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NORWEGIAN INSTITUTE OF BIOECONOMY RESEARCH

Can biorefining of forages make animal production more sustainable?

Seminar in connection with the PhD defense of
Vinni Kragbæk Damborg Jensen's doctoral thesis
Foulum, 31 January 2019

Steffen Adler
NIBIO – Norwegian Institute of Bioeconomy Research

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Norwegian Institute of Bioeconomy Research

680 employees in different locations.
Annual turnover 77 million Euro.
Owned by the Ministry of Agriculture and Food.

NIBIO'S MAIN AREAS

Geography and Statistics

Biotechnology and Plant Health

Food Production and Society

Forest and Forest Resources

Environment and Natural Resources

NIBIO provides knowledge on biological resources from soil, forests and water.

Photos: Ragnar Våga Pedersen, Lars Dalen and Erling Fløistad

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Biorefining of forage crops

Grass juice in the diet of growing pigs

ProRefine – a CORE Organic project

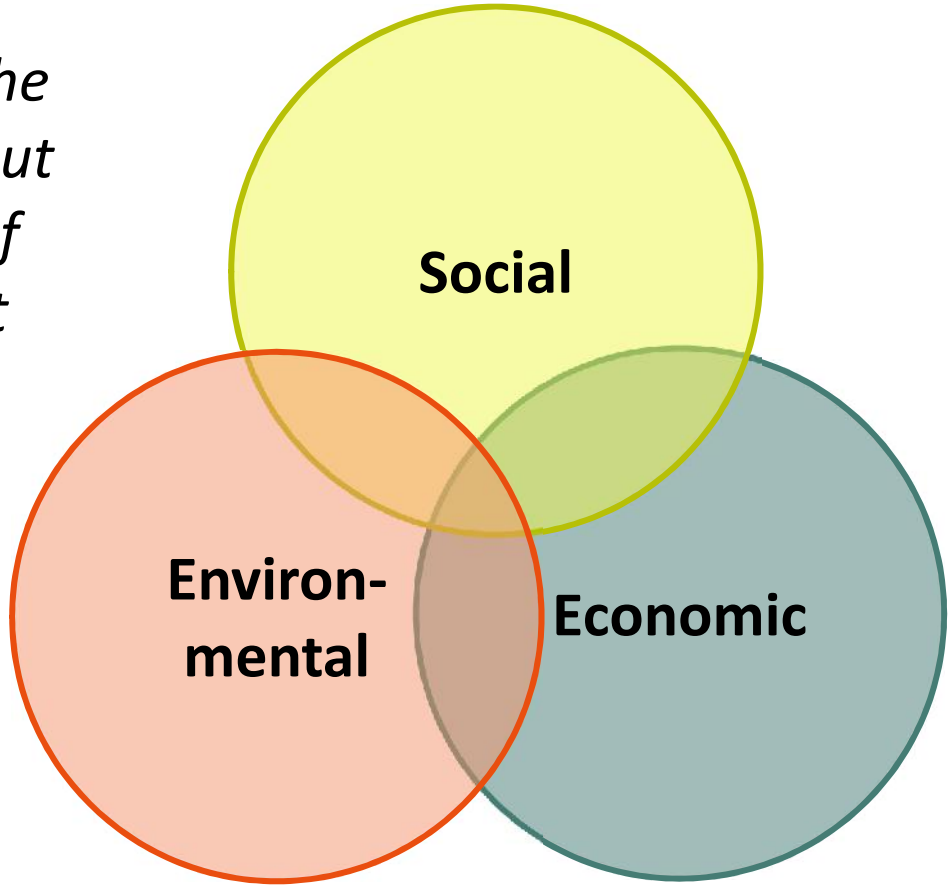
BIOREFINING OF FORAGES

Sustainability

Development that meets the needs of the present without compromising the ability of future generations to meet their own needs.

