Protein Supplementation of Beef Cattle to Meet Human Protein Requirements

T.A. Wickersham & J.E. Sawyer

Conclusion

Net Protein Contribution – useful tool for describing the value of beef production systems.

-social sustainability – the ability to provide protein

-environmental sustainability – efficiency of nutrient utilization

Communicates the value of beef production systems to consumers

Key performance indicators must be evaluated together, sustainability is a balancing act.

Beef has a good story to tell, we must tell it.

TEXAS A&M AGRILIFE RESEARCH

Outline

1) **Introduction**

   -Howdy

   -Arriving at this topic

2) **Net protein contribution**

   -Protein & Amino Acids

   -Protein Quality

   -Protein Conversion

   -Beef's Role

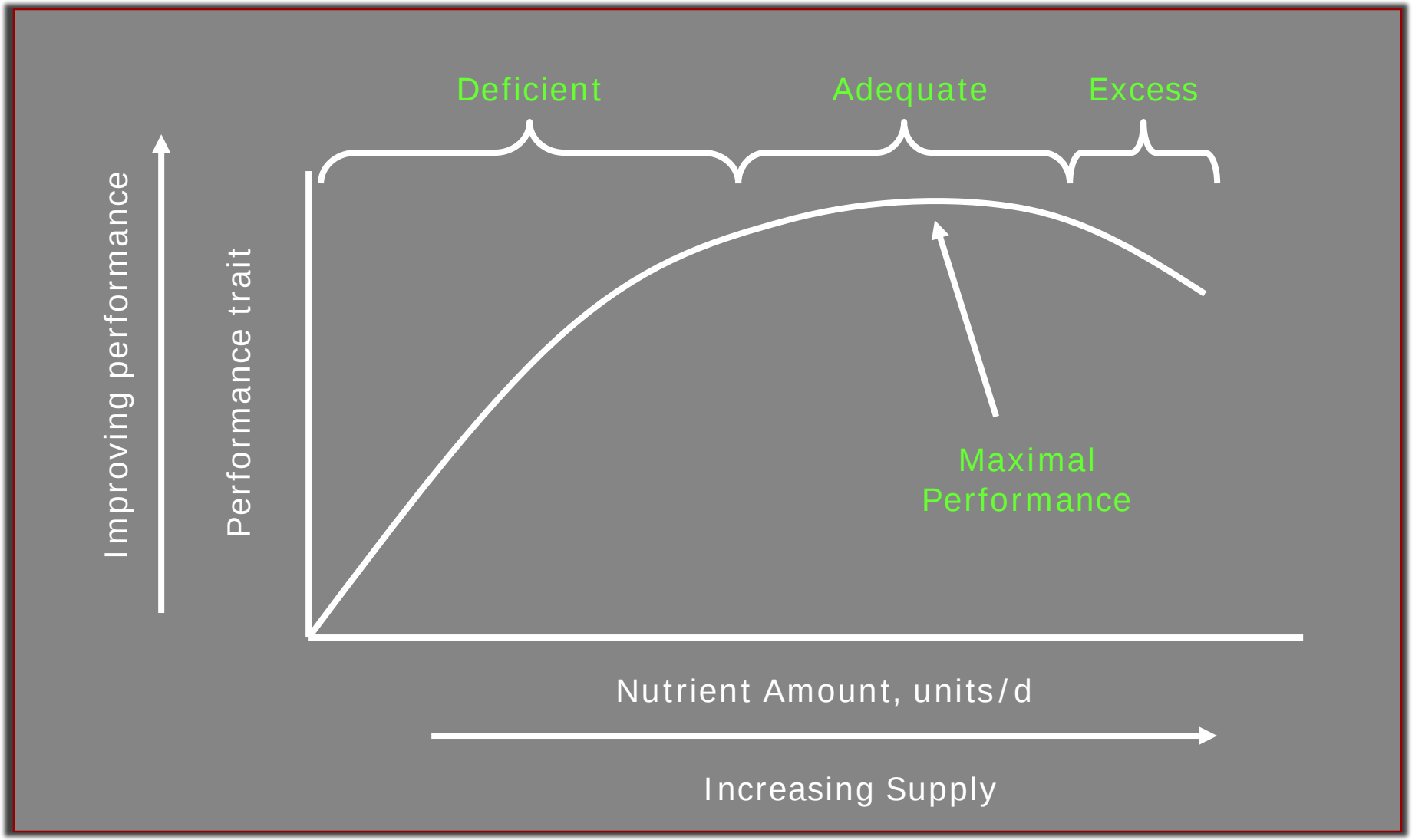
3) **Conclusion**

TEXAS A&M AGRILIFE RESEARCH

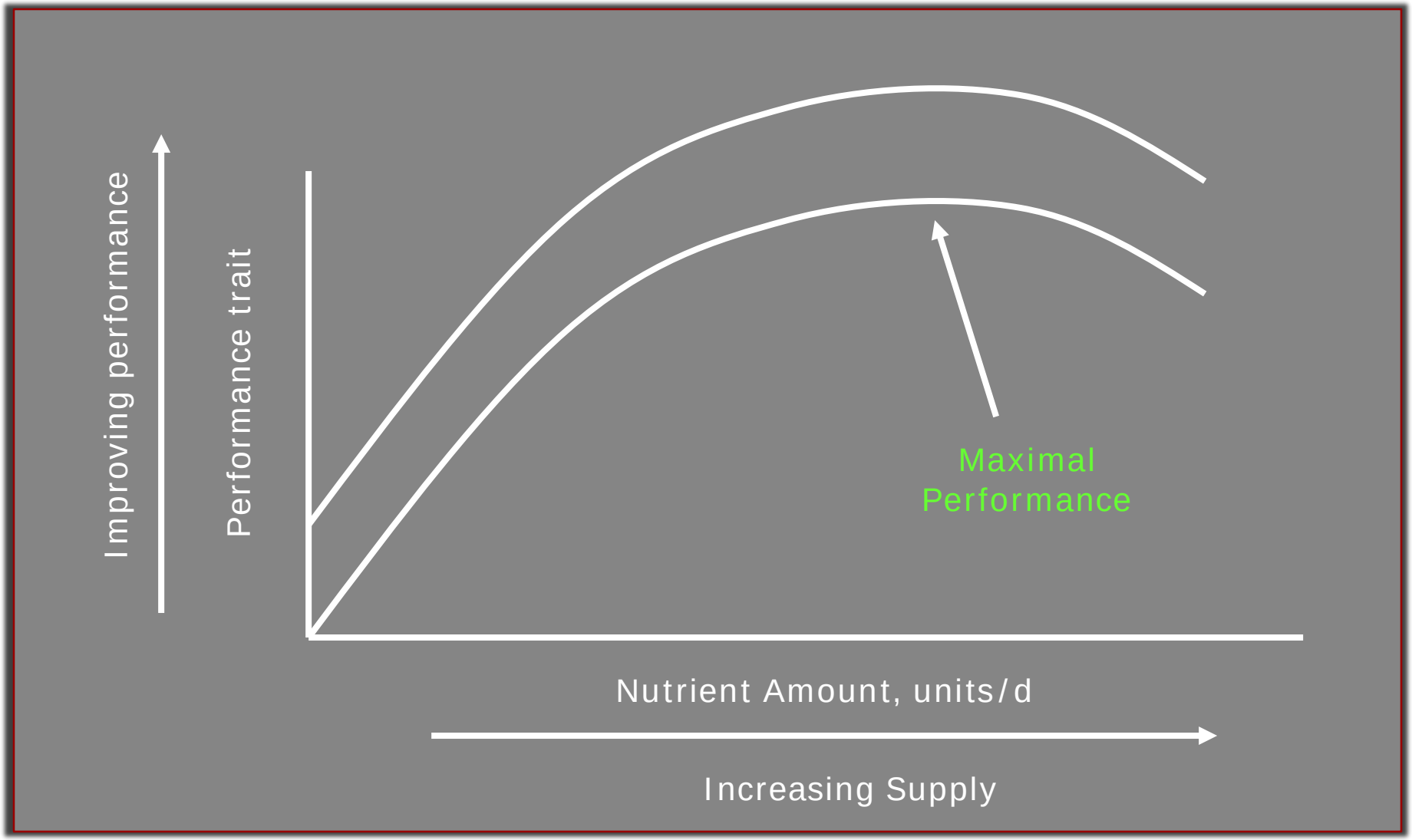
Roles

1) **Husband/Father**
2) **Professor**
3) **Rancher**

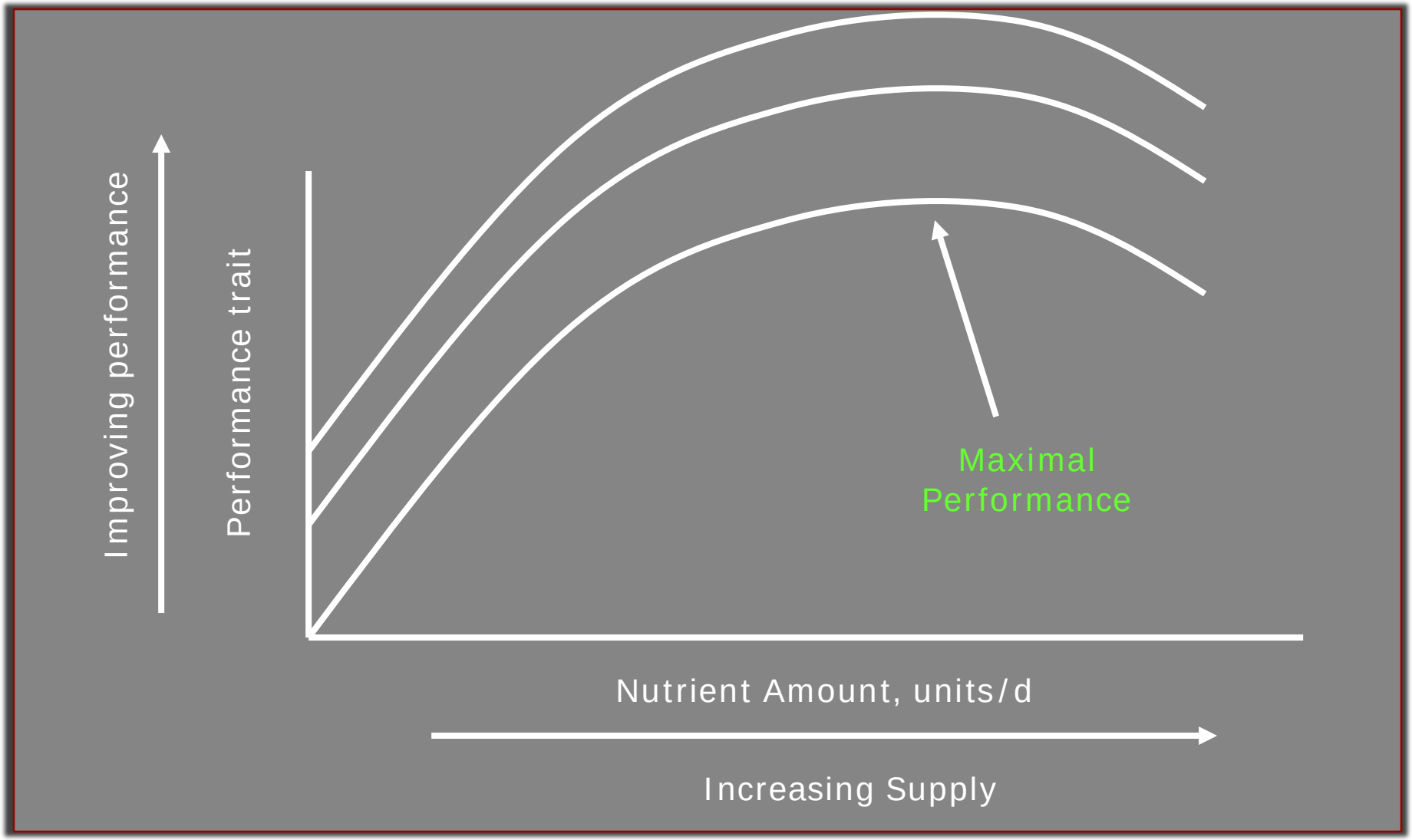
Protein Requirements



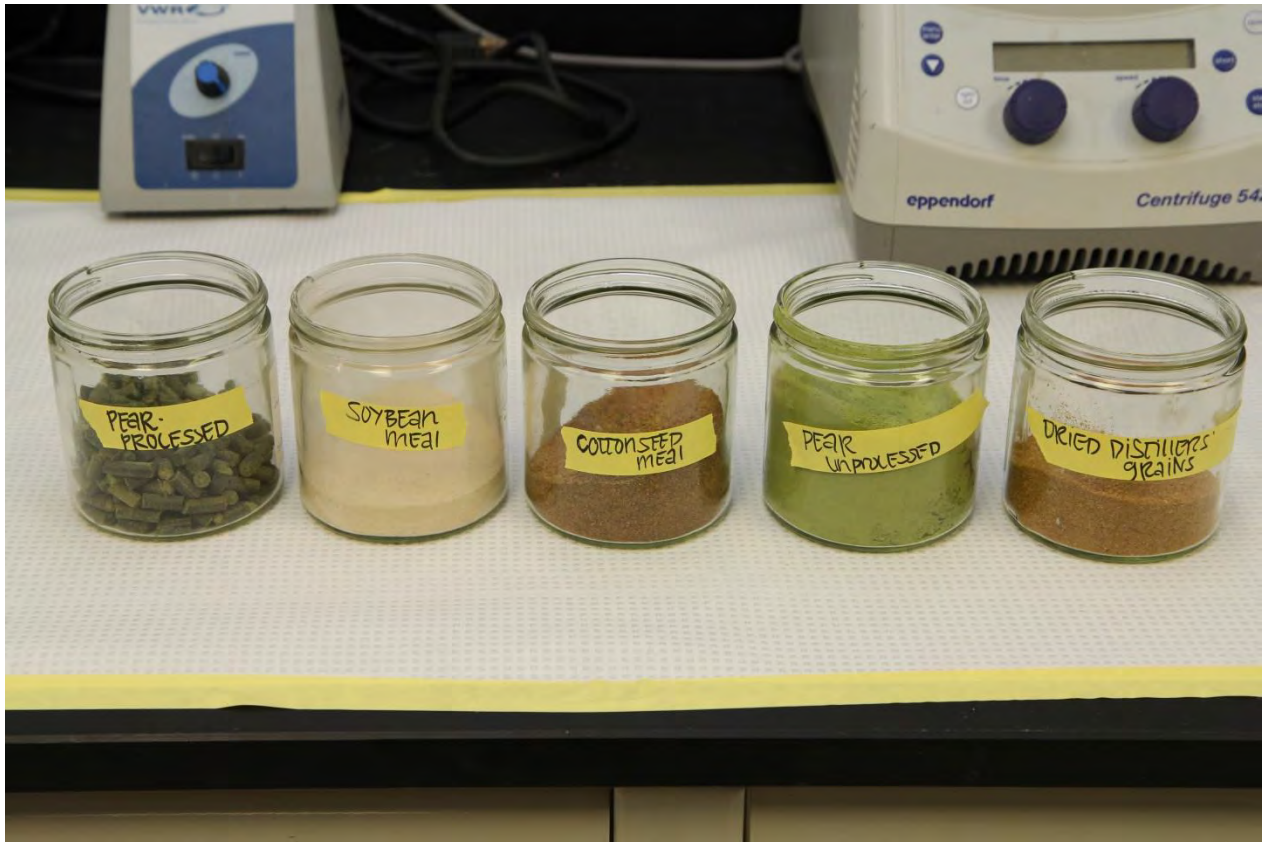
Protein Requirements



Protein Requirements

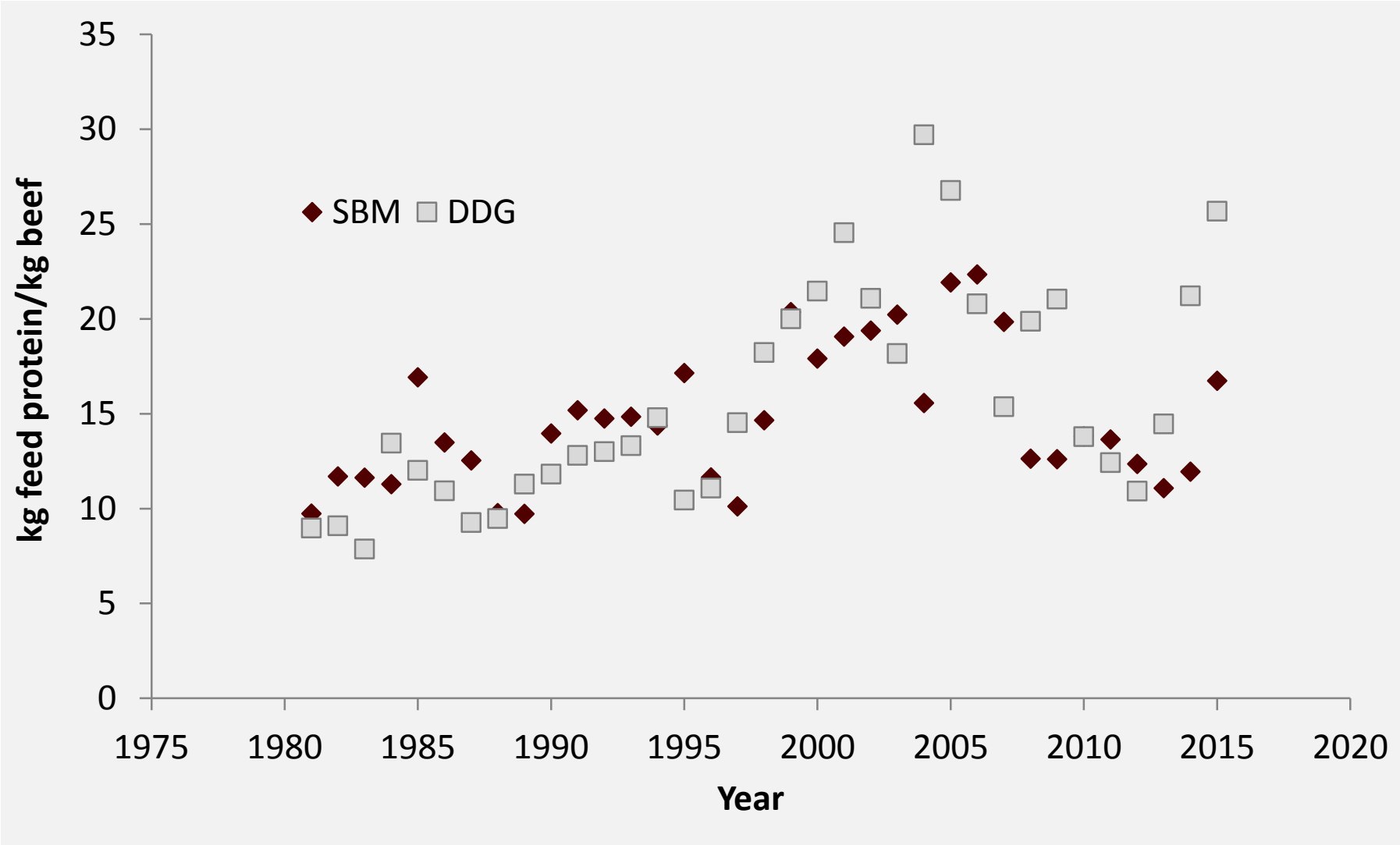


Byproduct Utilization



TEXAS A&M AGRILIFE RESEARCH

Byproduct Utilization



Fish

