Overview of Production and Nutrient Content of DDGS

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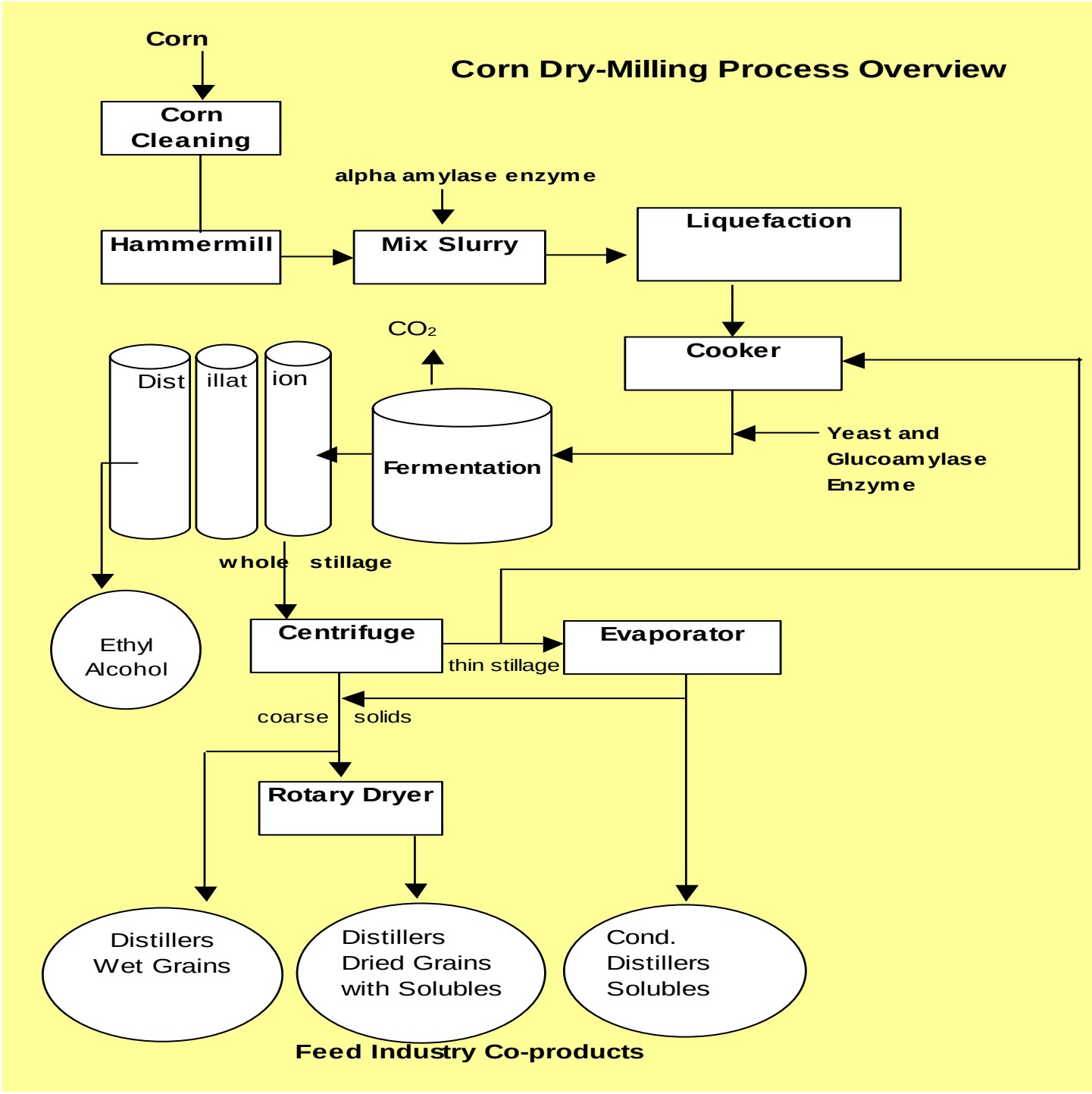
What is DDGS?

- **Distiller's dried grains with solubles (DDGS)**
  - By-product of the **dry-milling** ethanol industry
- Nutrient composition is **different** between dry-mill, wet-mill and beverage alcohol by-products
  - DDGS – fuel ethanol
  - DDGS - whiskey distilleries
  - Corn gluten feed – wet mill
  - Corn gluten meal – wet mill
  - Brewer's dried grains – beer manufacturing
- Nutrient content depends on the grain source used
  - **Corn DDGS - Midwestern US**
  - Wheat DDGS - Canada
  - Sorghum (milo) DDGS - Great Plains US
  - Barley DDGS

By-Products from Dry-Mill Ethanol Plants

- Distiller's grains
  - Wet – 30 to 35% DM
  - Dry – 90 to 92% DM
- Condensed distiller's solubles
  - Wet – 30 to 32% DM (variable)
  - Dry – 99% DM (new spray drying process developed at U of M)
- Distiller's dried grains with solubles
  - Wet – 30 to 35% DM
  - Dried – 88 to 90% DM (most common by-product)

