Calculating the Value of Small Grains in Livestock Diets

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Outline

- Introduction
- Evaluating Feed Ingredients
- Small grains for the integrated farmer
- Added value of small grain utilization
- Conclusions
Introduction
Introduction

- **Cost** – the leading consideration in selecting feed ingredients
- **Required Nutrients** – from maintenance, growth, reproduction
- **Nutritional Value** – allows cost comparison

**Objective of swine nutrition**

“Provide each nutrient in both quantity and form that will precisely meet the pig’s requirements for growth, reproduction, milk production, and if necessary, maintenance, at the least possible cost.”

-Dr. Robert Easter
Introduction

- **Essential Nutrients**
  1) Carbohydrates
  2) Protein
  3) Fat
  4) Vitamins
  5) Minerals
  6) Water

**Energy Yielding Nutrients:**
Carbohydrates, fats, and protein are referred to as the 3 energy yielding nutrients. With carbohydrates being the major source of energy in cereal grains.

**Protein and Amino Acids:**
Crude protein is important for formulating ruminant diets but understanding amino acid concentration is critical for formulating swine diets.
Introduction

- **Corn and Soy** have been industry standards for energy and protein.
- **Small grains** such as wheat, hybrid rye, conventional rye, barley, and oats can also serve as energy sources.
- **Price** can vary based on seasonal variability and markets.
- **Cost effectiveness and nutritional value** should be determined for all potential feed ingredients.
Evaluating Feed Ingredients
Evaluating Feed Ingredients

1. **Supply** – availability of a specific commodity
   - Purchasing or growing – when and how much is available
   - Don’t forget to factor in logistics, handling, processing, etc.

2. **Physical Characteristics** – moisture, flow, particle size, storage life
   - Small grains typically have different moisture/storage requirements
   - Ensure augers and grinders are capable of handle small grains
   - Proper storage is always essential to maintain quality and decrease risk of mold and spoilage
3. **Nutrient Composition** – critical for determining value of a small grain
   - Feed analysis should be attained whenever possible
     - Buying or growing – it is important to know the exact composition of your ingredient!
     - Don’t forget to test for molds, mycotoxins, etc. – these can limit inclusion levels
   - Energy, Crude Protein (CP) for cattle, Amino Acid content for swine, fiber, mineral levels
   - Feedstuffs are usually classified as *Energy, Protein, or Roughage* based on nutrient values
     - Some feedstuffs may fit into more than one category!
     - Small grains are typically considered *Energy Sources*
4. **Cost** – Cheap does not always mean good value!
   - The amount of nutrients supplied by the replacement feed
     - Challenging as most feed ingredients cannot be directly compared!
   - Should include factors like:
     - Transportation, processing, storage
   - Nutrient contribution should then be compared to *palatability* (typically not an issue with small grains), *digestibility, and cost*!
   - Know the difference in value between food and feed grain
     - Milling and distilling markets for human consumption typically take the highest quality and pay the highest price
     - Food grain prices rarely fit into livestock markets – but be aware of what quality you might be giving up with lower priced grains
5. **Relative Value** – Price per quantity of nutrient delivered

   - The nutritional makeup determines a feedstuff actual value
   - Compares the value of a feed ingredient to the price of the industry standard
     - In this case *Corn*
   - Reflects the value of a new ingredient as it relates to the most expensive nutrients in a diet
     - Protein and Energy

6. **Limitations and Restrictions**

   - Digestibility – how available is the nutrient for the cow or pig
   - Palatability – will they consume it
   - Inclusion rate – can vary based on above factors
     - Effects on animal health and carcass quality
Evaluating Feed Ingredients

- **Corn** – the gold standard for energy feed
  - Advantages:
    - Excellent energy source for swine, cattle finishing, and dairy diets
    - High energy due to high starch content
    - Starch is rapidly digestible for both hogs and cattle
    - Highly palatable
  - Limitations:
    - Low CP – 7-9% and low lysine
    - Cattle: rapid digestibility, high inclusion levels, and excessive processing can result in acidosis issues
    - Minimal fiber components
Evaluating Feed Ingredients