Texas A&M AgriLife Research

Recommended Dietary Protein Levels

	Weight Range				
	< 20 g	20 -200 g	200-600 g	600 -1500 g	> 1500 g
Atlantic Salmon	48	44	40	38	34
Channel Catfish	44	36	32	32	28
Common Carp	45	38	32	28	28
Nile tilapia	40	34	30	28	26
Pacific Salmon	55	45	40	38	38
Rainbow Trout	48	40	38	38	36
Eur. Sea Bass	55	50	45	45	-
Gilthead Sea Bream	50	45	40	40	-

Nutrient Requirement of Fish & Shrimp, 2011

TEXAS A&M AGRILIFE RESEARCH

Challenge

Texas A&M AgriLife Research

Challenge

"Policies in favor of the global adoption of plant-based diets will simultaneously optimize the food supply, health, environmental, and social justice outcomes for the world's population. Implementing such nutritional policy is perhaps one of the most rational and moral paths for a sustainable future of the human race and other living creatures of the biosphere that we share."

"We are fully aware that such drastic dietary shift is complex and implicates behavioral and policy challenges at many levels."

Sabaté and Soret, American Journal of Clinical Nutrition 2014

TEXAS A&M AGRILIFE RESEARCH

Challenge

"Reducing meat consumption, or shifting meat consumption away from beef to poultry and pork has the potential to increase cropland food productivity and feed more people per hectare of cropland."

Cassidy et al. 2013, Environmental Research Letters

Texas A&M AgriLife Research

Opportunity

“Too often, the opponents of animal agriculture evaluate the desirability of animal production on gross calorie or protein intake/output values.”

Oltjen and Beckett, 1996; Journal of Animal Science

“Livestock contribute to food supply by converting low-value materials, inedible or unpalatable for people, into milk, meat, and eggs; livestock also decrease food supply by competing with people for food, especially grains fed to pigs and chickens.”

