POET®

HUMAN + NATURE

DDGS and Amino Acid Nutrition in Swine Diets

December 5, 2018

Today's Moderator

Dr. Kevin Herrick
Director of Technical Services
POET Nutrition

Dakota Gold by POET Nutrition

- POET's process for ethanol production results in a DDGS (Dakota Gold) with unique nutritional characteristics.
- POET Nutrition coordinates sales and distribution of Dakota Gold for both domestic and global markets while focusing on quality and consistency of its DDGS.
- Research has demonstrated Dakota Gold supports optimal performance for beef, dairy, poultry, and swine.
- For more information, go to www.dakotagold.com

Upcoming Events

- December 6: AgOutlook, Sioux Falls, SD
- January 9-10: SD Pork Congress, Sioux Falls, SD
- February 12-14: IPPE, Atlanta, GA
- March 12-14: Midwest Poultry, Minneapolis, MN
- May 15-16: DGTC Symposium, Minneapolis, MN

Key Learning Points

- Optimal DDGS inclusion for swine diets
- Amino acid considerations with greater DDGS inclusions
- Economics of greater DDGS inclusions
- Results from recent DDGS research
- DDGS market updates

Today's Panelists

Dr. Jerry Shurson
Animal Science Professor
University of Minnesota

Isaac Crawford
VP, Trading & Merchandising
POET Nutrition

Dr. Gerald (Jerry) Shurson received his B.S. degree in Animal Science and Agricultural Economics at the University of Minnesota, and his M.S. and Ph.D. degrees in swine nutrition at Michigan State University. He is currently Professor in the Department of Animal Science at the University of Minnesota with responsibilities for research, on-campus teaching, and extension.

Jerry is best known for his research contributions on determining the nutritional value of corn co-products produced by the fuel ethanol industry, but his diverse research program also involves numerous studies to better understand fiber, lipid, amino acid, and trace mineral nutrition in swine.

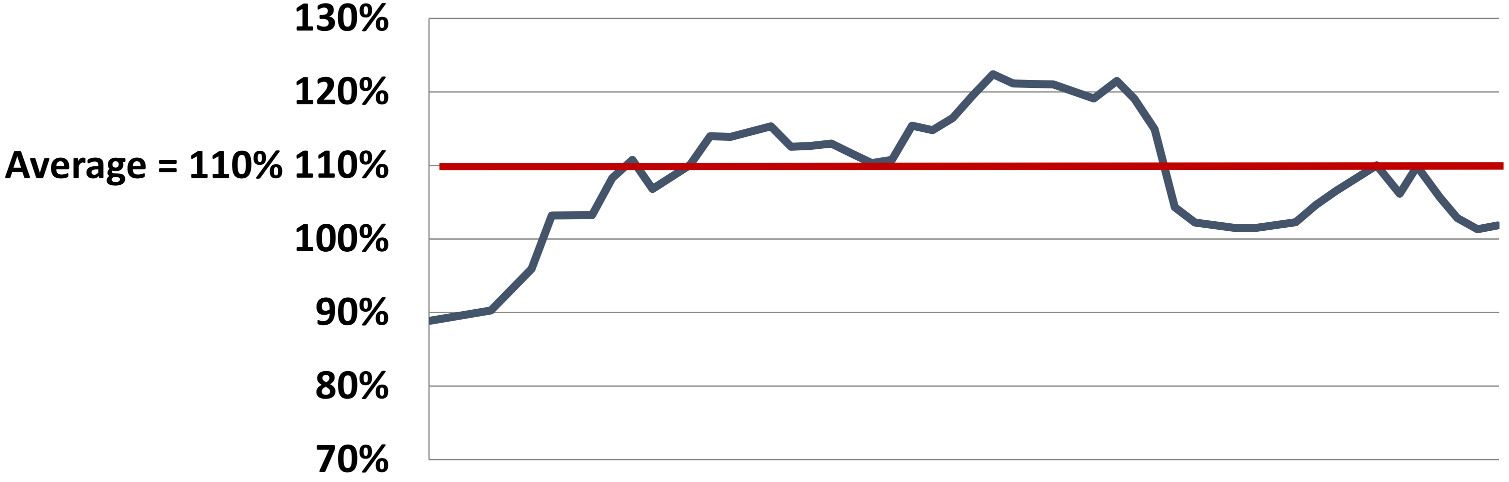
Precision DDGS Nutrition to Capture Greater Economic Value for Swine

Dr. Jerry Shurson

Department of Animal Science

University of Minnesota

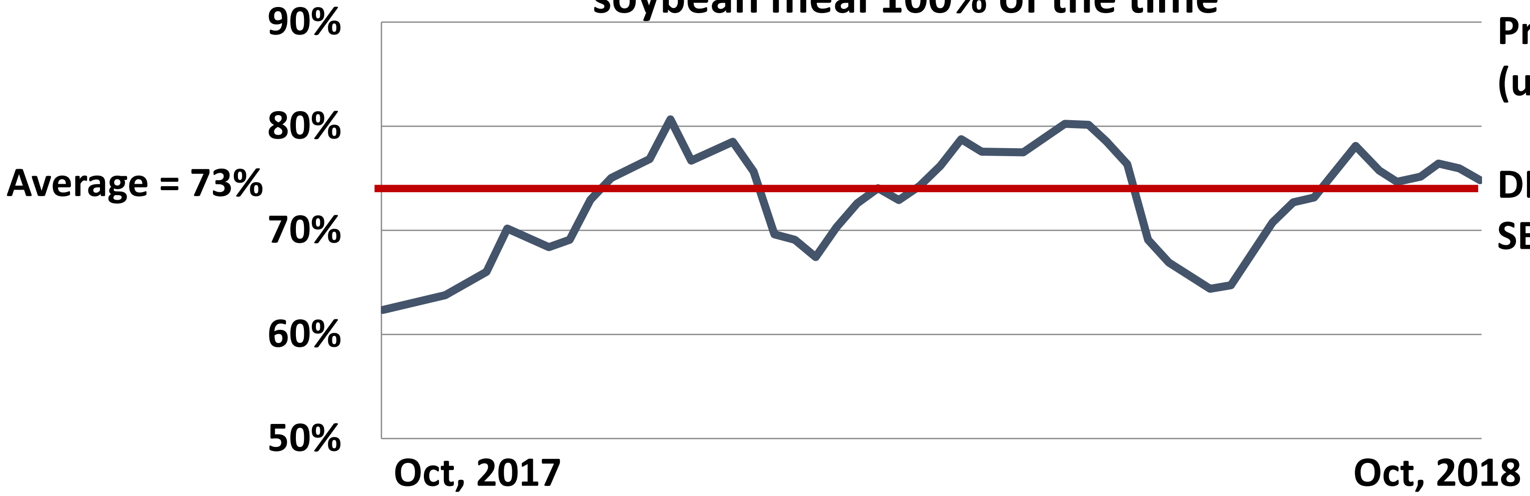
Price of DDGS was greater than corn 93% of the time



Price Range (Metric ton):

DDGS = $122 - $190
Corn = $131 - $159
SBM = $332 - $434

Price/unit of protein of DDGS was less than soybean meal 100% of the time

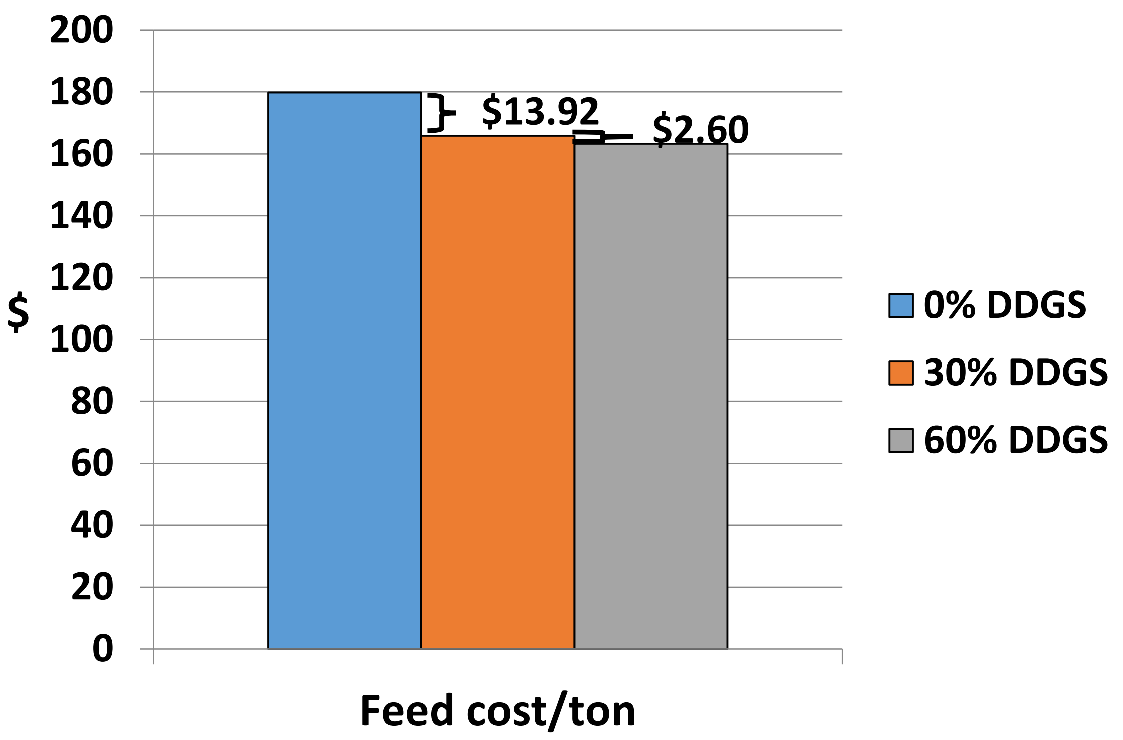


Price Range (unit of protein):

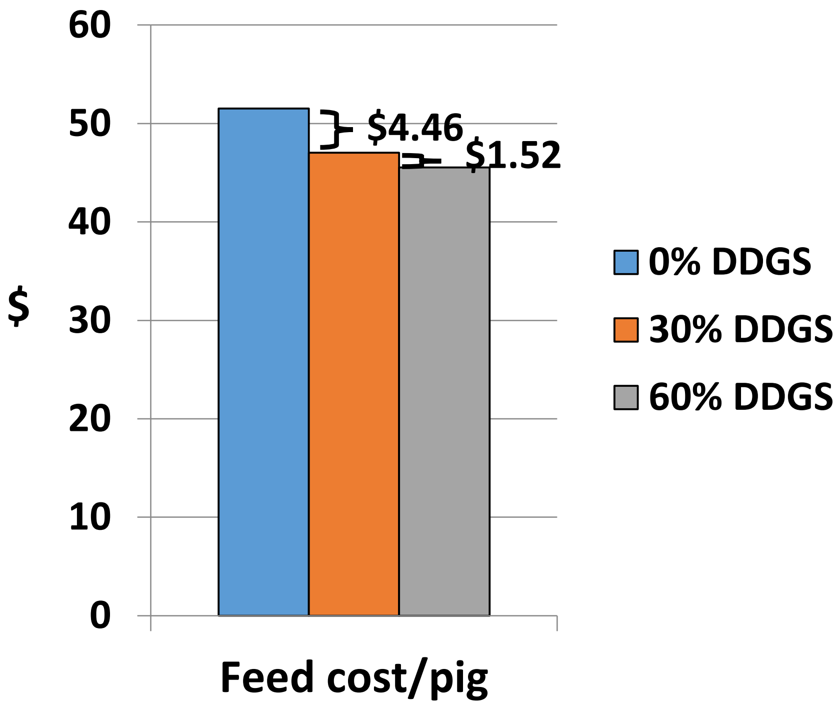
DDGS = $4.5 - 7.0
SBM = $7.0 - $9.1

Source: DTN DDG Weekly Update

Cost Savings of a 4-Phase DDGS Grower-Finisher Program using 2018 AVERAGE Ingredient Prices



Feed ingredient prices
- corn ($129/ton)
- soybean meal ($341/ton)
- DDGS ($142/ton)



Feed cost/pig
- 113 days on feed
- 581 lbs feed consumed/pig

Opportunities for Feed Cost Savings/Pig from Feeding DDGS Diets to Growing-Finishing Pigs in 2018

