Legume biomasses produce high protein yields in a green biorefinery concept

Marketta Rinne, Marcia Franco, Tomasz Stefański, Maryam Ghalibaf, Marina Fidelis, Eila Järvenpää & Nora Pap

Natural Resources Institute Finland

1

1

Novel ways to produce protein, energy and materials have recently become more important and competitive

- Unfortunately this does not mean that they would be more affordable, but conventional similar products have become:
  - More expensive
  - More difficult to obtain due to
    - Changing climate and extreme weather events
    - Political sanctions
  - Less desirable due to negative environmental impacts
- The level of costs will be at a higher level, but at least there are options to improve the security of supply

2

There is political will at EU and Finnish level to increase protein self sufficiency

- Finnish dairy and beef production is soya-free since year 2018
- Soy-based protein is used for pigs and particularly poultry

Soijasta luopuminen Suomessa ei ole utopiaa

Maa- ja metsätalousministeri Jari Leppä (kesk) esitti elokuun lopulla Suomesta soijatonta vuoteen 2025 mennessä. Vaikka tavoite rehusoijasta luopumisesta on erittäin kunnianhimoinen, se ei ole mahdoton.

A 34 HELSINGIN SANOMAT TORSTAINA 29.8.2019

TALOUS

Maatalous: Meijeriyhtiöitä ja lihataloja on jo luopunut Suomessa soijan käytöstä tai vähentänyt sitä

Ministeri karsisi soijarehun käyttö

Tulli pitää ministeri Jari Lepän tavoitetta

Maatalous

Ensimmäinen Suomessa, ehkä koko maailmassakin? WestFarmin emakkosikala toimii täysin ilman soijaa, kotimaisella valkuaisella

Satu Lehtonen

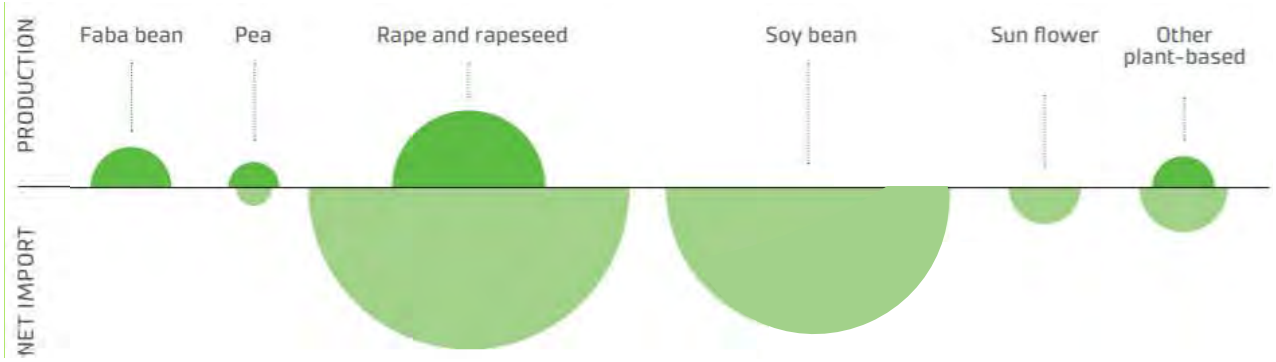
"Ympäristönäkökulma on meille erittäin tärkeä", sanoo yksi yhtiön omistajista, Henrik Holm.

CHRISTOFFER THOMASSON

WestFarmin omistajat ovat vasemmalta Kjell-Göran Paxal, Anders Lilandt, Tomas Långgård ja Henrik Holm.

3

Protein self-sufficiency of feed materials used as protein supplements in Finland



Source: ScenoProt / Luke Policy Brief 7/2018

4

Legumes have advantages over grasses

- The cell wall structure is different - maybe easier to extract the soluble protein?
- The symbiosis with Rhizobium bacteria:
  - The crude protein content of legumes is typically high
  - Legumes are not dependent on fertilizer nitrogen
  - The environmental impacts caused by mineral fertilizer usage are reduced

5

We used 6 different types of legumes as the feedstock for a biorefinery:

1. Red clover 1st cut
2. Red clover 2nd cut
3. White clover
4. Goat's rue
5. Pea
6. Faba bean

6

Harvest dates and composition of the legume biomasses

	Red clover 1st cut	Red clover 2nd cut	White clover	Goat's rue	Pea	Faba bean
Harvest date in 2021	16.6.	18.8.	16.6.	9.6.	6.8.	13.8.
Dry matter, g kg^{-1}	171	121	171	128	278	188
Composition, g/kg dry matter						
Ash	110	106	113	83	49	62
Crude protein	193	199	224	**270**	**131**	234

In this preliminary trial, the varieties, agronomic factors and harvest times could not be fully optimized, so there would still be scope for improving the results

