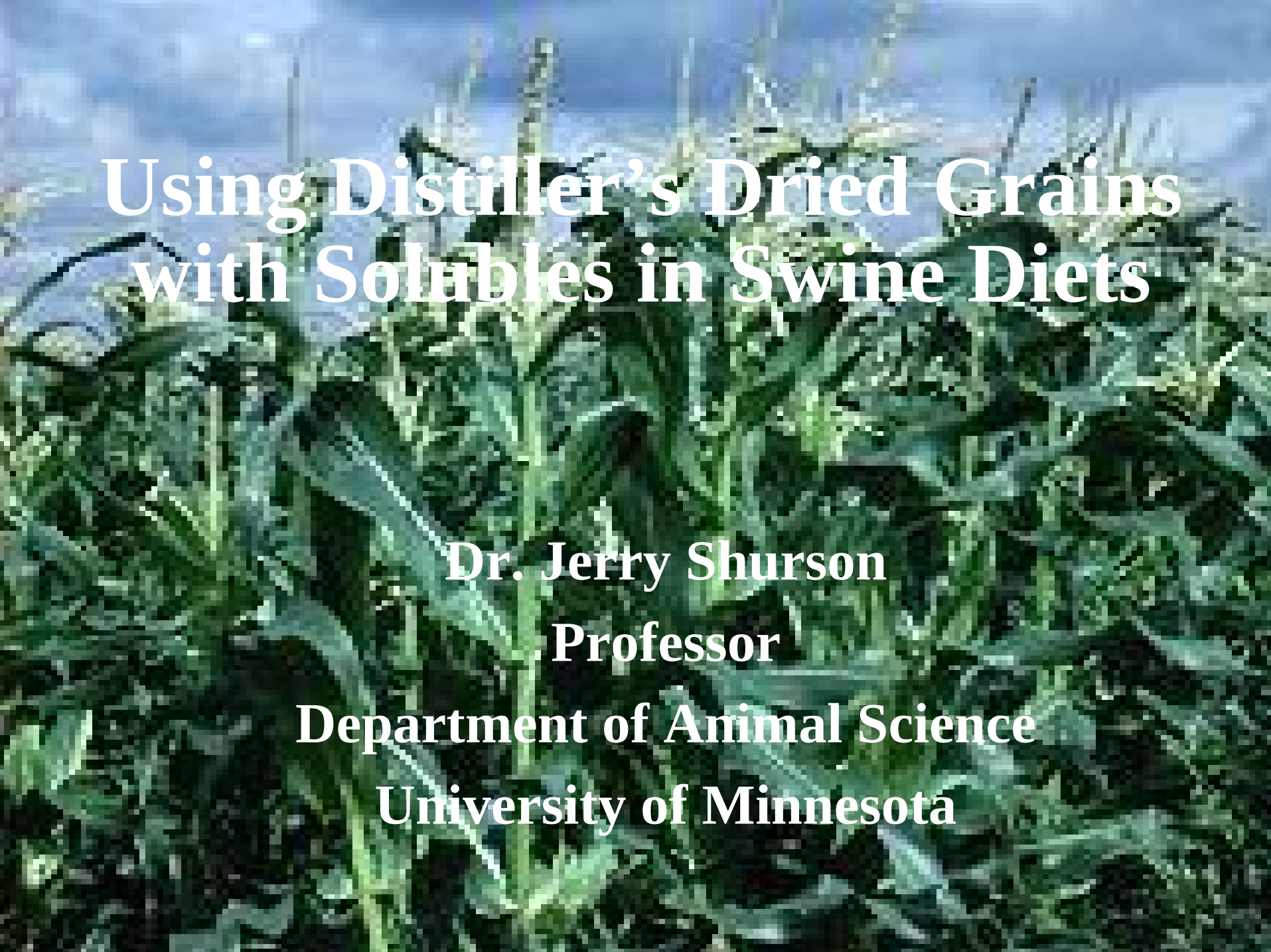

Using Distiller's Dried Grains with Solubles in Swine Diets

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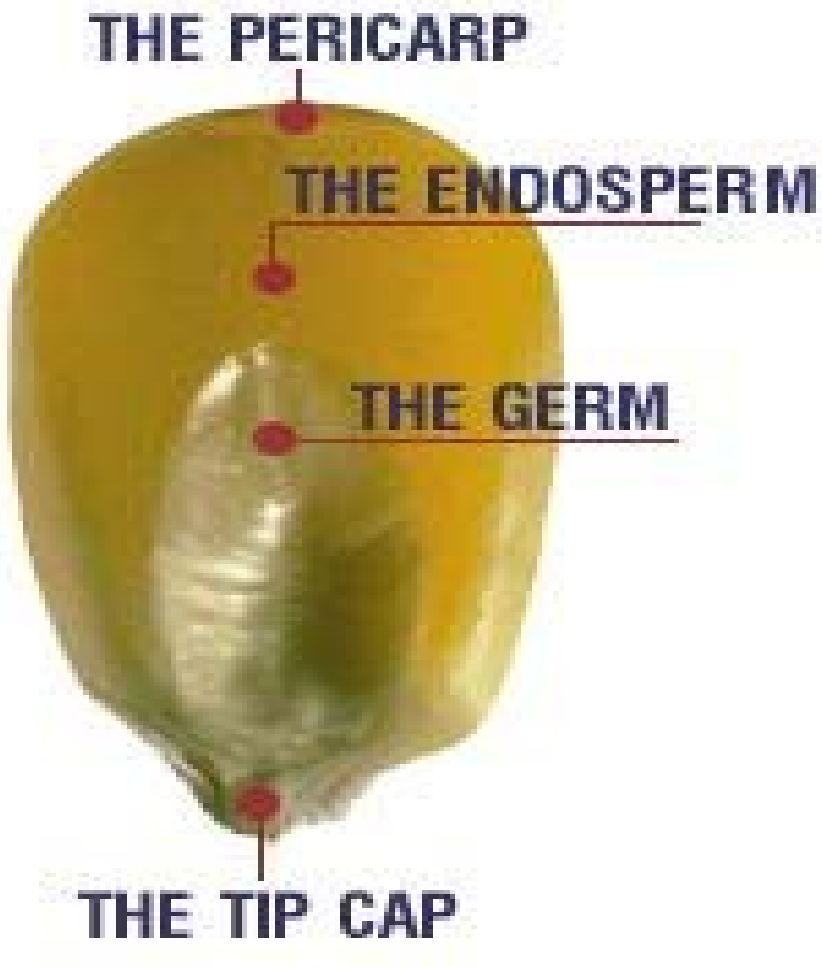
An Overview of DDGS Production

Production of DDGS

- Tightly linked to the production of fuel ethanol
- DDGS is a co-product of the dry milling ethanol production process
- About 40% of ethanol is produced using dry milling
- The other 60% of ethanol is produced by wet milling
  - co-products include: corn gluten feed, corn gluten meal, and corn germ meal

