GRØN BIORAFFINERING

Green Valleys DEMO 10.05.2021

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Green Biorefining Technologies Group

CBIO
AARHUS UNIVERSITY CENTRE FOR CIRCULAR BIOECONOMY

Interreg
Öresund-Kattegat-Skagerrak
European Regional Development Fund
EUROPEAN UNION
Green Valleys

CROSS DISCIPLINARY AU CENTER FOR DEVELOPMENT OF BIOECONOMY

AGROECOLOGY ENGINEERING ANIMAL SCIENCE FOOD SCIENCE CHEMISTRY

Research areas

http://cbio.au.dk/

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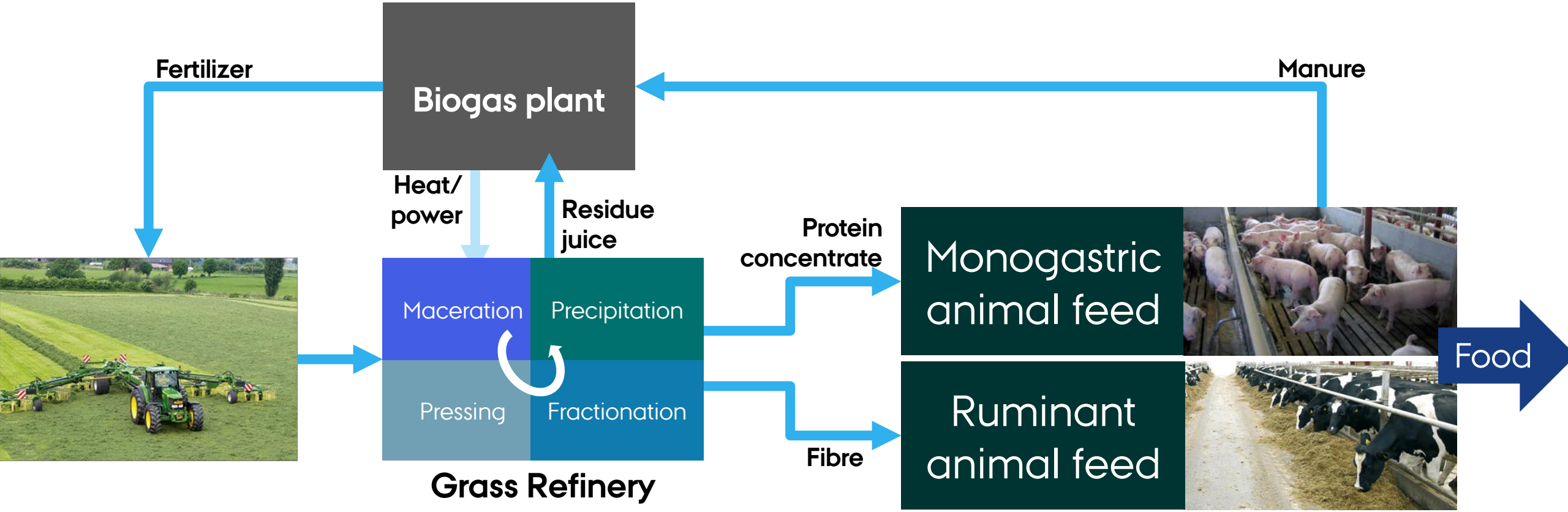
PILOT/DEMO FACILITETER PÅ AU FOULUM

PROTEIN FODER FRA GRØN BIOMASSE



PILOT/DEMO FACILITETER PÅ AU FOULUM

Videoer fra Demonstrationsplatformen...

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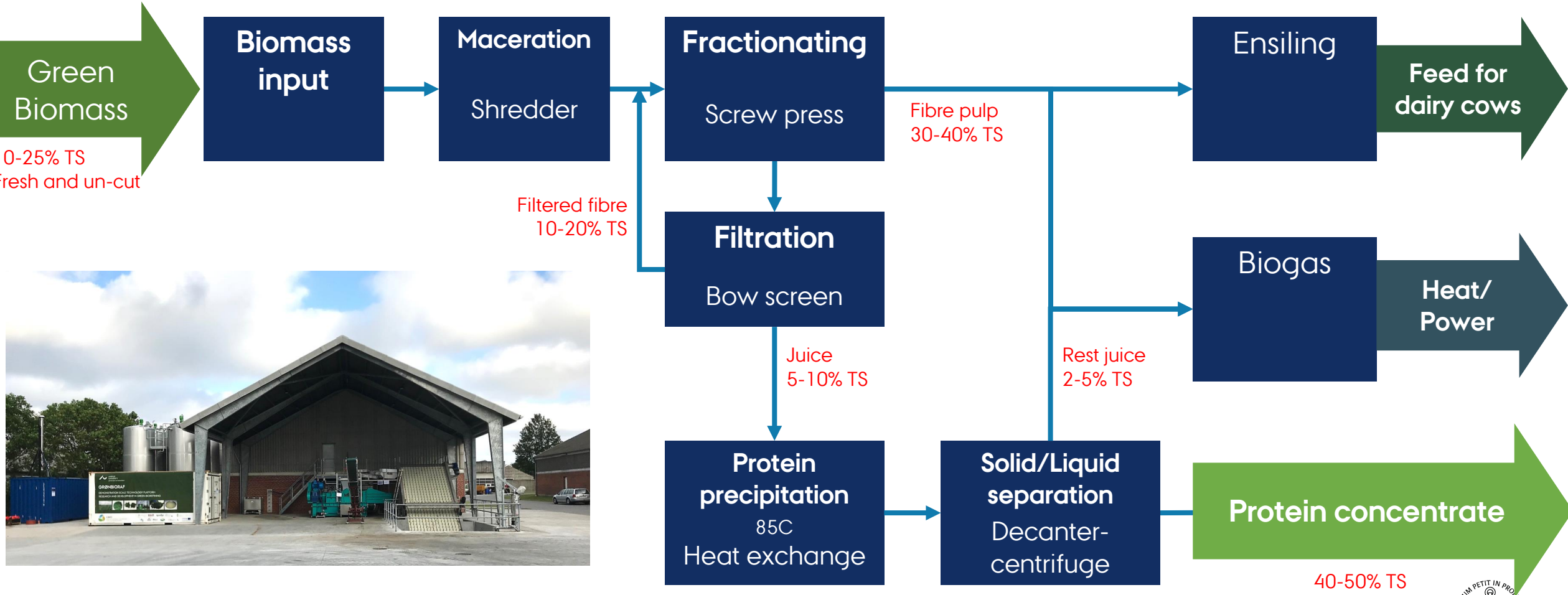
AU FOULUM SIMPLE FLOW DIAGRAM



