Alternative feed ingredients and technologies for improved nutritive value of feed

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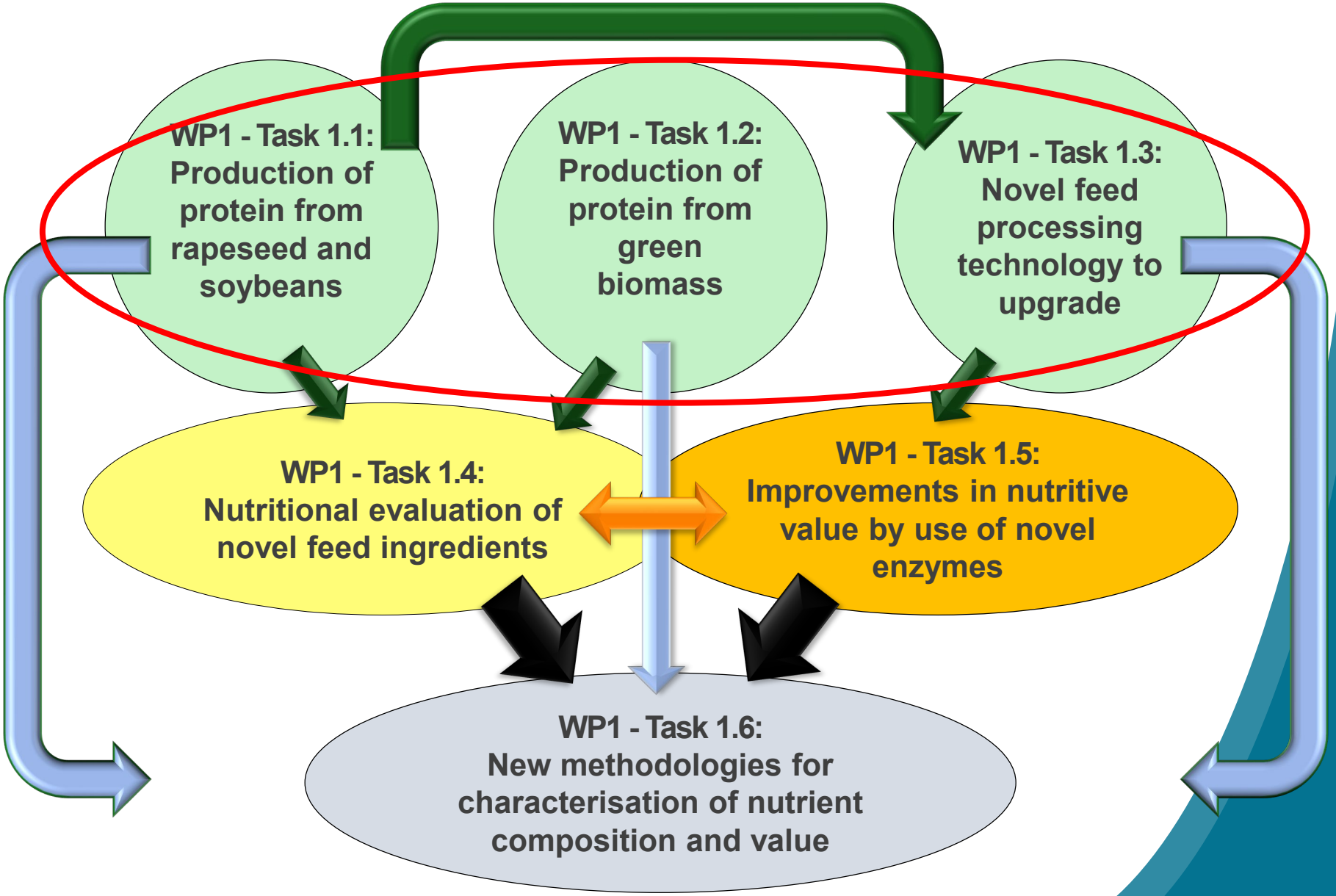
Points to be addressed

- Overview of activities in WP1 of Feed-a-Gene
- Alternative feed ingredients from:
  - European grown soybeans
  - Rape seed meal
  - Green biomass
- Technologies
  - Modified separation techniques for European grown soybeans
  - Tail-end separation of rapeseed meal by physical meals
  - “Cracking” of green biomass

Feed-a-Gene

Adapting the feed, the animal and the feeding techniques to improve the efficiency and sustainability of monogastric livestock production systems