Components of Yellow Dent Corn

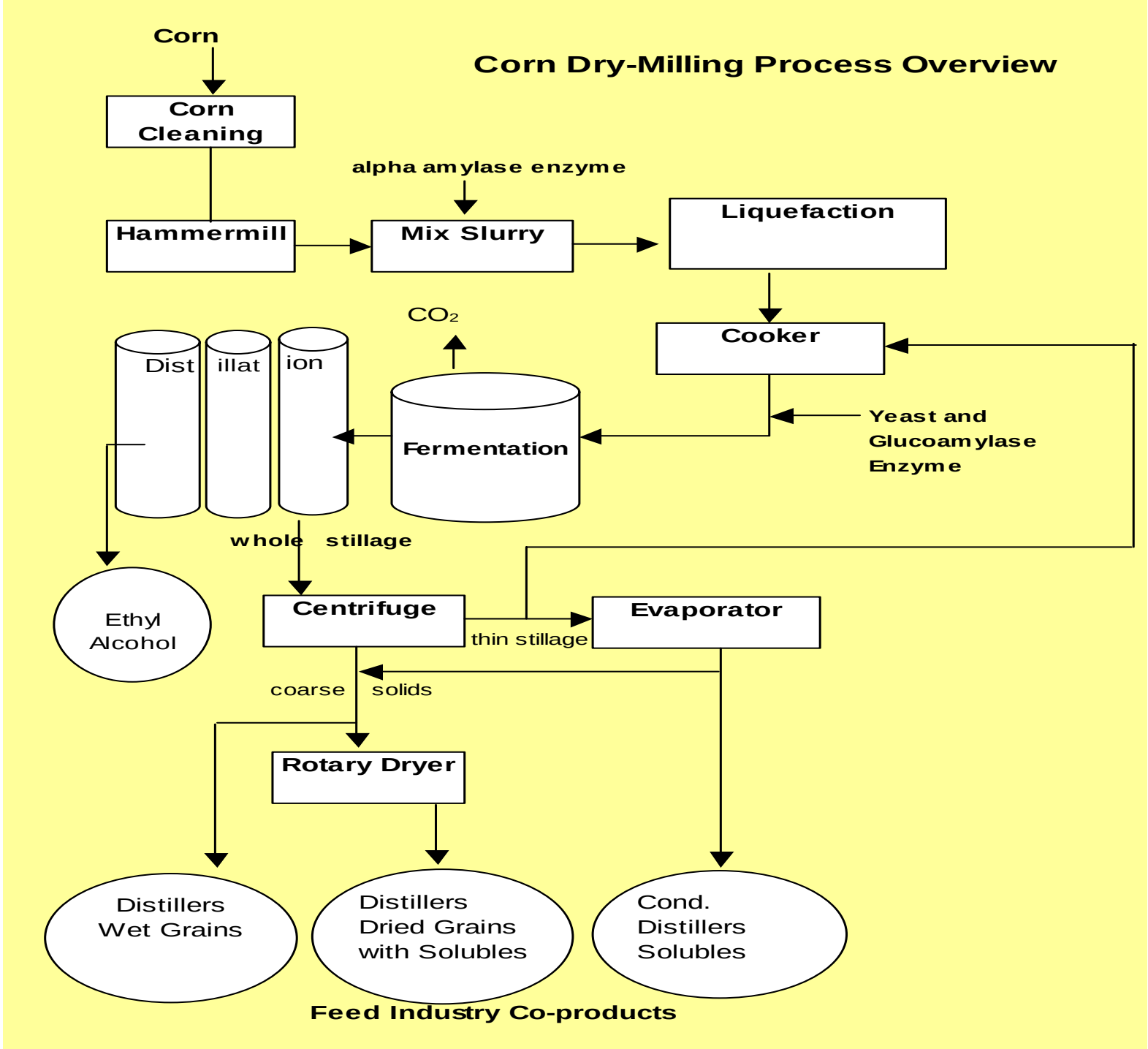
Starch	61.0 %
Corn Oil	3.8 %
Protein	8.0 %
Fiber	11.2 %
Moisture	16.0 %



Slide courtesy of Ms. Kelly Davis, CVEC

Production of DDGS

- Yeasts and enzymes are used to ferment the starch fraction of corn
- Ethanol and carbon dioxide are produced
- Distiller's grain and distiller's solubles are the residues remaining after fermentation
- These fractions and blended and dried to produce distiller's dried grains with solubles (DDGS)

