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Refining proteins from green crops for high quality feed products for monogastric animals and dairy cows

Mette Lübeck

Section for Sustainable Biotechnology, Department of Chemistry and Bioscience

Aalborg University



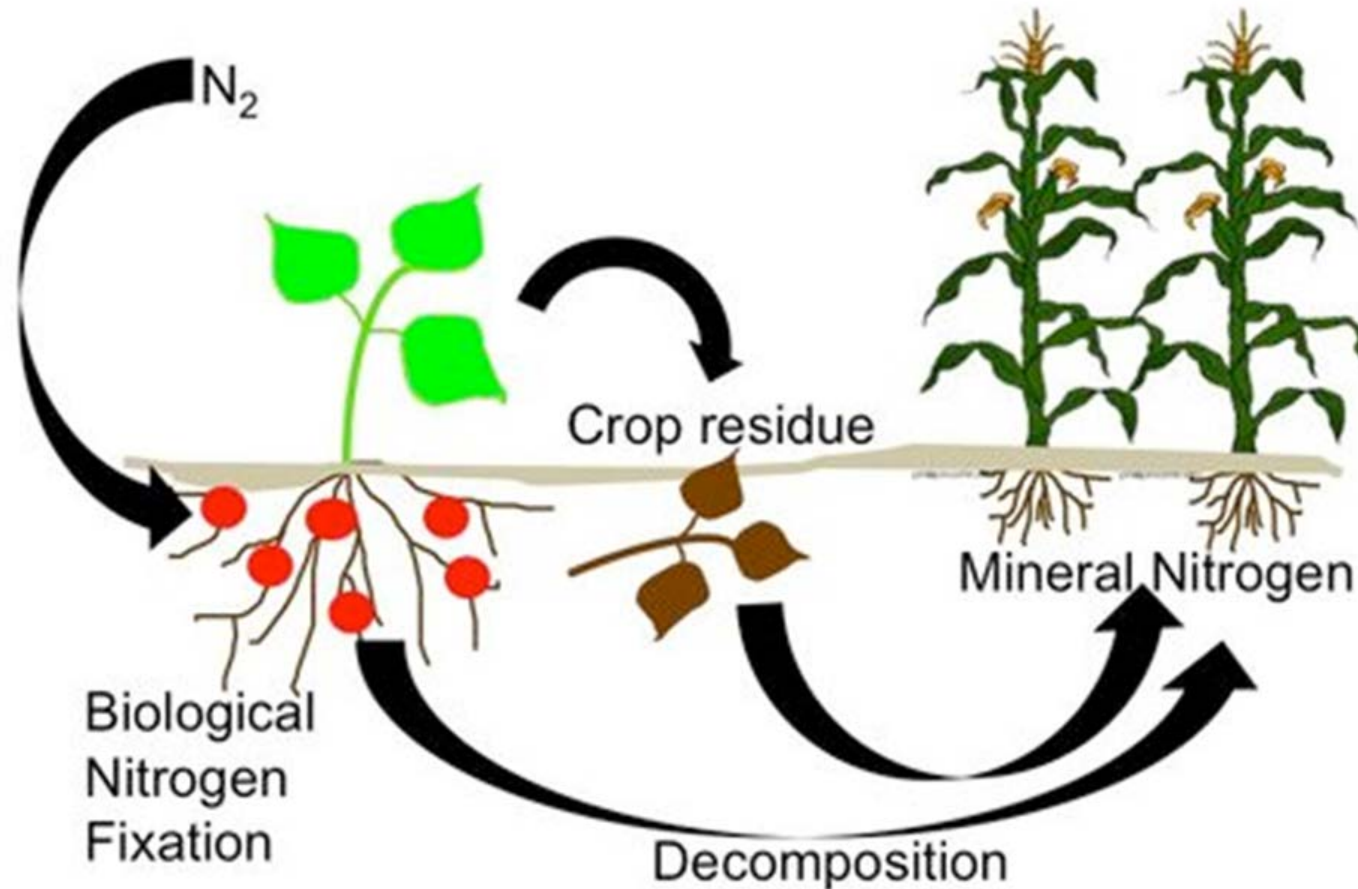


Introduction

- This research is based on the vision of developing **sustainable farming systems** based on **locally produced feeds**.
- This is especially important for the organic sector which has several key challenges:
 - **Increased demand** for organic products (20% increase in egg production/y)
 - Supply of **organic protein feed** for monogastric livestock (5% conventional)
 - Need for **organic fertilizers**
- Improved, climate-friendly, and robust **crop rotations** in areas with a low density of livestock.
 - Better efficiency of the nutrients, and **higher yields**.