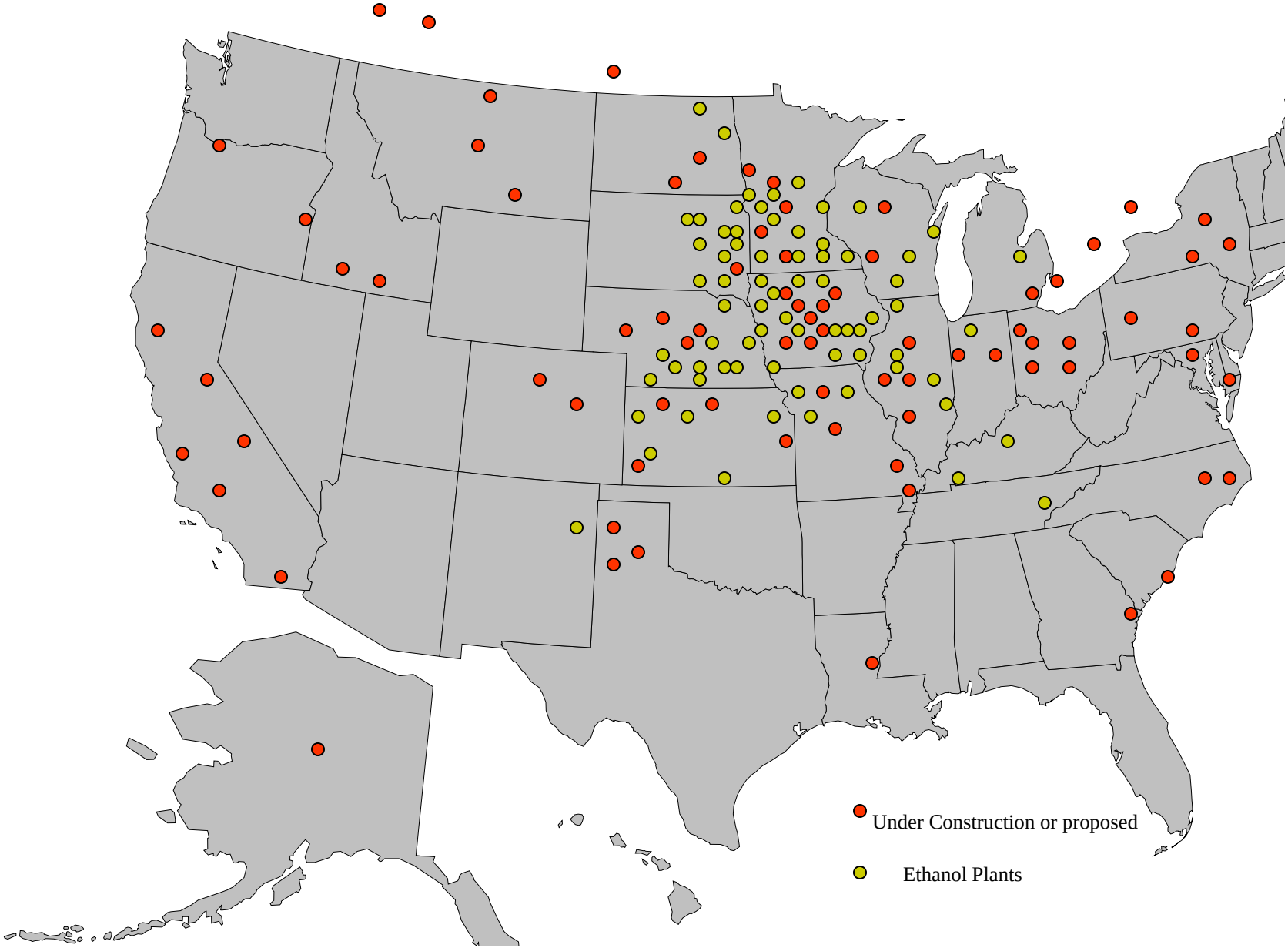

Corn
Corn Dry-Milling Process Overview
Corn Cleaning
alpha amylase enzyme
Hammermill
Mix Slurry
Liquefaction
CO_2
Cooker
Dist
illat
ion
Fermentation
Yeast and Glucoamylase Enzyme
whole stillage
Ethyl Alcohol
Centrifuge
thin stillage
Evaporator
coarse solids
Rotary Dryer
Distillers Wet Grains
Distillers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