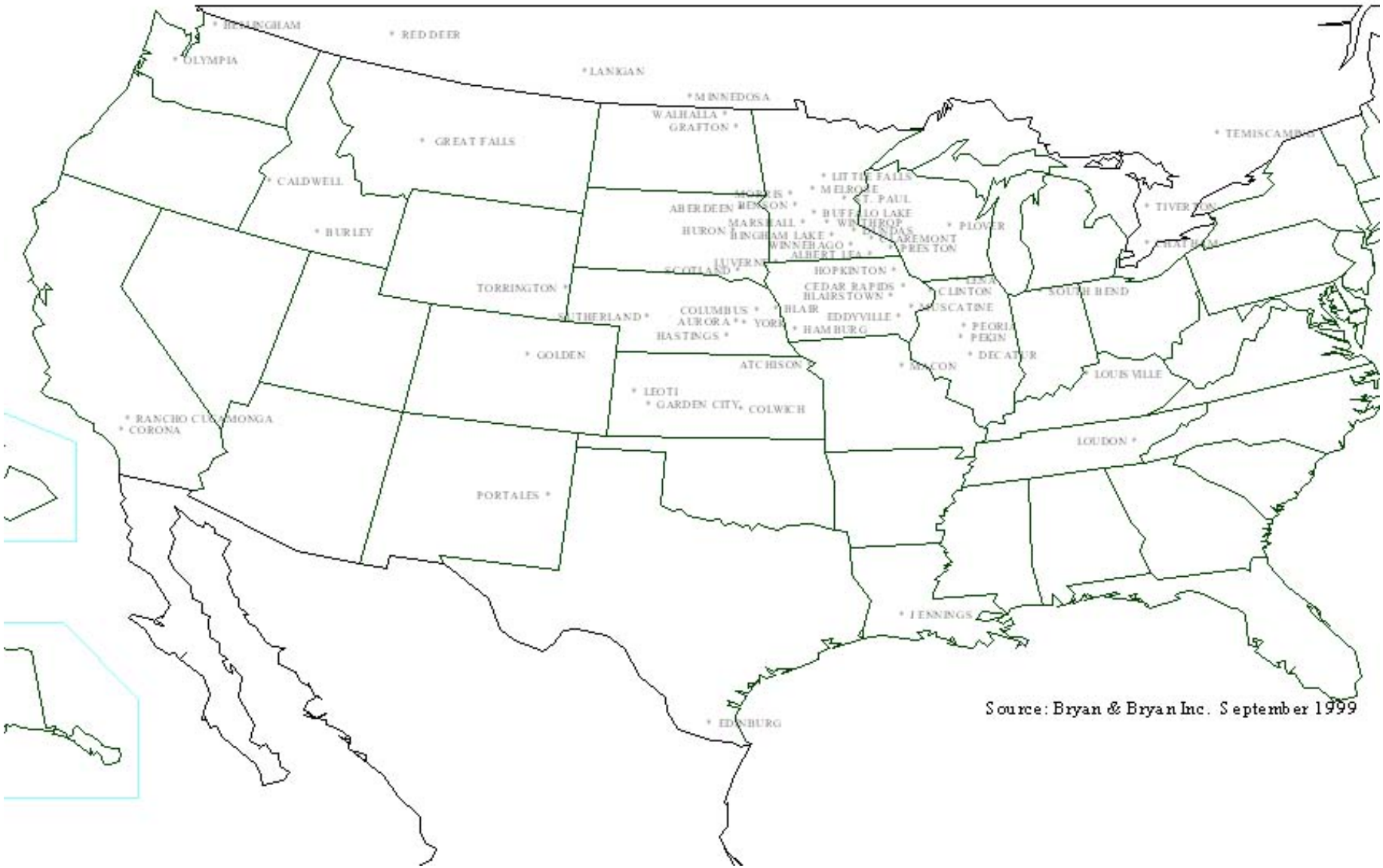

Corn
Corn Dry-Milling Process Overview
Corn Cleaning
alpha amylase enzyme
Hammermill
Mix Slurry
Liquefaction
CO2
Cooker
Dist
illat
ion
Fermentation
Yeast and Glucoamylase Enzyme
whole stillage
Ethyl Alcohol
Centrifuge
Evaporator
thin stillage
coarse solids
Rotary Dryer
Distillers Wet Grains
Distillers Dried Grains with Solubles
Cond. Distillers Solubles
Feed Industry Co-products