FORSKNING OG UDVIKLING I GRØN BIORAFFINERING SIDEN 2013

FOKUS PÅ BASE CASE

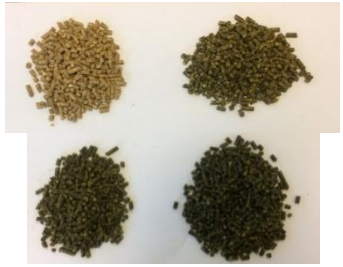


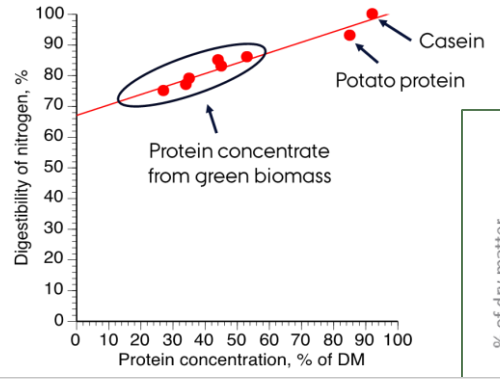
FIGURE 6: Fodringsforsøg med pressekage og almindelig græsensilage til malkekøer (Projekt BioValue).

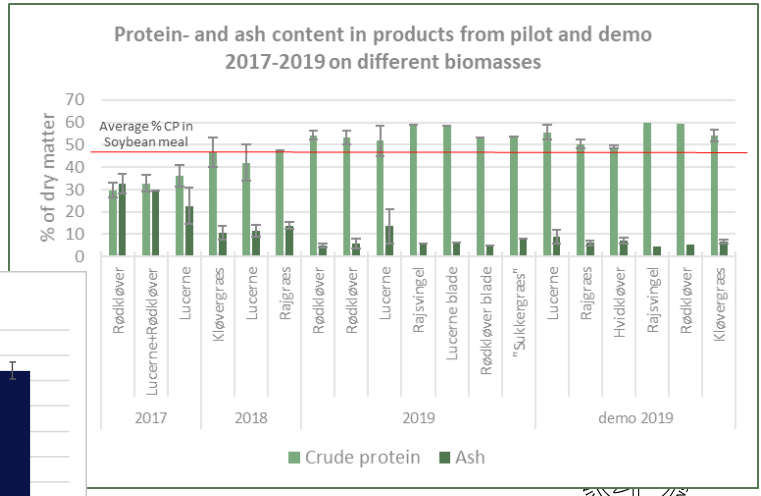
FIGURE 3: Fodringsforsøg med stigende mængder græsprotein til æglæggende høner (Projekt: OrganoFinery).

2015

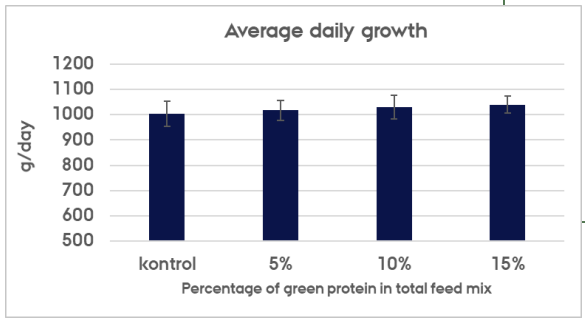
2016

2017





2019



L. Stødkilde-Jørgensen et. al 2021
https://doi.org/10.1016/j.anifeedsci.2021.114943

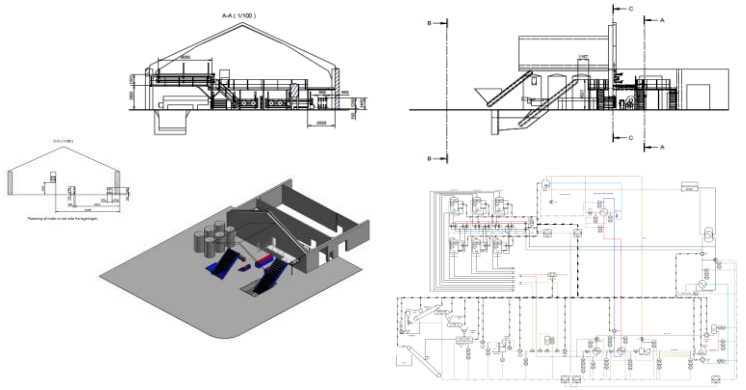
NY DEMONSTRATION SCALE PLATFORM
FOR RESEARCH AND TECHNOLOGY DEVELOPMENT IN GREEN BIOREFINING, 2019

Input: 10 ton/hr

Flexible process design

Automatic control and extended datacollection

Improved unit operations and processing



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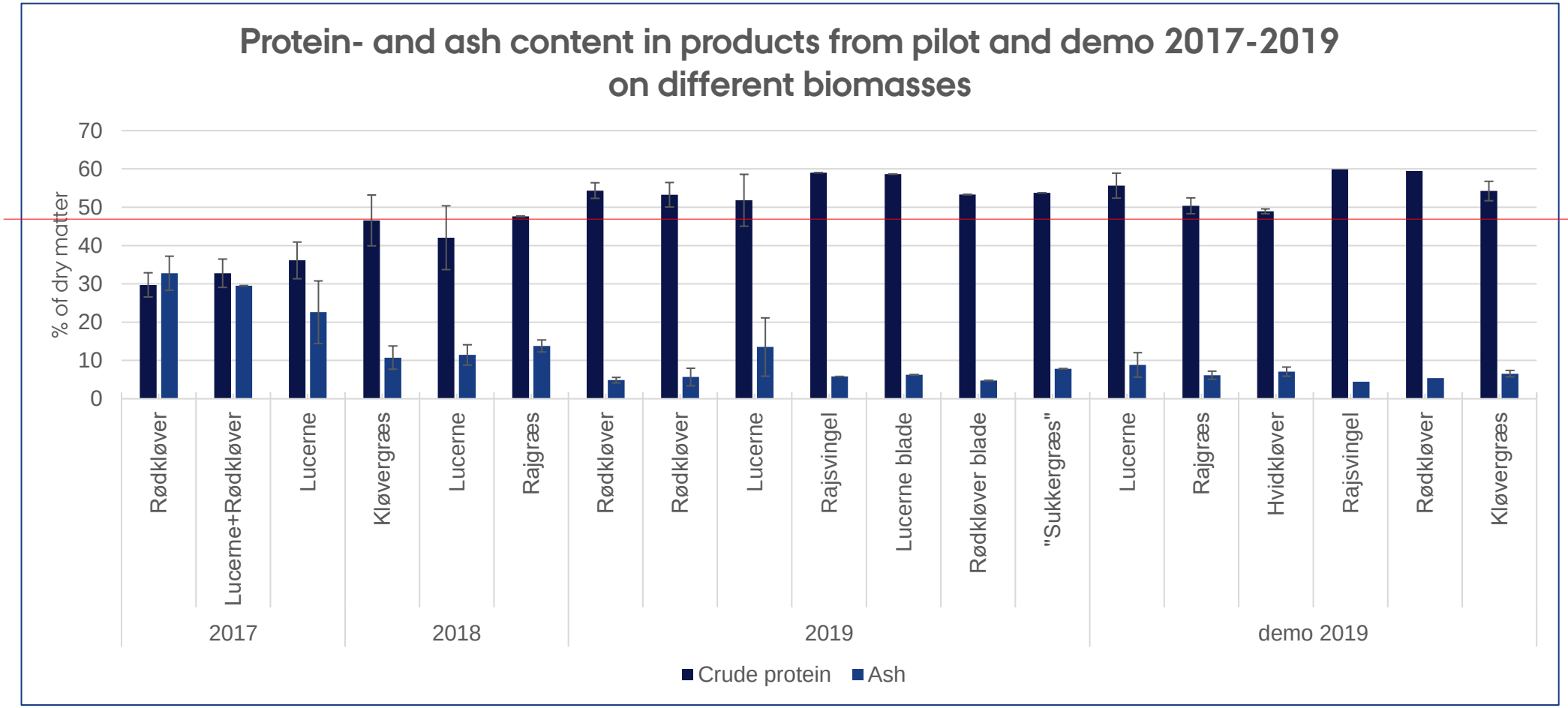
MORTEN AMBYE-JENSEN
ASSISTANT PROFESSOR

