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

Erik Fog
SEGES Organic Innovation

Tagung: Grünland nutzen und erhalten, Saarbrücken
20.11.2018
SEGES is one of Europe’s leading agricultural innovation companies
Scope of activities

- Veterinary matters
- Feed
- Nature & the environment
- CROPS & ROUGHAGE
- Buildings & machinery
- DanBred and other breeding
- Agricultural economics
- Training and advisory services
- Management
  - Livestock: cattle, pigs, poultry
- Legal matters & tax
- Digital tools for management and documentation
- RESEARCH TRIALS & ANALYSIS WITHIN ALL DISCIPLINES
- Quality
- Organic production
SEGES is the bridge-builder between research and practical farming
We innovate and disseminate knowledge to:

37,000 Farms

900 Horticulturists or nurseries

7,000 Small or medium-sized companies

SEGES
650 employees

8 out of 10 have an academic background

70 different educational qualifications
Why proteins from grass are so interesting - changing annual crops into grass land

- EU animal production is largely dependent on imported proteins (mainly soya).
  - A strategic plan for more EU produced protein is launched this week.
- 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.
- Difficult to supply organic pig and poultry with organic and locally produced proteins. Combined with nitrogen deficiency in organic plant production.
- Better conditions for insects and wildlife / higher biodiversity.
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**

M. Ambye-Jensen, Aarhus University
Danish research and innovation projects on grass proteins

• **OrganoFinery**: Developing a concept for grassprotein supply for organic animals combined with biogas production and digestate fertilizer for organic crops

• **BioValue**: Broard research platform on biorefinery

  Mutual big scale trials with grass protein production for feeding trials.

Aalborg and Aarhus Universities
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.
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

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THE GRASS BIOREFINERY CONCEPT

Harvest of fresh grass clover

Juice press

Press cake

Cattle feed

Feed for pigs and poultry

Protein separation

Fermentation

Biogas

Digestate fertilizer

Recidue liquid
**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

T. Frandsen - SEGES
Harvest technic 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 3% 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 protein concentrate with higher protein content.
  - Feeding trial with slaughter pigs started November 2018. Test feed with 48 % protein in grass 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 fobs.
  - Similar drymatter yield and even higher biogas yield in mixtures with fobs.
  - 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 more 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)

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Thank you for your attention