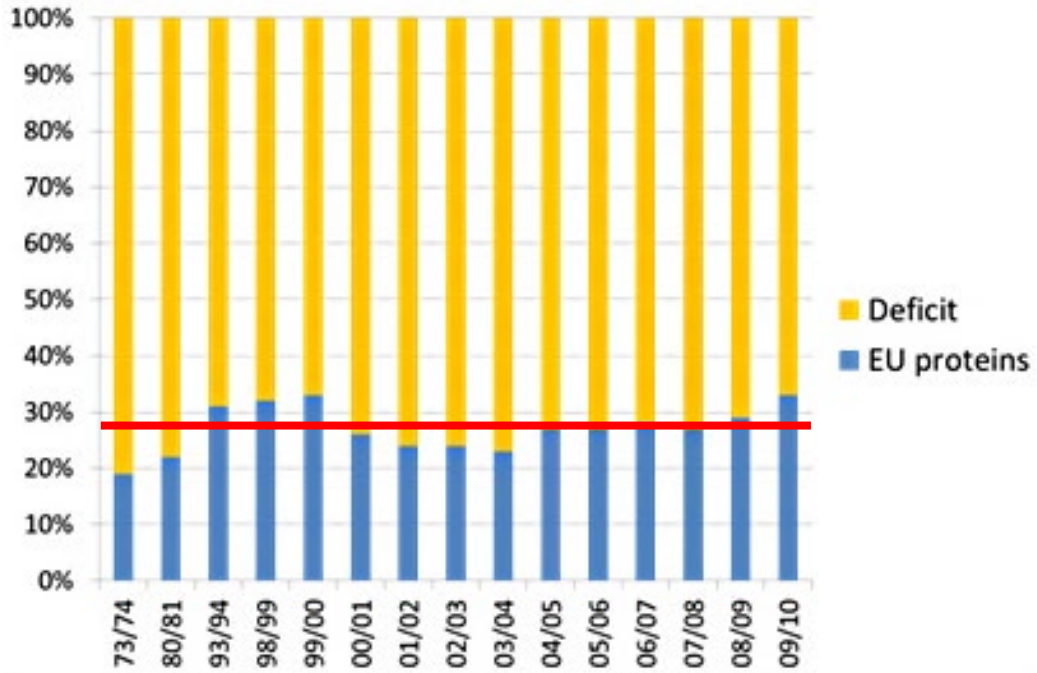
Overview of WP1 task activities



Background

- Europe has a chronic protein deficit; approximately 70% of all protein is imported
- Rapeseed, sunflower and soybeans are the three main protein crops in Europe with annual productions of 22.6, 9.1 and 2.5 mill tons; production of peas and beans are 2.1-2.4 mill tons (2017/18)

Evolution of EU protein deficit (1973-2010)



Source : Unip

Technology - Extrusion-pressing or flaking-pressing-cooking of European grown soybeans

- Medium-sized crushing plants for local and GMO-free soybean crops ⇨ interesting nutritional and economic values in Europe
- Study:
  - Effects of process factors (preparation, temperature) to get 4 separate products
- Methods:
  - 2 x 2 factorial design
    - Extrusion-pressing (EP) vs. flaking-pressing-cooking (FPC)
    - Dehulled or not before processing
- Variations of flow rate/speed + specific mechanical energy

Raw beans

Grinding

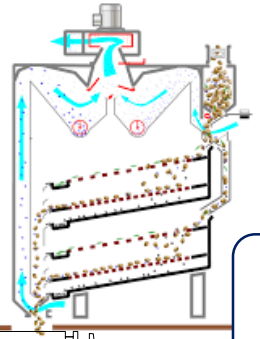
Damman-Croes cylindrical grinder with corrugating rolls