FORBEDRING AF PROTEIN INDHOLD I KONCENTRATET

Average % CP in Soybean meal



LATEST FEED TRIAL SUBSTITUTED 100% SOY WITH GREEN PROTEIN

WITH NO NEGATIVE EFFECT ON WEIGHT GAIN AND FEED UTILIZATION

1,2 ton DM Grass-clover protein concentrate production 2018

High protein concentration in the product batches (45-55%)

Grass-clover protein concentrate	
Water content	1,8 %
Crude protein	47,0 %
Fat	11,3 %
Ash	12,3 %

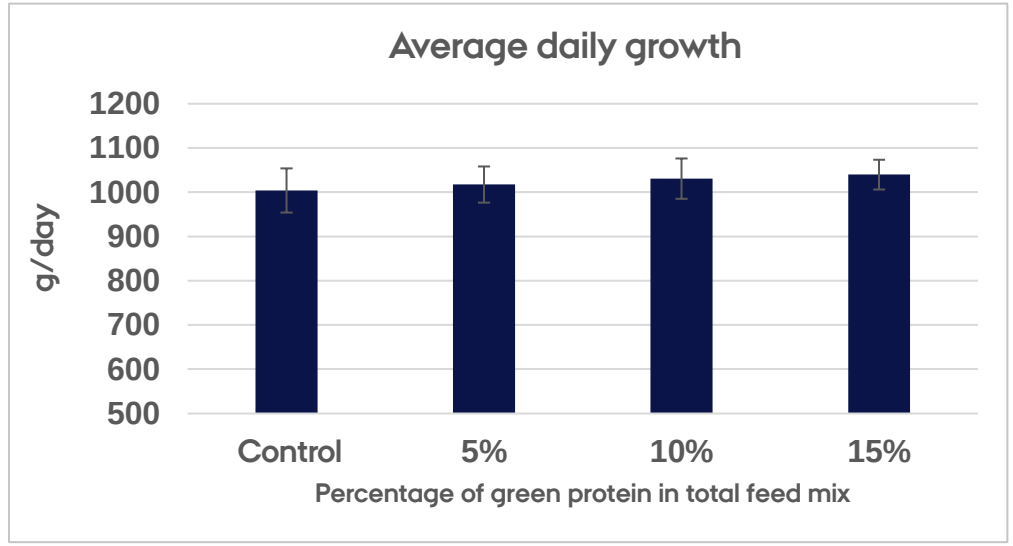
Feeding from 8 Nov. to 7 Mar.

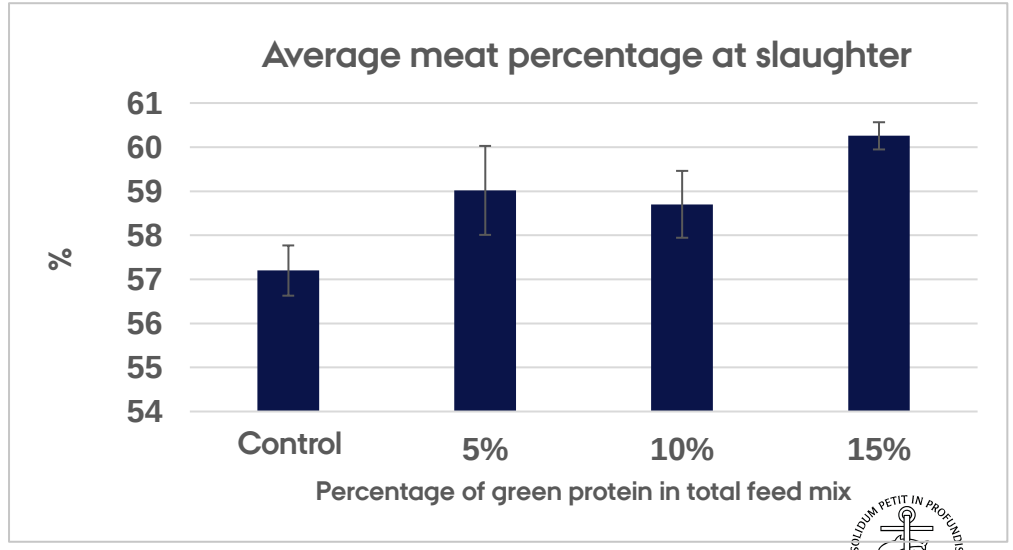
4 feed groups (Control, 5, 10, 15%)

Total of 48 pigs

Essential amino acids [g/16 g N]

	Grass-clover conc.	Soy meal
Lys	6,04	5,98
Met	2,24	1,31
Cys	0,70	1,43
Thr	4,71	3,92
Trp	2,17	1,36
Ile	5,19	4,91
Leu	8,82	7,68
His	2,26	2,61
Phe	5,84	5,06
Val	6,41	5,19
Arg	6,02	7,23
Glu	11,04	17,78





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OPTIMIZATION OF PROTEIN CONCENTRATES