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

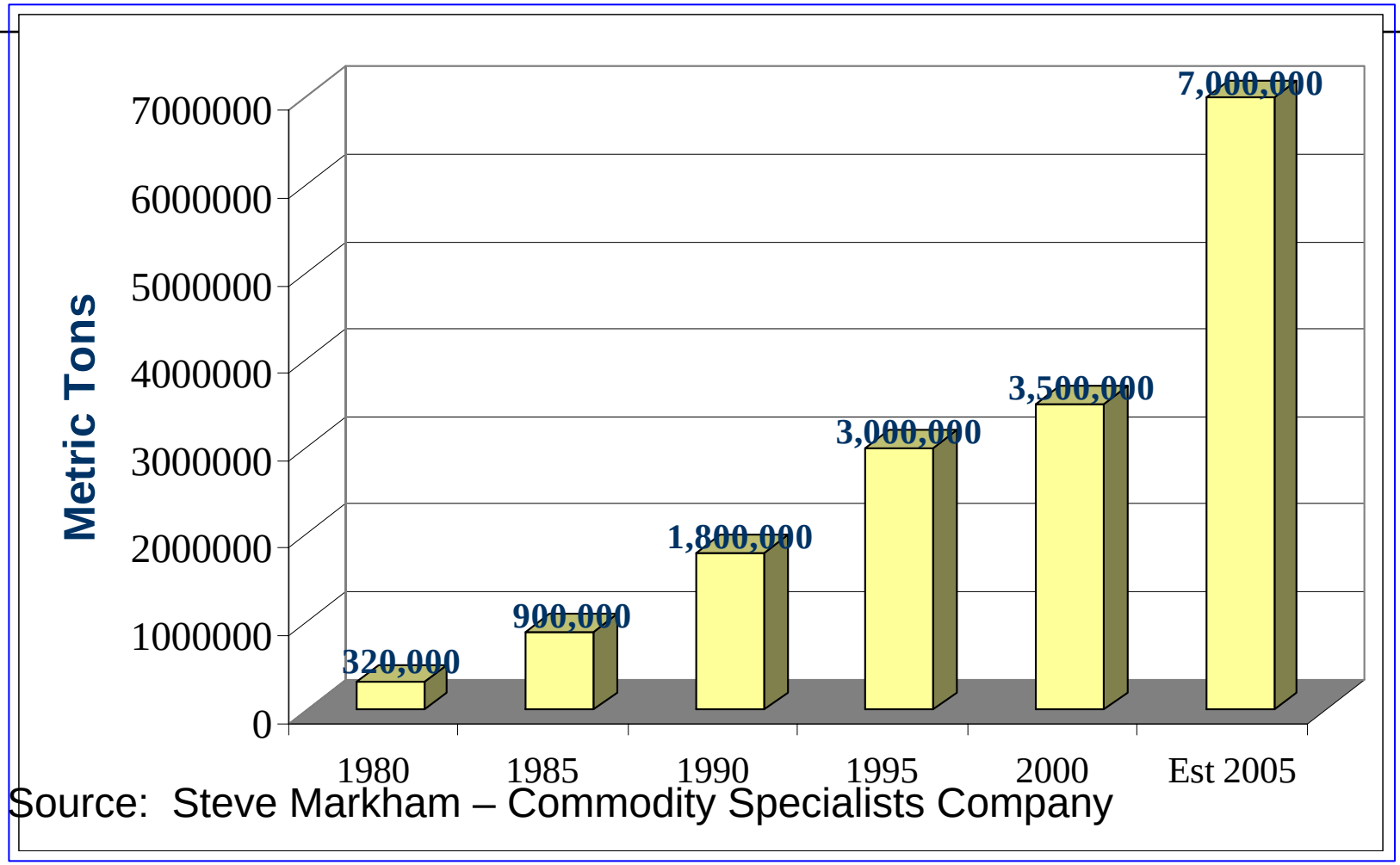
- Ethanol 10.2 liters
- DDGS 8.2 kg
- CO_2 8.2 kg