Crop rotation important – especially in organic farming

Legume based cropping system





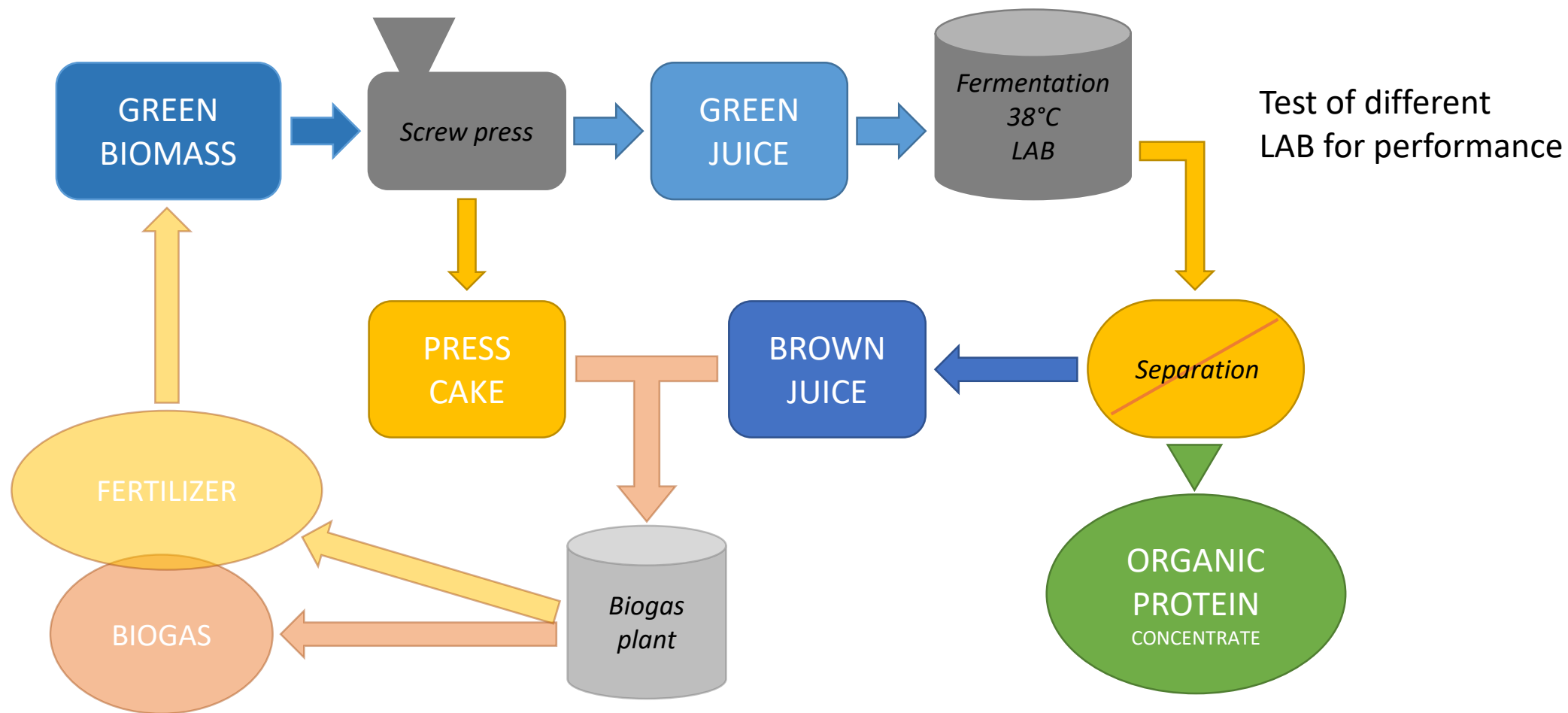
The farming system is based on “green crops”