Example with different process configurations and different biomasses, June 2020

Acidified with HCL

Fermented with lactic acid bacteria

Heated to 85° C

Heated to 55° C followed by 85° C

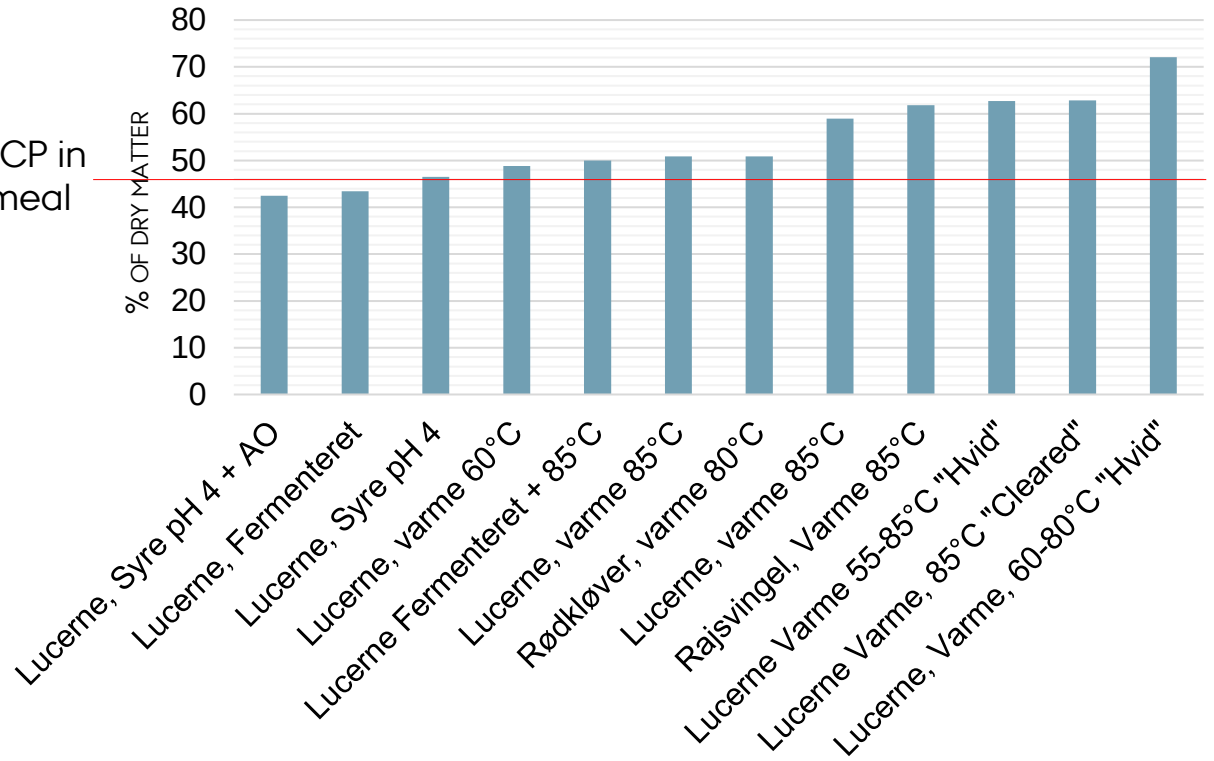
Alfa Max Bioraf
Optimizing protein yield and quality from Lucerne
Grant: GUDP (DK)
2019 - 2022

From 2020 all products are dried on site

New feed trial 2020
Svineafgiftsfonden

Average % CP in Soybean meal

Protein content in different products 2020



PROTEIN EKSTRAKTION GENERELT

Tallene er udbytter i % af input

Hel plante
Tørstof =100%
Protein = 100%

Fraktionering

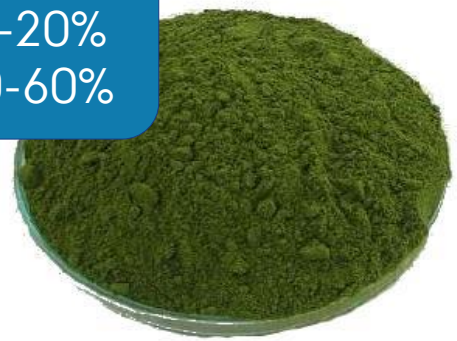
Fibre press cake
Tørstof 50-70%
Protein = 40-60%

Juice

Rest juice.
Tørstof = 10-20%
Protein = 0-10%

Protein udfældning og separation

Protein Konc.
Tørstof = 10-20%
Protein = 20-60%



Vigtige faktorer for udbytterne

- Plant maturity
- Plant moisture content
- Plant protein content
- Fractionation & precipitation method
- Etc....

MASSE BALANCE – EKSEMPEL (ikke optimeret!)

FM: Fresh matter
DM: Dry matter
CP: Crude protein

1000	kg	Wet biomass			
190	kg DM	19%	DM		
38	kg CP	20%	CP		

Maceration and pressing

Pulp

Pulp				Yield	
470	kg	Wet pulp		47%	(w/w)FM
146	kg DM	31%	DM	77%	(w/w)DM
26	kg CP	18%	CP	69%	(w/w)CP

Green juice

Green juice				Yield	
530	kg	Wet green juice		53%	(w/w)FM
44	kg DM	8%	DM	23%	(w/w)DM
12	kg CP	27%	CP	31%	(w/w)CP

MASSE BALANCE – EKSEMPEL (ikke optimeret)

1000	kg	Wet biomass
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146	kg DM	31%	DM	77%	(w/w)DM
26	kg CP	18%	CP	69%	(w/w)CP

Green juice

Precipitation and separation

Protein concentrate

Protein concentrate				Yield	
35	kg			4%	(w/w)FM
16	kg DM	45%	DM	8%	(w/w)DM
8	kg CP	51%	CP	21%	(w/w)CP

Green juice				Yield	
530	kg	Wet green juice		53%	(w/w)FM
44	kg DM	8%	DM	23%	(w/w)DM
12	kg CP	27%	CP	31%	(w/w)CP

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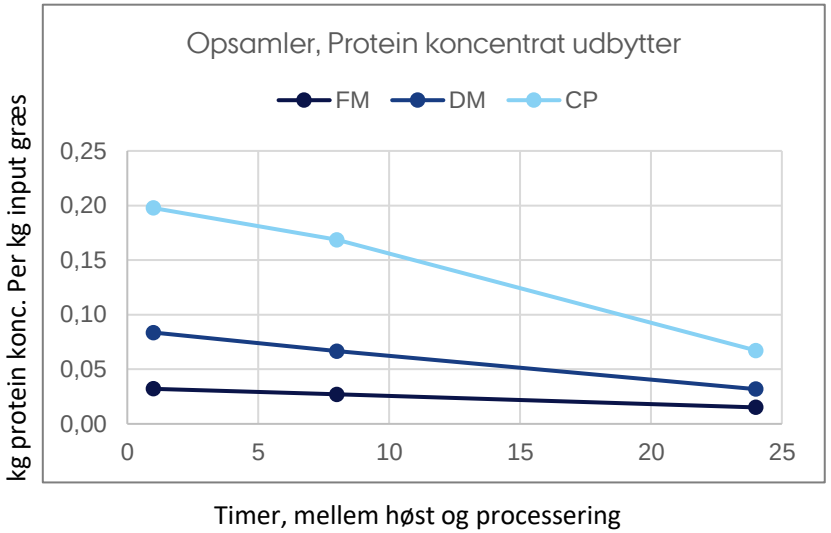
FRISK GRÆS ELLER ENSILAGE?

