Protein feed from clover grass for pigs and poultry.
Results from Danish innovation projects

Erik Fog
SEGES Organic Innovation
AGROMANIA 27–11-2018
SEGES is one of Europe’s leading agricultural innovation companies
Scope of activities

Veterinary matters
Nature & the environment
CROPS & ROUGHAGE
Buildings & machinery
Agricultural economics
RESEARCH TRIALS & ANALYSIS WITHIN ALL DISCIPLINES

DanBred and other breeding
Training and advisory services
Management
Livestock: cattle, pigs, poultry
Legal matters & tax
Digital tools for management and documentation
Quality
Organic production

SEGES
SEGES is the bridge-builder between research and practical farming
Why proteins from grass are so interesting - changing annual crops into grass land

• EU animal production is largely dependent on imported proteins (mainly soya).
  • EU report on the development of plant proteins in Europe (November 2018).

• 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.
Bio-refinery as improvement of Danish organic production

More grass clover - More Nitrogen

Extraction of grass protein
Less protein import

Biogas from residues and household waste
Bio-energy and nutrient recycling
The biorefining process and mass flow

Harvest of fresh grass clover

Screw press

Fermentation

Separation

Protein paste
Feed for pigs and poultry

Dry matter: 100 %
Protein: 100 %

Press cake
Cattle feed or biogas

Dry matter: 50-70 %
Protein: 40-60 %

Liquid fraction
Biogas production

Dry matter: 10-20 %
Protein: 30-60 %

Dry matter: 10-20 %
Protein: 0-10 %
Danish research and innovation projects on grass proteins

- **Biobase**: A pilot plant for green biorefinery has been established at Aarhus University, Foulum.

  - Expanding in 2019 to demonstration scale (10 x pilot scale) – Project: **Grønbioraf**
Danish research and innovation projects on grass proteins

- **OrganoFinery**: Developing a concept for grass protein supply for organic animals combined with biogas production and digestate fertilizer for organic crops

- **BioValue**: Broad research platform on biorefinery

  Mutual big scale trials with grass protein production for feeding trials.
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.
Danish implementation projects on grass proteins

- Grass Protein Factory: A Danish consortium setting up a factory concept for grass protein production. Including Aarhus University, engineering company, machinery suppliers, feed company and farmers.
- Biomass Protein: A project with similar goals.
- Bioraf-Business: Optimizing grass supply and business plans.
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
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

Graph showing
- Grass yield (ton/DM)
- Protein yield (ton)
- Dry matter yield (ton)

T. Frandsen - SEGES
Harvest technique is important for protein yield and quality.
Feed value – Grass-clover protein concentrate

- Hens (OrganoFinery)
  - Feed with 4, 8 or 12 percent grass protein concentrate gave the same egg yield as the control feed. – And more yellow yolks.

(Stenfeldt et al. 2017, Aarhus University)
Feed value – Grass-clover protein concentrate

- Chicken (MultiPlant)
  - Up to 13 % of crude protein (8 % protein concentrate) can come from grass protein without influencing the growth rate. (Trial with relatively low protein concentration in test feed)
  - Yellow pigments from the grass embedded in the chickens.
  - Higher levels of omega-3 fatty acids in chicken fat with higher levels of grass protein in feed.

(L. Stødkilde, Aarhus University)
Feed value – Grass-clover protein concentrate

- Pigs (Biobase & Feed-a-gene / SuperGrassPork)
  - Pigs had good appetite to feed with grass protein.
  - The protein digestibility of protein from test feed with low protein content (35 % crude protein) was lower than in soy-concentrate.
  - Expected to be better in grass-clover protein concentrate with higher protein content.
  - Feeding trial with slaughter pigs started November 2018. Test feed with 48 % protein in grass-clover protein concentrate.
    (L. Stødkilde, Aarhus University)
Feed value – Press cake from grass-clover protein production

- Milking cows (BioValue)
  - Test feeding with press cake compared to grass-clover silage.
  - Lower dry matter content and higher fiber content in the press cake compared to the grass-clover silage.
  - Good appetite to the press cake silage, higher in vivo digestibility, higher feed efficiency and a higher milk yield with press cake.

(Vinni K Damborg phd work, Aarhus University)
Grass protein and biodiversity

- Project MultiPlant has tested different mixtures of grass, legumes and forbs.
  - Similar dry matter yield and even higher biogas yield in mixtures with forbs.
  - Nitrogen fixation follows the amount of legumes.
  - Different plant species promote different insect species.

J. Eriksen, Aarhus University
Economy in green biorefinery - only profitable in organic farming

<table>
<thead>
<tr>
<th></th>
<th>Conventional (k-DKK / year)</th>
<th>Non-GMO (k-DKK / year)</th>
<th>Organic (k-DKK / year)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total income</td>
<td>22,078</td>
<td>26,423</td>
<td>31,095</td>
</tr>
<tr>
<td>Total costs</td>
<td>29,780</td>
<td>29,781</td>
<td>29,730</td>
</tr>
<tr>
<td>Result</td>
<td>-7,702</td>
<td>-3,358</td>
<td>1,365</td>
</tr>
</tbody>
</table>

Model calculation on a biorefinery plant processing 20,000 tons DM grass-clover per year and producing 3,600 tons dried protein concentrate.

Source: M. Gylling (2018), Copenhagen University, IFRO.
Great perspectives in grass land for biorefinery

- Prospect for commercial green biorefinery and increased conversion to organic farming
  - Especially in areas with few cattle.

- Next step: Grass protein for human consumption

- Environmental benefits
  - Less nitrate leaching, higher biodiversity

- Greenhouse gas mitigation
  - More carbon sequestration in the soil (humus)
Thank you for your attention