Ingredient prices	30% DDGS	60% DDGS	Cumulative
Highest	**- $4.42**	**- $1.43**	**- $5.85**
Average	**- $4.46**	**- $1.52**	**- $5.98**
Lowest	**- $6.33**	**- $4.36**	**- $10.69**

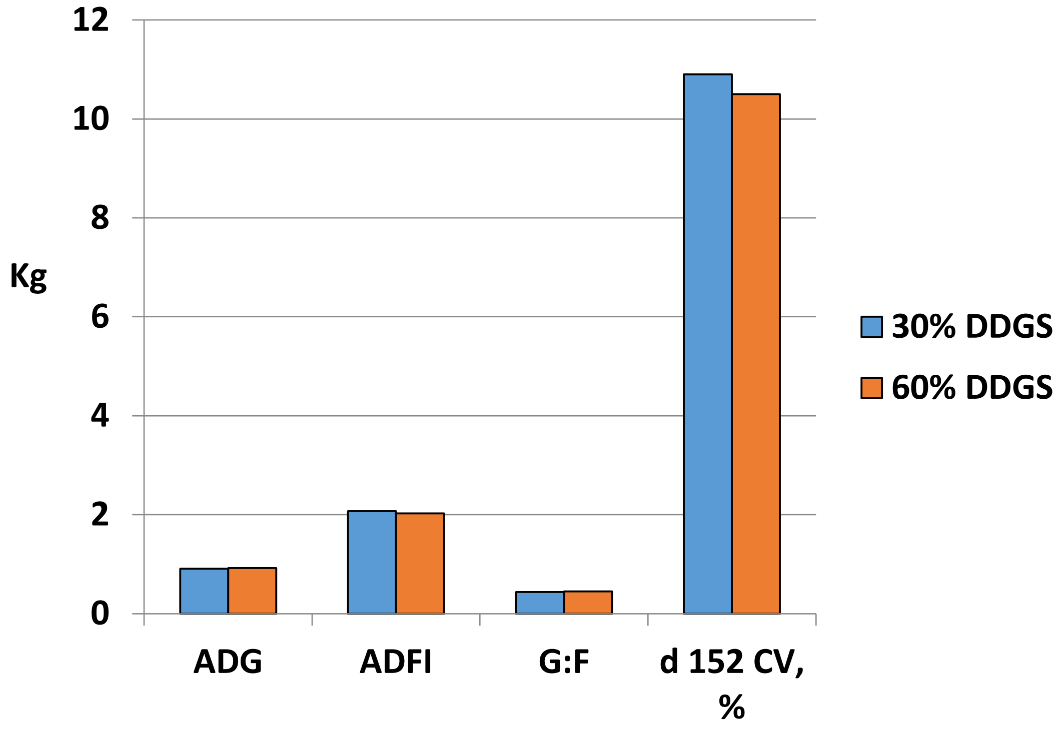
$/ton	**Highest**	**Average**	**Lowest**
Corn	144	129	125
Soybean meal	388	341	313
DDGS	172	142	111

Common Dietary DDGS Inclusion Rates in Commercial Swine Diets

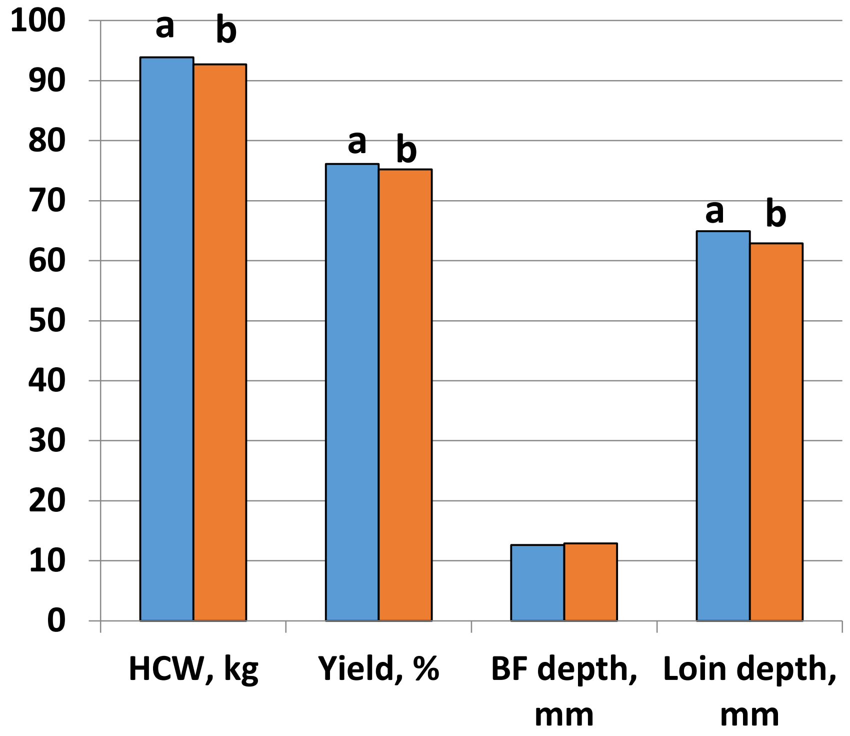
	Diet inclusion rate, %
Starter (> 7 kg BW)	5 – 20
Grower	10 – 30
Finisher	10 – 30
Gestation	20 – 50
Lactation	10 – 30



Feed Cost Savings is Driving Higher DDGS Inclusion Rates in Growing-Finishing Pig Diets



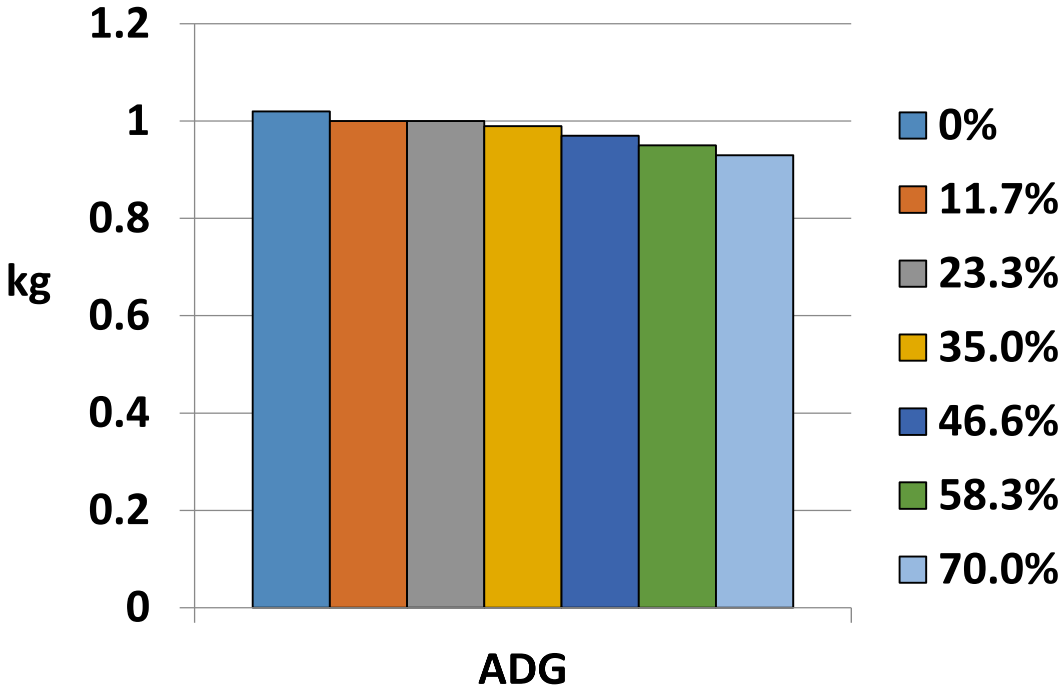
Grower-finisher (d 56-155)
1,860 pigs in commercial facility

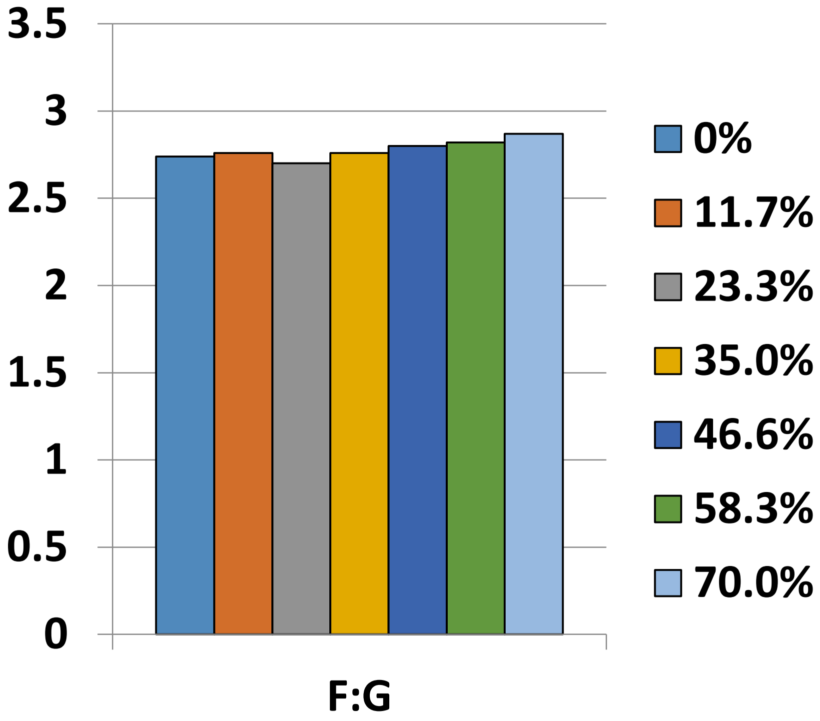


[a,b]Means with different letters differ ($P < 0.05$)

Weber at al. (2015)

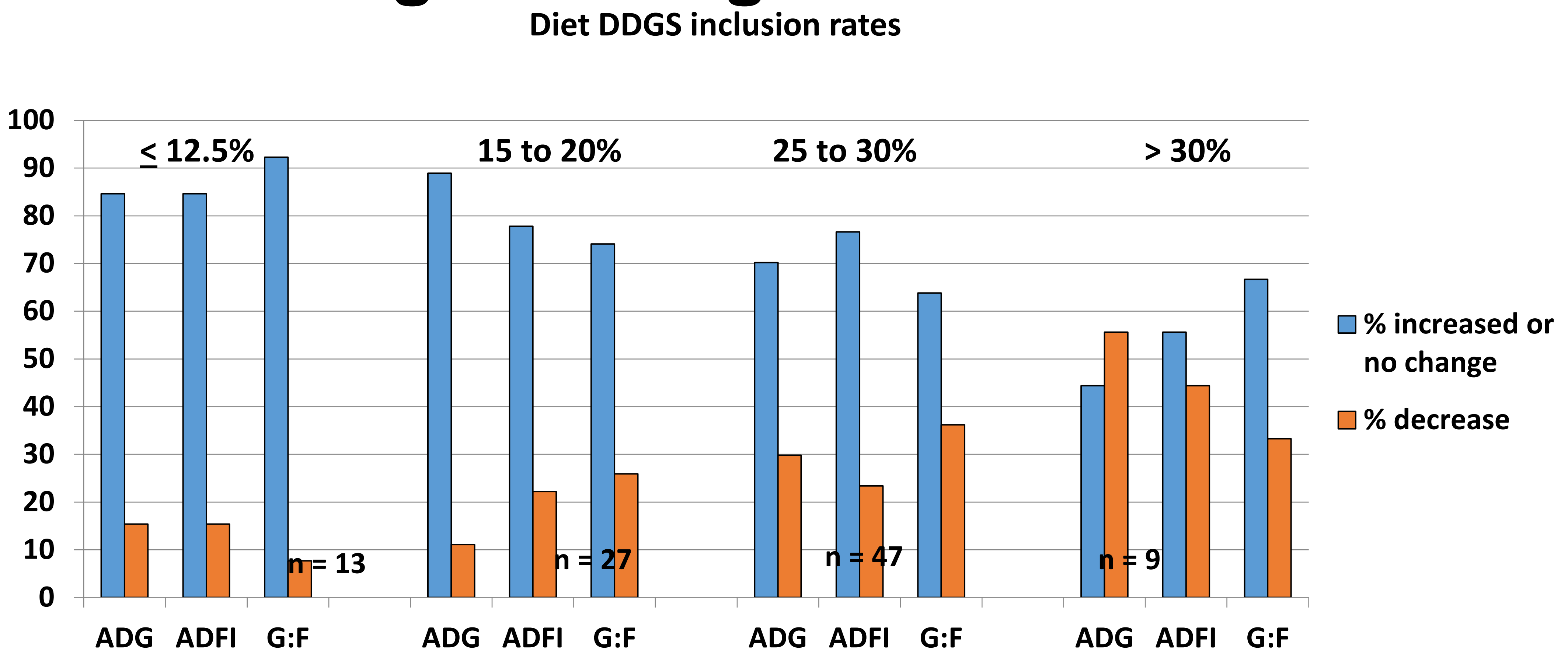
Growth Performance Responses From Increasing DDGS Inclusion rates in Growing-Finishing Pig Diets