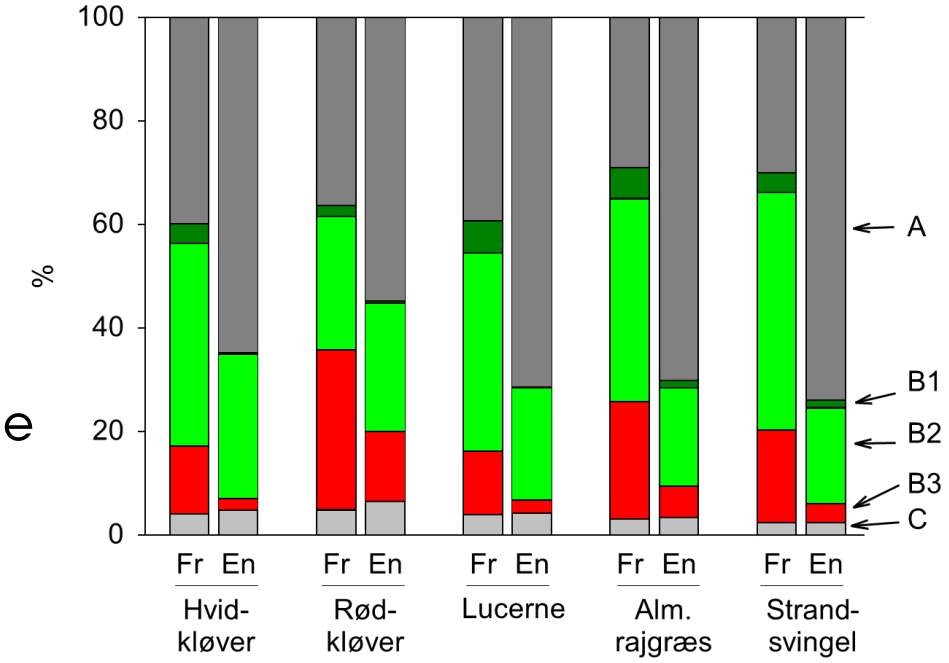
- I danmark har vi fokuseret på at presse frisk græs, kløver og Lucerne
- Dette giver den bedste kvalitet af proteinkoncentratet
- Kvalitet og udbytte falder over tid – mellem høst til processering
- Det er vigtigt at det friske græs bliver processeret så hurtigt efter høst som muligt (
- Dette stiller store krav til logistikken mellem høst og proces

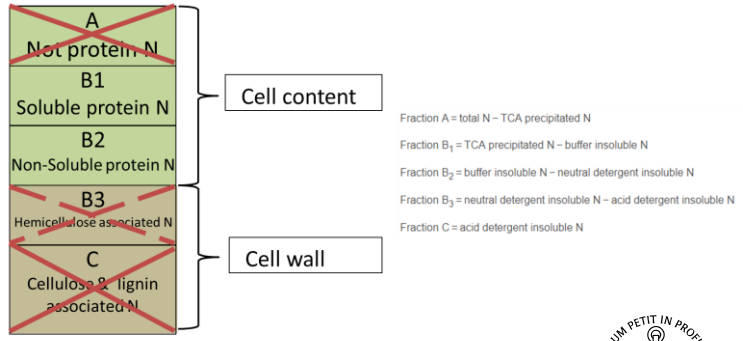


FM: Fresh matter
DM: Dry matter
CP: Crude protein

FRISK GRÆS ELLER ENSILAGE?

- I sverige har der været fokus på at presse ensilage
- Dette giver store fordele i logistikken
- Fiber pulpen kan stadig have høj kvalitet når det er fra ensilage
- Proteinet I planterne nedbrydes under ensileringen
- I stedet for protein koncentrat vil man få frie aminosyre
- Der er finds dog muligheder for at minimere protein nedbrydning under ensilering – dette kunne give anledning til proteinprodukter fra ensileret biomasse uden alt for stort tab





COMMERCIAL IMPLEMENTATION IN DENMARK

Two commercial consortia's are operating production facilities from 2021

TailorGrass – Ausumgaard, Vestjyllands Andel, R&D engineering og SEGES
Press release from the consortia
Inaugurated 4th Sep 2020

Fra grønt protein til køledisken –DLG, Danish Agro og DLF (BioRefine DK)
Press release from BioRefine Denmark
Planned operation from Spring 2021

Both are supported by DK funding through GUDP (Green Development & Demonstration Programme)

Focus on organic protein feed products from grass, clover and lucerne together with feed for dairy cows and biogas production.
Scale will be approx. 4x the AU Demonstration platform.
Processing green biomass from 1000-2000ha agricultural land.

GUDP has funded a total of 16 R&D projects in green Biorefining since 2013

TAK !
AND THANK YOU FOR LISTENING

Questions are very welcome!

Contact:
maj@eng.au.dk

Green Biorefining Technologies Group

#AUBiorefining

GRØNBIORAF
DEMONSTRATION SCALE TECHNOLOGY PLATFORM
RESEARCH AND DEVELOPMENT IN GREEN BIOREFINING

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European Regional Development Fund
EUROPEAN UNION
Green Valleys