Smith et al., 2013 Animal Frontiers

TEXAS A&M AGRILIFE RESEARCH

Options

1) **Increase efficiency of livestock production**
   - **Technology**
   - **Diet formulation**
2) **Decrease consumption of livestock products**
   - **Not really an option that seems likely unless forced**
   - **Humans like/demand livestock protein sources**
   - **Animal proteins have greater value than plant based proteins**
3) **Increase use of inedible feedstuffs**
   - **Grasslands**
   - **Byproducts**

TEXAS A&M AGRILIFE RESEARCH

Options

1) **Increase efficiency of livestock production**

   Technology

   Diet formulation

2) ~~**Decrease consumption of livestock products**~~

   ~~**Not really an option that seems likely unless forced**~~

   Humans like/demand livestock protein sources

   Animal proteins have greater value than plant based proteins

3) **Increase use of inedible feedstuffs**

   Grasslands

   Byproducts

TEXAS A&M AGRILIFE RESEARCH

Options

1) **Increase efficiency of livestock production**

   Technology

   Diet formulation

2) ~~**Decrease consumption of livestock products**~~

   ~~**Not really an option that seems likely unless forced**~~

   Humans like/demand livestock protein sources

   Animal proteins have greater value than plant based proteins

3) **Increase use of inedible feedstuffs**

   Grasslands

   Byproducts

   Ruminants

Texas A&M AgriLife Research

U.S. Net Protein Contribution of Livestock

Species	HeP	Diet DIAAS	PQR	HePCE	NPC
Swine					
Broilers					
Cattle					
w/SBM					
w/o SBM					
70% corn, w/o SBM					
45% corn, w/o SBM					
120% corn, w/o SBM					

HeP = human-edible protein required/kg of meat
DIAAS = digestible indispensable amino acid score
PQR = protein quality ratio
HePCE = human-edible protein conversion efficiency
NPC = net protein contribution
Summary diets adapted from Peters et al., 2014

TEXAS A&M AGRILIFE RESEARCH

HeP – Human Edible Protein

- **Protein that can be consumed and utilized by people.**
- **Human edible calories**

TEXAS A&M AGRILIFE RESEARCH

U.S. Net Protein Contribution of Livestock

Species	HeP	Diet DIAAS	PQR	HePCE	NPC
Swine	1057				
Broilers	1273				
Cattle					
100%+SBM	651				
45% corn	198				
70% corn	306				
100% corn	439				
120% corn	526				

HeP = human-edible protein required/kg of meat
DIAAS = digestible indispensable amino acid score
PQR = protein quality ratio
HePCE = human-edible protein conversion efficiency
NPC = net protein contribution
Summary diets adapted from Peters et al., 2014

Texas A&M AgriLife Research

DIAAS – Digestible Indispensable AA Score

- **Measure of the capacity of a protein source to meet the requirements for all of the indispensable AA (essential AA).**
  - **Digestible indispensable AA content**
  - **Indispensable AA requirement, based on toddlers**
- **DIAAS can be > 100 or < 100**
  - **DIASS of > 100 means the protein source supplies more than the required amount of the most limiting AA**
  - **DIAAS of < 100 means the protein source supplies less than the required amount of the most limiting AA**
- $$DIAAS(\%) = \frac{mg\ of\ DIAA\ in\ test}{mg\ of\ DIAA\ in\ reference} \times 100$$

TEXAS A&M AGRILIFE RESEARCH

FAO, 2013; Wolfe et al., 2016

DIAAS Examples

Protein Source	DIAAS	Protein Source	DIAAS
Wheat	40.2	Beef	111.6
Corn Grain	42.4	Pork	113.9
Soybeans	99.6	Chicken	108.2
Soybean (cake)	97.0	Lamb	116.8
Soybeans (expeller)	100.3	Milk	115.9
Corn Silage	42.4	Eggs	116.4

- **DIASS of > 100 means the protein source supplies more than the required amount of the most limiting AA**
- **DIAAS of < 100 means the protein source supplies less than the required amount of the most limiting AA**
- **Truncation**

TEXAS A&M AGRILIFE RESEARCH

Ertl et al., 2016

U.S. Net Protein Contribution of Livestock

Species	HeP	Diet DIAAS	PQR	HePCE	NPC
Swine	1057	79.9			
Broilers	1273	87.5			
Cattle					
100%+SBM	651	61.0			
45% corn	198	42.4			
70% corn	306	42.4			
100% corn	439	42.4			
120% corn	526	42.4			