Bruntland Report (1992)

Three pilars



BIOREFINING OF FORAGES

Biorefining of forages is not new, but it has attained new interest

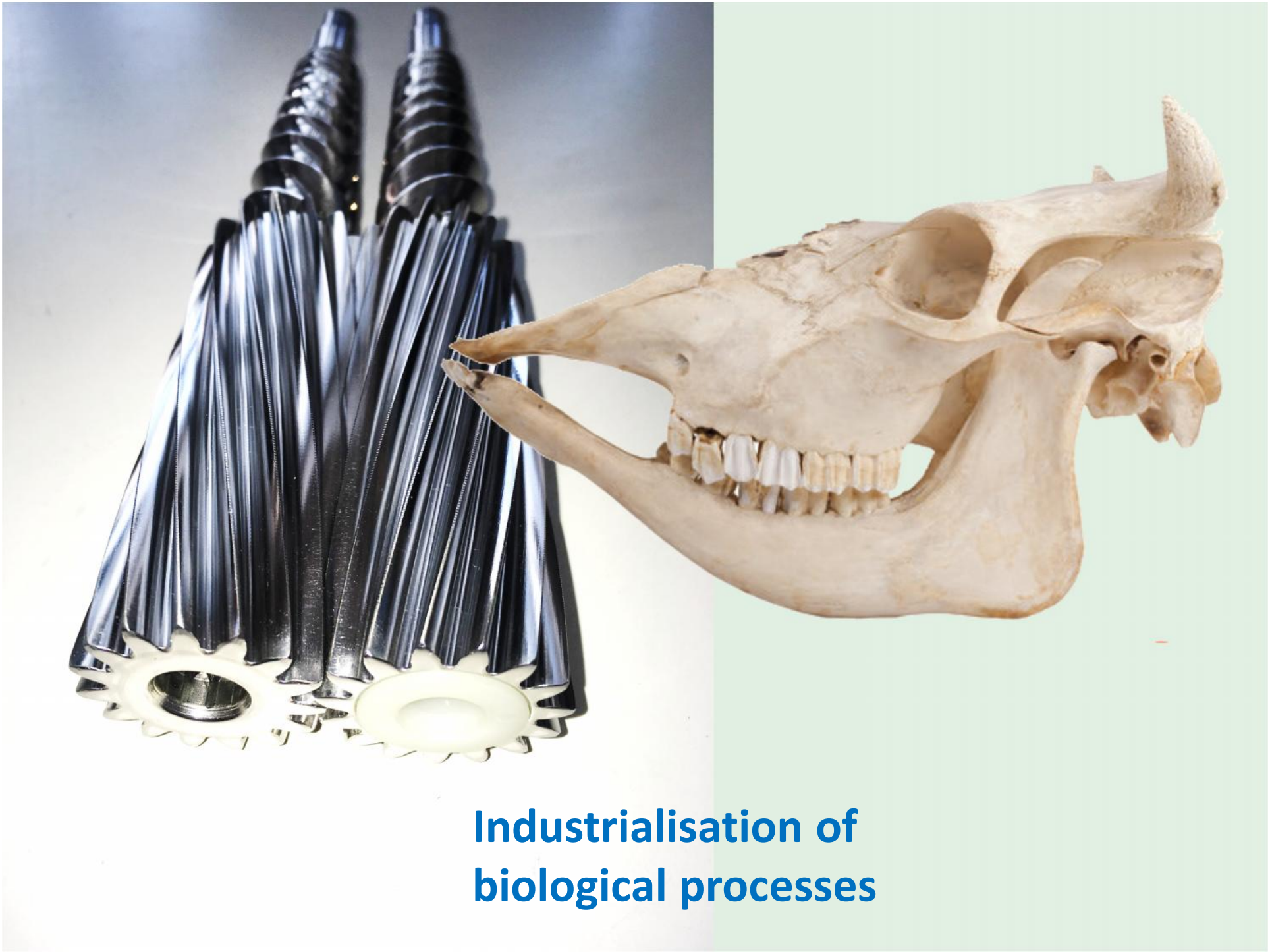
- Houseman & Connell, 1976
- Wilkins, 1977
- Näsi, 1983

- Soya protein became a cheap alternative
- New interest in biorefining after 2000
  - Kamm et al., 2016
  - Kromus et al., 2004
  - Grass 2004
  - Stødkilde et al., 2017; Damborg et al 2018
  - Franco et al, 2018