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

Ethanol Plants in North America - June 16, 2004

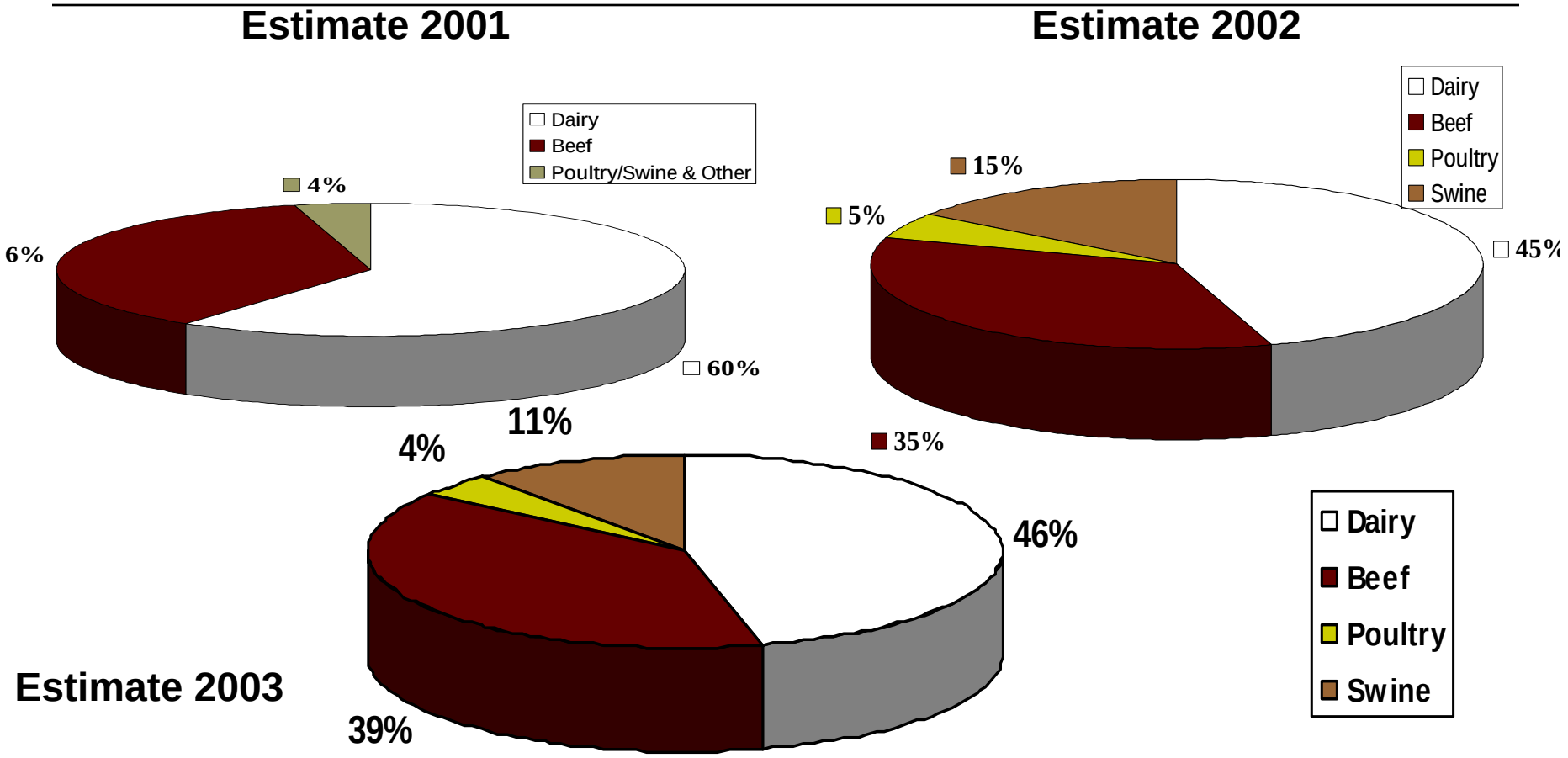


U.S. DDGS Production



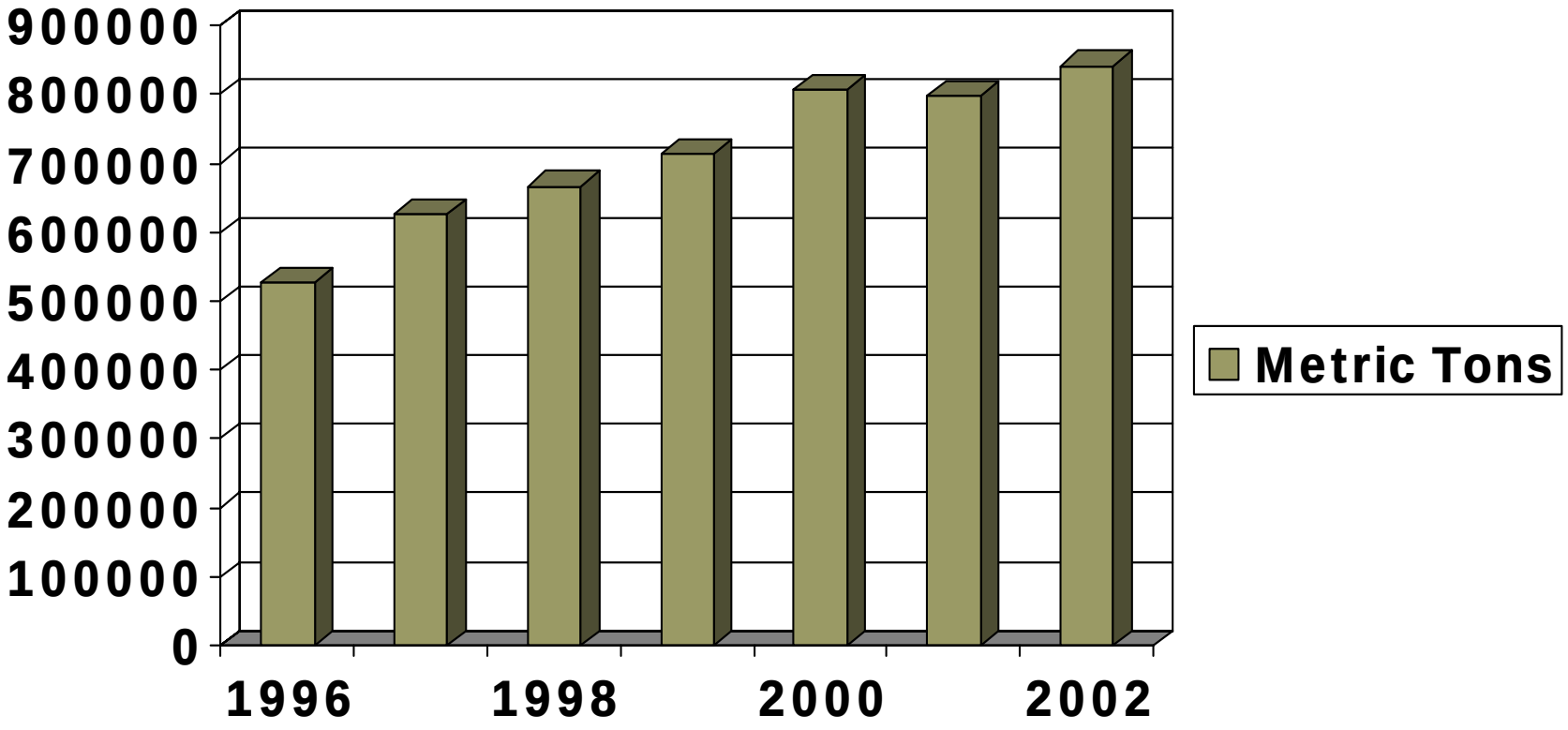
Source: Steve Markham – Commodity Specialists Company