Dry-Milling Average Yield Per Bushel

- Ethanol 4.2 liters
- DDGS 8.2 kg
- CO_2 8.2 kg

Slide courtesy of Ms. Kelly Davis, CVEC

Map of U.S. Ethanol Plants



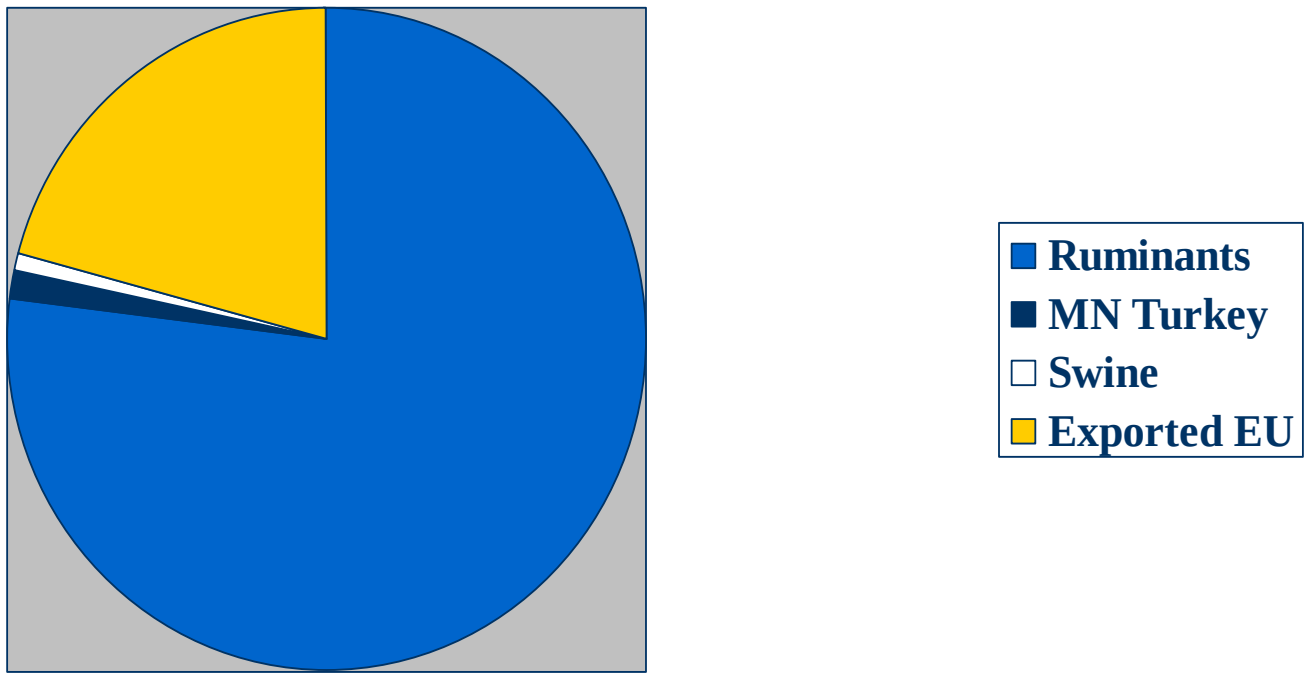
DDGS Production

- 19 new ethanol plants are currently under construction
- additional capacity is being added to existing plants
- DDGS will increase from 3.3 million tonnes in 2000 to 5.5 million tonnes in 2005
  - 66% increase in supply of DDGS

DDGS Production and Use

- 3.2 to 3.5 million metric tonnes (MT) of DDGS are produced in North America/year
  - ~ 900,000 MT produced in MN-Dakota region
  - ~ 700,000 MT exported to the EU
  - ~ 2.65 million MT fed in U.S. and Canada
    - ~ 2.58 million MT (80%) fed to ruminants
    - ~ 45,000 MT fed in MN turkey industry
    - ~ 27,000 MT used in swine diets

Markets for DDGS Produced in North America



Use of DDGS in Swine and Poultry Diets is Increasing

- DDGS produced by new Midwestern ethanol is higher in nutrient content and digestibility than DDGS from older plants
- Increased supply of DDGS has made it more economical to replace some of the corn, soybean meal, and dicalcium phosphate

The Use of DDGS in Swine Diets

DDGS Quality is Variable

- Nutritionists want PREDICTABILITY AND CONSISTENCY in feed ingredients.
- The keys for getting maximum value from DDGS are:

"Know what you have (or want)"

and

"Know how to use it"

DDGS Quality is Variable

- Color ranges from very light to very dark
- Odor ranges from sweet to smoky or burnt
- Range in concentration in selected nutrients:
  - Dry matter – 87 to 93%
  - Crude protein – 23 to 29%
  - Crude fat – 3 to 12%
  - Ash – 3 to 6%
  - Lysine – 0.59 to 0.89%

Source: Cromwell et al. (1993)