7

Red clover (*Trifolium pratense*), var. Selma

1st cut

2nd cut

8

White clover (*Trifolium repens*), var. Lena

9

Goat's rue (*Galega orientalis*), var. Gale

10

Pea (*Pisum sativum*), var. Hulda

11

Faba bean (*Vicia faba*), var. Kontu

12

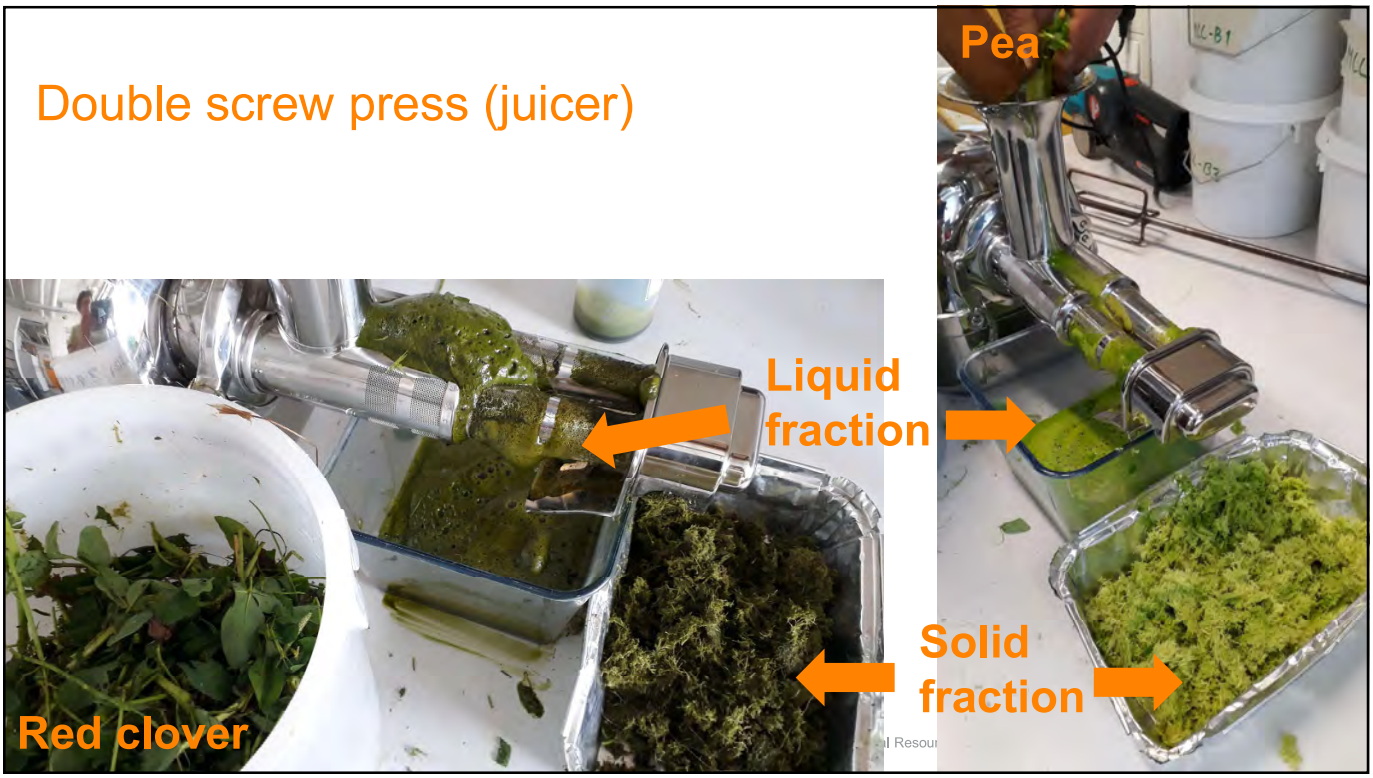
12

The plant biomasses were separated into liquid and solid fractions

- An efficient double screw press was used
- The composition of the raw material and the liquid fraction was analysed
    - Dry matter, ash (minerals) and nitrogen (crude protein) concentrations
- The yields of the respective fractions were calculated based on the raw material and liquid fraction amounts

13

Double screw press (juicer)