Alfa Max Bioraf

MultiPlant
flerårige højværdiafgrøder i økologisk planteproduktion

SuperGrassPork
Økologisk svineproduktion baseret på græs-protein

@gograssEU
GO-GRASS
go-grass.eu

Græs Prof

Green-Eggs

BIOVALUE SPIR

BioBase

GO GRASS
Grass-based circular business models for rural agri-food value chains

Grass Biochar

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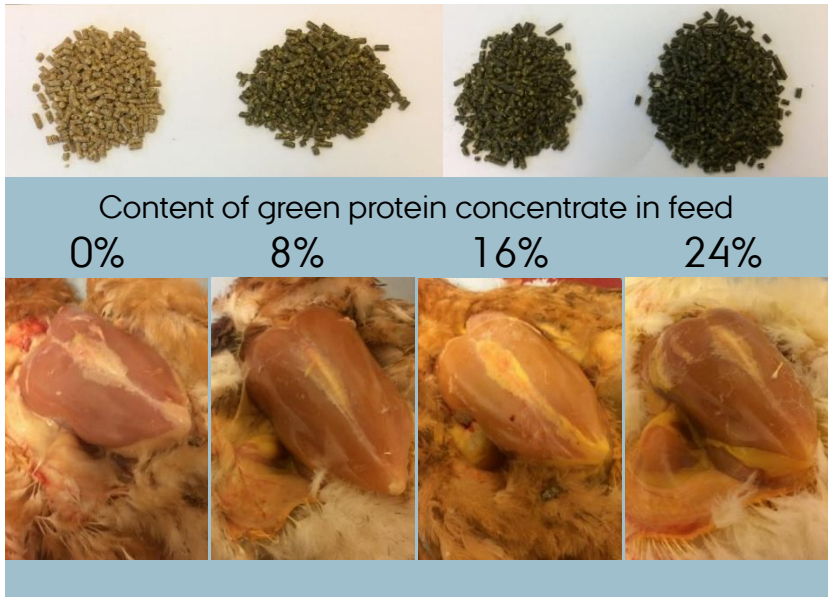
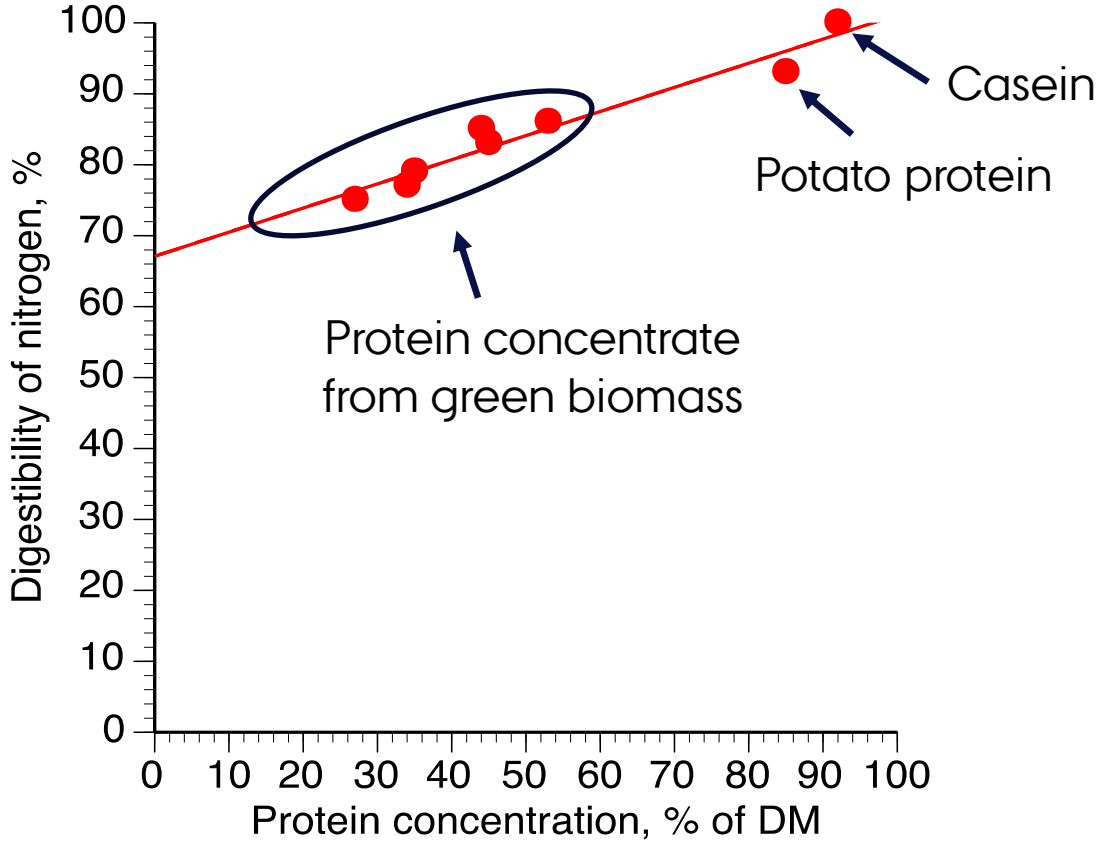
FEED TRIALS WITH PROTEIN CONCENTRATE

Feed experiment studies from 2015-2019

- Rats (digestibility)
- Poultry (both meat and egg production)
- Pigs (digestibility and meat production)



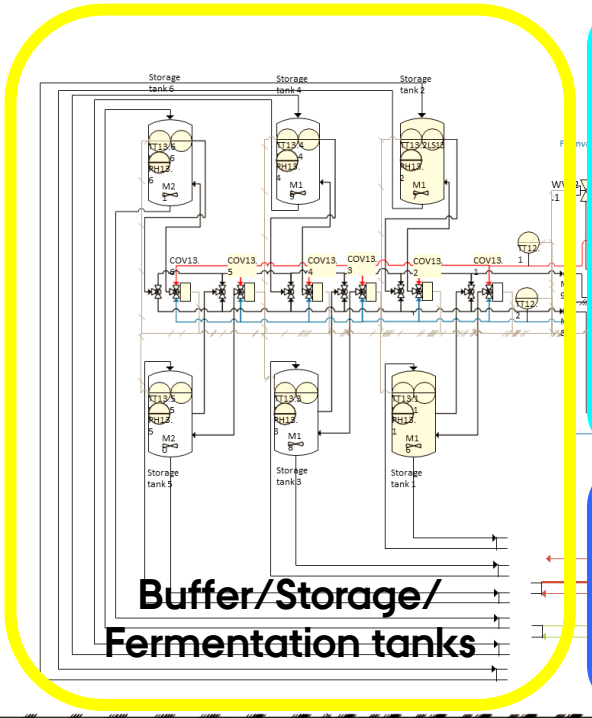


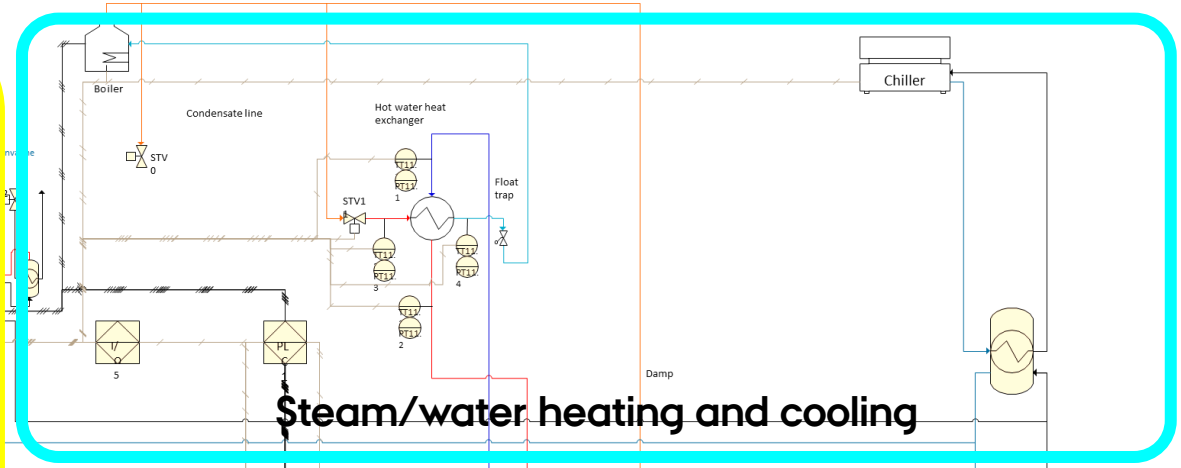
From S.K. Jensen and L. Stødkilde-Jørgensen