U.S. DDGS Consumption



CSC 2004

U.S. DDGS Exports Are Increasing



Source: Commodity Specialists Company

Comparison of Corn DDGS to Other DDGS Sources and Other Grain By-products

Comparison of Nutrient Composition (100% Dry Matter Basis) of Golden DDGS to Corn Gluten Feed, Corn Gluten Meal, Corn Germ Meal, and Brewer's Dried Grains

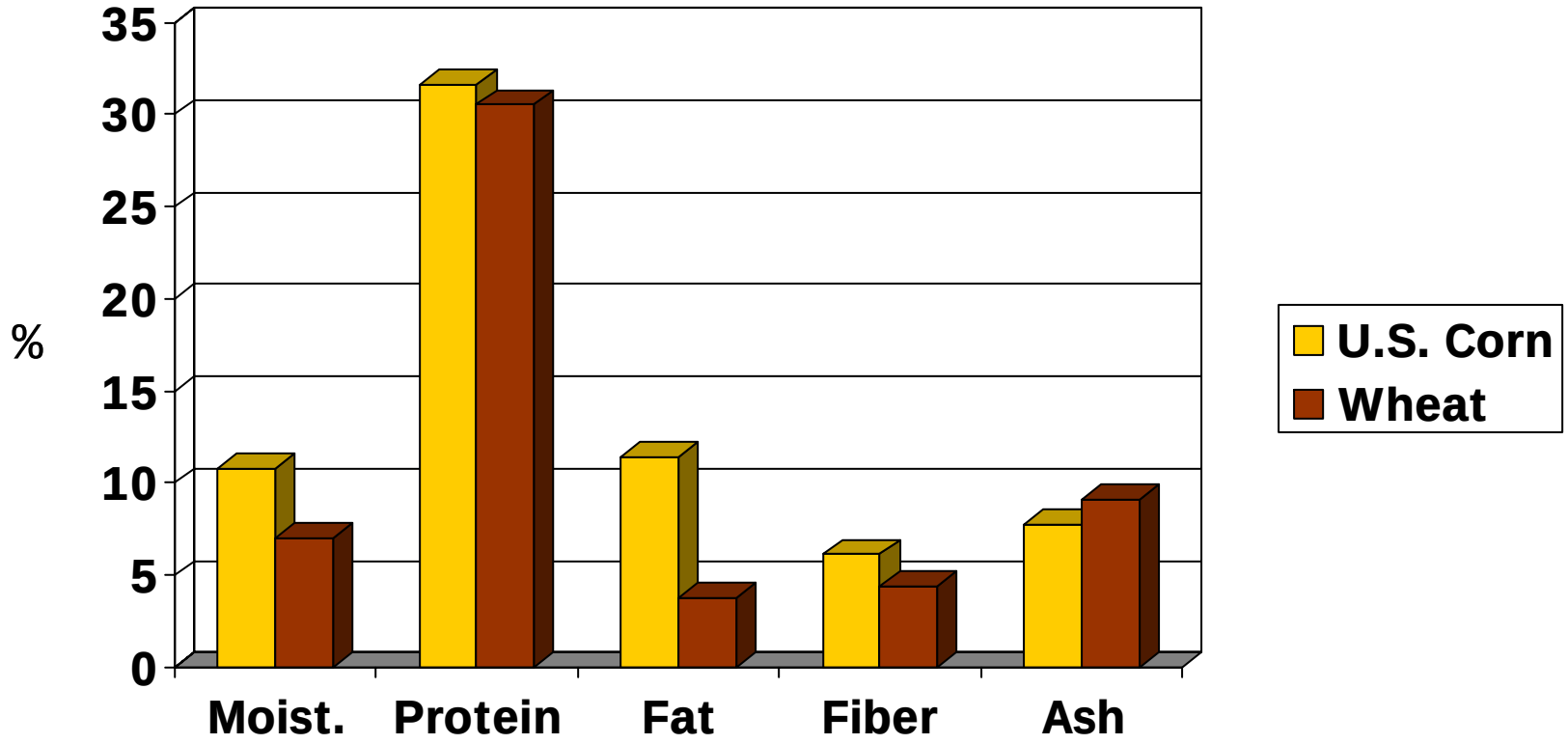
	"New Generation" DDGS (UM)	Corn Gluten Feed (NRC)	Corn Gluten Meal (NRC)	Corn Germ Meal (Feedstuffs)	Brewer's Dried Grains (NRC)
Protein, %	**30.6**	**23.9**	**66.9**	**22.2**	**28.8**
Fat, %	***10.7***	**3.3**	**3.2**	**1.1**	**7.9**
NDF, %	**43.6**	**37.0**	**9.7**	**No data**	**52.9**
DE, kcal/kg	***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**

Golden Corn DDGS vs. Canadian Wheat DDGS

Corn DDGS (Gimli, MB)

Corn DDGS (Chatham, ON)