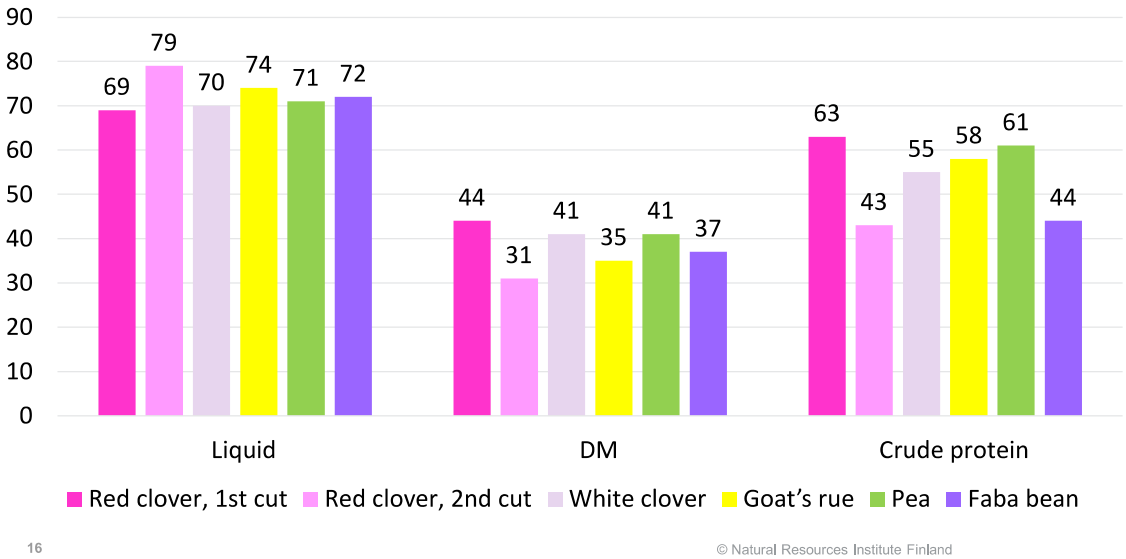


14

The liquid fractions were quite dilute (high water content), but the crude protein content of the dry matter was high

15

The yields of liquid, dry matter and crude protein as % of the original fresh matter



16

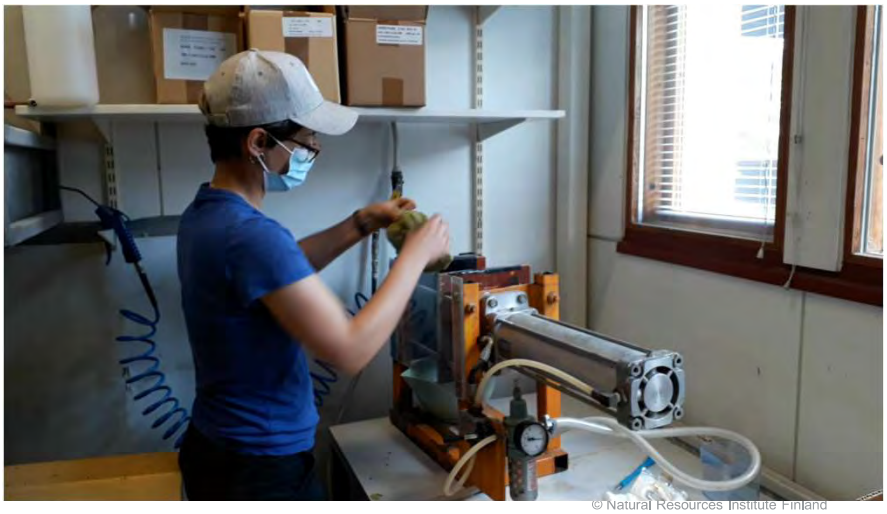
We also evaluated the effects of sample preparation on the liquid yields

- Preparation methods used:
  - Fresh immediately after harvesting
  - Frozen and melted
  - Dried and rehydrated
- All preparation methods include logistic challenges and costs
- The practical solution could be a combination of several preparation methods
- Ensiling was not used, because in this project, the use for human foods was targeted
  - In feed solution, using silage as the starting material could be a worthwhile solution

17

17

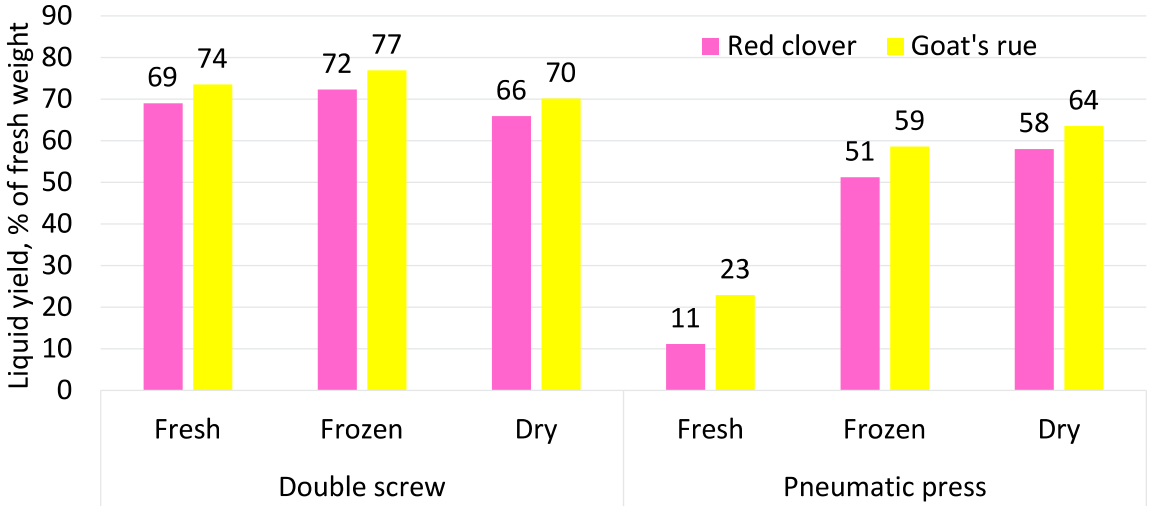
The samples were fractionated with the double screw press, and in addition, using a pneumatic piston press