ground beans

Dehulling

Denis D50 cleaner separator

dehulled beans

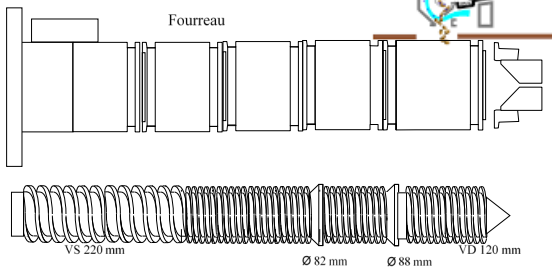


Flaking

Croix, contra-rotating smooth cylinders

Extrusion

Extrusion single-screw extrudor



Cooking+drying

Olexa horizontal cooker

Pressing

Ole

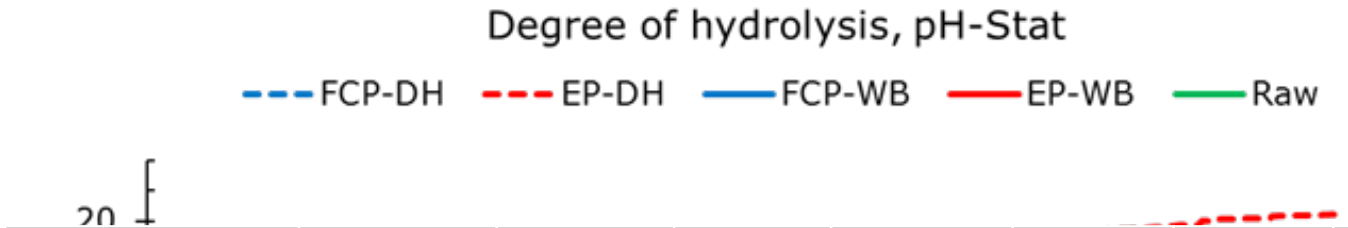
oil

Soymeal experimental products

Study results	Dry Matter	Oil	Proteins		Protein solubility	Dietary Fiber	Trypsin inhibitors
	% on crude weight basis			*% de-oiled DM*	*% on crude*		*TIU / mg*
Raw soybean	87	18	38	55.7	95	17.3	25
FCP-whole beans	91	8	47	55.8	82	21.1	3.6
EP-whole beans	94	5	50	56.0	70	21.1	2.6
FCP-dehulled	92	6	51	58.4	89	17.5	7.6
EP-dehulled	94	5	52	58.8	76	16.4	3.5

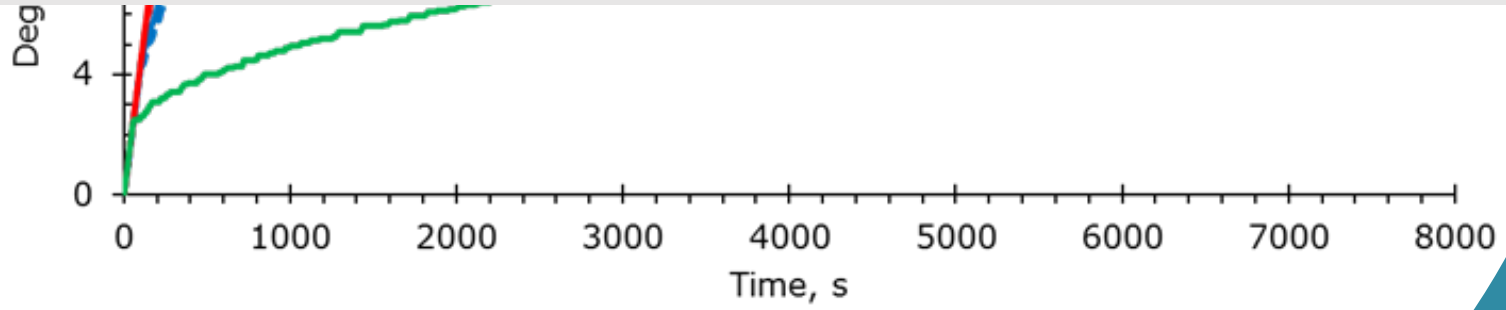
EP vs FCP impact	-3.2	+ 3.6	+ 0.2	whole beans
	-1.1	+ 1.8	+ 0.3	dehulled beans
Dehulling impact	-1.9	+ 3.9	+ 2.7	with FCP process
	+ 0.2	+ 2.2	+ 2.8	with EP process

In vitro digestion kinetics - pH-stat method



	Soybean raw	FCP-DH	EP-DH	FCP-WB	EP-WB	SEM	P treatment
Rate k (×10^{-6})	46.1^{a}	80.0^{b}	82.0^{b}	87.1^{b}	115.9^{c}	0.290	<0.001
DH max.	12.4^{a}	19.1^{b}	21.5^{d}	20.3^{c}	19.9^{bc}	0.319	<0.001

FCP-DH = flaking-cooking process of dehulled beans; EP-DH = extrusion process of dehulled beans; FCP-WB = flaking-cooking process of whole beans; EP-WB = extrusion process of whole beans