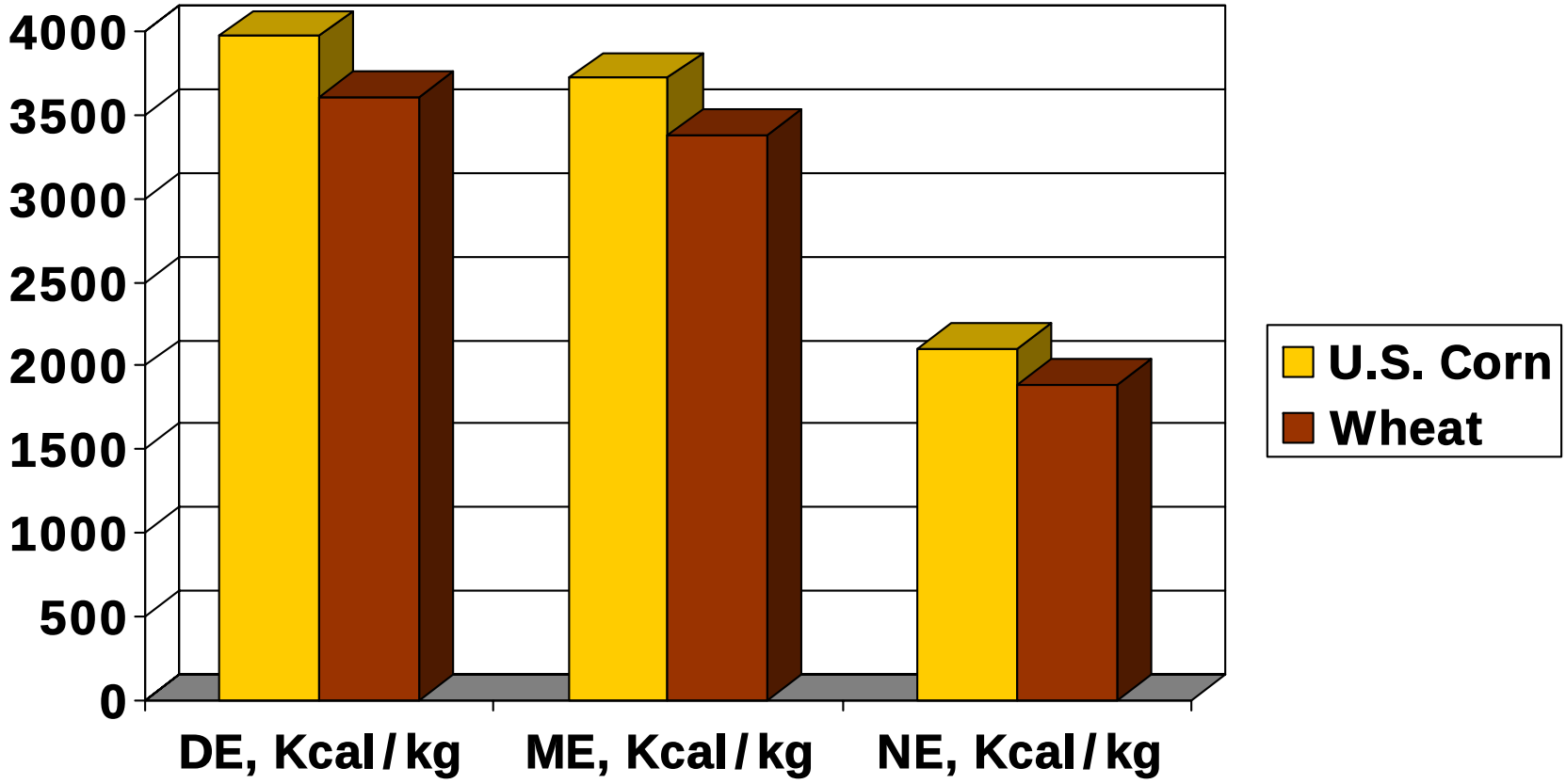
Comparison of Proximate Analysis of U.S. Golden Corn DDGS to Canadian Wheat DDGS (100% Dry Matter Basis)



U.S. Corn = average of values obtained from samples from 9 new dry-mill ethanol plants (Shurson and Whitney, 2004)

