Protein Supplementation of Beef Cattle to Meet Human Protein Requirements

T.A. Wickersham & J.E. Sawyer
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.
Outline

1) Introduction
   - Howdy
   - Arriving at this topic

2) Net protein contribution
   - Protein & Amino Acids
   - Protein Quality
   - Protein Conversion
   - Beef’s Role

3) Conclusion
Roles

1) Husband/Father
2) Professor
3) Rancher
Protein Requirements

- Deficient
- Adequate
- Excess

Increasing Supply

Maximal Performance

Performance trait

Nutrient Amount, units/d

Improving performance
Protein Requirements

Performance trait

Nutrient Amount, units/d

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Protein Requirements

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Maximal Performance

Nutrient Amount, units/ d

Increasing Supply
Byproduct Utilization
Fish
### Recommended Dietary Protein Levels

**Nutrient Requirement of Fish & Shrimp, 2011**

<table>
<thead>
<tr>
<th>Species</th>
<th>&lt; 20 g</th>
<th>20 -200 g</th>
<th>200-600 g</th>
<th>600 -1500 g</th>
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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
“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
“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
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
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   - Ruminants
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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
HeP – Human Edible Protein

- Protein that can be consumed and utilized by people.
- Human edible calories
### U.S. Net Protein Contribution of Livestock

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Summary diets adapted from Peters et al., 2014
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

- \[ DIAAS(\%) = \frac{mg \ of \ DIAA \ in \ test}{mg \ of \ DIAA \ in \ reference} \times 100 \]

FAO, 2013; Wolfe et al., 2016
## DIAAS Examples

<table>
<thead>
<tr>
<th>Protein Source</th>
<th>DIAAS</th>
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</tr>
</thead>
<tbody>
<tr>
<td>Wheat</td>
<td>40.2</td>
<td>Beef</td>
<td>111.6</td>
</tr>
<tr>
<td>Corn Grain</td>
<td>42.4</td>
<td>Pork</td>
<td>113.9</td>
</tr>
<tr>
<td>Soybeans</td>
<td>99.6</td>
<td>Chicken</td>
<td>108.2</td>
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<tr>
<td>Soybean (cake)</td>
<td>97.0</td>
<td>Lamb</td>
<td>116.8</td>
</tr>
<tr>
<td>Soybeans (expeller)</td>
<td>100.3</td>
<td>Milk</td>
<td>115.9</td>
</tr>
<tr>
<td>Corn Silage</td>
<td>42.4</td>
<td>Eggs</td>
<td>116.4</td>
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- **DIAAS 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**

Ertl et al., 2016
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Summary diets adapted from Peters et al., 2014
PQR - Protein Quality Ratio

- Provides a means of evaluating how the animal production system modified the protein quality.

\[ PQR = \frac{Output \ DIAAS}{Input \ DIAAS} \quad \text{or} \quad PQR = \frac{Edible \ Product \ DIAAS}{Weighted \ Diet \ DIAAS} \]

- 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
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Summary diets adapted from Peters et al., 2014
HePCE – Human-Edible Protein Conversion Eff.

- Human-edible feed conversion efficiency

  \[
  \text{HeFCE} = \frac{\text{He Output}}{\text{He Input}}
  \]

- Human-edible protein conversion efficiency

  \[
  \text{HePCE} = \frac{\text{HeProtein Output}}{\text{HeProtein Input}}
  \]

  \[
  0.45 = \frac{197 \text{ g HeP}}{439 \text{ g HeP to produce}}
  \]

Ertl et al., 2016
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Summary diets adapted from Peters et al., 2014
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
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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 \(\leq 78.5 \text{ g HeP/kg BW}\)
  - Product basis \(\leq 191 \text{ g HeP/kg edible product}\)
- NPC – optimize relative to other constraints but greater than 1.0 indicates the production system is net contributor to protein supply.
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- social sustainability – the ability to provide protein
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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.
Beef producers (you) do good things, really good things by bringing 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