- Alfalfa
- Red clover
- White clover
- Clover grass
- Brassica species

Harvest 3-4 times/year



The process developed in the "OrganoFinery" project



Overall biorefining results – pr. HA (10-11 tons TS)

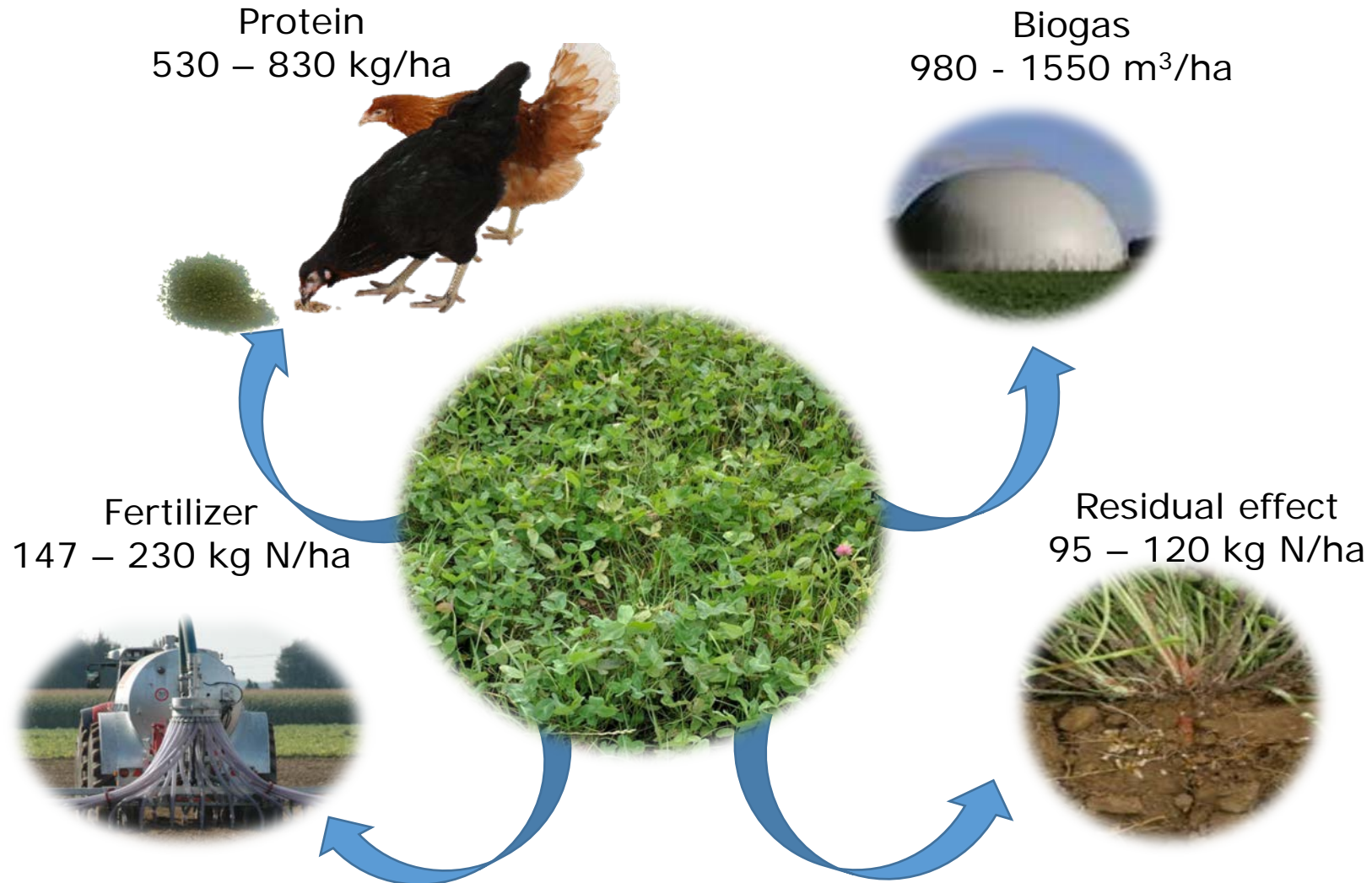


Figure: Nanna K. Ytting

Process in demo-scale – protein feed production at a production facility for green feed pellets