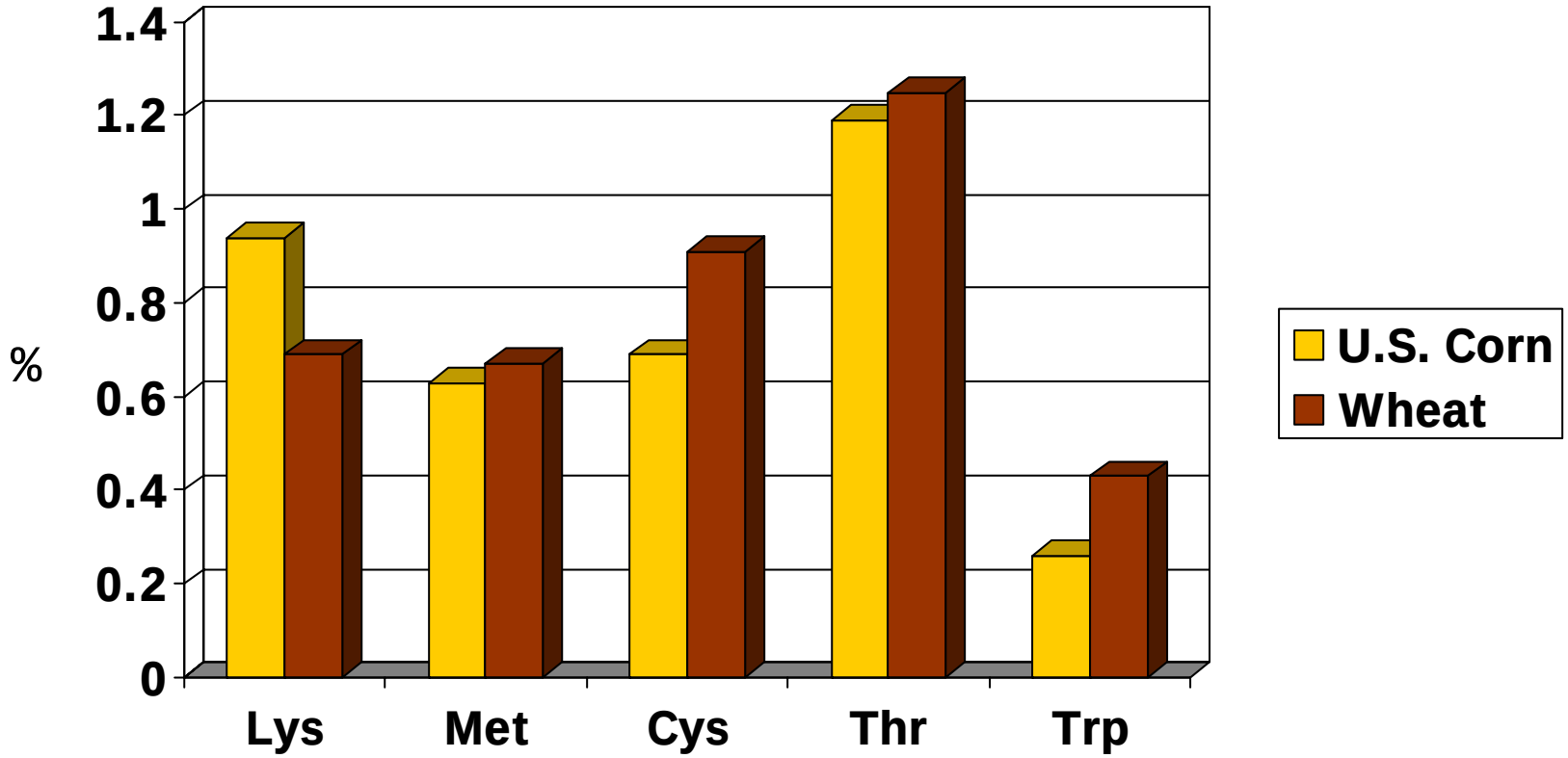
Wheat = actual analyzed values of DDGS produced by Mohawk, Minnedosa, MB

Comparison of Calculated DE, ME, and NE Values for Swine Between U.S. Golden Corn DDGS and Wheat DDGS (100% Dry Matter Basis)



U.S. Corn = average of values obtained from samples from 9 new dry-mill ethanol plants (Shurson and Whitney, 2004)
Wheat = actual analyzed values of DDGS produced by Mohawk, Minnedosa, MB
DE and ME calculated using equations from Noblet and Perez (1993)
NE calculated using equation from Ewan (1989)

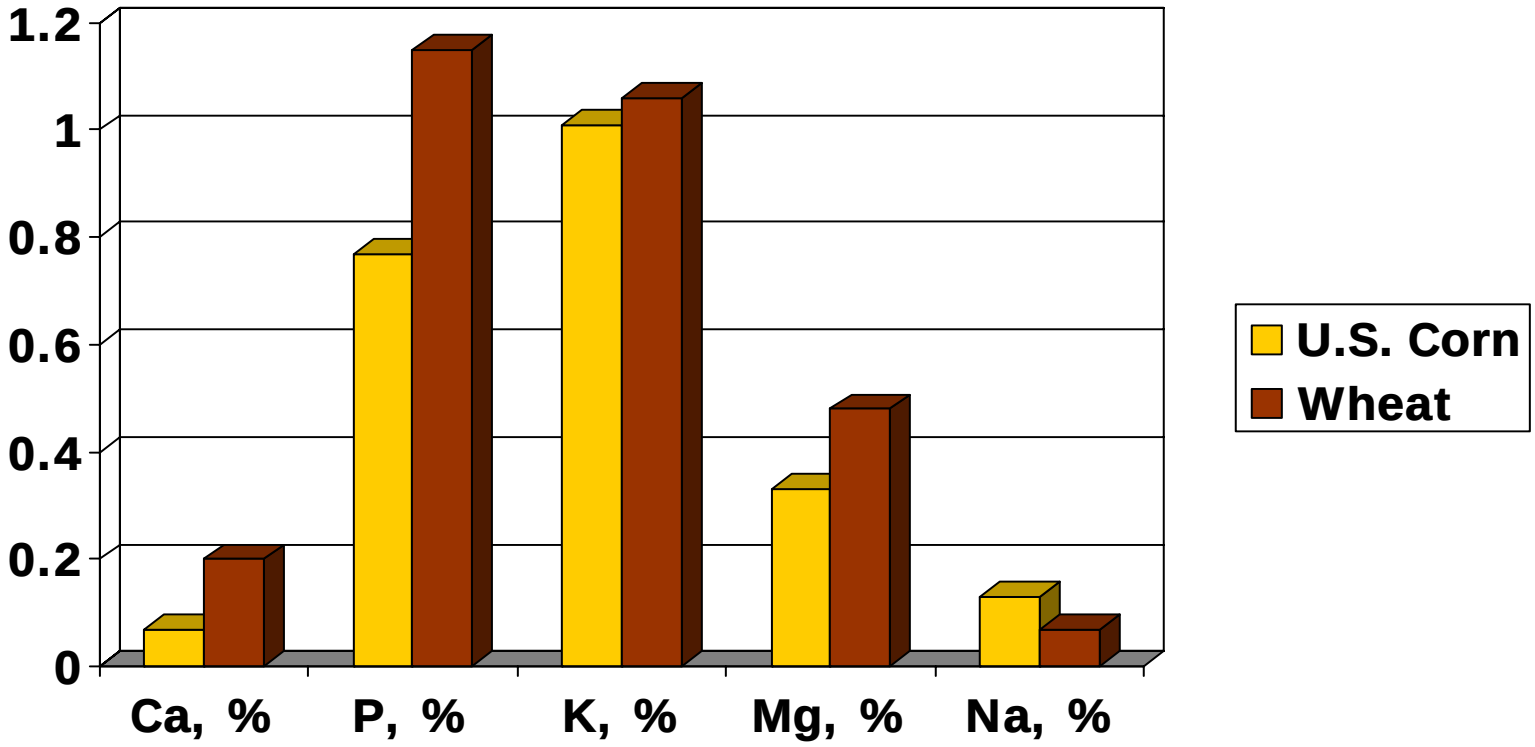
Comparison of Amino Acid Analysis of U.S. Golden Corn DDGS to Wheat DDGS (100% Dry Matter Basis)