- **Wheat**
  - Advantages:
    - Similar energy source to corn for swine
    - Greater energy source than corn for ruminants
    - Similar to corn in digestibility, palatability, and amino acid availability for swine
    - Greater crude protein value than corn for ruminants
    - Highly palatable
Evaluating Feed Ingredients

- **Wheat**
  - Limitations:
    - Dusty and less palatable in too finely ground
    - Rapid digestibility can result in even greater instances of acidosis in cattle if not properly managed
    - Typically grown for human consumption
      - Substantially higher priced than corn
      - Availability and logistics can = even higher prices
Evaluating Feed Ingredients

- **Conventional Rye**
  - Advantages:
    - Good energy source – about 94% the energy as corn for swine and ruminants
    - Similar amino acid availability for swine
    - Higher content of fiber
      - May promote gut health in swine
      - May minimize risks of acidosis in ruminants
    - Greater crude protein value than corn for ruminants


- **Conventional Rye**
  - Limitations:
    - Highly susceptible to ergot
      - Ergot decreases palatability, decreases potential inclusion level, and can severely decrease performance and intake of animals
    - Sow diets must be virtually free of ergot
    - Should always be tested for ergot prior to use in livestock diets!
    - Minimal acreage grown and primarily goes to cover crop market and for human milling and distilling
      - Can be very high priced compared to corn
    - Fine grinding can result in dusty, unpalatable diets
Evaluating Feed Ingredients

- **Hybrid Rye**
  - Advantages:
    - Good energy source – about 94% the energy as corn for swine and ruminants
    - Similar amino acid availability for swine
    - Higher content of fiber
      - May promote gut health in swine
      - May minimize risks of acidosis in ruminants
    - Greater crude protein value than corn for ruminants
    - Minimal risk for ergot contamination
    - Highly palatable
**Hybrid Rye**

Limitations:

- Minimal acreage grown and primarily goes to human milling and distilling markets
  - Can be very high priced compared to corn
  - Some distilling markets will pay a premium for hybrid rye
- Fine grinding can result in dusty, unpalatable diets
- Poor management can still result in some risk for ergot contamination
  - Should always be tested for ergot prior to use in livestock diets!
- **Barley**
  - Advantages:
    - Good energy source – about 90% the energy of corn
      - Even though lower energy hogs typically compensate by consuming more
    - High fiber
    - Similar to corn in amino acid availability for swine
    - Greater crude protein value than corn for ruminants
    - Similar energy value to corn for ruminants
Barley

Limitations:

- Minimal acreage grown and primarily goes to human milling and distilling markets.
- Large variability between types and varieties of barley and can result in notable differences in animal performance.
  - Test weight can also vary drastically between varieties and due to growing conditions.
- Lower digestibility than corn.
Evaluating Feed Ingredients

- **Oats**
  - Advantages:
    - Highly palatable in both swine and ruminant diets
    - High fiber
    - Can be beneficial in gestating sow diets – gut fill and to combat constipation issues
    - Can be included to help with incidence of diarrhea in weaned or small feeder pigs
    - Lower potential for bloat or acidosis in cattle
    - Greater crude protein than corn for ruminants
Evaluating Feed Ingredients

- **Oats**
  - Limitations:
    - Lowest energy source of small grains <90% corn
    - Lower digestibility for swine and ruminants
    - Minimal production and increased demand for oats in human milling and for horse feed
      - Low production and high cost often limit their use in livestock diets
      - Often too expensive for livestock diets
## Evaluating Feed Ingredients

### Protein and Energy Value of Small Grains for Ruminants (NRC, 2001)

<table>
<thead>
<tr>
<th>Grain</th>
<th>Crude Protein, %</th>
<th>Net Energy-gain (Mcal/cwt)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Corn</td>
<td>9</td>
<td>64</td>
</tr>
<tr>
<td>Wheat</td>
<td>14</td>
<td>65</td>
</tr>
<tr>
<td>Rye</td>
<td>12</td>
<td>59</td>
</tr>
<tr>
<td>Barley</td>
<td>12</td>
<td>61</td>
</tr>
<tr>
<td>Oats</td>
<td>13</td>
<td>52</td>
</tr>
</tbody>
</table>
Calculating the per bushel energy value of a small grain relative to corn