Study conducted by a major U.S. commercial swine integrator
96 day feeding period (37 to 129 kg)

Growth Performance Responses with Increasing DDGS Inclusion Rates in Nursery and Growing-Finishing Diets



96 observations from 27 published studies since 2010

DDGS Sources Vary in Energy and Digestible Nutrient Content

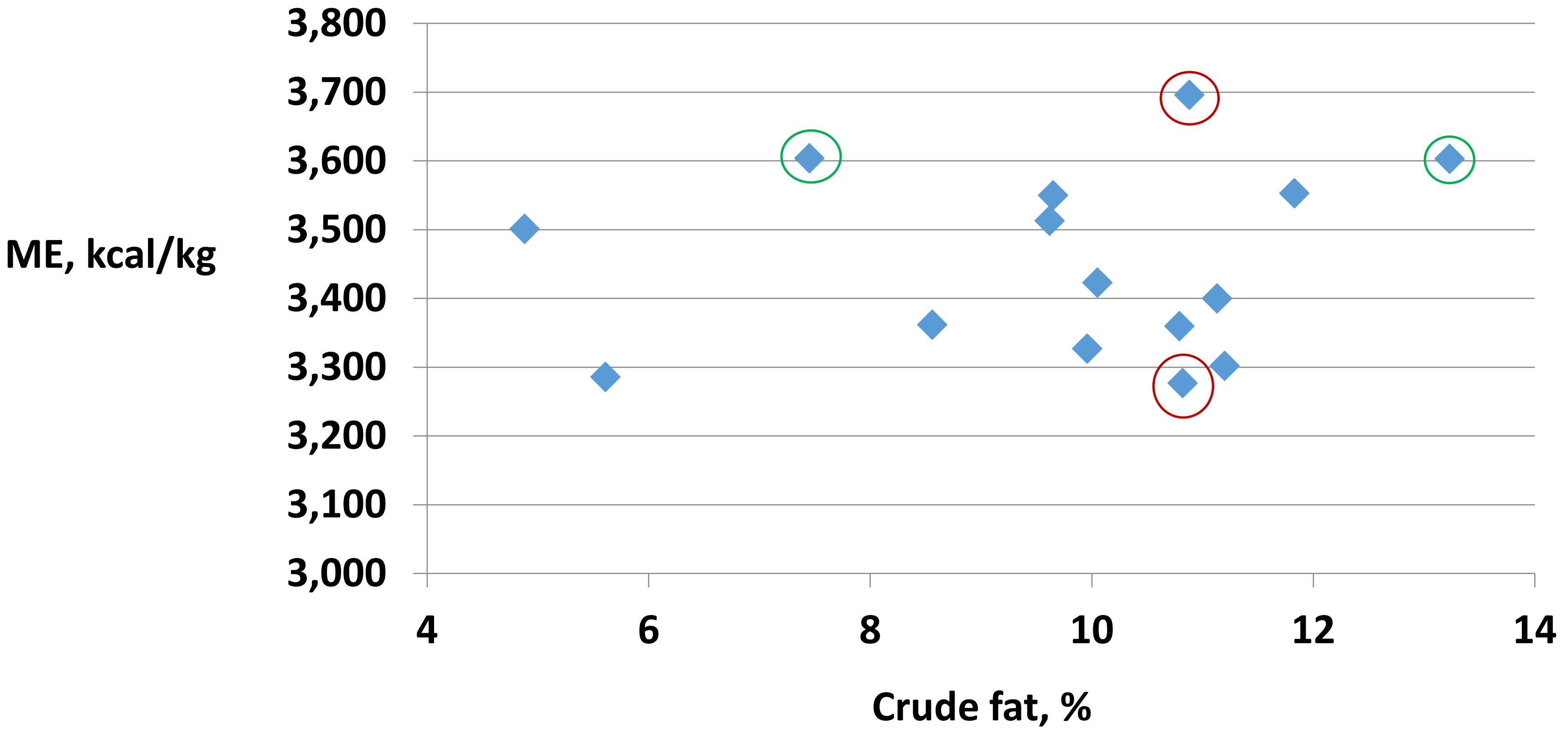
	NRC (2012)	Range of published values	Difference
ME, kcal/kg	3,396	2,917 – 3,872	955
NE, kcal/kg	2,343	1,797 – 2,603	806
SID Lys, %	0.55	0.20 – 0.82	0.62
SID Met+Cys, %	0.79	0.58 – 1.26	0.68
SID Thr, %	0.70	0.48 – 1.46	0.98
SID Trp, %	0.14	0.06 – 0.22	0.16
STTD P, %	0.39	0.41 - 0.75	0.34

All values on an as-fed basis (89% DM)

Using an average NE value of 2,120 kcal/kg may be appropriate for most DDGS sources.

Accurate Energy and Digestible Nutrient Values are Essential when Feeding High Dietary Levels of DDGS

Crude Fat Does Not Predict Metabolizable Energy (ME) Content of DDGS for Swine



Kerr et al. (2013)

Swine ME Can Be Estimated From Chemical Composition of DDGS

DE, kcal/kg = - 2,161 + (1.39 × GE, kcal/kg) – (20.7 × % NDF) – (49.3 × % Crude Fat)

ME, kcal/kg = − 261 + (1.05 × DE, kcal/kg) − (7.89 × % CP) + (2.47 × NDF) − (4.99 × % Crude Fat)

Urriola et a. (2014)

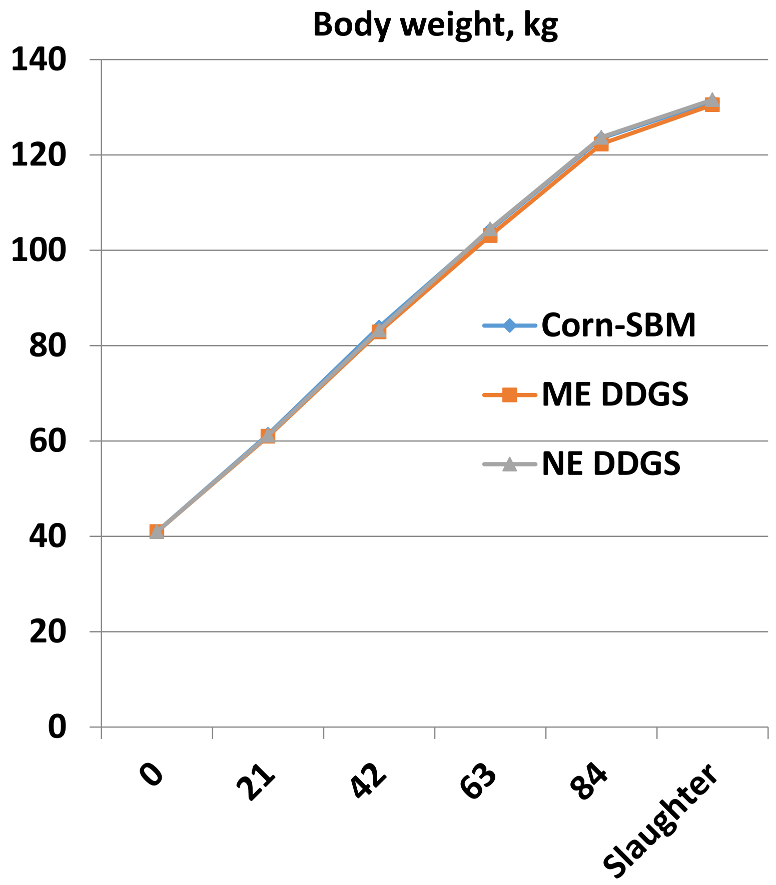
Swine NE Can Be Estimated From Chemical Composition of DDGS

NE, kcal/kg = - 1,130.5 + (0.27 × GE, kcal/kg) + (23.86 × % Crude Fat) – (10.83 × % NDF)

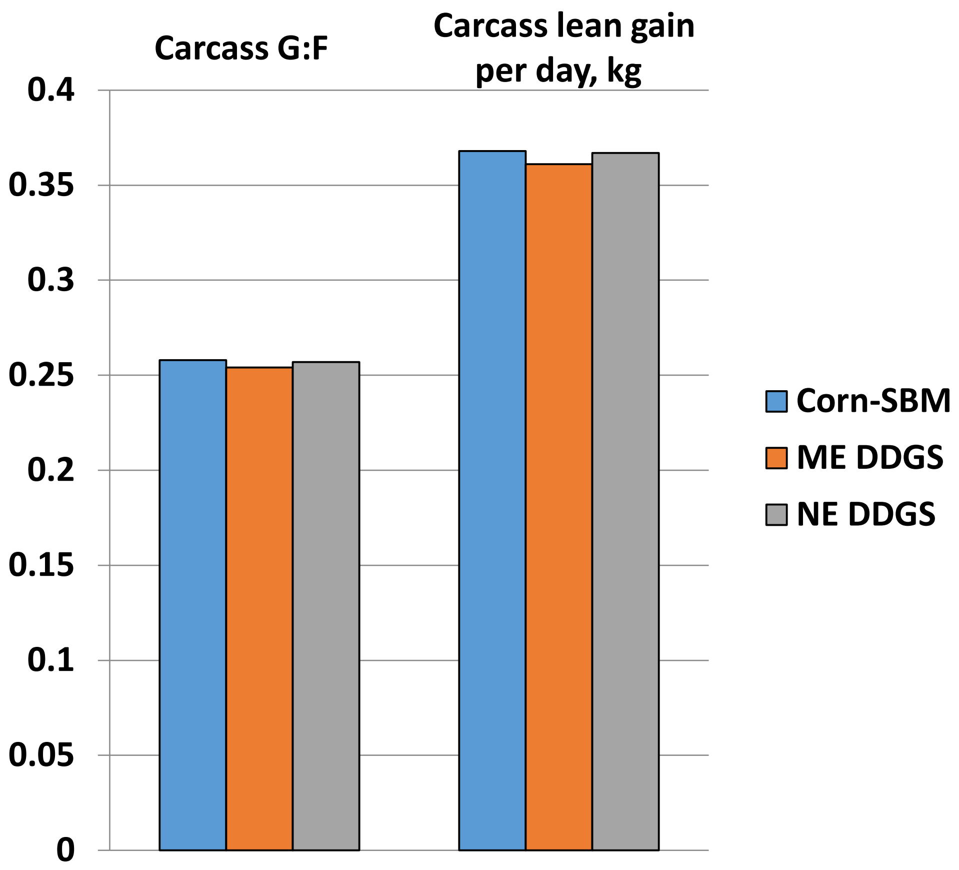
$R^2 = 0.99$

Wu et al. (2016)

Minimal Benefits of Formulating DDGS Diets on a NE vs. ME Basis?