HeP = human-edible protein required/kg of meat
DIAAS = digestible indispensable amino acid score
PQR = protein quality ratio
HePCE = human-edible protein conversion efficiency
NPC = net protein contribution
Summary diets adapted from Peters et al., 2014

TEXAS A&M AGRILIFE RESEARCH

PQR - Protein Quality Ratio

- **Provides a means of evaluating how the animal production system modified the protein quality.**
  - $PQR = \frac{Output\ DIAAS}{Input\ DIAAS}$ **or** $PQR = \frac{Edible\ Product\ DIAAS}{Weighted\ Diet\ DIAAS}$
  - Example: Corn $PQR = \frac{111.6}{42.4} =$ **2.63**
  - Example: Corn & SBM $PQR = \frac{111.6}{(42.4 \times 75\%) + (100.3 \times 25\%)} =$ **1.96**
  - **Greater PQR = improvement in protein quality by livestock**
  - **Minimize weighted diet DIAAS**
  - **Edible product DIAAS fixed by biology**

TEXAS A&M AGRILIFE RESEARCH

U.S. Net Protein Contribution of Livestock

Species	HeP	Diet DIAAS	PQR	HePCE	NPC
Swine	1057	79.9	1.43		
Broilers	1273	87.5	1.23		
Cattle					
100%+SBM	651	61.0	1.82		
45% corn	198	42.4	2.63		
70% corn	306	42.4	2.63		
100% corn	439	42.4	2.63		
120% corn	526	42.4	2.63		

HeP = human-edible protein required/kg of meat
DIAAS = digestible indispensable amino acid score
PQR = protein quality ratio
HePCE = human-edible protein conversion efficiency
NPC = net protein contribution
Summary diets adapted from Peters et al., 2014

TEXAS A&M AGRILIFE RESEARCH

HePCE – Human-Edible Protein Conversion Eff.

- **Human-edible feed conversion efficiency**
  - $$\mathbf{HeFCE} = \frac{\mathbf{He\ Output}}{\mathbf{He\ Input}}$$
- **Human-edible protein conversion efficiency**
  - $$\mathbf{HePCE} = \frac{\mathbf{HeProtein\ Output}}{\mathbf{HeProtein\ Input}}$$
  - $$\mathbf{0.45} = \frac{\mathbf{197\ g\ HeP}}{\mathbf{439\ g\ HeP\ to\ produce}}$$

TEXAS A&M AGRILIFE RESEARCH

Ertl et al., 2016

U.S. Net Protein Contribution of Livestock

Species	HeP	Diet DIAAS	PQR	HePCE	NPC
Swine	1057	79.9	1.43	0.19	
Broilers	1273	87.5	1.23	0.15	
Cattle					
100%+SBM	651	61.0	1.82	0.30	
45% corn	198	42.4	2.63	1.00	
70% corn	306	42.4	2.63	0.64	
100% corn	439	42.4	2.63	0.45	
120% corn	526	42.4	2.63	0.37	

HeP = human-edible protein required/kg of meat
DIAAS = digestible indispensable amino acid score
PQR = protein quality ratio
HePCE = human-edible protein conversion efficiency
NPC = net protein contribution
Summary diets adapted from Peters et al., 2014

TEXAS A&M AGRILIFE RESEARCH

NPC = PQR × HePCE

- **NPC = Net protein contribution**
- **Captures the benefit or harm of a livestock feeding system to the supply of human-edible protein**
- **Values < 1 = feed the nutrients to people**
- **Values > 1 = feed the nutrients to livestock**
- **Limitations**
  - **Only considers protein**
  - **Doesn't consider human desire to consume**

TEXAS A&M AGRILIFE RESEARCH

U.S. Net Protein Contribution of Livestock

Species	HeP	Diet DIAAS	PQR	HePCE	NPC
Swine	1057	79.9	1.43	0.19	0.28
Broilers	1273	87.5	1.23	0.15	0.19
Cattle					
100%+SBM	651	61.0	1.82	0.30	0.55
45% corn	198	42.4	2.63	1.00	2.62
70% corn	306	42.4	2.63	0.64	1.69
100% corn	439	42.4	2.63	0.45	1.18
120% corn	526	42.4	2.63	0.37	0.98