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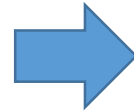
In collaboration with
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Nybro Tørreri
KMC
Runi
Bounum Maskinstation
SEGES





Process overview – from harvest to green juice

fresh biomass



screw pressing





Process overview – fermentation of green juice

Fermentation



Transport to separation of proteins





Process overview – separation of protein concentrate

Separation of protein and drying (KMC)



Pelletizing of wet paste (Vestjysk Andel)



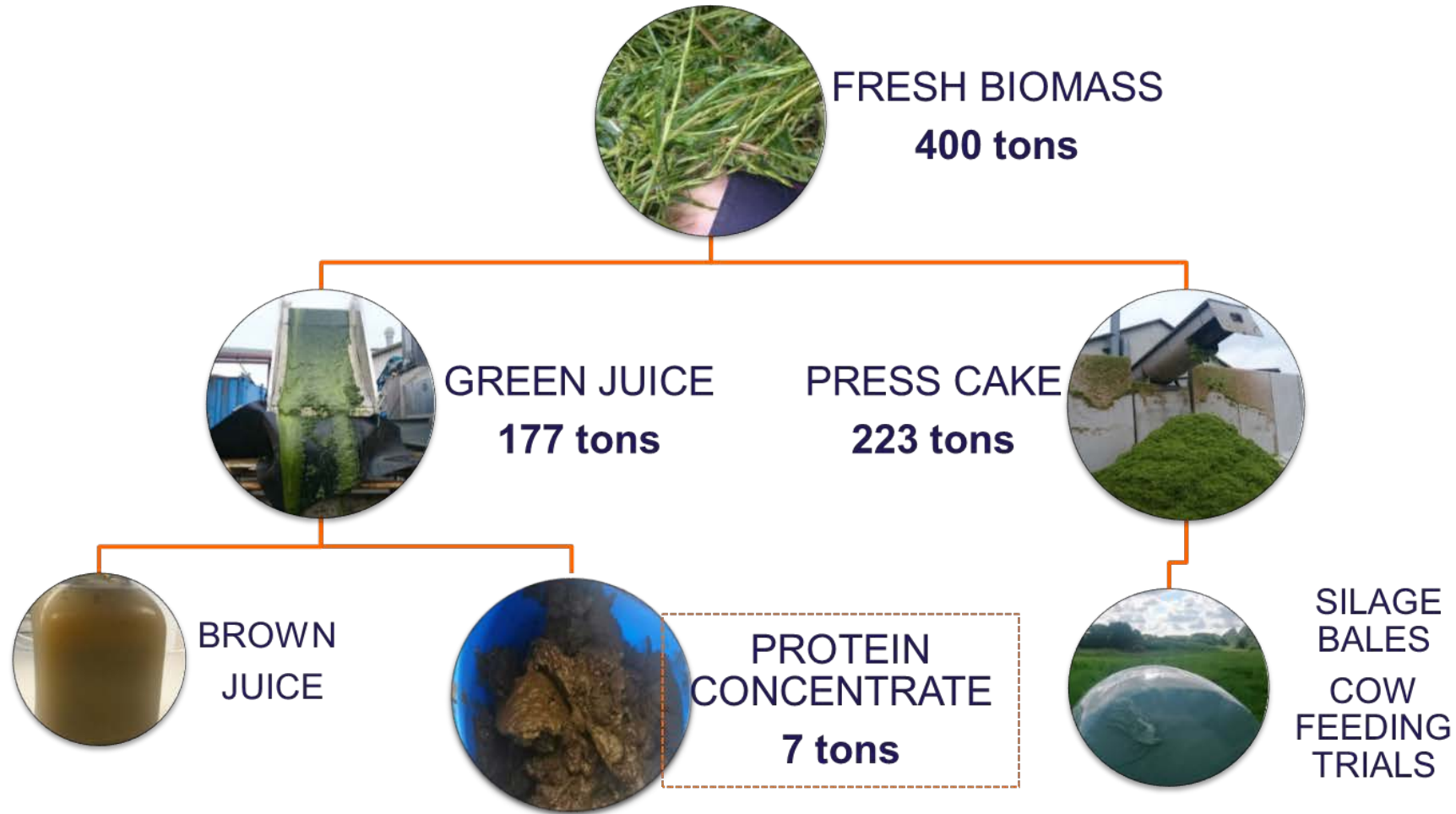
Process overview – preparation of silage bags of press-residue