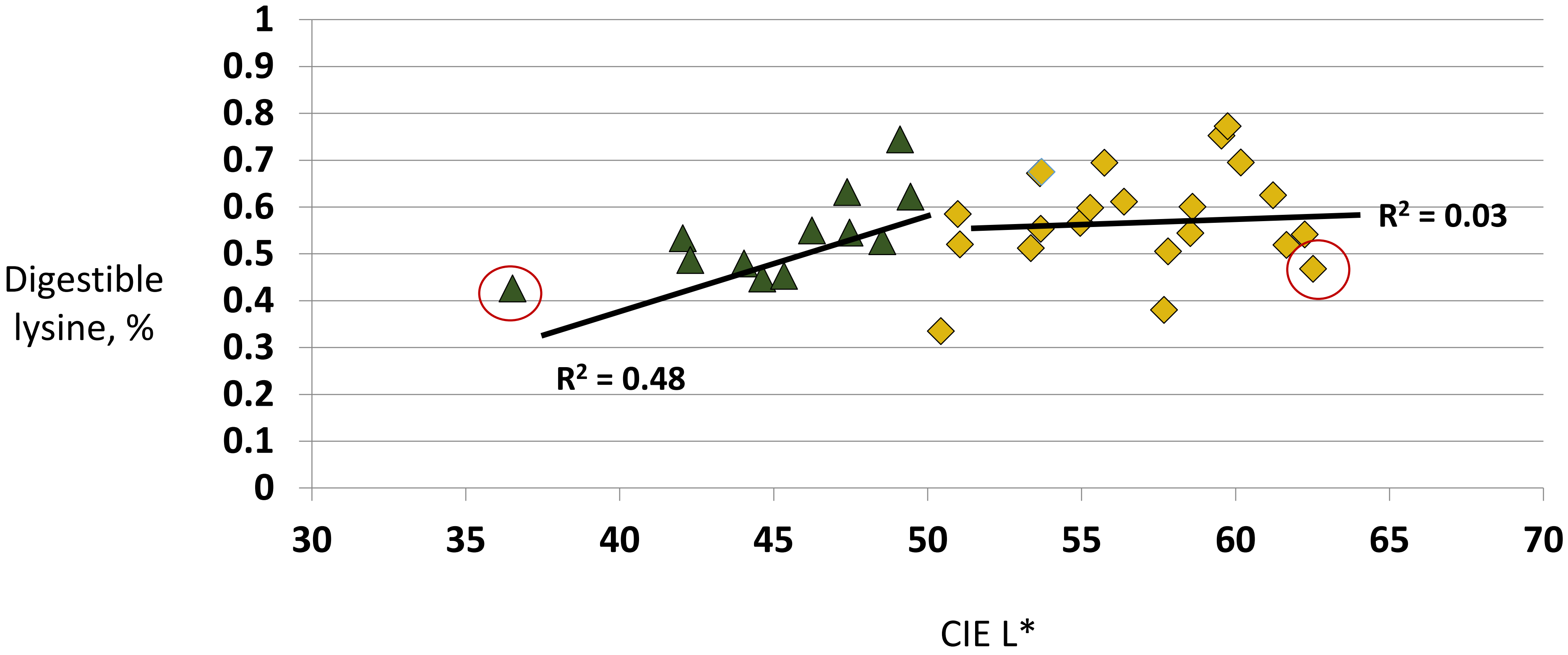
Acosta et al. (2015)



25% DDGS diets Phase 1
30% DDGS diets Phase 2 and 3
ME values from NRC (2012)
NE values from NRC (2012) equation 1-7

(Noblet et al., 1994)

Color is a Poor Indicator of Amino Acid Digestibility in DDGS



Urriola et al. (2013)

SID Amino Acid Content can be Accurately predicted for DDGS

SID Lys, g/kg = -1.03 + (Lys, g/kg × 0.88) – (NDF, g/kg × 0.003) $R^2 = 0.98$

SID Met+Cys, g/kg = 0.05 + (Met+Cys, g/kg × 0.92) – (NDF, g/kg × 0.005) $R^2 = 0.99$

SID Thr, g/kg = 1.30 + (Thr, g/kg × 0.64) – (ADF, g/kg × 0.028) $R^2 = 0.99$

SID Trp, g/kg = -0.17 + (Trp, g/kg × 0.89) $R^2 = 0.99$

SID Leu, g/kg = 0.30 + (Leu, g/kg × 0.90) – (ADF, g/kg × 0.018) $R^2 = 0.97$

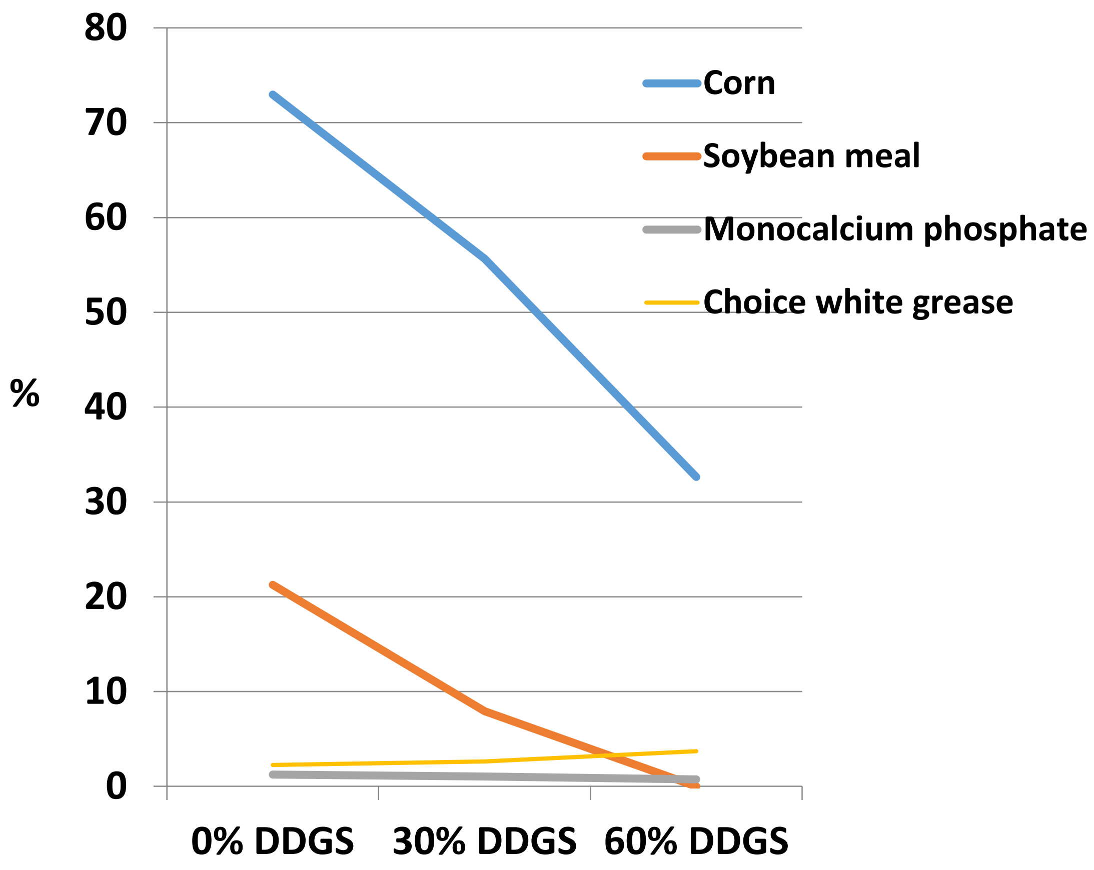
SID Ile, g/kg = 0.07 + (Ile, g/kg × 0.90) – (NDF, g/kg × 0.005) $R^2 = 0.99$

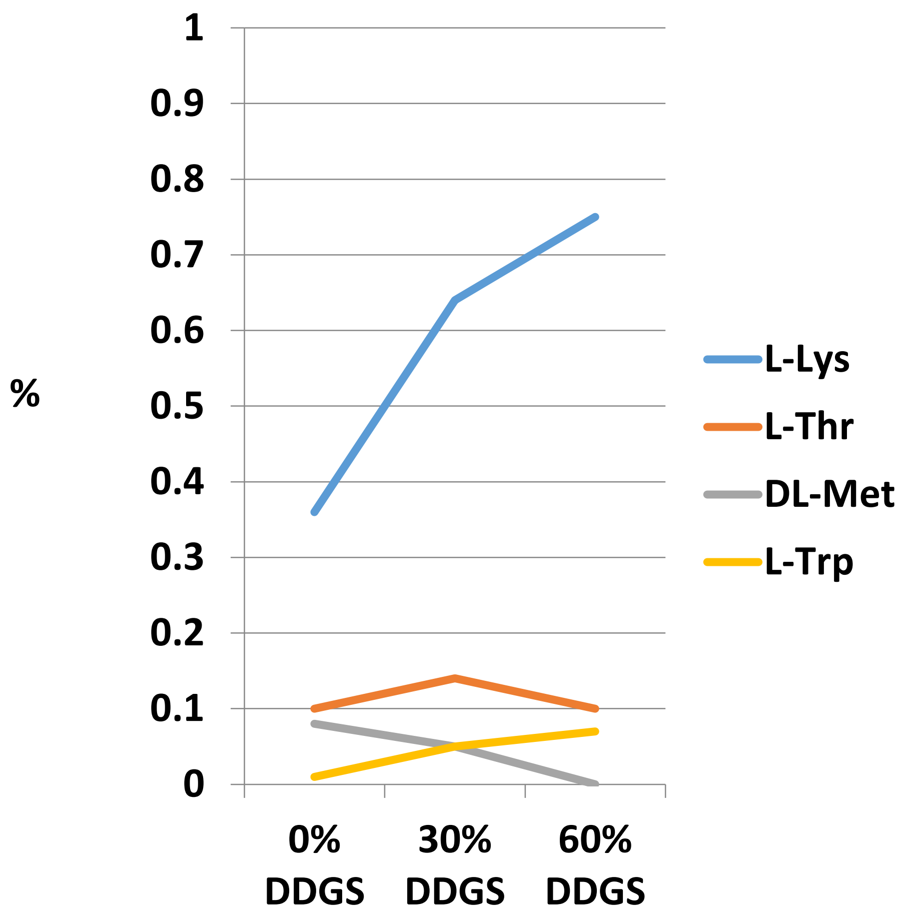
SID Val, g/kg = -0.49 + (Val, g/kg × 0.87) – (ADF, g/kg × 0.070) $R^2 = 0.99$

*Values on 88% DM basis

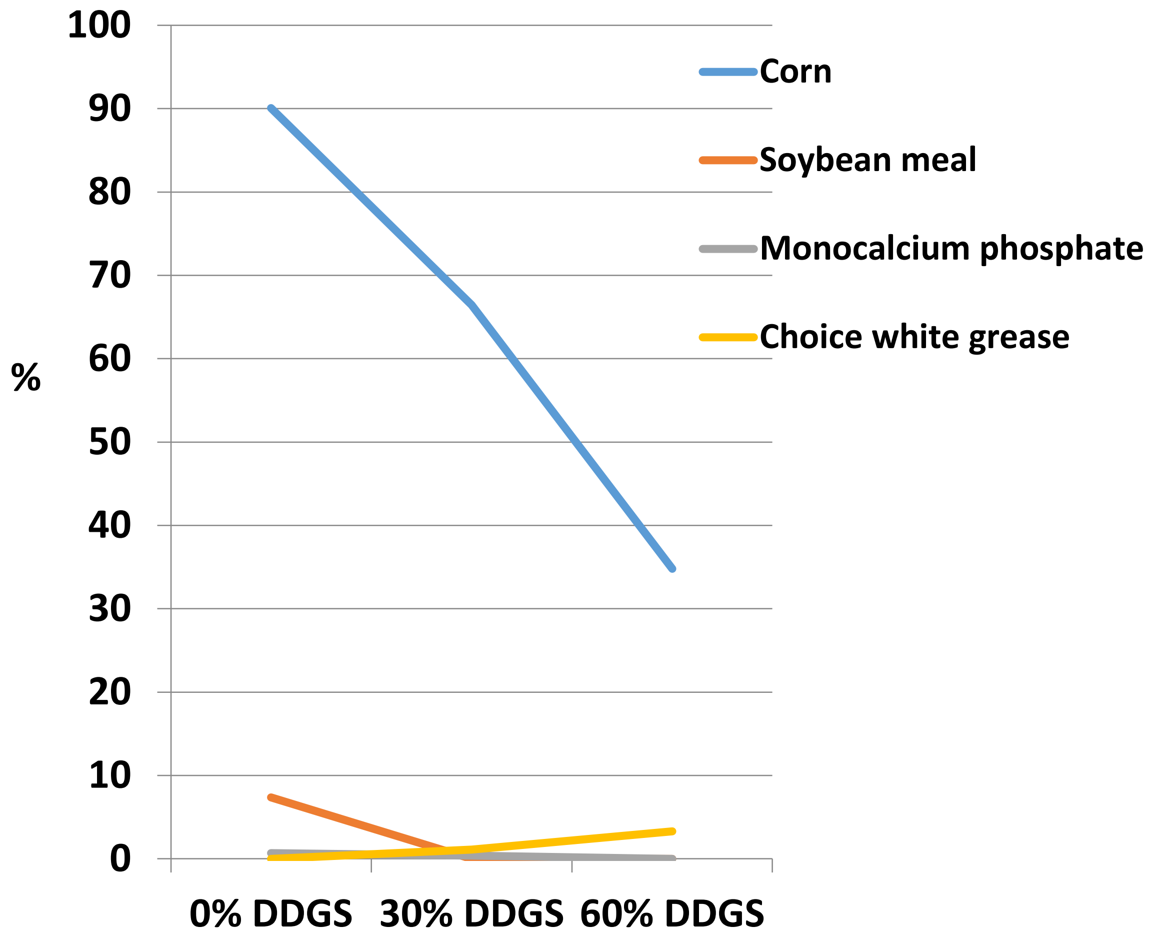
Zeng et al. (2017)

