



# Protein feed from clover grass for pigs and poultry.

Results from Danish innovation projects

Erik Fog

SEGES Organic Innovation

AGROMANIA 27–11-2018

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# Scope of activities

**Veterinary**  
matters

Feed

**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**



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research and practical farming**

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# 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**



Dry matter: 100 %  
Protein: 100 %

**Screw press**



**Press cake**  
Cattle feed or biogas



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

**Fermentation**



**Separation**



**Liquid fraction**  
Biogas production



Dry matter: 10-20 %  
Protein: 0-10 %

**Protein paste**  
Feed for pigs and poultry



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

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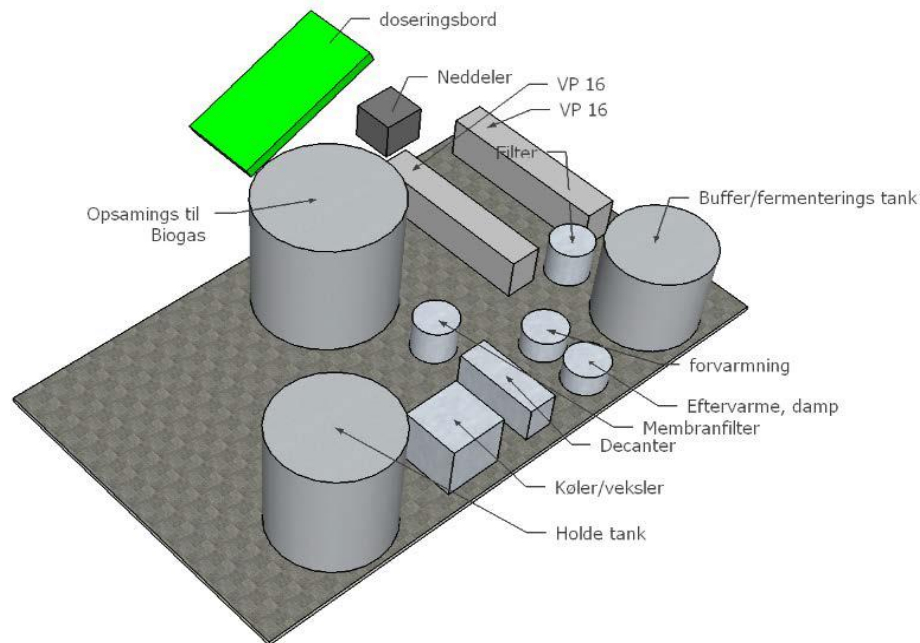


# Danish research and innovation projects on grass proteins

- **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

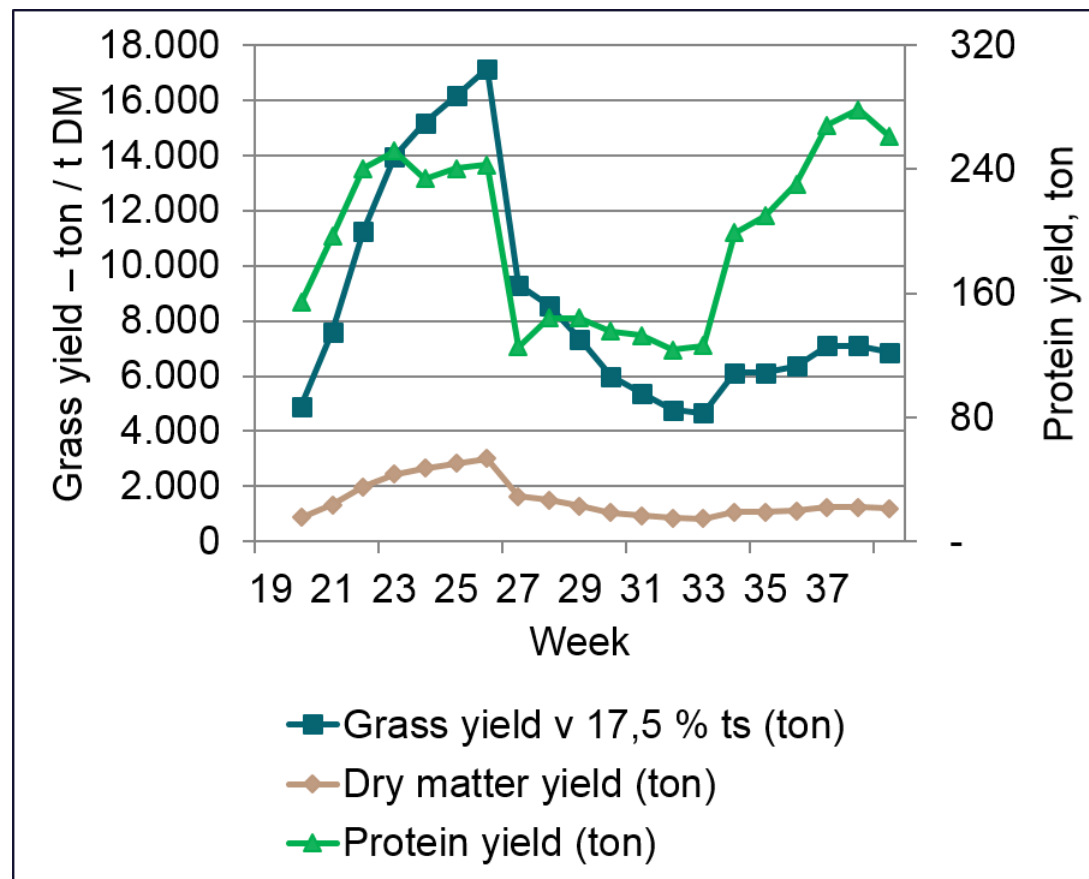
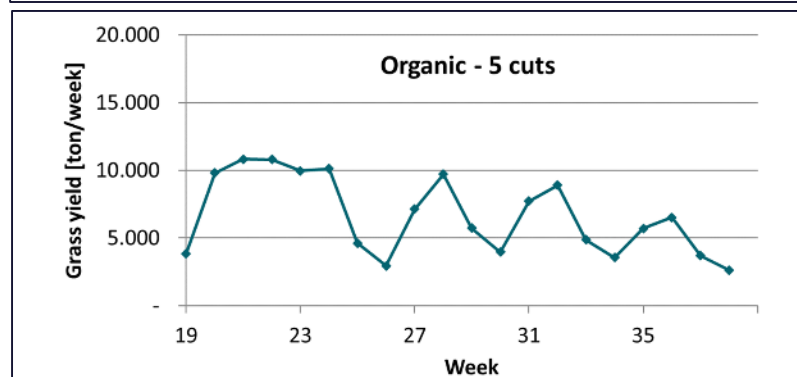
Crop	Yield (ton DM / ha)	Protein Kg / ha	Lysine Kg / ha	Methionine Kg / ha
Grass – clover mixture	13	2600	200	90
Alfalfa	12	2600	200	90
Peas	6	1300	92	13
Field bean	6	1500	92	11
Soy-bean (US)	3	1050	65	14