HeP = human-edible protein required/kg of meat
DIAAS = digestible indispensable amino acid score
PQR = protein quality ratio
HePCE = human-edible protein conversion efficiency
NPC = net protein contribution
Summary diets adapted from Peters et al., 2014

TEXAS A&M AGRILIFE RESEARCH

General Guidelines

- **Ration DIAAS – keep as low as possible (corn 42.4)**
- **DIAAS truncation hurts livestock products**
- **HeP – keep as low as possible**
  - **Body weight basis ≤ 78.5 g HeP/kg BW**
  - **Product basis ≤ 191 g HeP/kg edible product**
- **NPC – optimize relative to other constraints but greater than 1.0 indicates the production system is net contributor to protein supply.**

TEXAS A&M AGRILIFE RESEARCH

Challenge

"Policies in favor of the global adoption of plant-based diets will simultaneously optimize the food supply, health, environmental, and social justice outcomes for the world's population. Implementing such nutritional policy is perhaps one of the most rational and moral paths for a sustainable future of the human race and other living creatures of the biosphere that we share."

"We are fully aware that such drastic dietary shift is complex and implicates behavioral and policy challenges at many levels."

Sabaté and Soret, American Journal of Clinical Nutrition 2014

TEXAS A&M AGRILIFE RESEARCH

Conclusion

Net Protein Contribution – useful tool for describing the value of beef production systems.

-social sustainability – the ability to provide protein

-environmental sustainability – efficiency of nutrient utilization

Communicates the value of beef production systems to consumers

Key performance indicators must be evaluated together, sustainability is a balancing act.

Beef has a good story to tell, we must tell it.

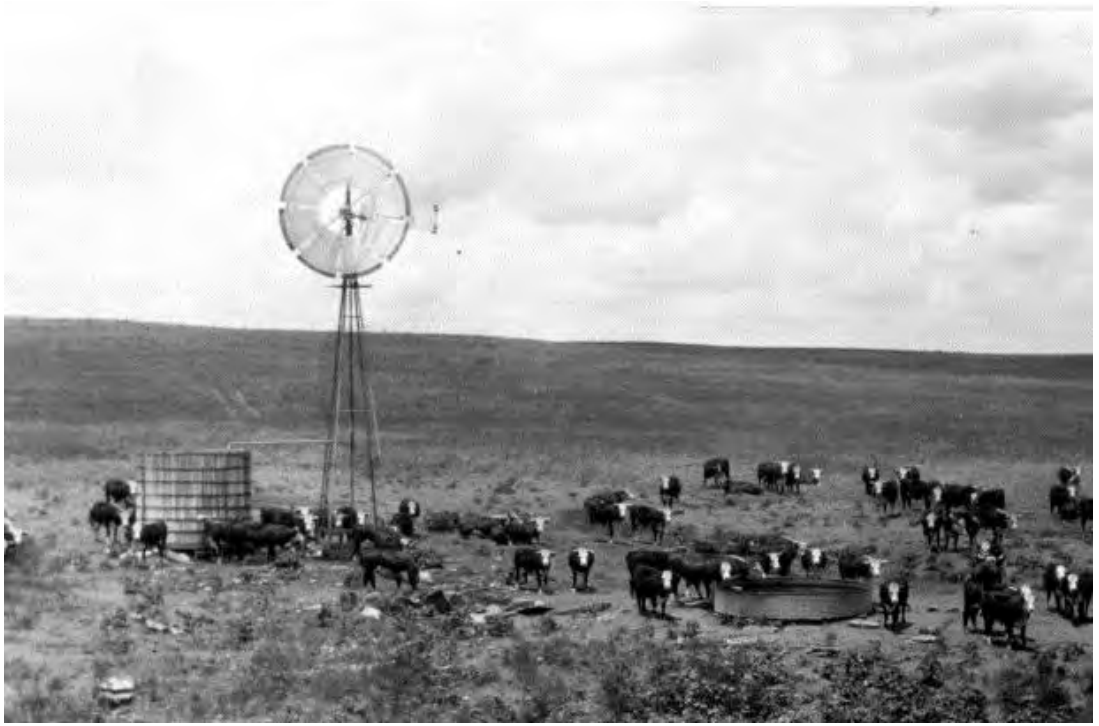
TEXAS A&M AGRILIFE RESEARCH

Conclusion

Beef producers (you) do good things, really good things by bring a high-quality protein to consumers by feeding sources that humans cannot eat.

Do we think about this enough?

Do we tell them this?



Questions