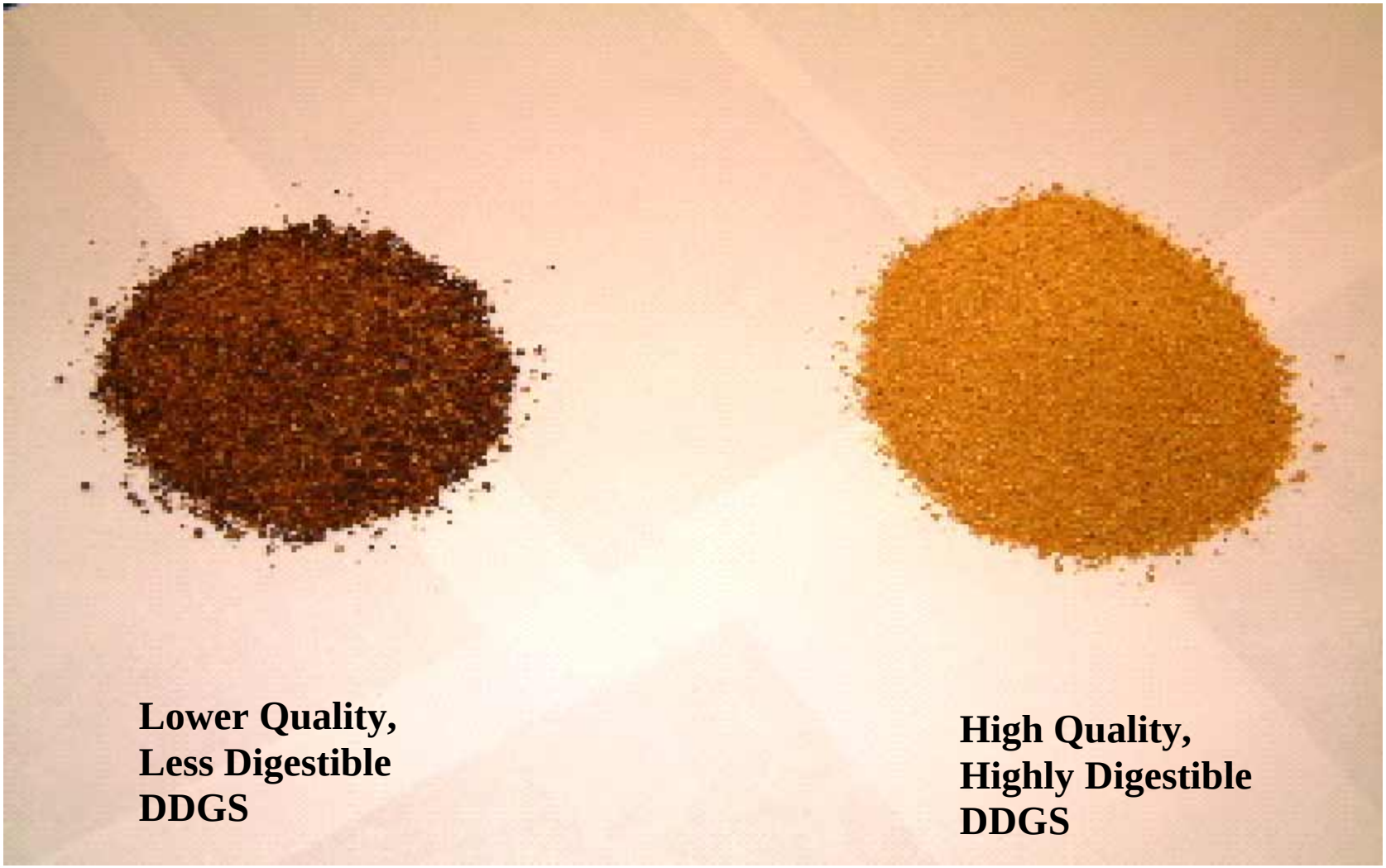
Nutrient	Average (CV)	Range
Crude protein, %	31.9 (5.6)	29.1 – 33.5
Crude fat, %	11.4 (3.9)	10.8 – 11.9
ADF, %	18.4 (7.7)	16.1-20.4
NDF, %	35.5 (5.0)	33.0-38.4
ADICP, %	3.88 (6.22)	3.54-4.21
Starch, %	2.83 (51.9)	1.29-5.27
Ca, %	<0.01	
P, %	0.89 (2.48)	0.87-0.90
S, %	0.90 (5.15)	0.84-0.98
Cu, ppm	3.41 (14.5)	2.39-3.97

