Investigating Clover Protein for Organic Pork Production

Notes from my visit to Denmark
May 2019
Jude Becker
Why an alternative to soy?

- Soy has driven expansion of Midwest pork industry for decades.
- Offers a competitive advantage versus other global regions. “Corn/Soy” flavor-
- No vegetable alternative can match the CP content with lysine balance.
Emerging Consumer Preference and Climate/Environmental issues

- Facing increasing negative feedback from customers on soy use in pig diets.
- As pressure to sequester carbon increases on the Ag sector, row crop monocultures will become less desirable.
Cost of certified organic soybean meal a burden on pig farm economy

- Major financial stumbling block for organic pork has been cost of feed over the past 20 years.
- Many farms have sought alternative sources of protein that were more internalized/renewable and less cash intensive.
Trip to Denmark/ Arhus University

• Following Midwest Organic Pork Conference in 2019, opportunity to visit Denmark arose.
• Heard about “Clover Protein” project.
Factors of project origination in Denmark

- **Why protein from grass is so interesting-changing annual crops into grass land**
  - EU animal production is largely dependent on imported proteins (mainly soya).
  - The climate load from animal production has to be reduced –more carbon sequestration in grass.
  - Less nitrate leaching from grassland
  - Danish environmental programs for coastal waters. Report suggest 25 % of land in grass for protein production.
  - Difficult to supply organic pig and poultry with organic and locally produced proteins. Combined with nitrogen deficiency in organic plant production.
  - Growing demand for organic products.
  - Better conditions for insects and wildlife / higher biodiversity.
Limited supply of protein for current market demands, similar argument could be constructed in the U.S.

THE PROTEIN CHALLENGE: INCREASING POPULATION AND MEAT IN THE DIET

70 pct.

Total global consumption of animal proteins from 2007 to 2030 may increase by around 70 percent; an increase in the demand for plant-based proteins for food is also expected.

Source: Based on FAO (2006a, 2010a)
ENVIRONMENTAL REASONS FOR BIOREFINING GREEN CROPS

More perennial green biomass will have several positive environmental impacts.

- Reduced Nitrate leaching compared to cereals and corn
- No pesticide use necessary
- Positive soil carbon input (around 1 ton C/ha)
- Increased biodiversity using crop mixtures (even herbs)

We are specifically focusing on Grasses, Clover and Lucerne


THE PROTEIN CHALLENGE: PROTEIN DEFICIT IN EU

- Meat production in EU is 63% dependent on soy import
- Equal to a production area the size of England
- Increased soy production adds to deforestation and soil depletion
- EU food industry is vulnerable to world market changes

Source: EU Commission. "Complex" includes meals, seeds and beans


Deforestation embodied in traded crop commodities, by crop groups, for the period 1990-2008, totaling 22.4 Mha
Process development and upscaling of biorefining technology

Pilot facilities for biobased production and process integration
PROTEIN FEED FROM GREEN BIOMASS

BASE CASE SCENARIO

Fertilizer

Heat/power

Residue juice

Protein concentrate

Maceration

Precipitation

Pressing

Fractionation

Grass Refinery

Biogas plant

Manure

Monogastric animal feed

Ruminant animal feed

Food
Danish research and innovation projects on grass proteins

- **MultiPlant**: Developing a multi species concept of forage for grass protein and biogas.
- **SuperGrassPork**: Feed value of grass protein for pigs and further development of the biorefining process.
- **GreenEggs**: Egg quality and production on grass protein combined with green leaves from willows in the hen yard.
Concept Background

Multiple attempts have been made in the U.S. to derive a suitable protein supplement from hay and forage legumes such as clover and alfalfa. Most have not met with the intended results.

To my surprise, the effort in Denmark was based on using the liquid content of the plant rather than the dry material. This is a central concept.

As plant dries following cutting, protein adheres to dry material in plant and following this is no longer separable. Time is of the essence!
After green material is conveyed into chopper at even flow rate, it is ground through this roller grinder.

Most desirable mixture is clover or alfalfa. Certain other grass species and weeds present at very low percentages are acceptable.