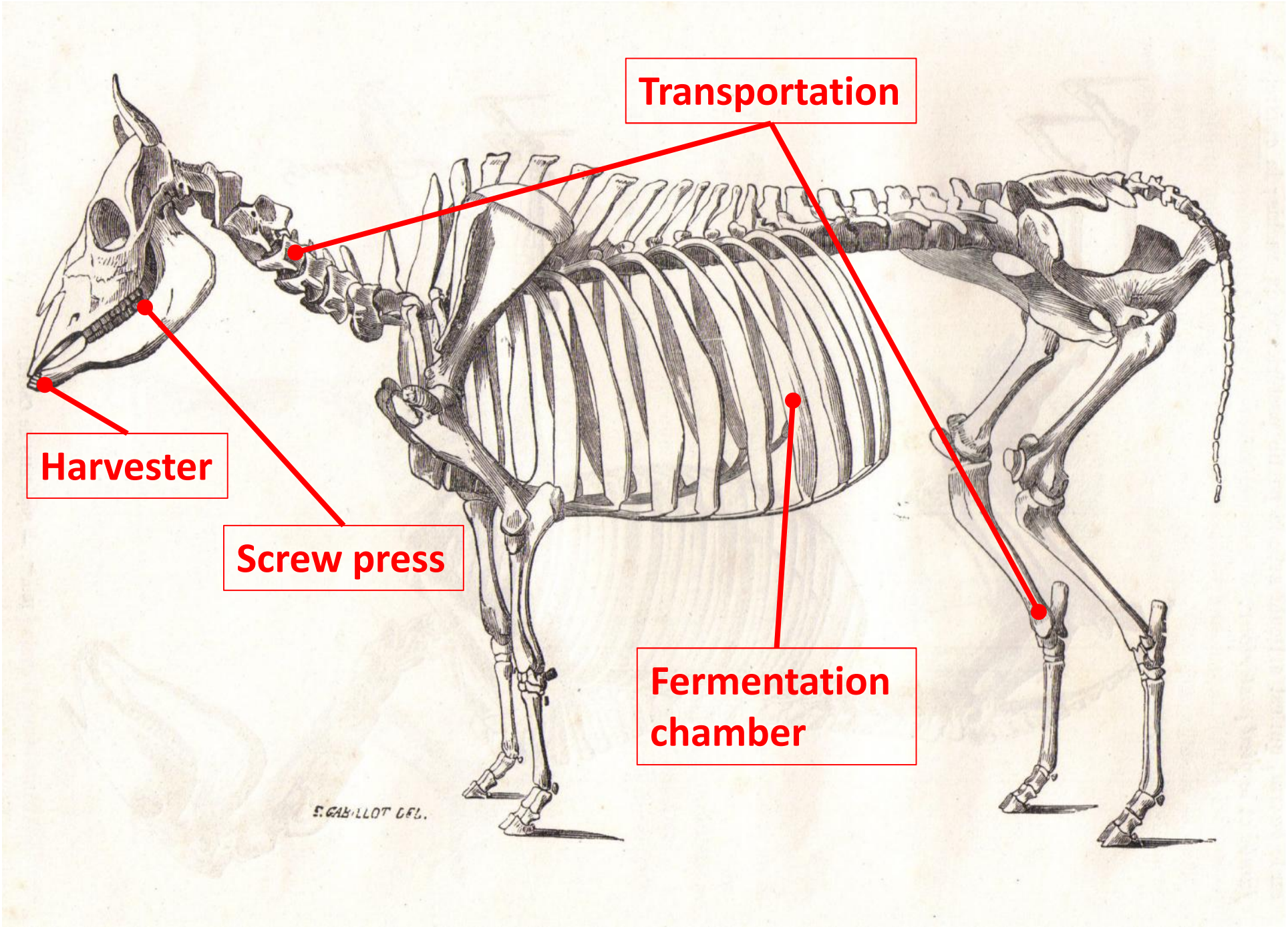
BIOREFINING OF FORAGES

- Compared to annual crops, perennial forages can utilise the growing season efficiently and produce high yields of DM and CP
- Why separate protein-rich from fibre-rich fractions?
  - Most monogastrics are not able to digest plant fibres efficiently
  - Alternative use

Lucerne



Industrialisation of biological processes



Wikimedia: Mayer C., 2011, domaine public (décès des auteurs 1917 et 1911)