Effect of dietary treatments on SID of amino acids and growth in piglets

	Conv. SBM	FCP-DH	EP-DH	FCP-WB	EP-WB		P-value		
						SEM	Trt	R	Trt x R
Lys	.847^{b}	.819^{b}	.990^{a}	.965^{a}	.946^{a}	.043	.0001	.015	.0001
Met	.848^{b}	.872^{b}	1.00^{a}	.994^{a}	.985^{a}	.039	.0001	.375	.0001
Thr	.870^{cd}	.831^{d}	1.00^{ab}	.982^{ab}	.936^{bc}	.055	.0001	.010	.0001
Leu	.843^{b}	.743^{c}	.990^{a}	.953^{a}	.942^{a}	.046	.0001	.0001	.0001
Ile	.826^{b}	.749^{b}	.997^{a}	.954^{a}	.938^{a}	.054	.0001	.255	.0001
His	.908^{c}	.799^{d}	.996^{ab}	.957^{abc}	.937^{bc}	.047	.0001	.0001	.129
Val	.820^{c}	.754^{c}	.983^{ab}	.947^{ab}	.934^{b}	.049	.0001	.011	.0001
Arg	.929^{c}	.835^{d}	1.008^{ab}	.982^{bc}	.980^{bc}	.040	.0001	.025	.007
ADG, g/d	621^{a}	322^{b}	615^{a}	572^{a}	608^{a}	95.7	.0001	.022	.978
ADFI, g/d	1032^{a}	894^{ab}	879^{ab}	944^{a}	949^{a}	126.6	.0001	0.658	.0004
FCR, kg/kg	1.67^{a}	2.96^{b}	1.45^{a}	1.66^{a}	1.56^{a}	.840	.0001	.786	.422

FCP-DH = flaking-cooking process of dehulled beans; EP-DH = extrusion process of dehulled beans; FCP-WB = flaking-cooking process of whole beans; EP-WB = extrusion process of whole beans

Rape seeds

- Rape seeds are the most important protein crop in Europe
- The digestibility of nutrients (energy, protein and amino acids) in RSM is lower than in SBM primarily because the hull layer contain very lignified cell walls
- Additionally, a relatively high proportion (~17%) of the protein and amino acids is associated to the hull layer