Some weeds, however, will cause issues for machinery at even low rates.
This weed had flowers and early seed head structures which plugged the screen. Even a small presence was causing issues for operation the day of our visit.
Harvest technique is important for protein yield and quality
Season variations have to be managed

- Calculated yields during the grass season.
  - 3000 ha
  - 5 cuts
  - 4 blocks of 750 ha

4 blocks of 900, 1050, 600 and 450 ha

Grass yield – ton/t DM

Week

Protein yield, ton

Grass yield v 17.5 % ts (ton)
Dry matter yield (ton)
Protein yield (ton)
Ground material is pressed through screens to extract “juice”.
Liquid content prior to drying contains protein and nutrients
Final dried product ready for inclusion in ration
Protein conc.
DM = 10-20%
Protein = 30-60%
High protein yields in legume rich forage

<table>
<thead>
<tr>
<th>Crop</th>
<th>Yield (ton DM / ha)</th>
<th>Protein Kg / ha</th>
<th>Lysine Kg / ha</th>
<th>Methionine Kg / ha</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grass – clover mixture</td>
<td>13</td>
<td>2600</td>
<td>200</td>
<td>90</td>
</tr>
<tr>
<td>Alfalfa</td>
<td>12</td>
<td>2600</td>
<td>200</td>
<td>90</td>
</tr>
<tr>
<td>Peas</td>
<td>6</td>
<td>1300</td>
<td>92</td>
<td>13</td>
</tr>
<tr>
<td>Field bean</td>
<td>6</td>
<td>1500</td>
<td>92</td>
<td>11</td>
</tr>
<tr>
<td>Soy-bean (US)</td>
<td>3</td>
<td>1050</td>
<td>65</td>
<td>14</td>
</tr>
</tbody>
</table>

Modified from S. Krogh Jensen, Aarhus University
LATEST FEED TRIAL SUBSTITUTED 100% SOY WITH GREEN PROTEIN
WITH NO NEGATIVE EFFECT ON WEIGHT GAIN AND FEED UTILIZATION

1,2 ton DM Grass-clover protein concentrate production 2018
High protein concentration in the product batches (45-55%)

Feeding from 8 Nov. to 7 Mar.
4 feed groups (Control, 5, 10, 15%)
Total of 48 pigs

<table>
<thead>
<tr>
<th>Grass-clover protein concentrate</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Water content</td>
<td>18%</td>
</tr>
<tr>
<td>Crude protein</td>
<td>47%</td>
</tr>
<tr>
<td>Fat</td>
<td>11.3%</td>
</tr>
<tr>
<td>Ash</td>
<td>12.3%</td>
</tr>
</tbody>
</table>

### Essential amino acids [g/16 g N]

<table>
<thead>
<tr>
<th></th>
<th>Grass-clover conc.</th>
<th>Soy meal</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lys</td>
<td>6.04</td>
<td>5.98</td>
</tr>
<tr>
<td>Met</td>
<td>2.24</td>
<td>1.31</td>
</tr>
<tr>
<td>Cys</td>
<td>0.70</td>
<td>1.43</td>
</tr>
<tr>
<td>Thr</td>
<td>4.71</td>
<td>3.92</td>
</tr>
<tr>
<td>Trp</td>
<td>2.17</td>
<td>1.36</td>
</tr>
<tr>
<td>Ile</td>
<td>5.19</td>
<td>4.91</td>
</tr>
<tr>
<td>Leu</td>
<td>8.82</td>
<td>7.68</td>
</tr>
<tr>
<td>His</td>
<td>2.26</td>
<td>2.61</td>
</tr>
<tr>
<td>Phe</td>
<td>5.84</td>
<td>5.06</td>
</tr>
<tr>
<td>Val</td>
<td>6.41</td>
<td>5.19</td>
</tr>
<tr>
<td>Arg</td>
<td>6.02</td>
<td>7.23</td>
</tr>
<tr>
<td>Glu</td>
<td>11.04</td>
<td>17.78</td>
</tr>
</tbody>
</table>

From S.K. Jensen and L. Stødkilde-Jørgensen
Financial Results at Plant and Farm level

Clover protein is priced to the farm at same level as 5 year average of organic soybean meal, non-gmo soybean meal, and commodity soybean meal.

Returns for the plant/factory were negative for the commodity soybean meal, slightly negative for the non-gmo soybean meal, and positive for the organic soybean meal.

More work needs to be done, but “cheapness” of commodity soy will likely be difficult to compete against.
Possibilities in Midwestern U.S.

- Adequate soy is available at present, limited amounts of imported soy.
- Following visit in 2019, Ernie Peterson of Cashton Farm Supply made follow up visit to Arhus, DK.
- Interest level along with feasibility is being investigated at Cashton Farm Supply.
Thank you for your attention