Forages – a local protein source for growing pigs


Photo: Norsvin

Proceedings of the 9th Nordic Feed Science Conference 2018, Uppsala, Sweden

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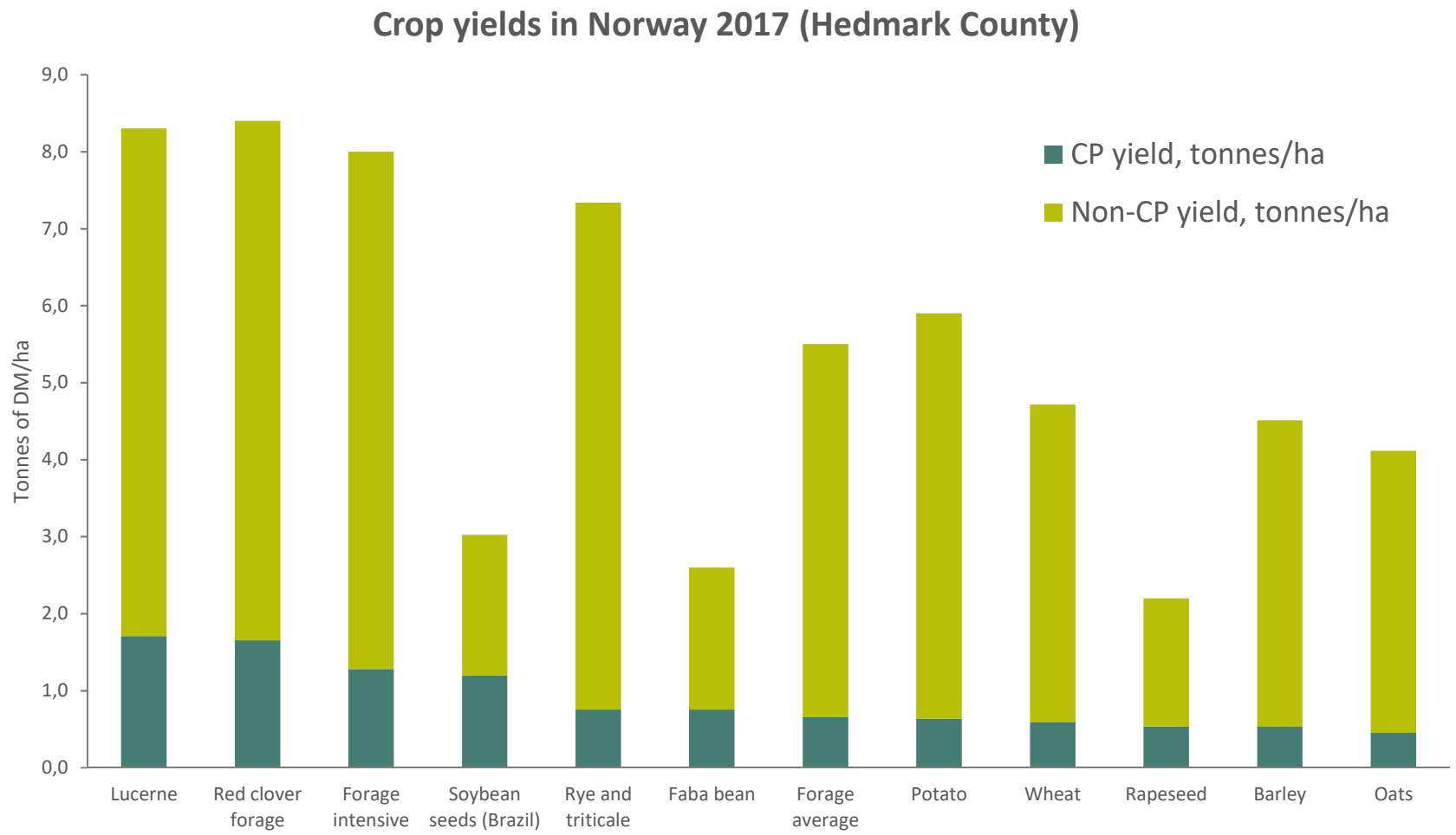
[3] Norsvin SA, Norway