General Rule: AVOID > 10 % CV

Quality control: Gold usually better

- Dark colour could indicate high heat and lower digestibility of protein, especially lysine
  - greater impact on non-ruminants
  - Shurson found drier temperatures amongst plants ranged from 260 to 1150 deg F
- No uniform standards established: Canada
  - American standards recently established

Color Extremes of DDGS



After Shurson, U Minnesota Website

#2. Fibre content

- Relatively high fibre
  - Most limiting factor for swine and poultry
    - Removal of fibre will enhance use of DDGS
  - Fibre best suited fro ruminants

#3: Flowability!

- So far – no problems in Ontario
- US: Large variation in flowability between plants
- Can cake very easily
- Appears to be plant specific

4. Lysine level low

- Typical of all corn-based products
- One of the most limiting amino acids for poultry and all livestock

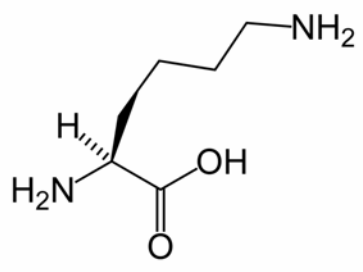
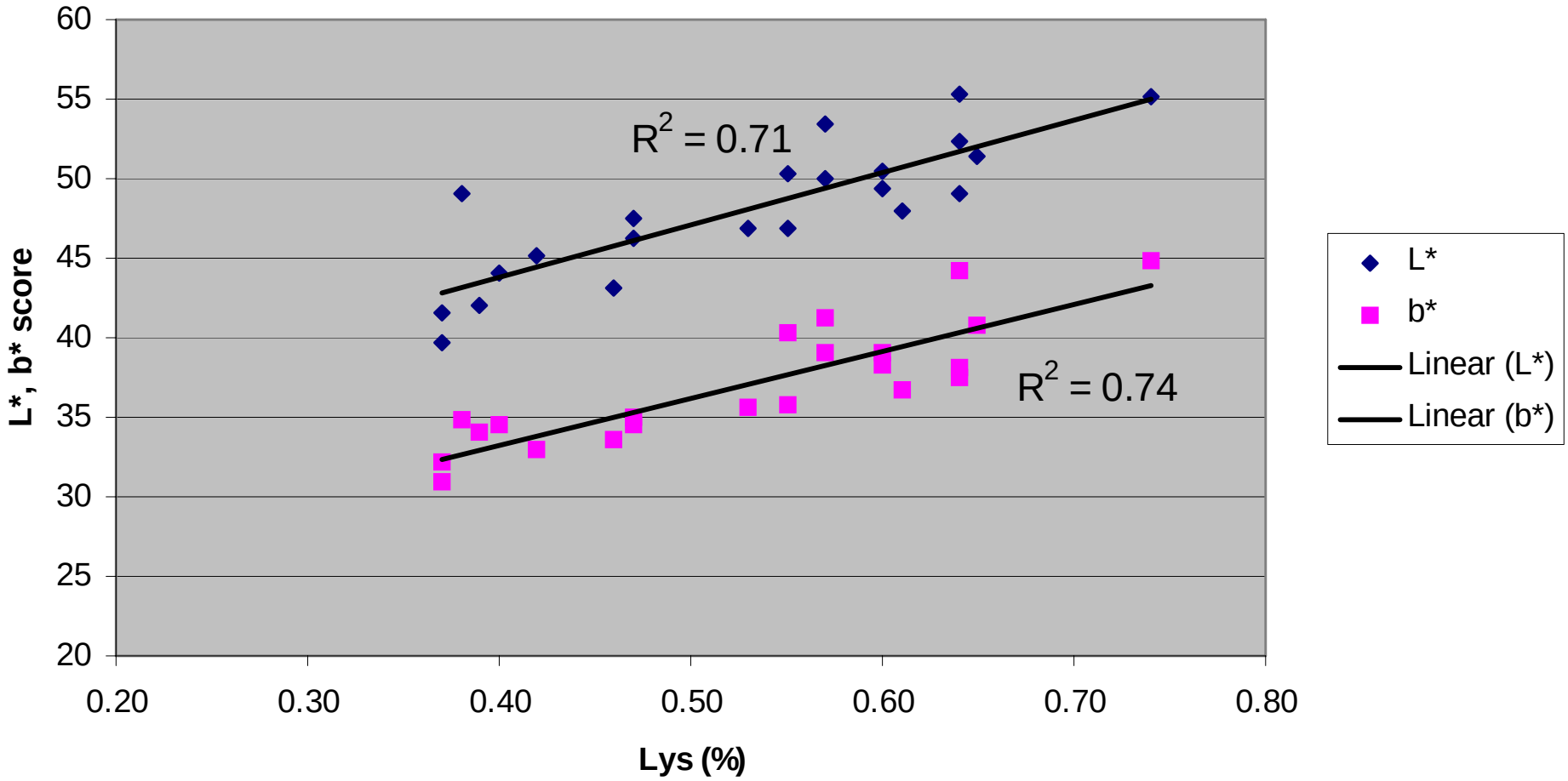


