



Protein feed from clover grass for pigs and poultry.

Results from Danish innovation projects

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SEGES Organic Innovation

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Scope of activities





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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

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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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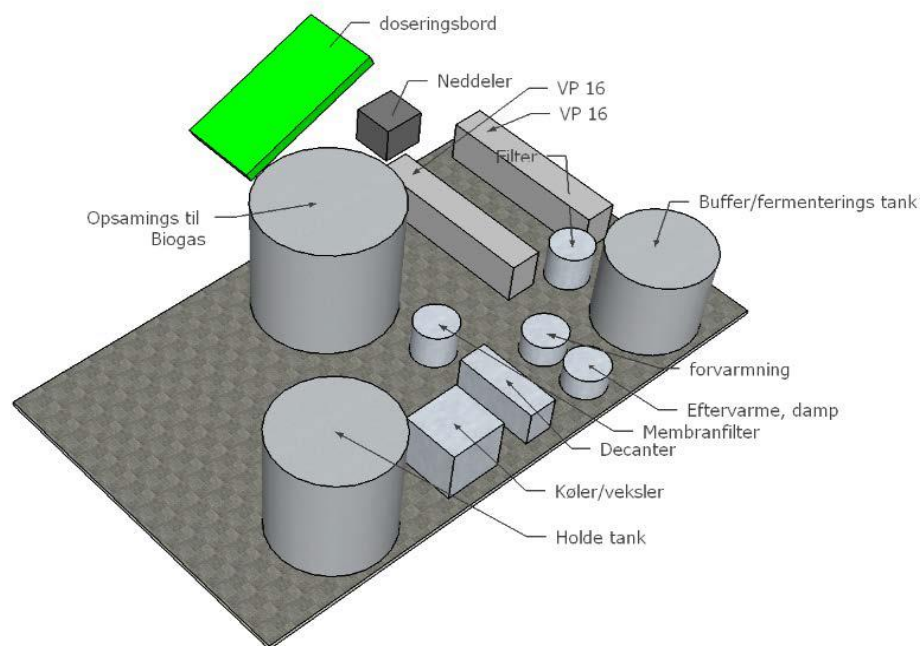


Danish research and innovation projects on grass proteins

- **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

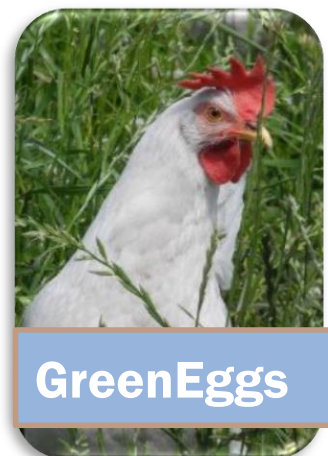
- **OrganoFinery**: Developing a concept for grass protein supply for organic animals combined with biogas production and digestate fertilizer for organic crops
- **BioValue**: Broad research platform on biorefinery

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

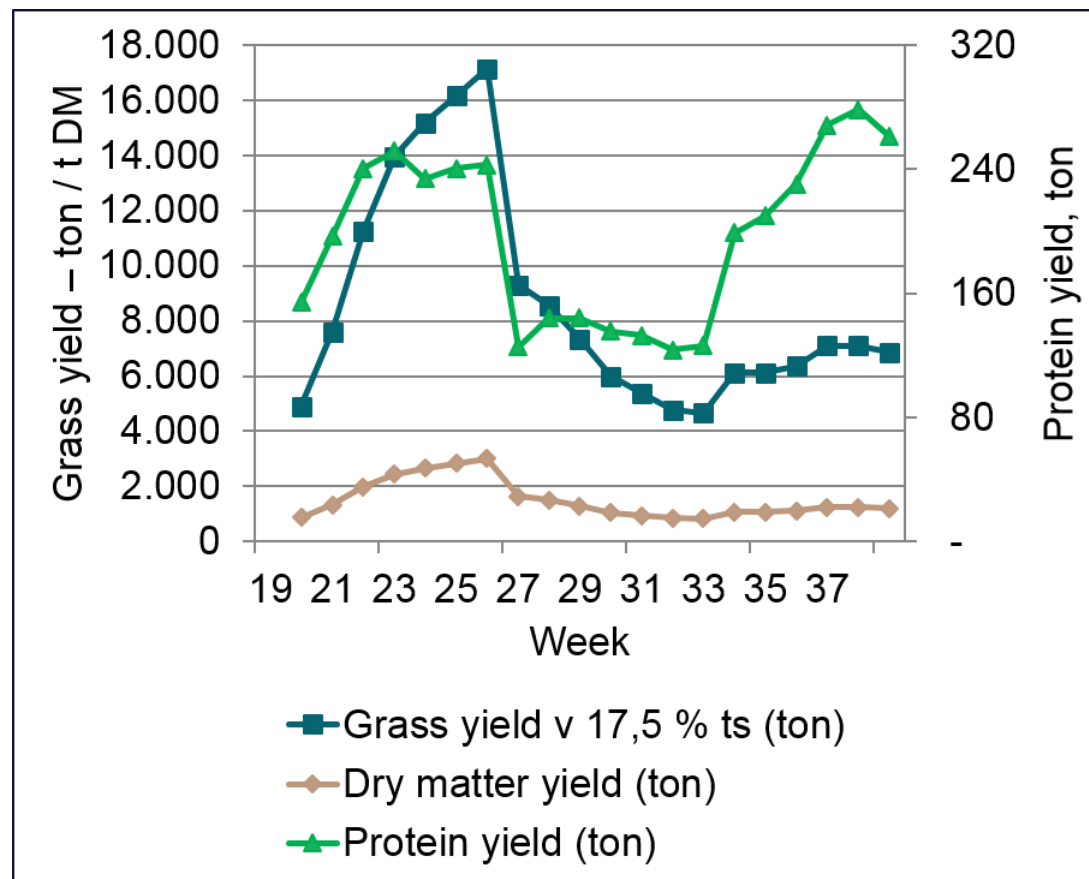
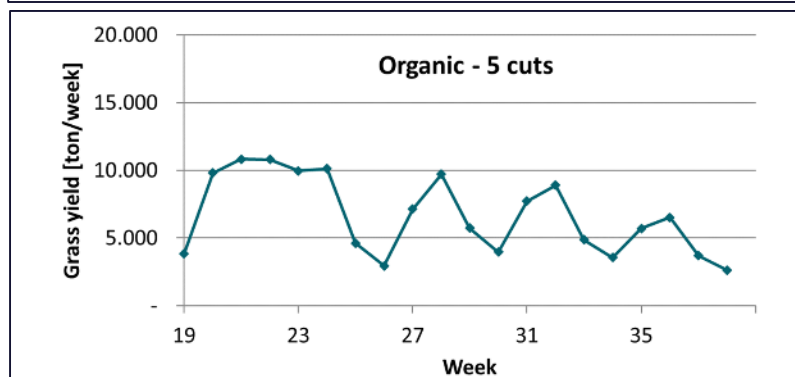
Crop	Yield (ton DM / ha)	Protein Kg / ha	Lysine Kg / ha	Methionine Kg / ha
Grass – clover mixture	13	2600	200	90
Alfalfa	12	2600	200	90
Peas	6	1300	92	13
Field bean	6	1500	92	11
Soy-bean (US)	3	1050	65	14