18

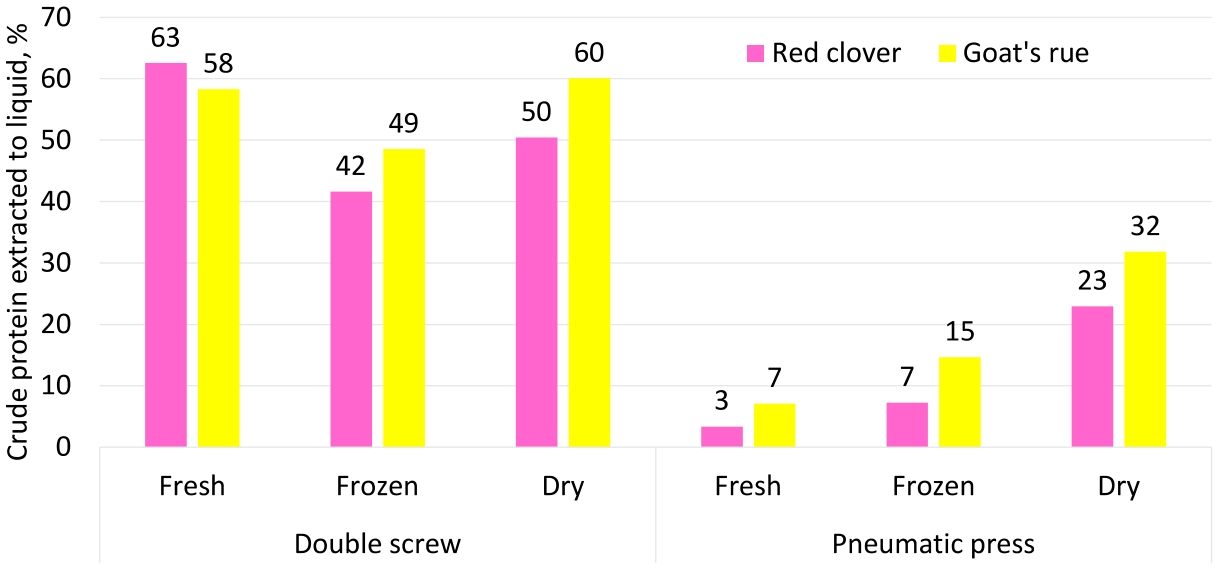
18

If an efficient press is used, all types of samples were equal. With a less efficient juice extraction method, breaking the plant cells with pretreatments improved the liquid yield.



19

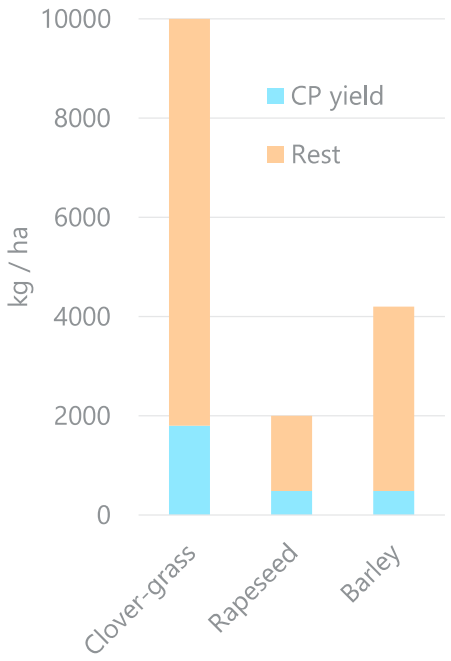
Why was the crude protein yield in frozen material lower than the liquid yield? These are preliminary results and work needs to be continued.



20

The green biomasses can compete with seed crops in producing protein and other components

- High dry matter yields per hectare
- Moderate to high crude protein concentrations
- Perennial options (forage legumes & grasses)



21

21

22

Kiitos!

Luke
LUONNONVARAKESKUS

23