Preparation of silage bales of the press-residue



Overall process numbers from Nybro-feed production

(NOT an optimized process)



Feed for trials in broilers, laying hens and pigs

Amino acid in the dry protein concentrate

Essential amino acid for poultry

g/kg DM	Arg	Cys	His	Ile	Leu	Lys	Met	Phe	Thr	Val	Total
<i>Soy bean^a</i>	31.4	5.8	10.1	18.5	29.3	26.2	5.2	19.7	15.6	18	179.8
<i>Red clover</i>	26.8	2.5	10.8	23.5	39.4	26.8	8.5	26.5	20.1	28.2	213.1
<i>Clover grass</i>	22.9	2.4	9.1	20.9	34.3	23.9	8.2	23	17.7	24.8	187.2
<i>Alfalfa</i>	20.1	3.4	9	21.8	35.4	21.5	7.8	25.5	17.6	24	186.1
<i>Oil seed radish</i>	23.4	4.7	10.1	21.7	37.3	25.4	9.1	25.3	19.2	26	202.2

^aSteenfeldt and Hammershøj, 2015.

Santamaria-Fernandez *et al.* 2017

Feeding trials with laying hens



- Three inclusion levels of the protein concentrate (CPC) in the diets were evaluated and compared with control diet:

A: Diet including 0% CPC (Control)

B: Diet including 4% CPC

C: Diet including 8% CPC

D: Diet including 12% CPC



Khanal, Tanka and **Steenfeldt, Sanna** (2017) Effect of Clover grass protein concentrate on performance, digestibility and egg quality of laying hens fed 100% organic diet. Organic Eprints (OrganoFinery)

Main conclusions from feeding trials with laying hens

- Clover grass protein concentrate (CPC) - a promising substitute for organic soybean
- Partial replacement of organic soybean with CPC (4, 8, and 12 %) did not influence egg production
- Total digestibility of dry matter was not influenced,
- The yellowness of the yolk increased significantly with CPC in the diet.