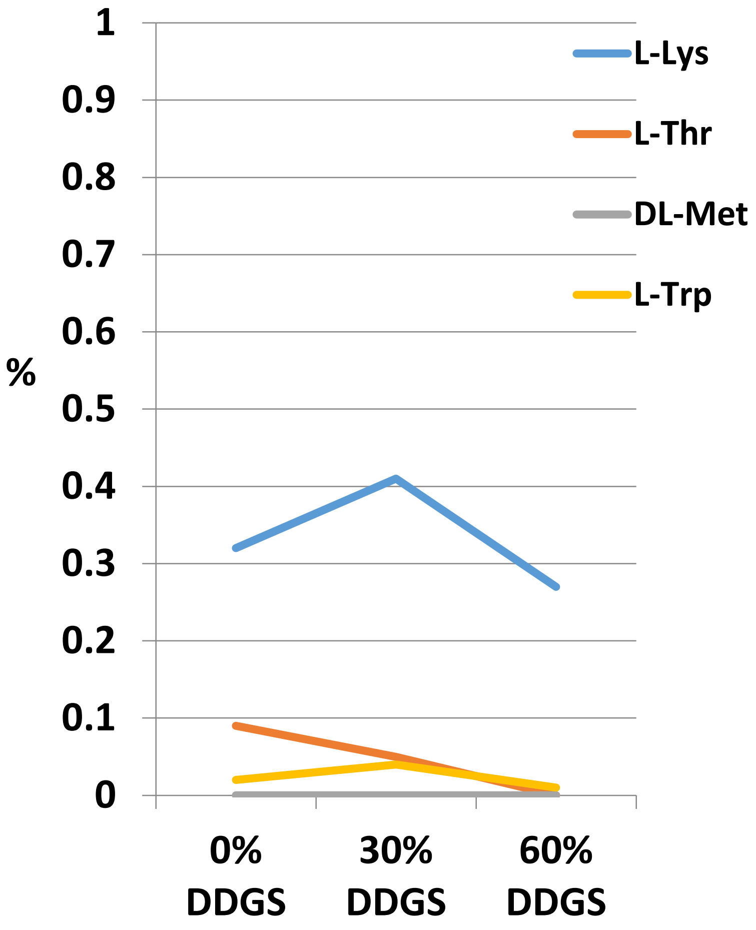
Ingredient Usage in Early Grower Diets



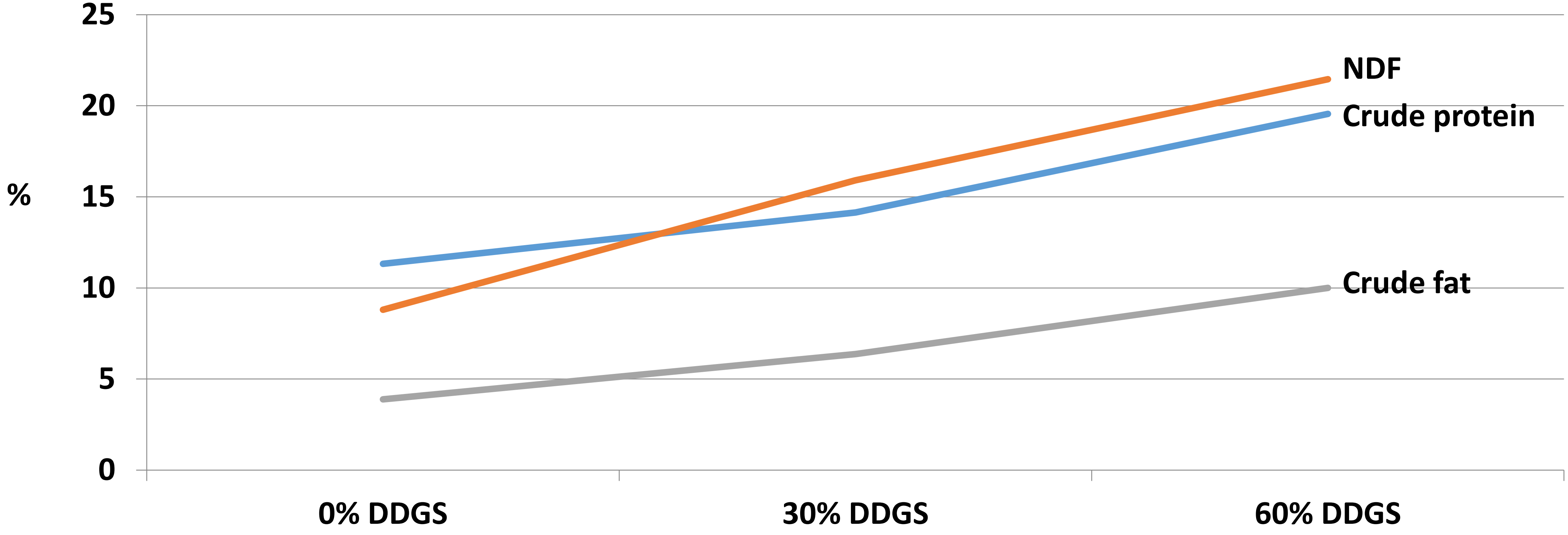


Ingredient Usage in Late Finisher Diets

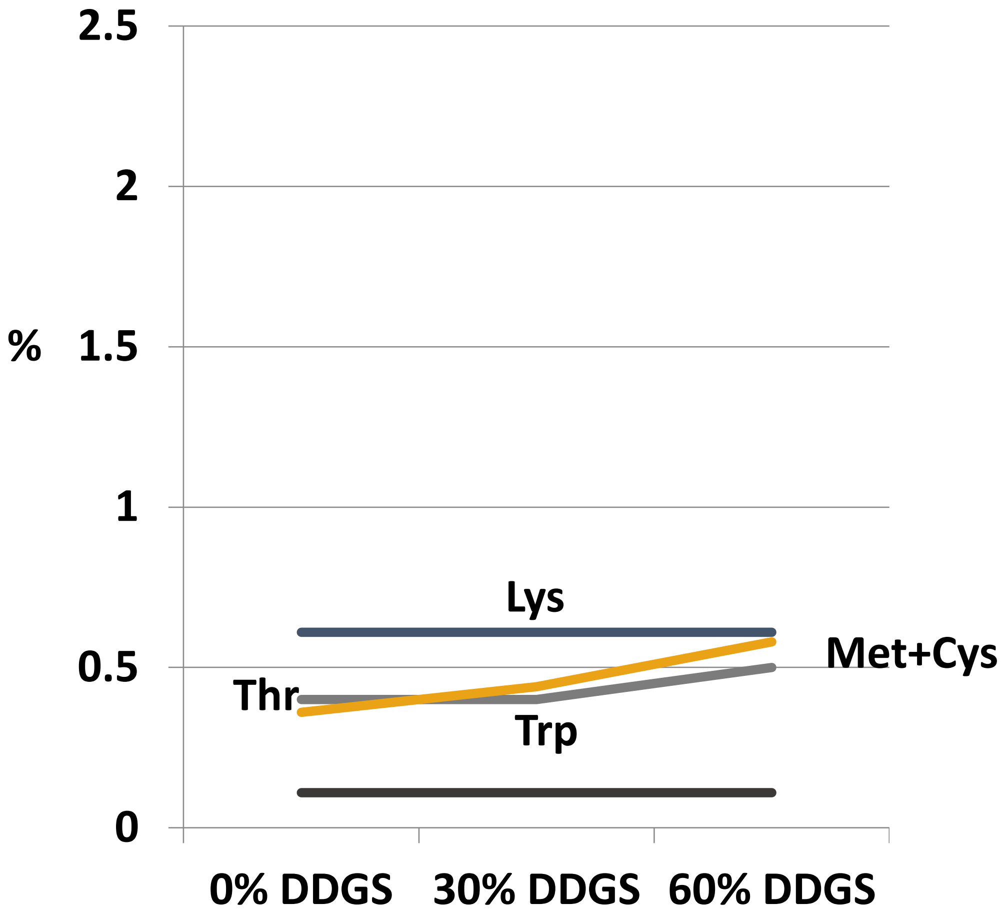


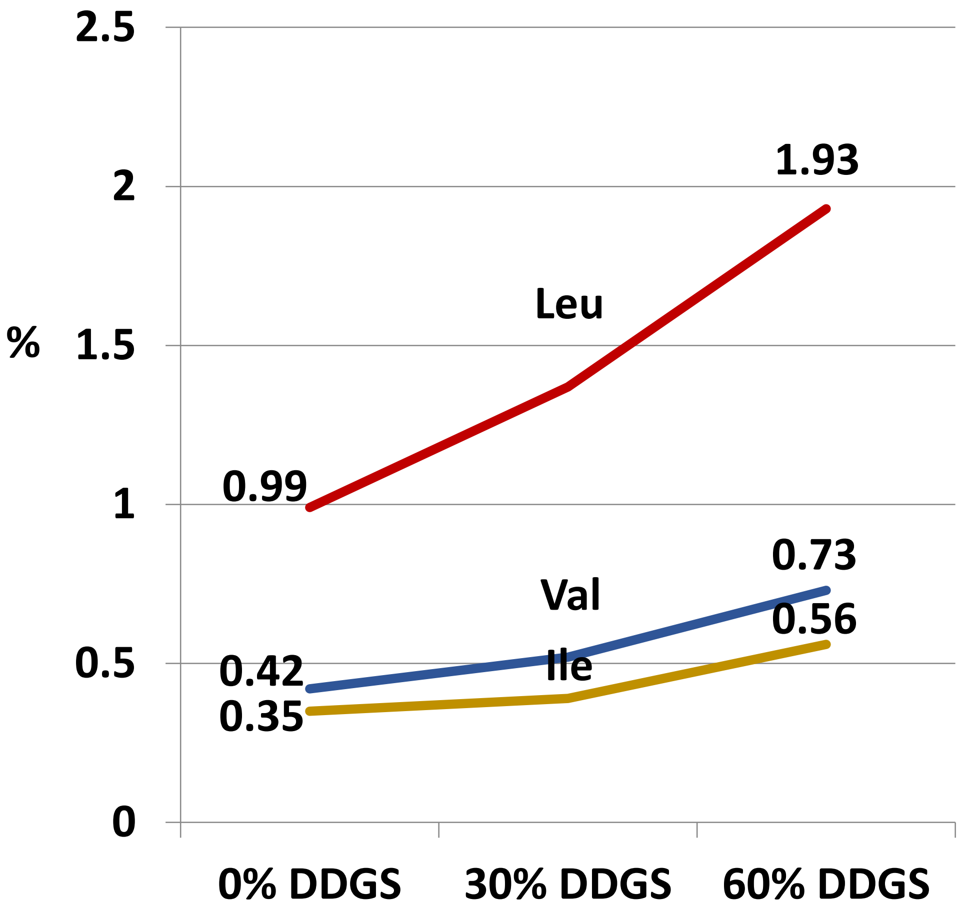


Changes in Finisher Diet Nutrient Content with Increasing DDGS Levels



Changes in Finisher Diet SID Amino Acid Content with Increasing DDGS Levels





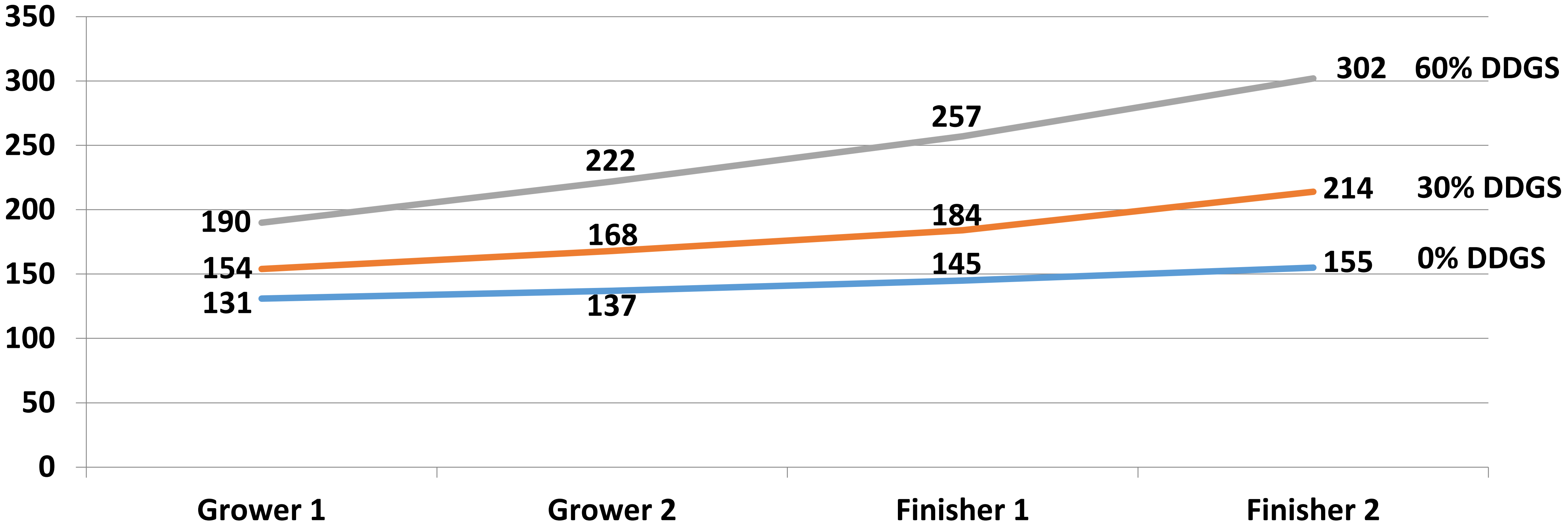
Branch Chain Amino Acids (BCAA)

- Corn protein - extremely high in Leu content
  - BCAA (Leu, Ile, Val) = 40% of essential amino acids in corn-soybean meal diets
- Excess Leu increases catabolism of Ile and Val
  - BCAA have similar structure and share the same catabolic pathways
  - Determining requirements is difficult
    - Excess of one BCAA increases catabolism of the others
  - Excess Leu has less negative effect on Val than Ile
- Limited studies for understanding BCAA interactions in swine diets
  - Excess Leu decreases ADG and ADFI
- Increased use of synthetic amino acids in swine diets:
  - Reduces proportion of amino acids from soybean meal
  - Increases proportion of amino acids from DDGS
  - Causes the BCAA imbalance to get worse
- Crystalline Ile and Val are commercially available
  - Ile = $13/kg
  - Val = $11/kg

Comparison of SID Amino Acid Ratios of DDGS and Soybean Meal

SID Amino Acid Ratios	Medium-Oil DDGS (NRC, 2012)	Soybean meal (NRC, 2012)	Optimal ratio for swine
SID Lys	100	100	100
Met+Cys:Lys	142	45	55
Thr:Lys	127	60	61
Trp:Lys	26	23	16-19
Leu:Lys	494	121	100-110
Ile:Lys	145	76	55 > 60 when Leu:Lys >140
Val:Lys	189	74	68

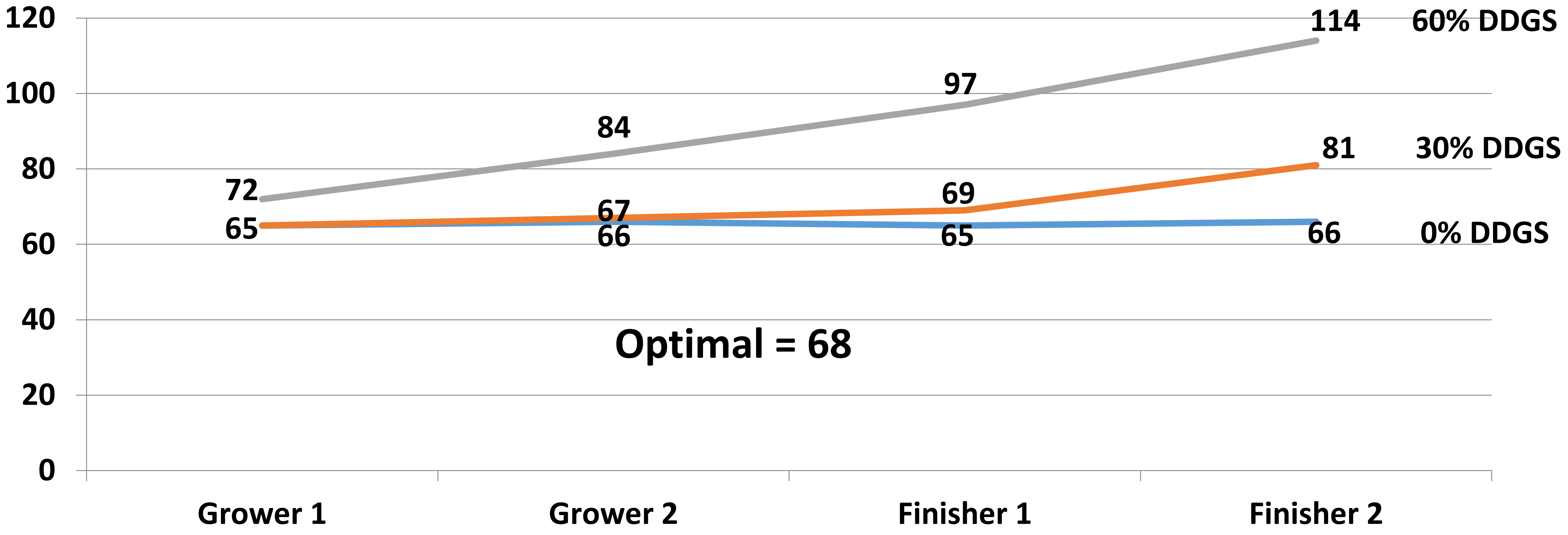
Changes in SID Leu:Lys with Increasing Dietary DDGS Levels



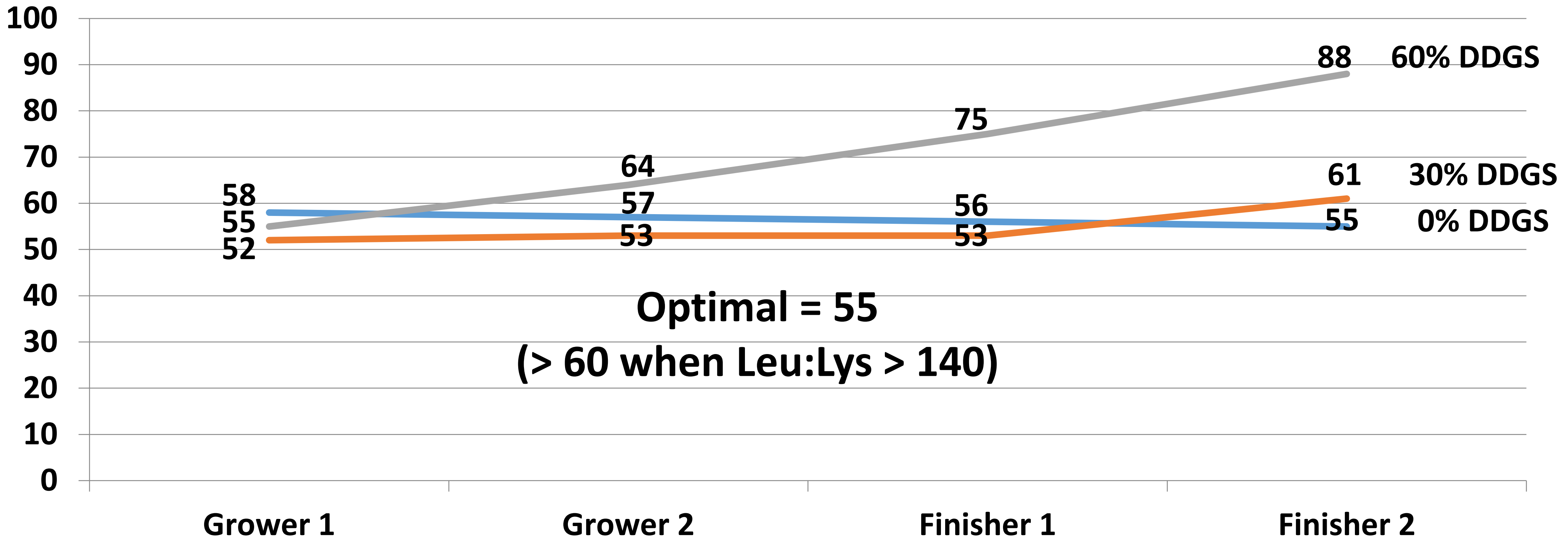
All Leu:Lys > 110

Maximum ratio has not been defined