Fig. 1. Regression of digestible lys (%) and color (L*, b*)

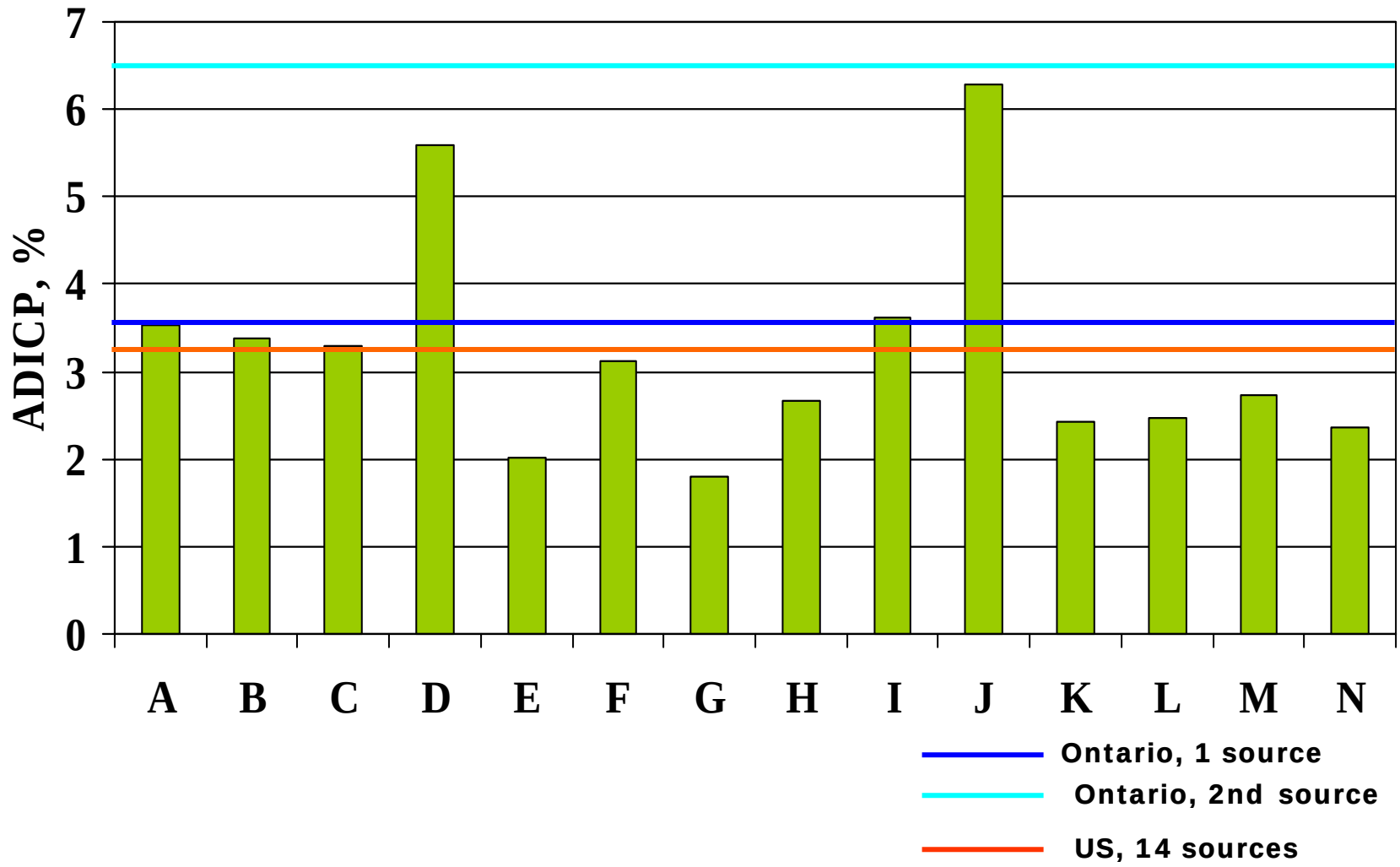


Source: Dr. Sally Noll (2003)

5. Bound protein can be high

- Result of excess heat
  - Binds lysine and any available reducing sugar (Maillard reaction)
- Protein that passes undigested through animal or bird
  - Estimated by protein in ADF fraction (ADICP or ADF-CP)
- Also variable across plants

ADICP (Acid detergent insoluble crude protein) of DDGS from various milling plants



Other considerations with DDGS

- #6. Fat: Primarily linoleic acid (18:2)
  - Good and bad
    - Good energy source
  - Unsaturated
  - High levels of 18:2
    - can lead to butterfat depression in dairy cows
    - Soft fat deposit in pigs

Other considerations with DDGS

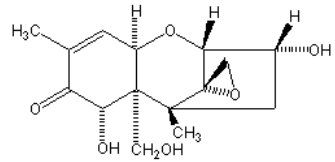
- #7. Fat stability
  - Limited data
  - In Mexico, no rancidity detected (at 2 from source to 28 deg C) after 16 week
  - Tests conducted in Taiwan indicated that fat was stable, product shipped from US, stored for 10 weeks at dairy farm

Other considerations with DDGS

- #8. High Phosphorous and Sulphur
  - Excess P can lead to pollution problems
    - Most of the P comes from the solubles
    - Average was 0.75% (range 0.42-1.06%)
  - Excess S (>0.4% in dietary DM) leads to PEM (polioencephalamalacia)
    - Average 0.68% (range 0.31- 1.93%)
  - Watch sodium levels in solubles fraction (0.25 – 0.58%), especially from dark-coloured samples (Dale and Batal, 2003)