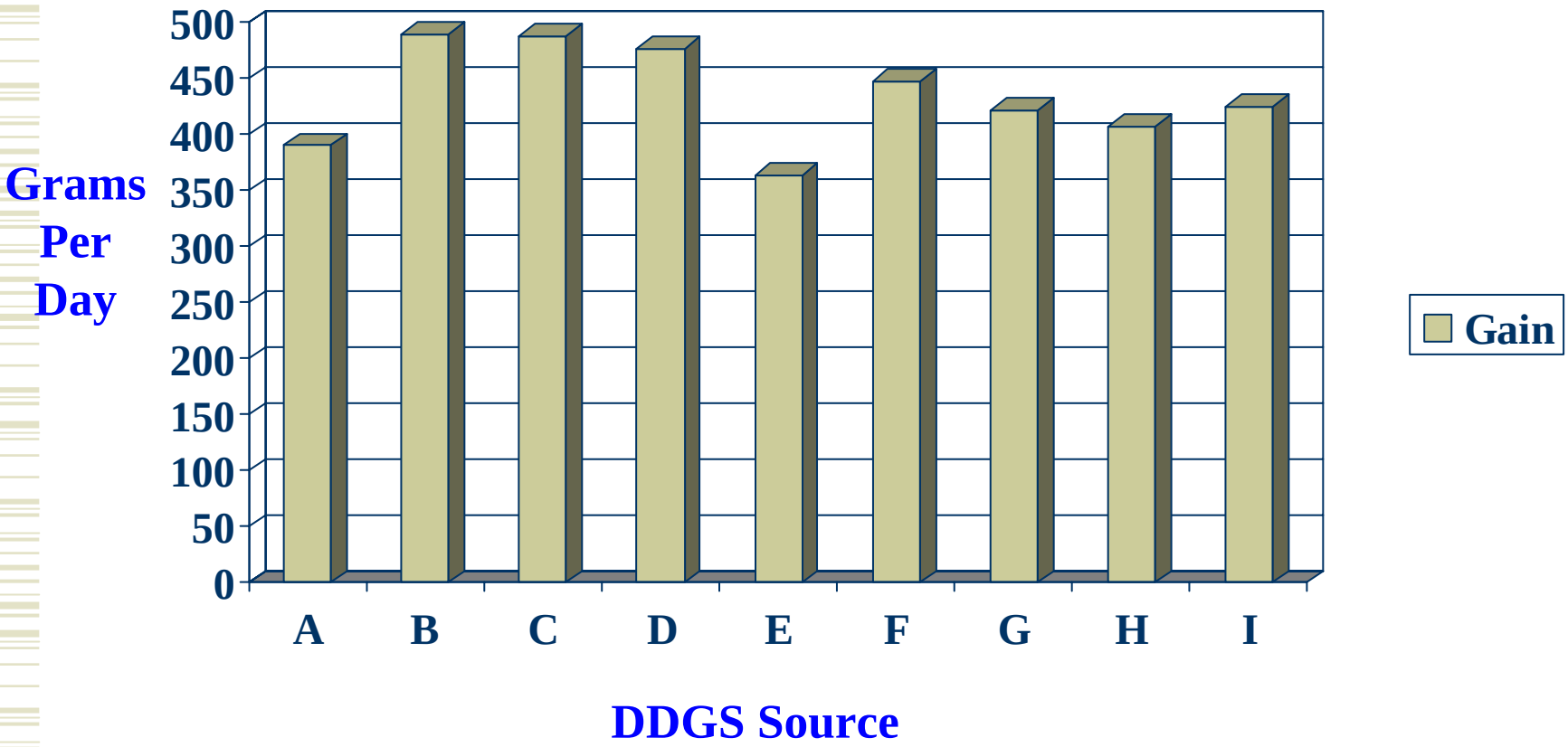
Low Quality,
Less Digestible
DDGS

High Quality,
Highly Digestible
DDGS

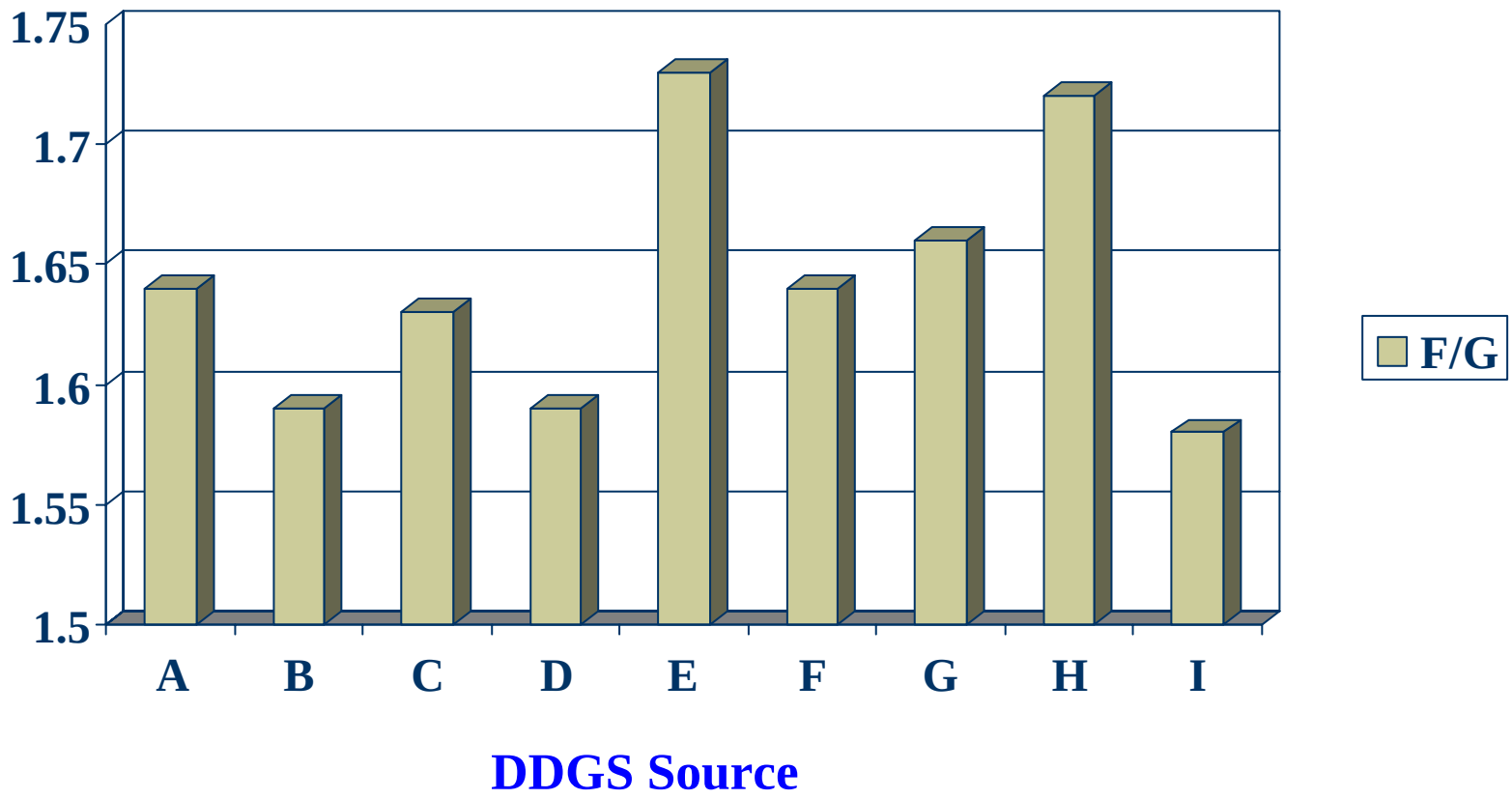
Nutrient Profile of Corn Distiller's Dried Grains with Solubles (DM Basis)

Nutrient	MW DDGS	Low Quality DDGS	NRC (1998)
Dry matter, %	88.9	88.3	93.0
Crude protein, %	30.2	28.1	29.8
Fat, %	10.9	8.2	9.0
Fiber, %	8.8	7.1	4.8
Calcium, %	0.06	0.44	0.22
Phosphorus, %	0.89	0.90	0.83
P availability, %	90.0	?	79.0
DE, kcal/kg	3965	3874	3449
ME, kcal/kg	3592	3521	3038
Lys, %	0.83	0.53	0.67
App. Dig. Lys, %	0.44	0.00	0.34
Met, %	0.55	0.50	0.54
App. Dig. Met, %	0.32	0.24	0.42
Thr, %	1.13	0.98	1.01
App. Dig. Met, %	0.62	0.36	0.60
Trp, %	0.24	0.19	0.27
App. Dig Trp, %	0.15	0.15	0.15

Growth of Chicks Fed Nine Sources of DDGS



Feed Conversion of Chicks Fed Nine Sources of DDGS



Nutritional Value of DDGS for Swine

- Must use high quality DDGS
  - Light color = high amino acid digestibility
- Excellent energy and available phosphorus source
- Nutritional value higher than previously thought
- May improve gut health (i.e. ileitis, gut edema)
  - Decreased mortality and improved growth performance
- Effective partial replacement for corn and soybean meal

Quality Considerations for Selecting DDGS Sources for Swine and Poultry

- Physical characteristics
  - Bulk density – .44 to .48 kg/cubic meter
  - Particle size:
    - maximum coarse particles - 10% on 2000 screen
    - maximum fine particles - 15% on 600 screen & in pan
  - Smell – fresh, fermented
  - Color – goldenrod