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

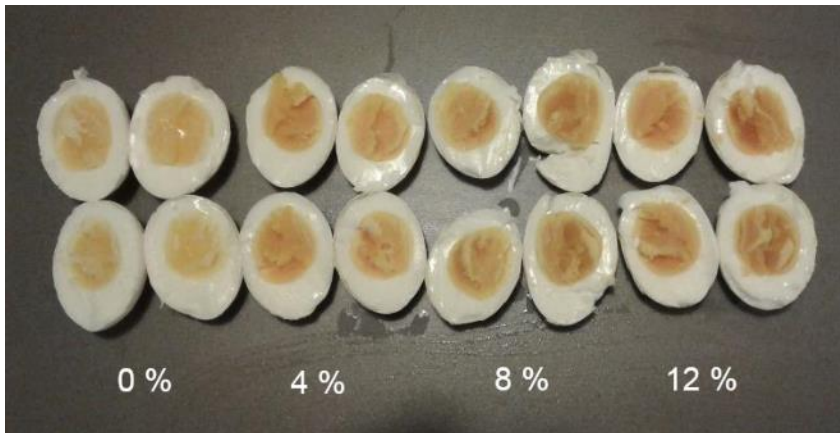


Harvest technique is important for protein yield and quality



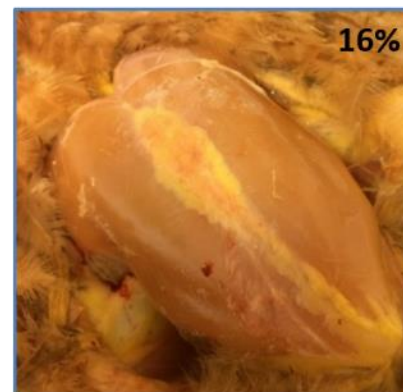
Feed value – Grass-clover protein concentrate

- 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

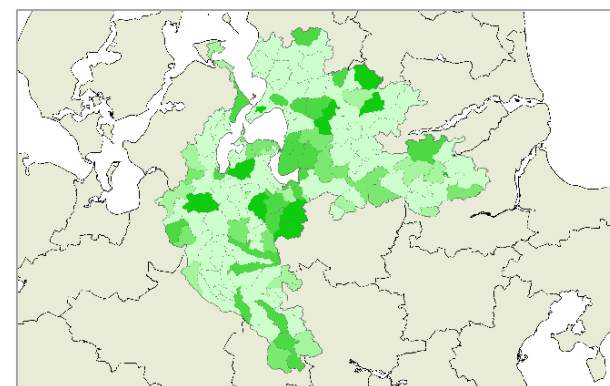
	Conventional (k-DKK / year)	Non- GMO (k-DKK / year)	Organic (k-DKK / year)
Total income	22,078	26,423	31,095
Total costs	29,780	29,781	29,730
Result	-7,702	-3,358	1,365

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



The background of the slide is a close-up photograph of various green plants, including clovers and other leafy vegetation, with several small white flowers in bloom. A semi-transparent dark green horizontal band is overlaid across the middle of the image.

Thank you for your attention

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