Changes in SID Val:Lys with Increasing Dietary DDGS Levels



Changes in SID Ile:Lys with Increasing Dietary DDGS evels



Threonine in High Fiber Diets

- Physiological roles
  - Protein synthesis of lean tissue
  - Major component of GI epithelial cells, digestive enzymes, mucosal secretions
  - High concentration in immunoglobulins and immune defense proteins
  - Precursor for *in vivo* glycine synthesis
- High fiber diets decrease amino acid digestibility
  - Increase endogenous losses
    - Mucins contain 20-30% Thr
    - Mucin proteins are poorly digested and amino acids are not re-absorbed
  - Effect of insoluble fiber > solubles fiber
    - Increasing mucin secretion
    - Increasing GI tissue mass
  - Greater effect on Thr utilization for protein deposition than other amino acids
    - Increased fiber can reduce Thr utilization efficiency by 9%

High Fiber Diets Increase SID Thr Requirements (20-50 kg pigs)

Reference	NRC (2012)	Low fiber	High fiber
Mattai et al. (2016)	0.61%	0.72% (8.5% NDF)	0.77% (17% NDF)
Wellington et al. (2018)	0.61%	0.68% (12.5% TDF)	0.78% (18.5% TDF)

Note: 30% DDGS diets contain 15.2% NDF
60% DDGS diets contain 21.4% NDF

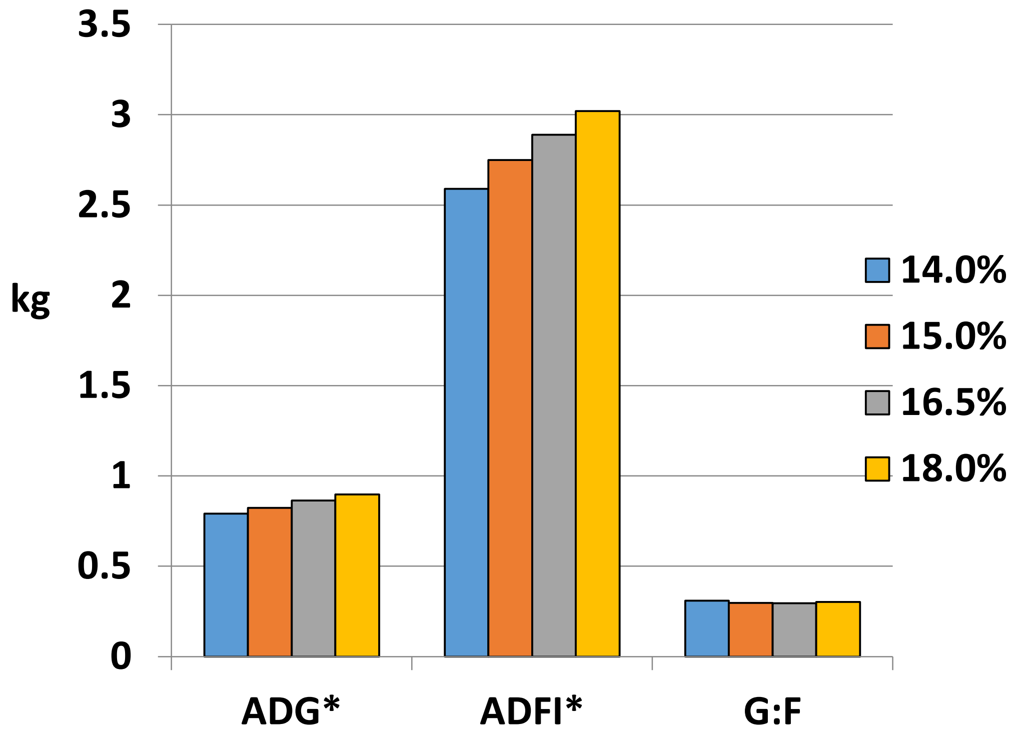
Tryptophan in DDGS diets

- Physiological roles
  - Protein synthesis of lean tissue
  - Regulation of immune responses
  - Precursor for serotonin
    - Regulates appetite and stress
    - Dependent on adequate Trp being transported across the blood-brain barrier
- Competes with large neutral amino acids (**Ile**, **Leu**, Phe, Tyr, and **Val**) for transport across the blood-brain barrier
  - Excess LNAA decrease serotonin concentrations
- DDGS is high in Met and Thr which decrease Trp uptake by brain
  - High CP, Met, Thr in a Trp deficient diet may reduce feed intake
- Trp:LNAA < 3.1% can reduce growth performance