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

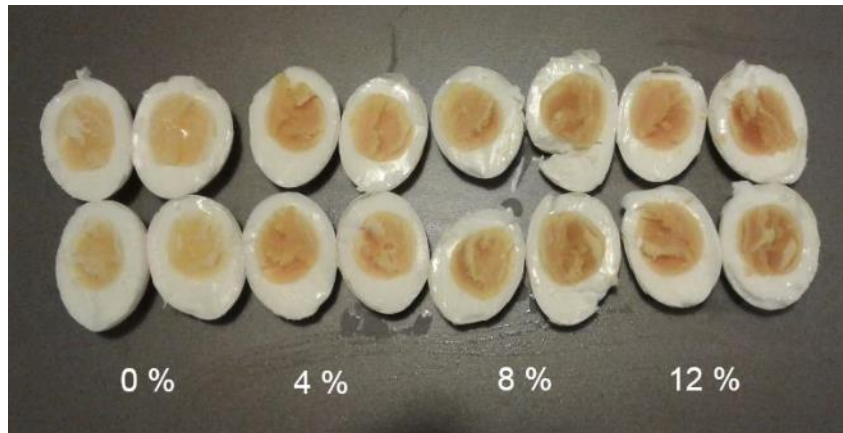


# Harvest technique is important for protein yield and quality



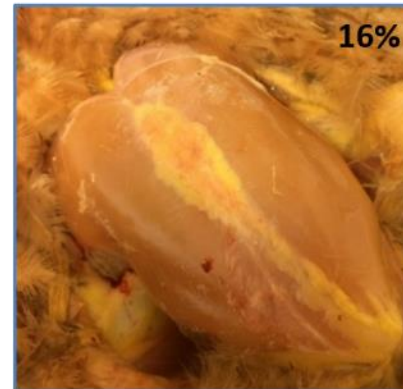
# Feed value – Grass-clover protein concentrate

- 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.



# 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.



## Economy in green biorefinery - only profitable in organic farming

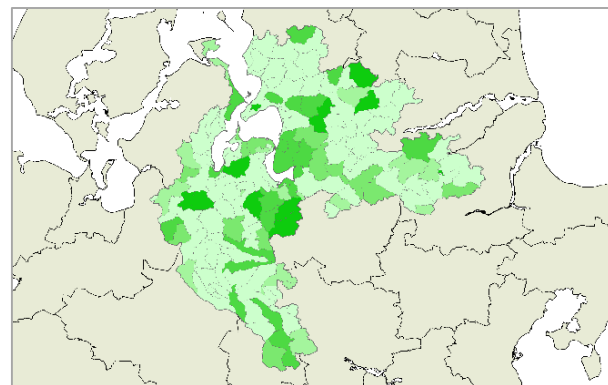
	Conventional (k-DKK / year)	Non- GMO (k-DKK / year)	Organic (k-DKK / year)
Total income	22,078	26,423	31,095
Total costs	29,780	29,781	29,730
<b>Result</b>	<b>-7,702</b>	<b>-3,358</b>	<b>1,365</b>

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)



Pct. area converted into grass to minimize nitrate leaching



**Thank you for your attention**

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