Source: Ethanol website, 2005

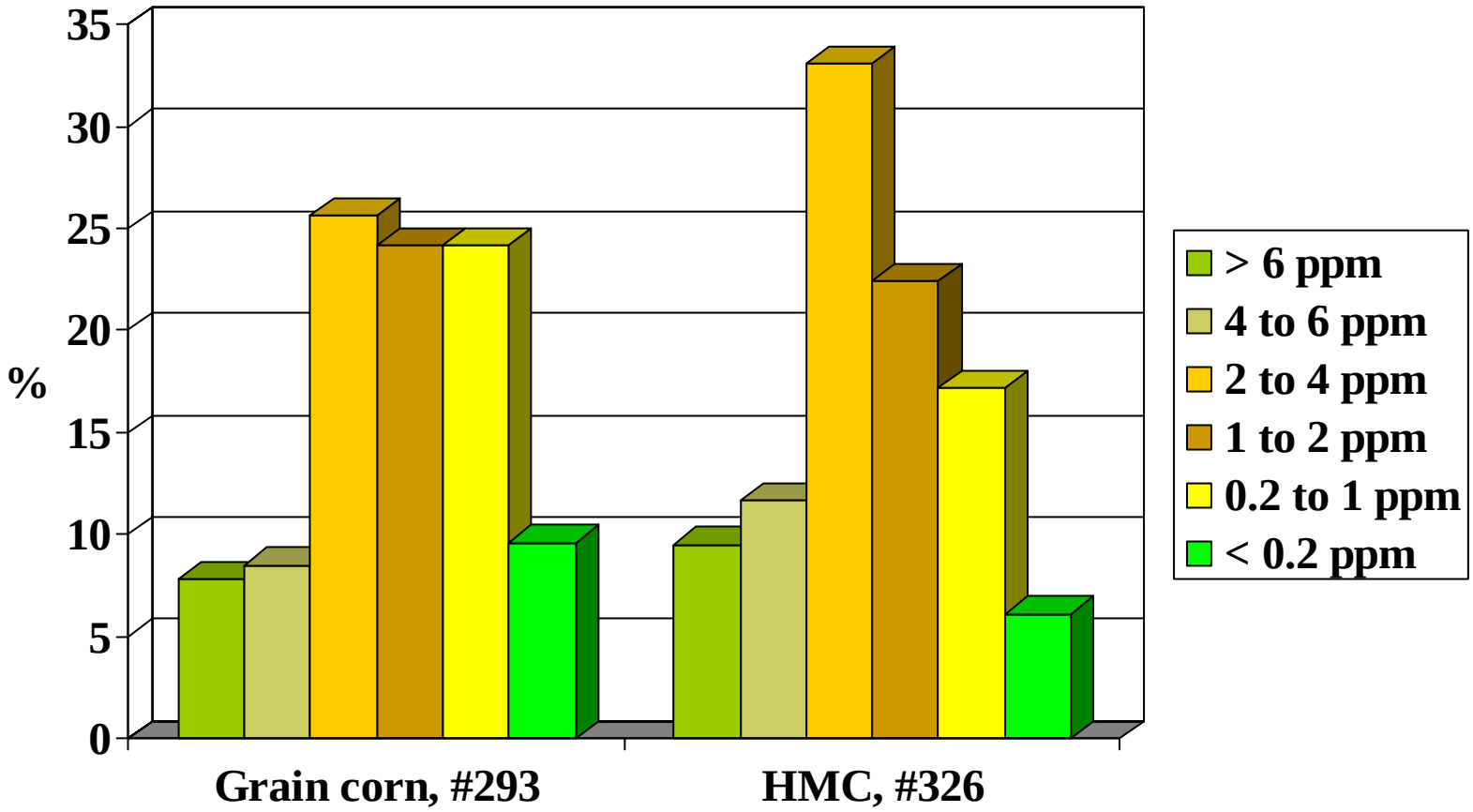
9. What about mycotoxins?



- Elevated level of vomitoxin (DON) in 2006 corn
- Distillers will concentrate toxin level by up to 3x
- Improper storage (especially wet distillers) can allow molds to continue to grow
- Fast reliable test for mycotoxins in DDGS not available

DON levels in 2006 (Oct – Nov).