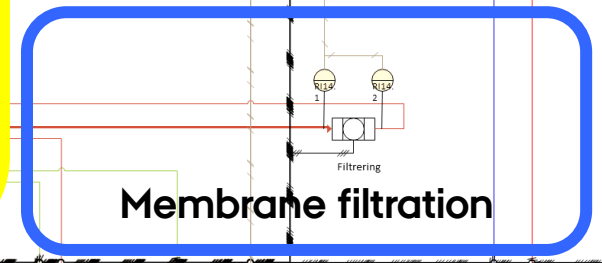
PID OF THE DEMONSTRATION PLATFORM

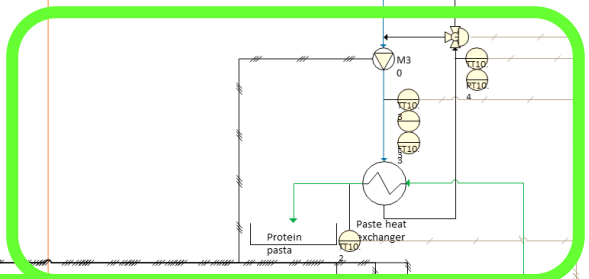
[Demo processing video](), 2019

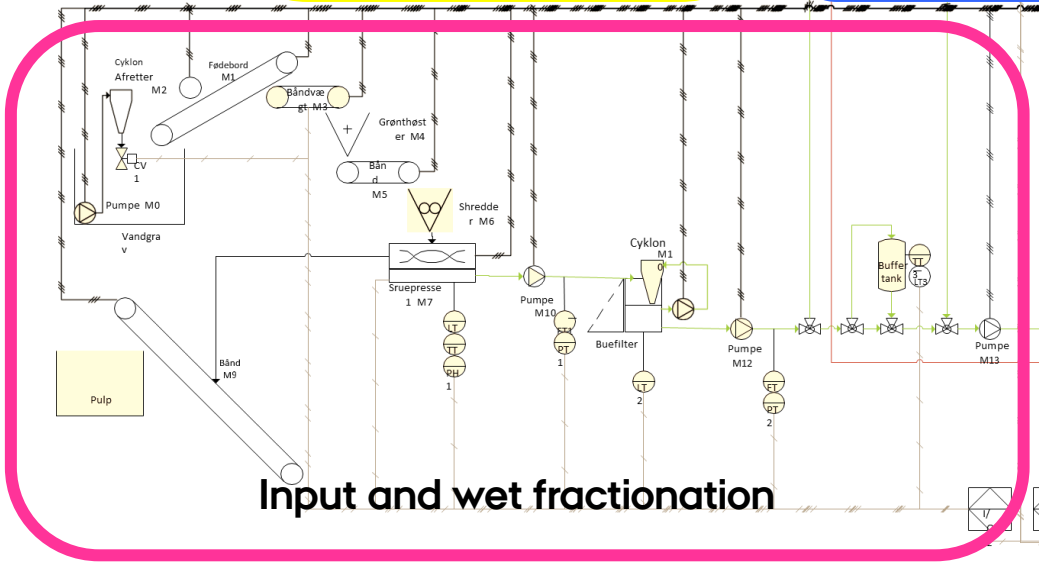
[More CBIO videos]()