FORAGES – A LOCAL PROTEIN SOURCE FOR GROWING PIGS



FORAGES – A LOCAL PROTEIN SOURCE FOR GROWING PIGS

Aim of the project

Assess the effects of including forage juice preserved with formic acid in the diet of growing pigs on growth rate and meat quality on a commercial farm

FORAGES – A LOCAL PROTEIN SOURCE FOR GROWING PIGS

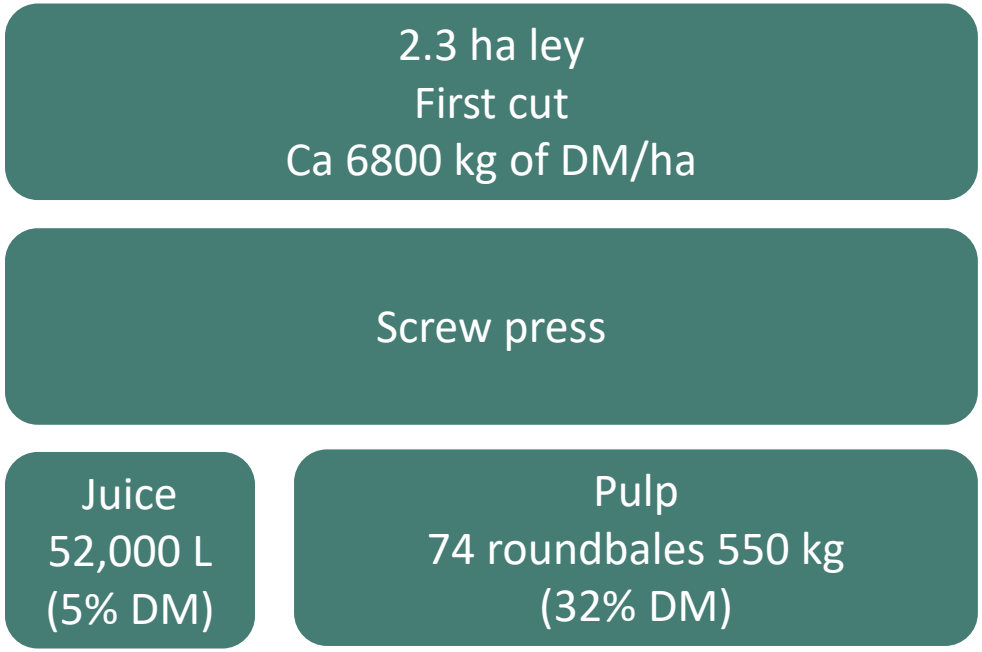
Production of forage juice

- Commercial pig farm in Hedmark County, Norway
- Organically managed ley (80% timothy and meadow fescue, 20% red clover)
- Phenological stage of heading (grasses)
- First cut from 2.3 ha
- Harvested and preserved 13-16th June 2016
- Pulp was baled and sold to a nearby dairy farm

https://www.youtube.com/watch?v=38heTQEXCKk

FORAGES – A LOCAL PROTEIN SOURCE FOR GROWING PIGS

Forage production and processing



FORAGES – A LOCAL PROTEIN SOURCE FOR GROWING PIGS

Feeding experiment

- 160 crossbred piglets (43 kg, 83 days)
- 2 test and 2 control groups of 20 animals
- Test diet contained 10% grass juice on DM basis
- Control diet: Vekst 120 (Kambo)
- Liquid-fed according to a feed curve with increasing feed intake

FORAGES – A LOCAL PROTEIN SOURCE FOR GROWING PIGS

Diets

- 16% crude protein, isoenergetic, 20% DM, similar AA comp.
- Felleskjøpet Agri, Norway

Test diet

- 10% forage juice and 90% adjusted concentrate feed mixture on DM basis
- 4.9% soybean meal