U.S. Corn = average of values obtained from samples from 9 new dry-mill ethanol plants (Shurson and Whitney, 2004)

Wheat = actual analyzed values of DDGS produced by Mohawk, Minnedosa, MB

Comparison of Macro-mineral Analysis of U.S. Golden Corn DDGS to Wheat DDGS (100% Dry Matter Basis)



U.S. Avg. = average of values obtained from samples from 9 new dry-mill ethanol plants (Shurson and Whitney, 2004)

Wheat = actual analyzed values of DDGS produced by Mohawk, Minnedosa, MB

Proximate Analysis of Golden DDGS (100% Dry Matter Basis)

Nutrient	Golden DDGS
Dry matter, %	89.2
Crude protein, %	31.6
Fat, %	11.5
Crude fiber, %	6.2
Ash, %	7.8
NFE, %	42.8
ADF, %	11.2

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

	"New" DDGS Calculated U of M	"New" DDGS Trial avg. U of M	DDGS Calculated U of M	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 DE and ME Estimates of DDGS for Swine (88% DM)

	DE, Mcal/kg	ME, Mcal/kg	NE, Mcal/kg
U of M – Golden DDGS (1999)	3.49	3.37	No data
U of M – Traditional (1999)[1]	3.41	3.10	No data
KSU – New Generation (2004)[2]	3.87	3.49 – 3.70	2.61
KSU – "Old Generation" (2004)[3]	3.73	3.13 – 3.59	2.45
Hanor-Hubbard-Ajinomoto (2004)[4]	No data	3.25	2.42
NRC (1998)	3.45	2.67	No data

[1] Calculated values
[2] Determined by growth and metabolism trials (source Dakota Gold)
[3] Not DDGS but corn gluten from a NE ethanol plant
[4] Determined by growth trials (source Dakota Gold)

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

	Golden 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.

Energy Value of DDGS for Ruminants

Good Quality DDGS contains:

7-11% more energy than “book values”

10-20% more energy than corn

NE_L = 1.00 Mcal/lb

NE_M = 1.06 Mcal/lb

NE_G = 0.73 Mcal/lb

TDN = 94%

DE = 1.84 Mcal/lb

ME = 1.64 Mcal/lb

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

	Golden DDGS	Traditional 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)

	Golden DDGS	Traditional 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

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 Swine (88% dry matter basis)

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

	Golden 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.

Composition of Distiller's Grains for Cattle

Nutrient	% of DM
Crude Protein	30-36
RUP, % of CP	47-57
NE_L, Mcal/lb	1.00
Fat, %	9.8
ADF, %	19.0
NDF, %	38.0
Ca, %	0.15
P, %	0.83

Protein Value in Distiller's Grains for Ruminants

> 30% of DM and more than old "book values"

- Similar for DDG & DDGS

Good source of Ruminally Undegradable Protein (~55% RUP)

- RUP is slightly less for wet vs. dried DDG

Protein quality

- Fairly good quality
- Lysine is the first limiting amino acid

Relative Value of DDGS Differs Depending on Species

Assumptions:

- **Corn** **$2.00 / bu**
- **SBM** **$175.00 / ton**
- **Urea** **$360.00 / ton**
- **Non-ruminant diets corn/SBM**
- **Ruminant diets typical diets with competing by-products.**

Feed	Dollars/ ton
Dairy Lactation	$114.24
Poultry Finisher	$100.09
Layer Diet	$104.66
Swine G-F Diet	$96.34
Beef Feedlot	$108.00

Source: Tilstra, Land O' Lakes

U of M DDGS Web Site
www.ddgs.umn.edu

We have developed a DDGS web site featuring:

* research summaries
    - swine, poultry, dairy, & beef
    - DDGS quality
* presentations given
* links to other DDGS related web sites
* international audiences