The green biorefinery seen from the organic farmers perspectives

Erik Fog, Senior Adviser, SEGES Organic Innovation

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Outline

- The farmers role
- The grass clover as engine for organic rotations and environmental protection
- Practical challenges in the grass harvest
- Biomass logistics
- Feeding with grass protein
- Economics – competition with other sources of protein feed
- Outlook and new projects

The farmer is decisive for green biorefining

- He deliver the grass.
- He use the protein products.
- He use the residues as fertilizer.
- Should he build the biorefinery?

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Benefits of grass clover

- **In organic farming: The engine of the crop rotation**
  - **200 kg nitrogen per hectare + 30 kg N as pre crop value.**
  - **20 to 25 % grass clover in the rotation.**
  - **The nitrogen must be utilized to generate the value.**
- **In general: Soil improvement and environmental benefits**
  - **Soil improvement is important – but difficult to put an economic value on.**
  - **New targeted environmental regulation looks at extended grassland in water catchment areas.**

Grass harvest - Yields in trials

Yields (OrganoFinery – project)

- Research trials – Copenhagen Universitet

Yield (ton ha^{-1})	Crop DM	Crop protein	Protein in concentrate*)
White clover / Ryegrass	6.26	0.88	0.31
Red clover	8.82	1.47	0,51
Red clover / Cock's foot	9.50	1.36	0,48

- Field trials - SEGES

Yield (ton ha^{-1})	Crop DM	Crop protein	Protein in concentrate*)
Alfalfa	13.31	2.53	0.89
Red clover	16.45	2.86	1.00
Grass clover mixture	19.23	2.95	1.03

*) Protein in concentrate estimated to 35% of crop protein

Kilde:
Fog et al. 2017

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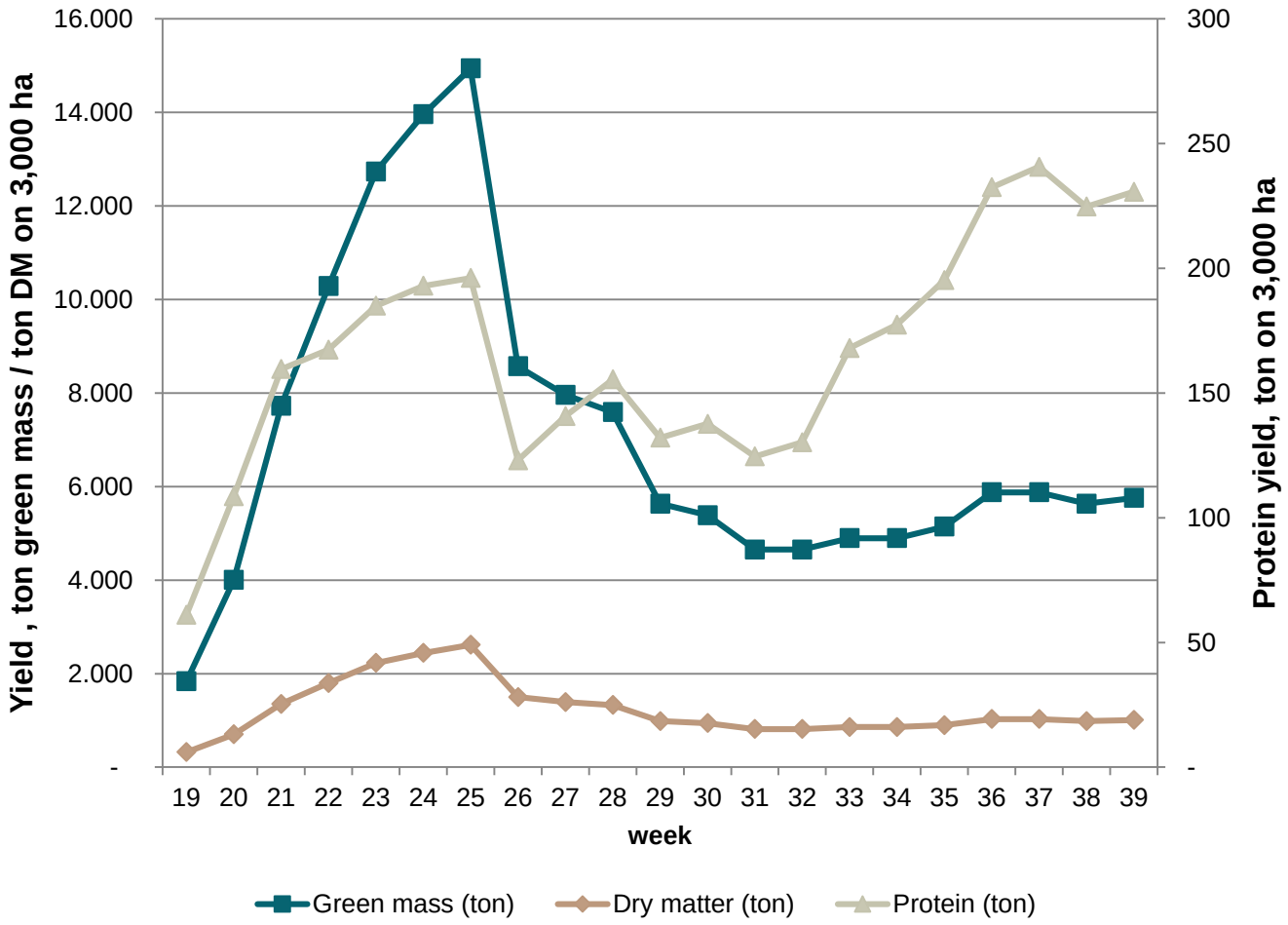
Grass harvest – Estimated weekly yields (3,000 ha)