Quality Considerations for Selecting DDGS Sources for Swine and Poultry

- Nutrient Specifications
  - Moisture – maximum 12%
  - Protein – minimum 26.5%
  - Fat – minimum 10%
  - Fiber – maximum 7.5%
  - DE value is 100% of corn DE
  - ME value is 93% of corn ME

Maximum Recommended Inclusion Rates of DDGS in Swine Diets

- Nursery pigs (>15 lbs)
  - Up to 25 %
- Grow-finish pigs
  - Up to 20% (higher levels reduce pork fat quality)
- Gestating sows
  - Up to 40%
- Lactating sows
  - Up to 20%

Limitations of Using DDGS in Swine Diets

- Amino acid digestibility is reduced in dark colored DDGS
- High fiber limits its use in pre-starter diets (<6.8 kg BW)
- Excess nitrogen can be minimized by using synthetic amino acids
- High oil content limits maximum inclusion rates in grow-finish diets due to pork fat quality

Limitations of Using DDGS in Swine Diets

- Dietary inclusion rates should be gradually increased in gestation (up to 40%) and lactation (up to 20%) diets to allow sows to adapt.
- Because of the high fiber content, sows will take 2x longer to eat their daily feed allottment than sows on a corn-soybean meal diet.

Maximizing the Value of Corn DDGS in Swine Diets

- Formulate diets using digestible amino acid values
- High available P reduces the level of dietary P supplementation
- Adding 10% DDGS to grow-finish diets may reduce mortality due to ileitis and gut edema

Example Swine Grower Diet with Containing 20% DDGS

Ingredient	%	Nutrient Composition	
Corn	60.05	Crude protein, %	19.07
DDGS	20.00	App. Dig. Lysine, %	0.74
Soybean meal, 46%	17.70	App. Dig. M + C, %	0.51
Dicalcium phosphate	0.60	App. Dig. Thr., %	0.48
Limestone	1.05	App. Dig. Trp, %	0.15
Salt	0.30	ME, kcal/kg	3309
Vitamin-TM premix	0.15	Ca, %	0.60
L-lysine HCl	0.15	P, %	0.53
Total	100.00	Avail. P, %	0.30

Example Swine Grower Diet with Containing 20% DDGS and 100 FTU/kg Phytase

Ingredient	%
Corn	60.70
DDGS	20.00
Soybean meal, 46%	17.65
Dicalcium phosphate	0.05
Limestone	0.95
Salt	0.30
Vitamin-TM premix	0.15
L-lysine HCl	0.15
Phytase - 1000	0.05
Total	100.00

Nutrient Composition	
Crude protein, %	19.10
App. Dig. Lysine, %	0.74
App. Dig. M + C, %	0.51
App. Dig. Thr., %	0.48
App. Dig. Trp, %	0.15
ME, kcal/kg	3330
Ca, %	0.44
P, %	0.43
Avail. P, %	0.20

Calculating the Value of DDGS in Swine Diets Using Soybean Meal 44%

Additions/1000 kg diet

+ 100 kg DDGS	x	cost/kg	= $
+ 1.5 kg limestone	x	cost/kg	= $
TOTAL ADDITIONS (A)			**= $**

Subtractions/1000 kg diet

- 88.5 kg corn	x	cost/kg	= $
- 10 kg SBM (44%)	x	cost/kg	= $
- 3 kg dicalcium phosphate	x	cost/kg	= $
TOTAL SUBTRACTIONS (S)			**= $**

S - A = Opportunity cost for DDGS/100 kg

Calculating the Value of DDGS in Swine Diets Using Soybean Meal 46%

Additions/1000 kg diet

+ 100 kg DDGS	x	cost/kg	= $
+ 1.5 kg limestone	x	cost/kg	= $
TOTAL ADDITIONS (A)			**= $**

Subtractions/1000 kg diet

- 89 kg corn	x	cost/kg	= $
- 9.5 kg **SBM (46%)**	x	cost/kg	= $
- 3 kg dicalcium phosphate	x	cost/kg	= $
TOTAL SUBTRACTIONS (S)			**= $**

S - A = Opportunity cost for DDGS/100 kg

U of M DDGS Web Site

We have developed a DDGS web site featuring:

* research summaries (swine, poultry, dairy, & beef)
* presentations given
* links to other DDGS related web sites

Visit this web site at:

www.ddgs.umn.edu