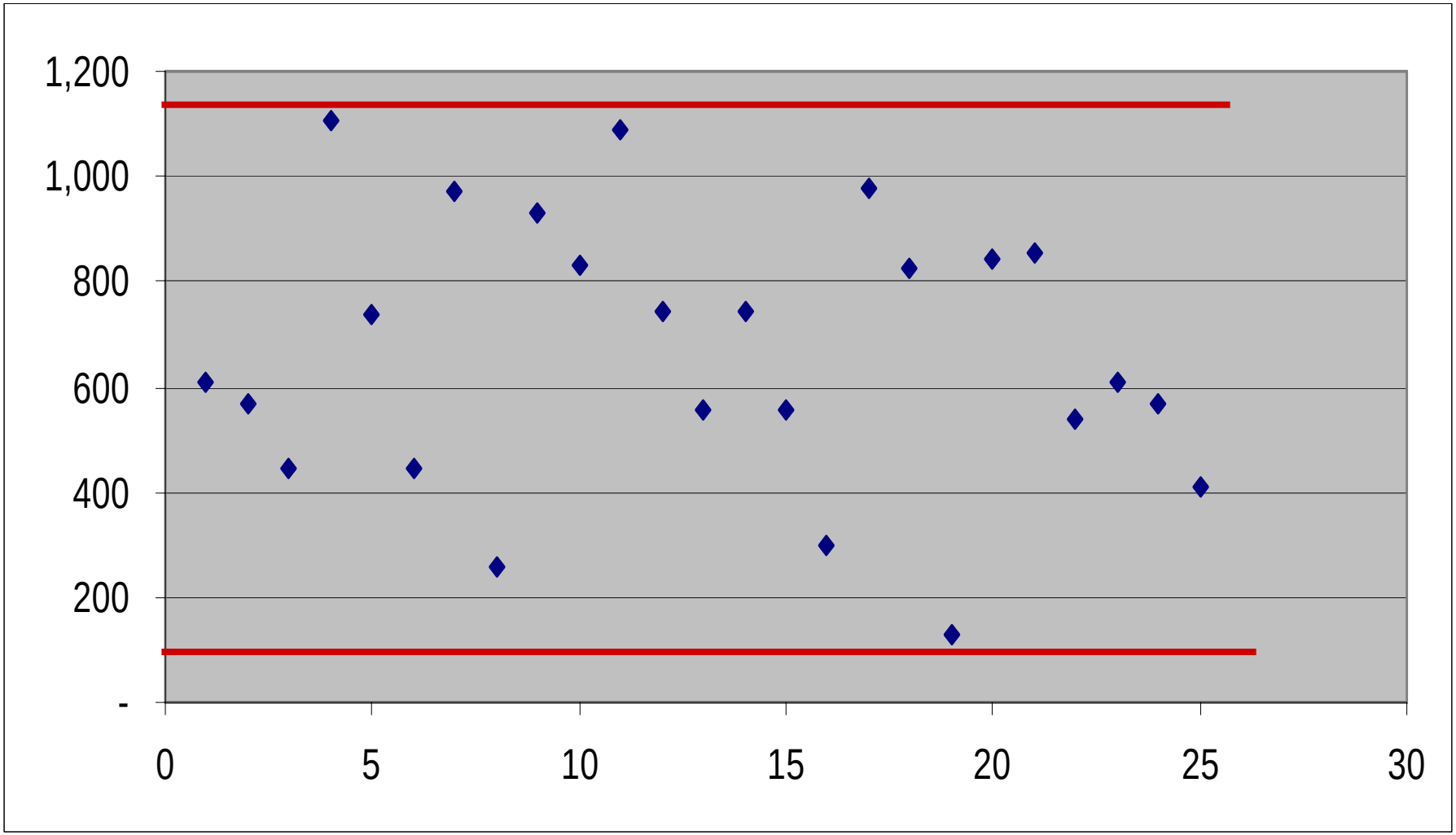
(AgriFood Labs, Guelph)



10. Watch particle size & bulk density….