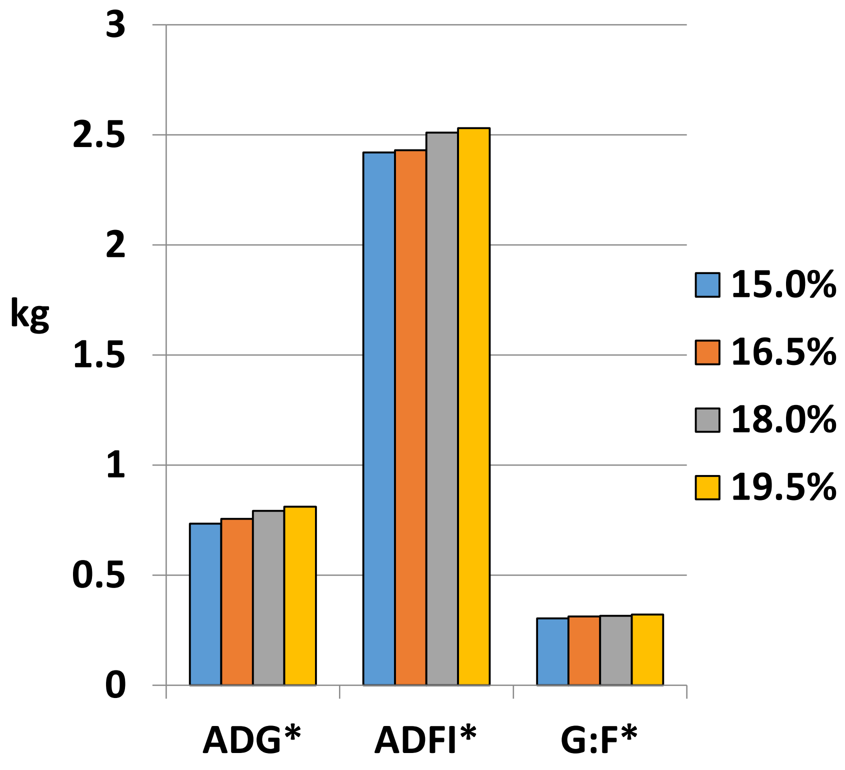
Recent Estimates of Optimal SID Trp:Lys in DDGS Diets

Reference	Pig Body Weight, kg	Optimal SID Trp:Lys
NRC (1998)	-	18
NRC (2012)	-	16-17
Hinson et al. (2010)	27 to 45	16
	67 to 85	> 13.9
	96 to 117	16
Hinson et al. (2010)	96 to 115 kg	16
Petersen and Stein (2012)	10 to 20 kg	17-21.5
Salyer et al. (2013)	36 to 70 kg	16.5
	70 to 130 kg	**> 19.5**
Nitikanchana (2013)	6 to 10 kg	20.3
	71 to 127 kg	**20**

Effects of Increasing SID Trp:Lys in 30% DDGS Diets on Growth Performance



Grower-finisher (105 d)
*Linear effect (P < 0.001)



Finisher (73 d)
*Linear effect (P < 0.03)

Salyer et al. (2013)

Conclusions

- Feeding 30-60% DDGS reduces feed cost by **$4.50 to $10/pig**
- Risk of reduced growth performance increases with increasing DDGS inclusion rates
- Risk can be minimized by
  - Estimating energy and SID amino acids in DDGS using prediction equations
  - Managing excess Leu by adding crystalline Ile and Val?
  - Increasing SID Thr to Lys ratio from 61% to 78%?
  - Increasing SID Trp to Lys ratio from 17% to 19.5+%?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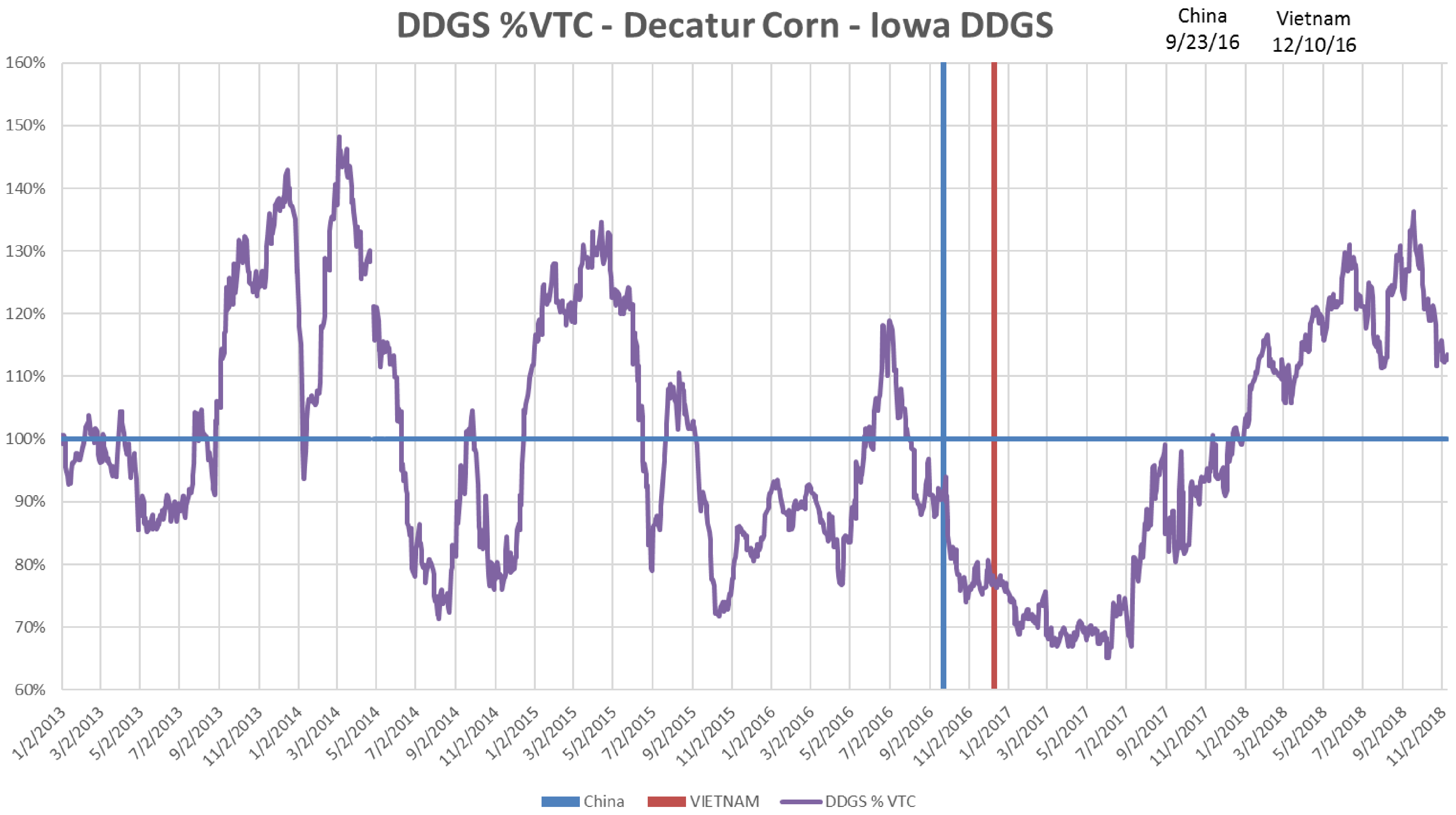
Isaac Crawford received his Bachelor of Science in Agriculture Education with an emphasis in Agribusiness and Management from the University of Minnesota, St. Paul.

He is currently the Vice President of Trading and Merchandising at POET Nutrition. In this role, he leads the Dakota Gold marketing groups both locally and internationally. He also works to develop new and existing supply chains while implementing flexibility into POET’s logistic portfolio.