Eggs from diets with 0, 4, 8 and 12 % CPC

Evaluation in broilers

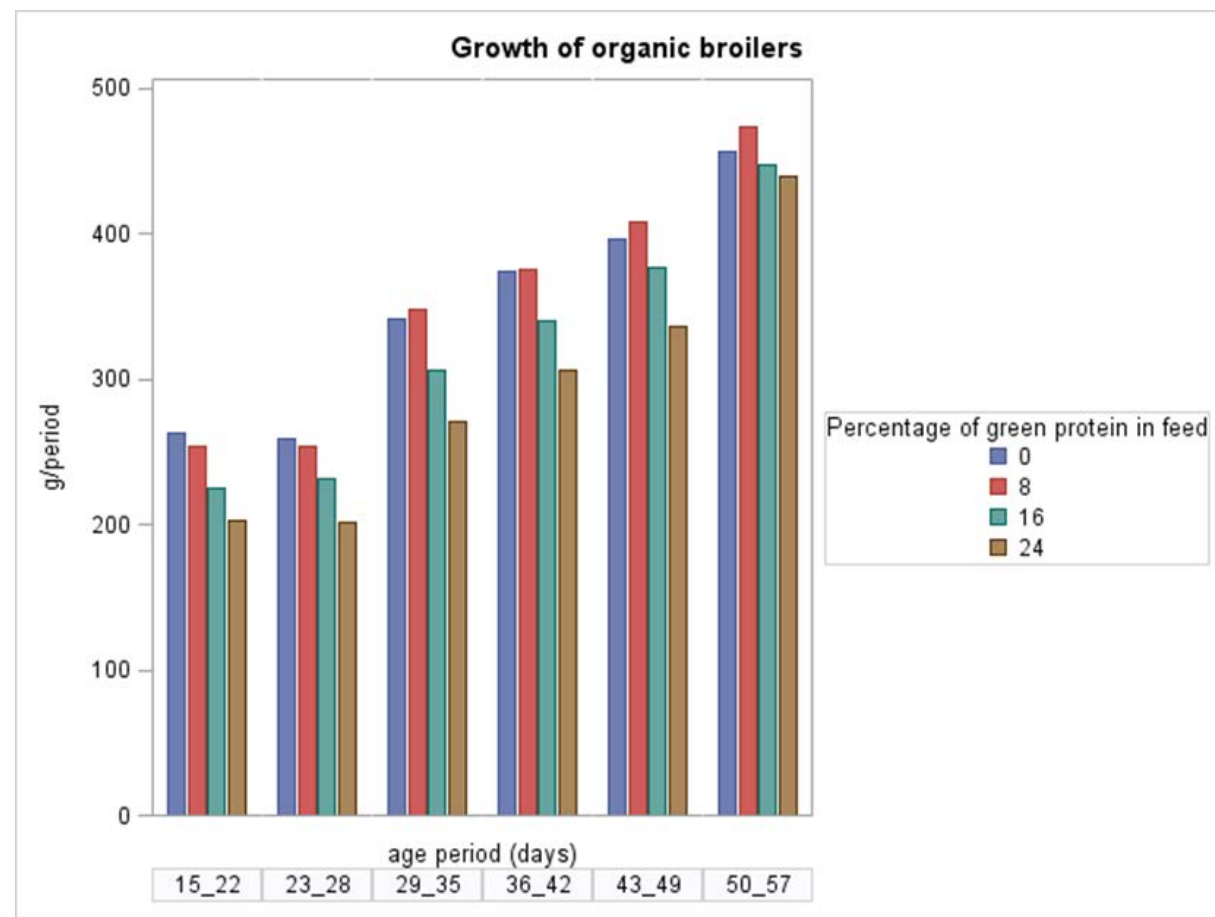
- Three inclusion levels of the protein concentrate (CPC) in the diets were evaluated:

A: Diet including 0% CPC (Control)

B: Diet including 8% CPC

C: Diet including 16% CPC

D: Diet including 24% CPC



Evaluation in broilers – color of the breast meat

Content of protein concentrate

0%

8%

16%

24%



Press residues as cow feed

- Silage of press residues was compared with silage of grass clover from the same field as forage for dairy cows.
- Surprisingly, >5 % more milk was produced

	Press cake silage	Grass clover silage
In vitro digestibility	70.7 %	67.6 %
Crude protein concentration	16,8 %	13,6 %
Daily DM intake	23.1 (± 0.3) kg/d	22.6 (± 0.3) kg/d
Daily milk yield	37.4 (± 0.9) kg/d	34.6 (± 0.9) kg/d

V.K. Damborg, S.K. Jensen, M.R. Weisbjerg: Value of pulp from green protein extraction of grass clover as forage for dairy cows. 2017 ADSA Annual Meeting.





Conclusions

- Protein concentrate can be extracted from fresh grass-clover juice.
 - Robust fermentation-centrifugation method → between **60-80% of the proteins in the green juice** can be concentrated
- Approximately 700 kg of crude protein/ha is realistic
 - Currently up to **45% protein content** in the protein concentrate
 - Protein concentrate has a good level of **essential amino acids**
 - Protein concentrate contains **lactic acid as an extra product** from the process
 - May contain **probiotic lactic acid bacteria**
 - The concentrate can **substitute soy protein in the diet**
- More nitrogen in the rotation of crops is part of the benefits
- Silage of grass press cake is a **valuable forage for dairy cows**
- Press cake and residual juice are valuable for biogas production
- A new company for commercialization of the process
 - BiomassProtein.com



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