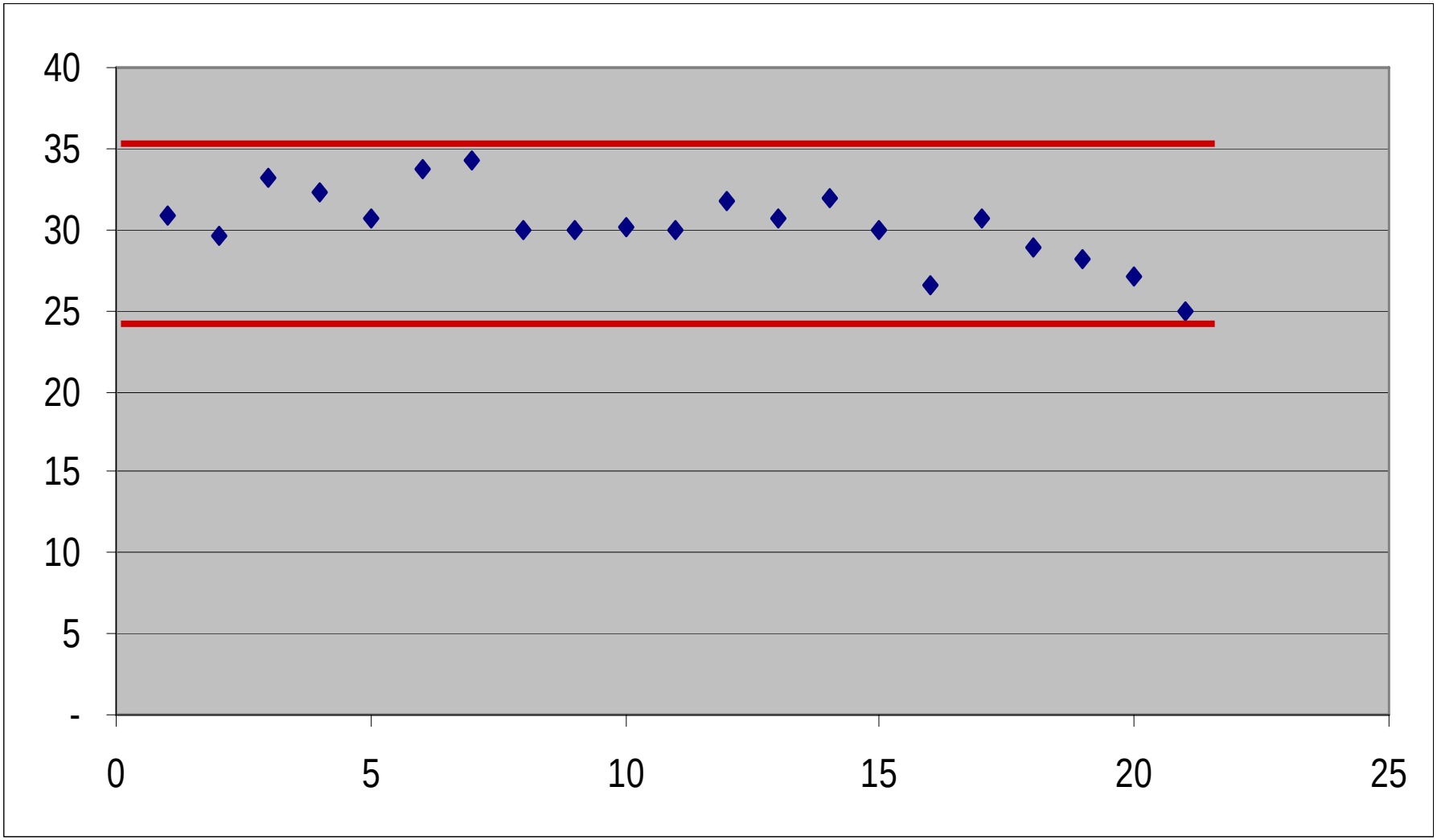
- **Particle size – separation in product**
  - **flowability**