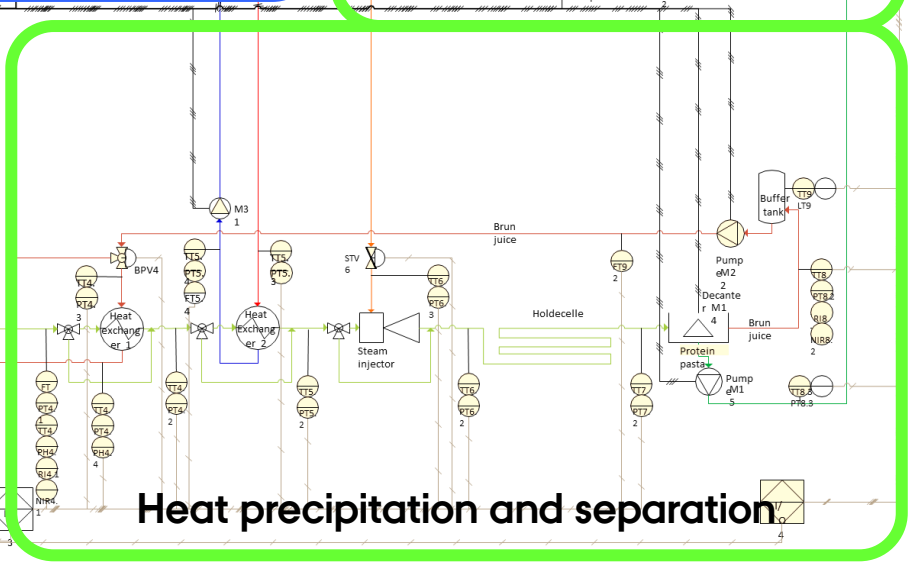












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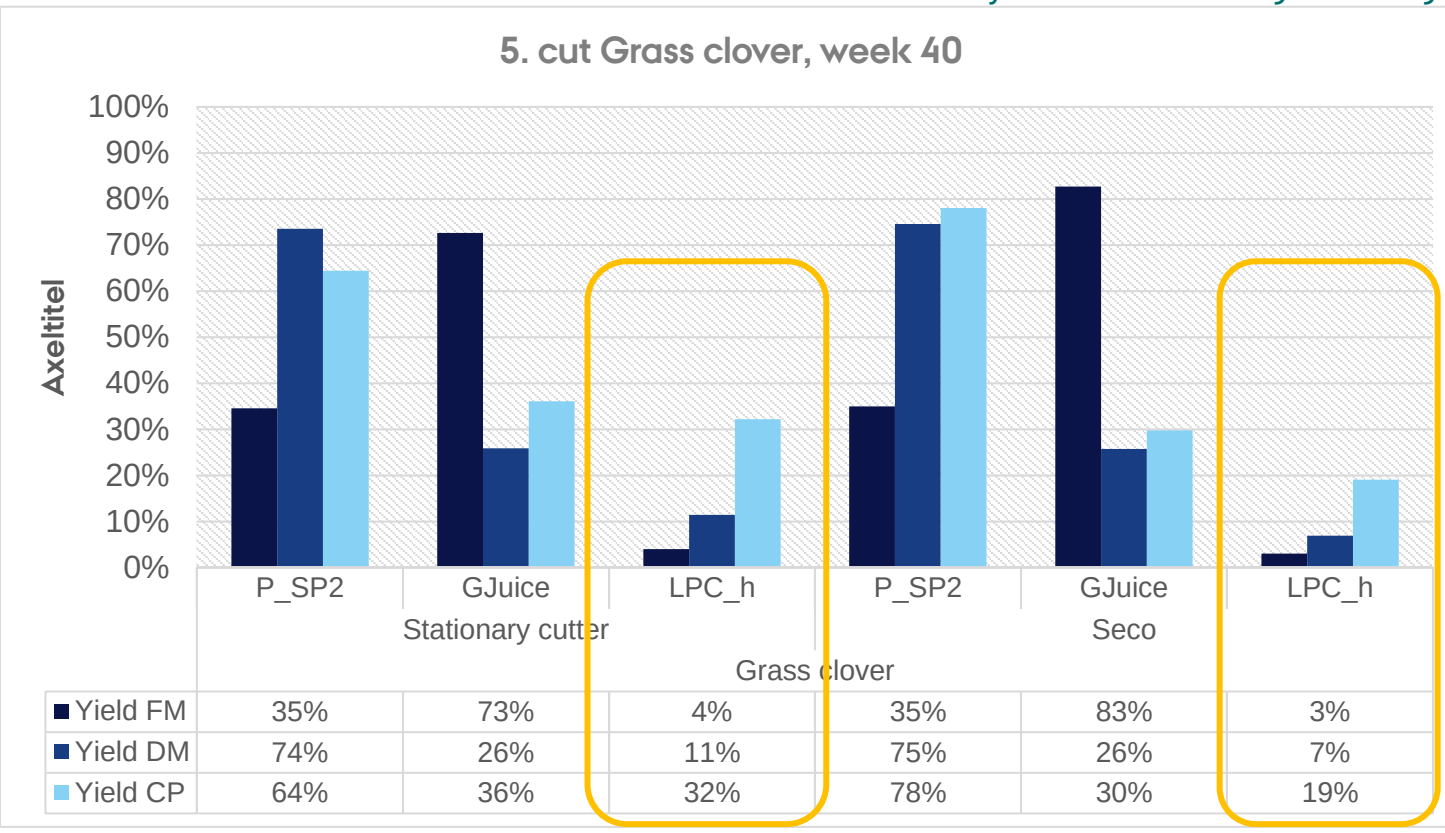
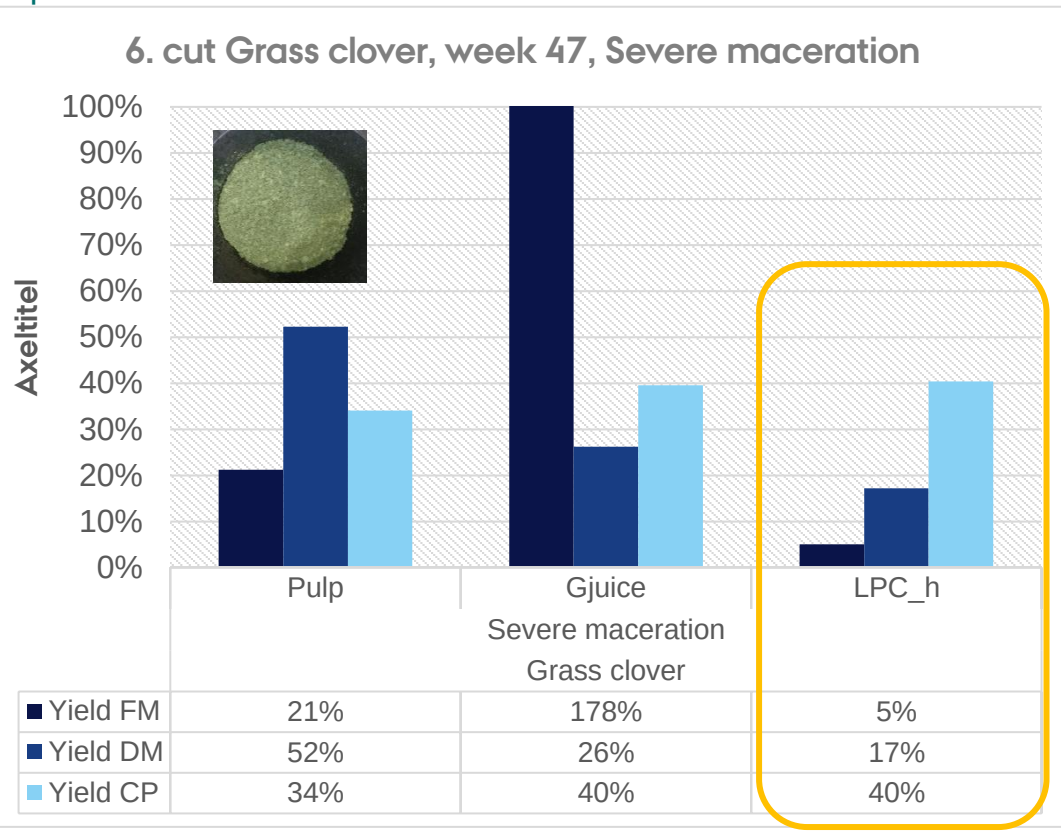
IMPROVING YIELDS OF PROTEIN IN DEMONSTRATION SCALE
TEST OF DIFFERENT TYPES OF MACERATION

The numbers are yields in %(weight/weight input material)



	P_SP2	GJuice	LPC_h	P_SP2	GJuice	LPC_h
Yield FM	35%	73%	4%	35%	83%	3%
Yield DM	74%	26%	11%	75%	26%	7%
Yield CP	64%	36%	32%	78%	30%	19%



	Pulp	Gjuice	LPC_h
Yield FM	21%	178%	5%
Yield DM	52%	26%	17%
Yield CP	34%	40%	40%

Stationary cutter

Slowly rotating feed mixer with knifes

FM: Fresh matter; DM: Dry matter; CP: Crude protein

This process includes the stationary cutter and a rotary knife cutter for meat processing. The cut biomass was mixed with water/liquid and pumped into the rotary knife cutter