Novel feed processing technology to upgrade

Mixing

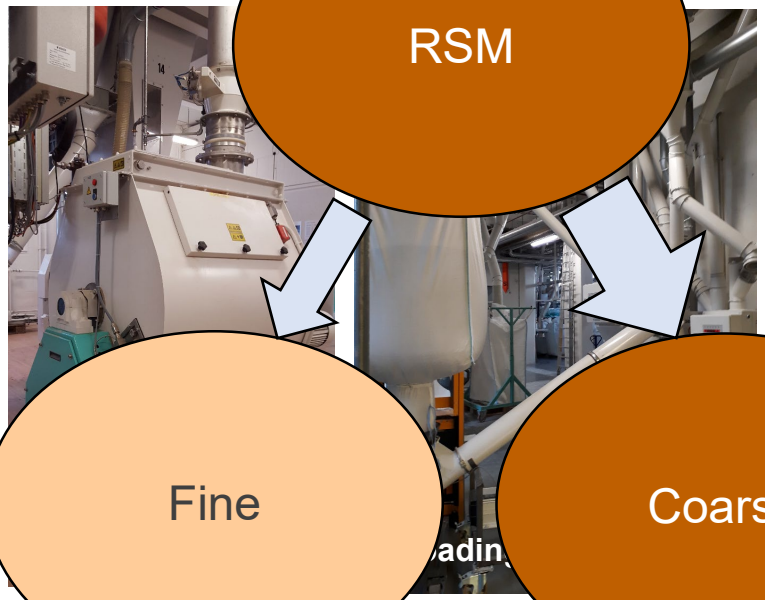
Crushing

Sifting

RSM

Fine

Coarse



BÜHLER

RSM
Crude protein: 37.9%
NDF: 31.8%

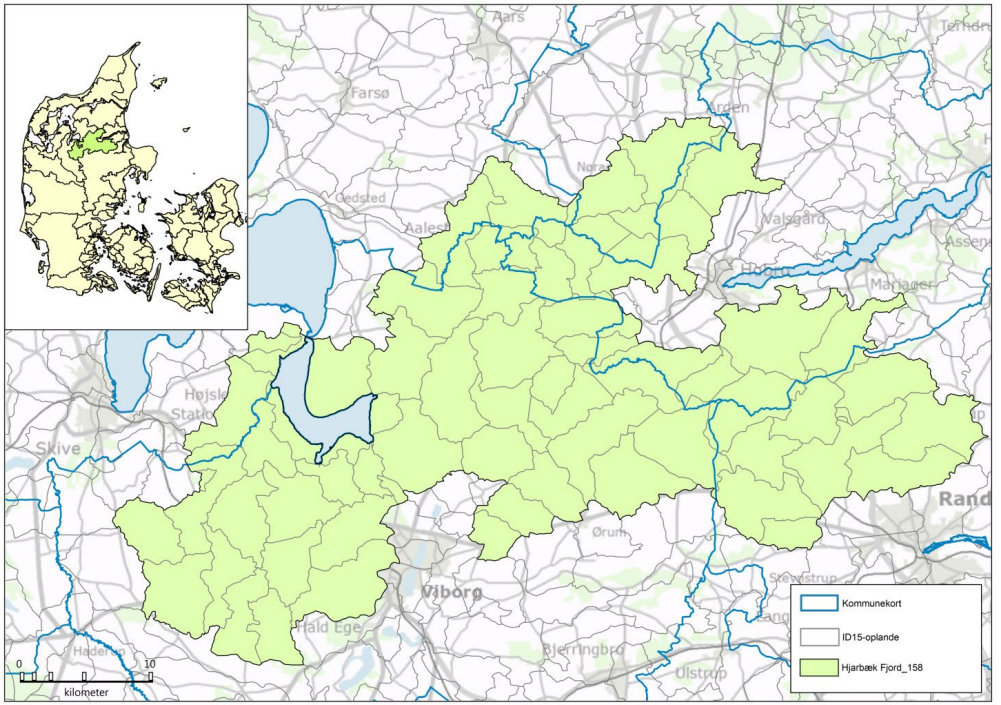
Fine
Crude protein: 44.9%
NDF: 21.3%

Coarse
Crude protein: 37.3%
NDF: 33.1%

The fine fraction is currently under nutritional evaluation in pigs

Protein from green biomass

- Interest in Denmark related to environmental issues as cash crops (i.e. cereals) may cause high leakage of nitrogen to creaks, lakes and inlets
- Related to sustainable intensification



Potential protein production

Type of crop	Kg protein per ha	Challenges
Wheat	~ 1000	
Soya beans	~ 1000	
Clover grass, temperate	~ 1500	Concentration
Red clover, temperate	~ 2500	+ ANF
Moringa oleifera, tropical (as crop)	~ 5000	+ ANF
Non-edible plants/crops	~ 5000+	+ Detoxification
Micro algea	~ >>>>	+ Technology

Protein from green biomass

Demonstration plant

Tons scale

Pilot plant

Kilo gram scale

Lab scale extraction

Gram scale

Plant production

Year….	2012		2014		2016		2018		2020		2020

Background

- Protein concentrate from green biomass could be an attractive alternative protein source for monogastric farm animals
- Laboratory studies have shown promising results when evaluated in a rat model

True faecal protein digestibility 77-86 %

Feed-a-Gene

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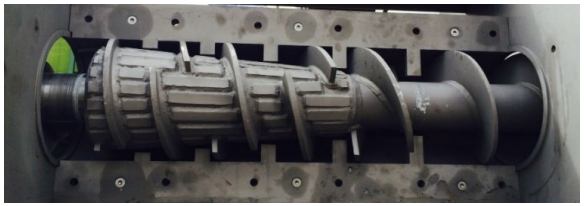
Processing of green biomass – Feed-a-Gene



15-25% TS

Green Biomass

Biomass input

Meceration

Shredder

Fractionation

Screwpress

Fibre
25-40% TS

Pulp

Rabbit feed

0-70% recirculation

Juice
5-12% TS

Tank

Residue juice
3-8% TS

Liquid/protein separation

Centrifuge

25-40% TS

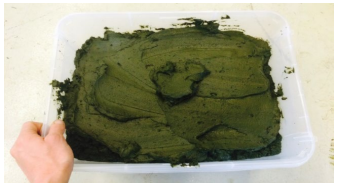
Protein concentrate, pigs/poultry

Protein precipitation

Heat exchange or fermentation

Biogas

Heat/ Power



Summary of studies with protein from green biomass to pigs

- Studies performed so far (year 2016-17) with ileal cannulated pigs have shown inferior SID of protein and amino acids in protein from green biomass compared to SBM, e.g SID of lysine in the range 69-72% in green protein concentrate compared to 84% in SBM
- A problem has been a high concentration of ash (15-30% of DM) resulting in a relatively low concentration (33-38% of DM) of protein
- However, improvements in harvest and protein precipitation techniques have increased the protein content of 2018 harvest to 49-54% of DM. The influence of that on the digestibility of nutrients have not been studied yet

Summary

- Development of technologies for processing of European grown soybeans in medium sized crushing plants
  - Similar nutritive value as conventional processed SBM
- Tail-end processing of RSM
  - Enabling concentration of high quality protein
- Cracking of green biomass
  - Potential new protein source for monogastric animals

Thank you very much for your attention!