- Corn NEg = 64
- Wheat NEg = 65
- Bushel of corn = 56 lbs
- Bushel of wheat = 60 lbs
- Corn = $3.75/bu…. What should we pay for wheat/bu?

\[
\frac{3.75}{56} = \frac{0.067}{lb}
\]

\[(65 ÷ 64) \times 100 = 101.6\% more energy in wheat than corn\]

\[
0.067 \times 1.016 = 0.068/\text{lb}
\]

\[
0.067/\text{lb} \times 60/\text{lbs} = 4.08/\text{bu for wheat}
\]
### Evaluating Feed Ingredients

#### Equivalent Value of Corn Grain and Small Grains for Ruminants

<table>
<thead>
<tr>
<th>Grain</th>
<th>Bushel weight (lbs)</th>
<th>Energy price ($/bu)</th>
<th>Protein price ($/bu)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Corn</td>
<td></td>
<td>$3.75/bu</td>
<td></td>
</tr>
<tr>
<td>Wheat</td>
<td>60</td>
<td>$4.08</td>
<td>$6.25</td>
</tr>
<tr>
<td>Rye</td>
<td>56</td>
<td>$3.46</td>
<td>$5.00</td>
</tr>
<tr>
<td>Barley</td>
<td>48</td>
<td>$3.07</td>
<td>$4.29</td>
</tr>
<tr>
<td>Oats</td>
<td>32</td>
<td>$1.74</td>
<td>$3.10</td>
</tr>
</tbody>
</table>
Evaluating Feed Ingredients

<table>
<thead>
<tr>
<th>Grain</th>
<th>Lysine, %</th>
<th>DE (kcal/kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Corn</td>
<td>0.29</td>
<td>3961</td>
</tr>
<tr>
<td>Wheat</td>
<td>0.37</td>
<td>3820</td>
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<tr>
<td>Rye</td>
<td>0.43</td>
<td>3716</td>
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<tr>
<td>Barley</td>
<td>0.46</td>
<td>3427</td>
</tr>
<tr>
<td>Oats</td>
<td>0.45</td>
<td>3112</td>
</tr>
</tbody>
</table>
## Evaluating Feed Ingredients

### Equivalent Value of Corn Grain and Small Grains for Swine

<table>
<thead>
<tr>
<th>Grain</th>
<th>Bushel weight (lbs)</th>
<th>Energy price ($/bu)</th>
<th>Protein price ($/bu)</th>
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<tbody>
<tr>
<td>Corn</td>
<td></td>
<td>$3.75/bu</td>
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<tr>
<td>Wheat</td>
<td>60</td>
<td>$3.88</td>
<td>$5.13</td>
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<tr>
<td>Rye</td>
<td>56</td>
<td>$3.52</td>
<td>$5.56</td>
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<tr>
<td>Barley</td>
<td>48</td>
<td>$2.78</td>
<td>$5.10</td>
</tr>
<tr>
<td>Oats</td>
<td>32</td>
<td>$1.68</td>
<td>$3.33</td>
</tr>
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</table>
Evaluating Feed Ingredients

**Summary** – Evaluating Feed Ingredients as a Commodity

- Small grains used as an energy source should be competitively priced to corn
- Remember they also contribute protein and amino acids to the diet
- Consider using a least cost diet formulation software
- Don’t forget other factors including:
  - Supply, logistics, grinding and processing requirements, etc.
- Purchasing small grains as a commodity is different than growing them for your own feeding system!
  - Lets talk about the *integrated* row crop and livestock farmer!
Small Grains for the Integrated Farmer
## Production Budget Model per Unit of Energy Produced for Cattle