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Harvest methods

- The grass has to be processed quickly after harvest in the field.
- Maxigrass (Grasstech.ie) – no soil contact – uncrushed grass - little capacity.


Foto: Grasstech.ie

Foto: T. Frandsen - SEGES

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Harvest methods

- Broad mover followed by a self-loading forage wagon
  - High capacity
  - Grass not crushed
  - Light wagons
  - Few tracks

Foto: Pöttinger.AT

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Biomass logistics

- Transport costs are serious for the economy.
- Trade off between short distances and economy of scale.
- Can local pressing units combined with regional refineries be a solution (cattle feed from press cake)?

Photo: P. Kiel- Biotest

Feeding with grass protein – wet or dry?

- Most farmers prefer dry feed from the feed company.
- Drying of protein paste – also a processing cost.
- Trials with protein paste in dry feed production showed technical difficulties even at low volume of grass protein paste (5 %)


Photo: M. Ambye-Jensen

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Norwegian trials with grass juice

- Grass juice as protein feed for pigs.
- Good acceptance from the pigs – lower feed value than control feed.
- Storage can be a challenge – conservation with formic acid.
- Danish test of lactic fermented protein paste in project SuperGrassPork.


Photo: Nordsvin

Economics

DKK / ha	1	2
Income, protein sale	**5,640**	**8,000**
Costs		
Bought grass crop	1,500	1,500
Juice pressing	1,300	800
Transport	1,900	1,500
Biorefining	3,300	1,500
Energy	1,100	200
Disposal of reject water	1,800	0
	10,900	**5,500**
Result	**-5,260**	**2,500**

1	2
9.10	3.25

Nessecary price of protein concentrate DKK / kg

The price must be able to compete with e.g. soy protein.
Current price for organic soy cake: 4.60 DKK / kg.
(conventional 2.30 DKK / kg)

Depending on the digestibility of the grass protein some animals can pay a good price (e.g. piglets)

Ref: Niels Tvedegaard, KU-IFRO

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Synergy with biogas production

- Share transport costs of grass and reject water.
- Waste heat from the biogas plant can be used for drying of protein paste.
- Reject water from the biorefinery can be used to make plant biomass fluid in the biogas plant.

Outlook and new projects

- Big interest among organic farmers for the concept – both for growing more grass and for exchanging soy protein with grass protein.
- Implementation of green biorefinery for protein feed depend first of all on product quality and price. Must be documented before the farmers will involve themselves in grass protein production.
- The projects SuperGrassPork and Green Eggs will document the feed value and further develop the biorefining technique. (Green Development Program / ICROFS)
- Green Bioraf (Grøn Bioraf) at AU Foulum and SUBLEEM 2.0 at Danish Technological Institute will develop an document optimized biorefining processes. (2019 -)
- Central Denmark Region has funded two innovation projects for planning og commercial biorefinery plants.
- Green Development Program has launched 14 mil. DKK as investment subsidy for the first full scale pilot plants.
- SEGES run Bioraf-Business project to show business opportunities for organic farmers.

Green proteins are future farming

- At SEGES we believe there are future possibilities for Danish farmers in growing green crops for biorefining.
- We have recently published two whitepapers on green biorefining and plant proteins for human consumption (in Danish).