DDGS Markets

Isaac Crawford
POET Nutrition


DDGS %VTC - Decatur Corn - Iowa DDGS
China
9/23/16
Vietnam
12/10/16
160%
150%
140%
130%
120%
110%
100%
90%
80%
70%
60%
1/2/2013
3/2/2013
5/2/2013
7/2/2013
9/2/2013
11/2/2013
1/2/2014
3/2/2014
5/2/2014
7/2/2014
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7/2/2017
9/2/2017
11/2/2017
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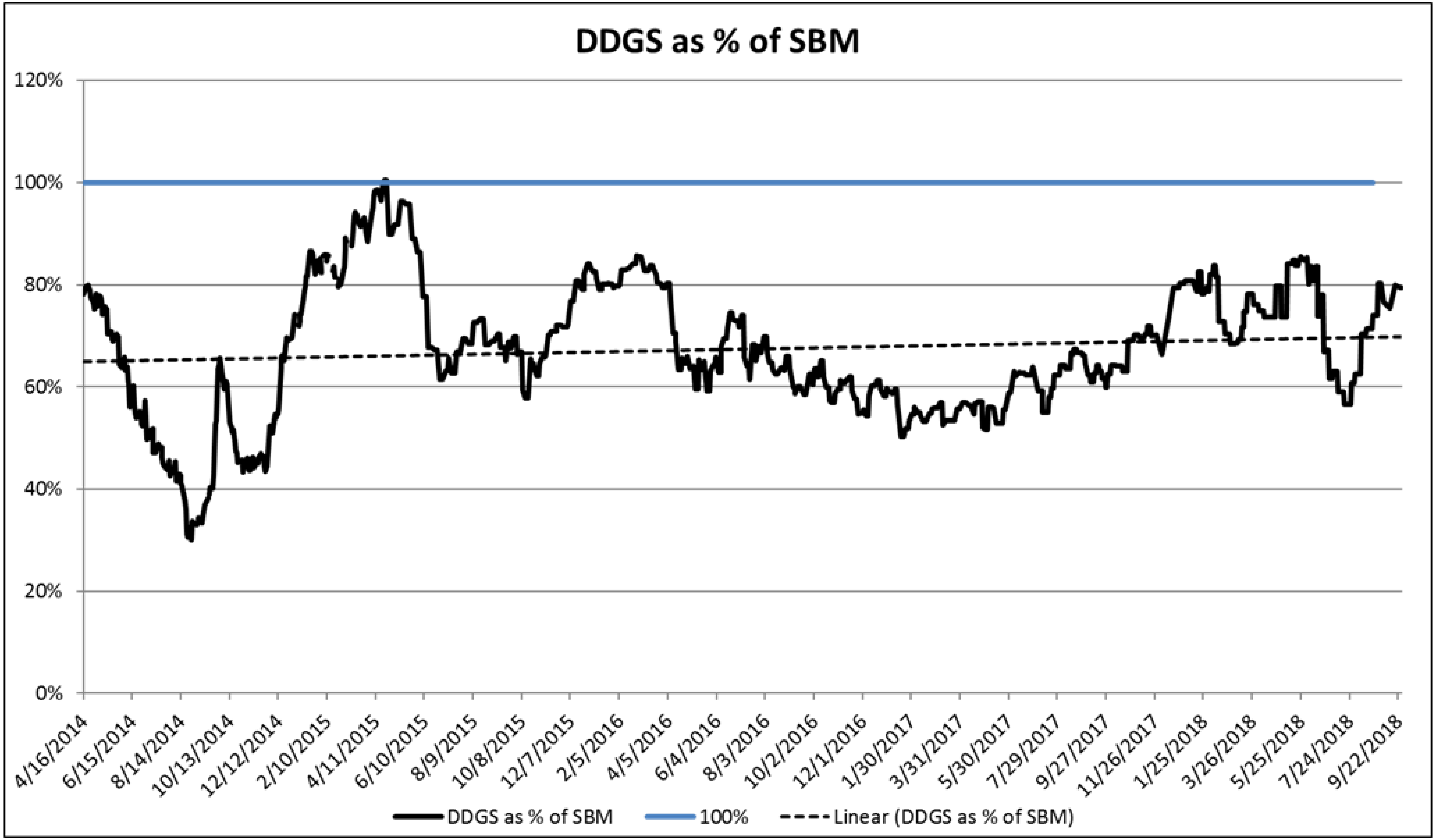
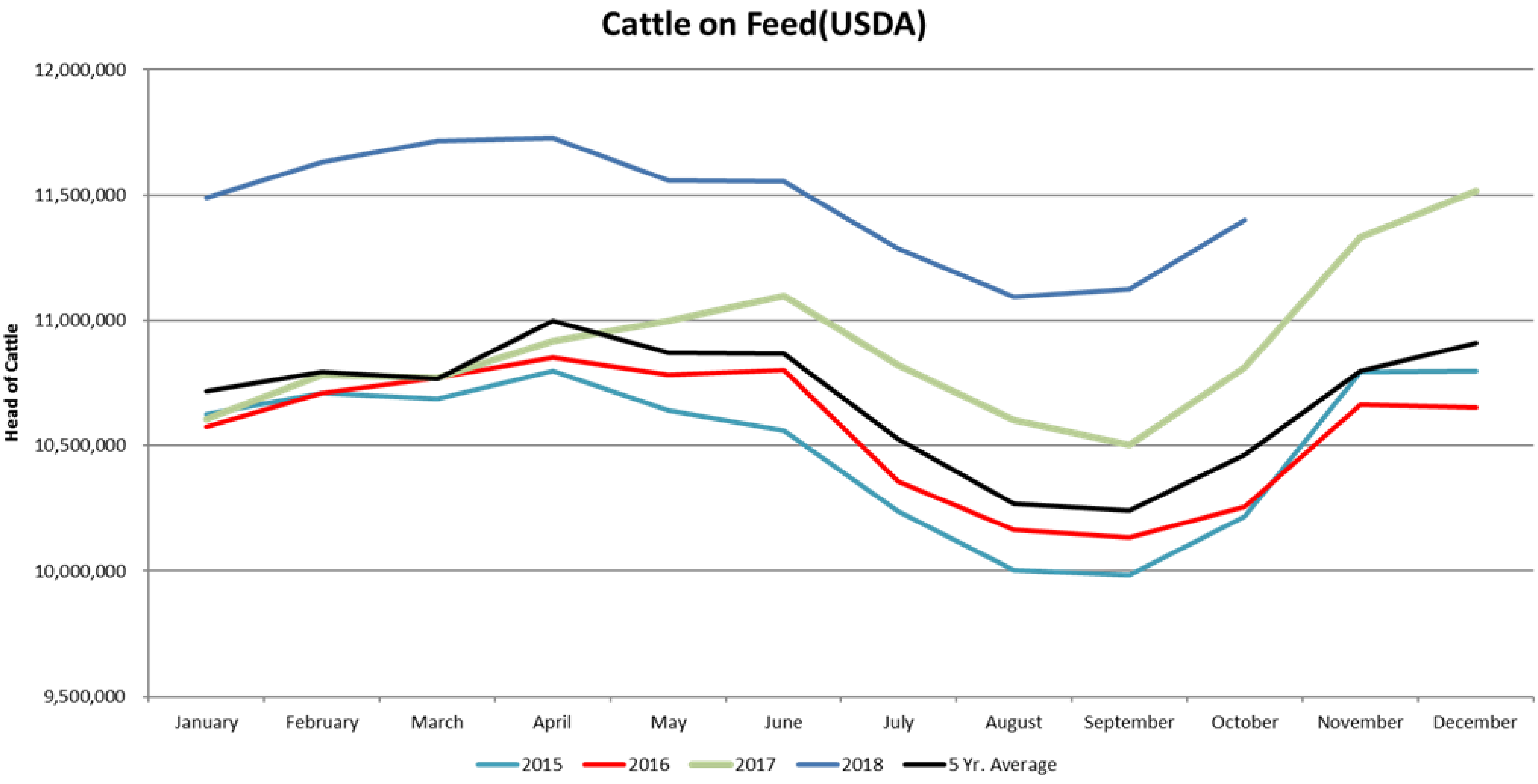
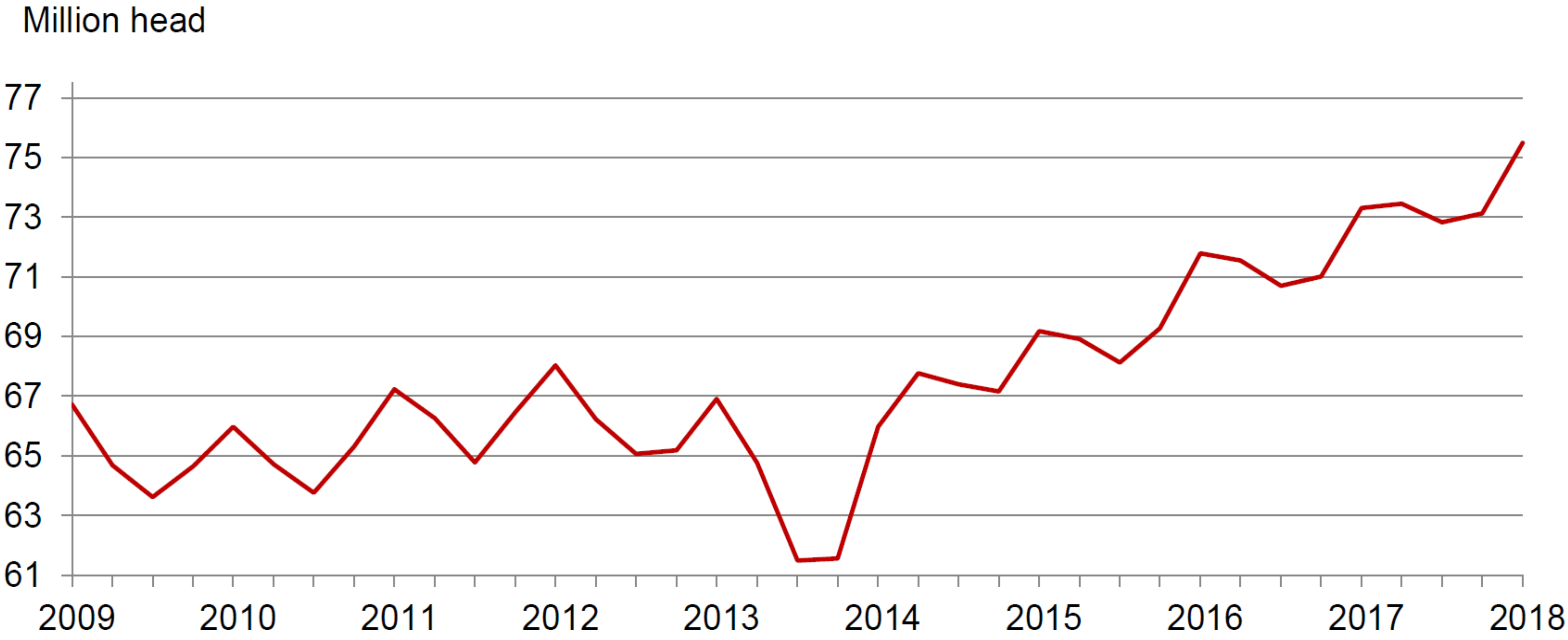
11/2/2018
China
VIETNAM
DDGS % VTC



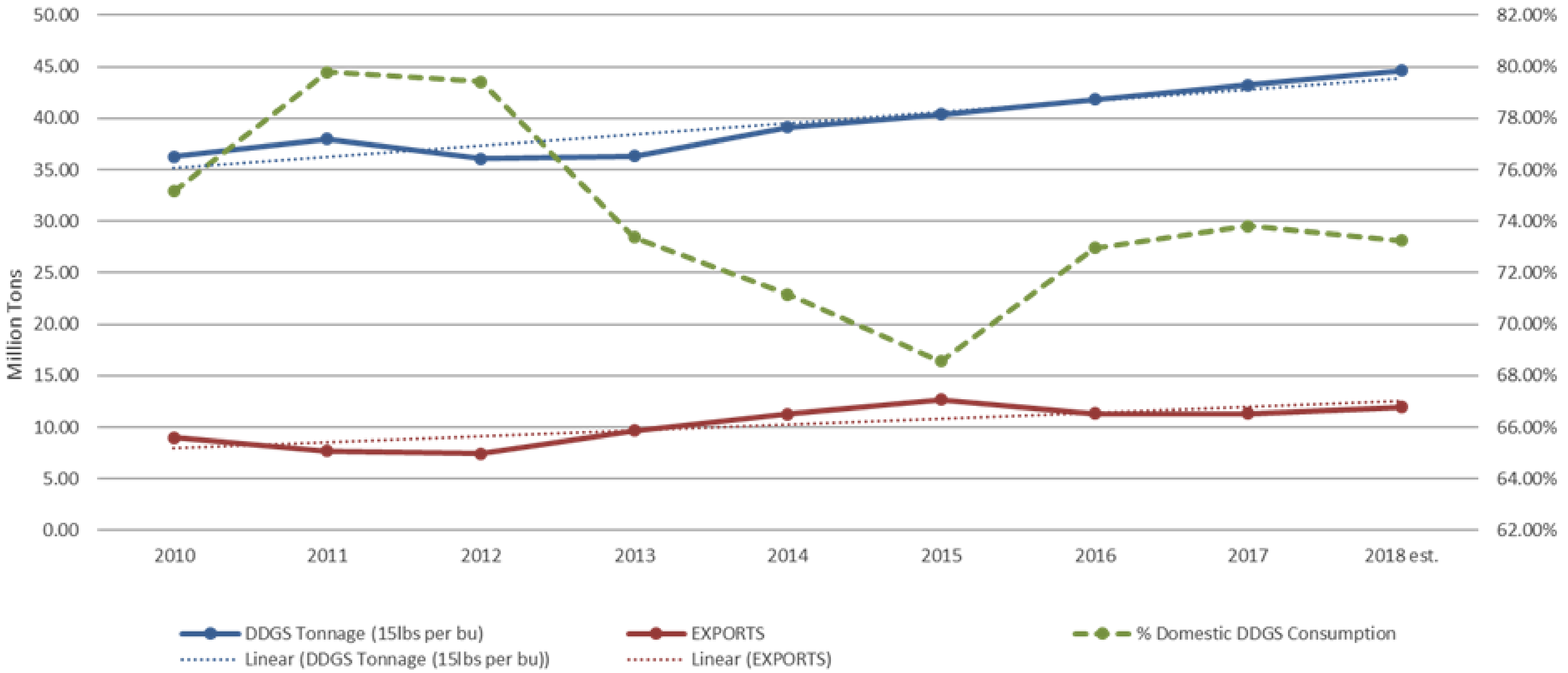
DDGS as % of SBM
120%
100%
80%
60%
40%
20%
0%
4/16/2014
6/15/2014
8/14/2014
10/13/2014
12/12/2014
2/10/2015
4/11/2015
6/10/2015
8/9/2015
10/8/2015
12/7/2015
2/5/2016
4/5/2016
6/4/2016
8/3/2016
10/2/2016
12/1/2016
1/30/2017
3/31/2017
5/30/2017
7/29/2017
9/27/2017
11/26/2017
1/25/2018
3/26/2018
5/25/2018
7/24/2018
9/22/2018
DDGS as % of SBM
100%
Linear (DDGS as % of SBM)


Cattle on Feed(USDA)
Head of Cattle
12,000,000
11,500,000
11,000,000
10,500,000
10,000,000
9,500,000
January
February
March
April
May
June
July
August
September
October
November
December
2015
2016
2017
2018
5 Yr. Average

Quarterly Hogs and Pigs Inventory – United States: September 1



Annual DDGS Production



Source: U.S. Energy Information Administration (2.75lbs per gallon)

Summary

- DDGS value is trending more as a protein.
- The value of DDGS depends on the nutrition need/want.
- Animal protein demand outside the US will continue to grow with development.
- DDGS demand likely to grow faster outside the US.
- International nutrition development is still needed for DDGS.

Question and Answer

Dr. Jerry Shurson

Isaac Crawford

THANK YOU