<table>
<thead>
<tr>
<th></th>
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<tbody>
<tr>
<td><strong>Yield, bu/acre</strong></td>
<td>180</td>
<td>85</td>
<td>100</td>
<td>80</td>
</tr>
<tr>
<td><strong>Seed</strong></td>
<td>$116.00</td>
<td>$50.00</td>
<td>$55.00</td>
<td>$36.00</td>
</tr>
<tr>
<td><strong>Fertilizer</strong></td>
<td>$125.00</td>
<td>$76.00</td>
<td>$65.00</td>
<td>$25.00</td>
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<tr>
<td><strong>Pesticides/Herbicide/Fungicide</strong></td>
<td>$75.00</td>
<td>$27.00</td>
<td>$25.00</td>
<td>$5.00</td>
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<tr>
<td><strong>Drying</strong></td>
<td>$40.00</td>
<td>$0.00</td>
<td>$0.00</td>
<td>$0.00</td>
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<tr>
<td><strong>Crop Insurance</strong></td>
<td>$22.00</td>
<td>$9.00</td>
<td>$7.00</td>
<td>$7.00</td>
</tr>
<tr>
<td><strong>Total Direct Costs/acre</strong></td>
<td><strong>$378.00</strong></td>
<td><strong>$162.00</strong></td>
<td><strong>$152.00</strong></td>
<td><strong>$73.00</strong></td>
</tr>
<tr>
<td><strong>NE (Mcal/acre)</strong></td>
<td>6,451.2</td>
<td>3,315</td>
<td>3,304</td>
<td>1,331.2</td>
</tr>
<tr>
<td><strong>Cost/Mcal of Energy</strong></td>
<td><strong>$0.059</strong></td>
<td><strong>$0.049</strong></td>
<td><strong>$0.046</strong></td>
<td><strong>$0.055</strong></td>
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## Small Grains for the Integrated Farmer

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<tbody>
<tr>
<td><strong>DE (Mcal/acre)</strong></td>
<td>18,110</td>
<td>8,837</td>
<td>9,439</td>
<td>3,614</td>
</tr>
<tr>
<td><strong>Cost/Mcal of Energy</strong></td>
<td><strong>$0.021</strong></td>
<td><strong>$0.018</strong></td>
<td><strong>$0.016</strong></td>
<td><strong>$0.020</strong></td>
</tr>
</tbody>
</table>
Small Grains for the Integrated Farmer

- Crop Diversity
  - Diversified rotation
  - Improved soil health
  - Winter cover crop opportunity – N-fixing legume

- Additional Straw or Organic Matter from small grain

- Labor and Resource management
  - Summer manure application

- Market Flexibility
Added Value of Small Grain Utilization
Added Value of Small Grain Utilization

Swine Health

Fiber and Gut Function

Satiety and Behavior
Added Value of Small Grain Utilization

- High in soluble fibers including arabinoxylans and fructans
  - Increased Butyrate production

- Improved gut health and mucosa
  - Decreased salmonella prevalence
  - Reduced antibiotic usage

<table>
<thead>
<tr>
<th>Fructans (1.2)</th>
<th>β-glucans (2.0)</th>
<th>Xylose (5.3)</th>
<th>Arabinose (2.6)</th>
<th>Cellulose (1.8)</th>
<th>Lignin</th>
</tr>
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<tbody>
<tr>
<td>Bono Rye</td>
<td>Brasetto Rye</td>
<td>Wheat</td>
<td>Corn</td>
<td></td>
<td></td>
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0 2 4 6 8 10 12 14
Added Value of Small Grain Utilization

- Increased fiber = increased satiety
  - Digesta mass and slower passage rate
- More continuous levels of glucose and insulin
- Aggression, tail biting, belly rooting
- Group housing – Sows
Conclusions

- Wheat, rye, barley, and oats all offer a favorable nutritional profile and can be incorporated into livestock diets as an alternative for corn

- The economic value of small grains looks different depending on your market system
  - Commodity prices need to be competitive with corn
  - Integrated farmer can see huge benefit from using small grains

- Cost of production and yield make small grains an attractive feed stuff for livestock producers

- The nutritional profile of small grains make them unique to corn and added value from these small grains may also be noted!
Questions?