Source: DiConstanzo, U Minn 2004



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

Shurson, 2006, U of Minnesota



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

Shurson, 2006 U Minnesota

Other considerations

- #11. Antibiotic residues
  - Virginiamycin (Lactrol), penicillin B and G used to control bacterial infections in fermenters
  - No antibiotic residues expected in DGS
    - Low pH in fermenters destroy penicillin
    - Temp > 200 deg F (93.3 deg C) destroy virginiamycin
  - Regular testing recommended as QA program

Feeding recommendations

- Many from US
  - Corn-soy based diets in US versus more complex diets in Canada
    - More by-products in Canada could limit use of DDGS
  - Inclusion levels also restricted by impact on environment
    - Example: DDGS recommended at 40% level in beef diets
    - 20% level is a much better balance not only for the animal but also for the environment

DGS at 40% diet dry matter => 950 lb steer, 3.75 lbs ADG

Ingredient	Supplied as fed	Supplied DM
Grass hay	1.5 lbs	1.35
Corn silage	18.0 lbs	5.20
Corn Grain	7.0 lbs	6.20
DGS, (35%DM)	24.0 lbs	8.40
Nutrient	**Amount**	**Supplied, DM basis**
DM intake, lbs	21.3	
Crude protein	3.75 lbs	17.7 % (excess)
Bypass protein	1.83 lbs	48.9 % (not req'd)
TDN	17.25 lbs	81.1 %
Calcium	22 grams	0.23 % (low)
Phosphorous	41 grams	0.43% (inverted)
Sulphur	39 grams	0.40% (PEM??)

N.B. High Phos Commodity Mineral required

DGS at 20% diet dry matter => 950 lb steer, 3.75 lbs ADG

Ingredient	Supplied as fed	Supplied DM
Grass hay	1.5 lbs	1.35
Corn silage	18.0 lbs	5.20
Corn Grain	12.0 lbs	10.70
DGS, (35%DM)	11.4 lbs	4.0
Commodity Min	0.24 lbs	0.24
Nutrient	**Amount**	**Supplied, DM basis**
DM intake, lbs	21.5	
Crude protein	2.86 lbs	13.4 %
Bypass protein	1.33 lbs	46.6 % (not req'd)
TDN	17.11 lbs	79.8 %
Calcium	51 grams	0.52 %
Phosphorous	33 grams	0.34% (1.52:1)
Sulphur	24 grams	0.25%

Thank you !

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.

Shurson, 2006, U of Minnesota