Control diet

- Commercial concentrate feed mixture mixed with water
- 7.6% soybean meal

FORAGES – A LOCAL PROTEIN SOURCE FOR GROWING PIGS

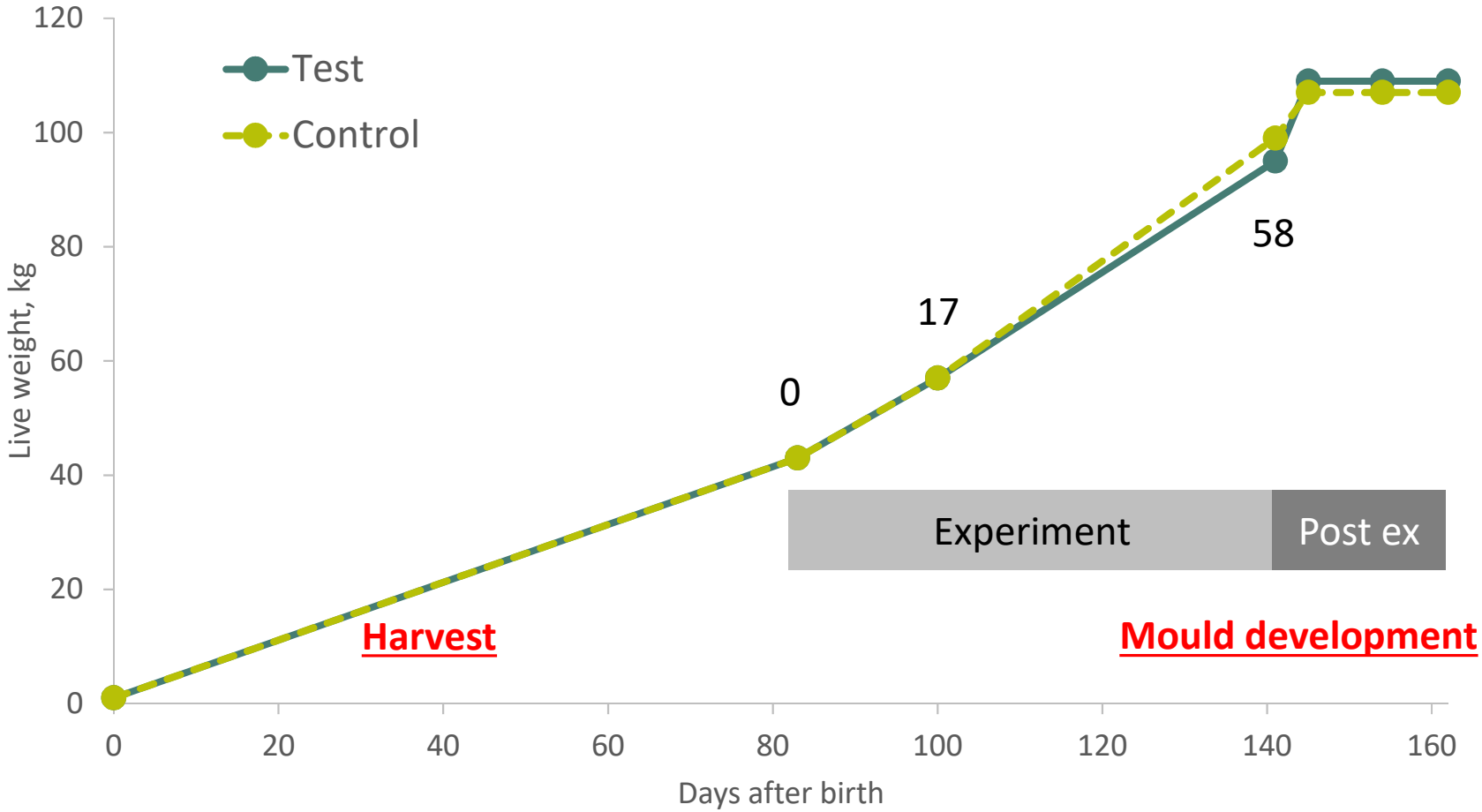
Results

	Test	Control	SEM	*P*-value
Feed conversion ratio, MJ/kg LW gain	24.3	23.2	0.97	NS
Average live weight gain, g/day				
Day 1 to 17	808	801	18.7	NS
Day 1 to 58	892	917	10.9	0.11
Day 18 to 58	**927**	**965**	**13.5**	**0.05**
Day 58 to slaughter[3]	1090	1148	49.1	NS
Mortality, %	2.5	2.5	-	NS

- Moderate live weight gain
- Mould developed in the upper layer after 3 month of storage
- Mycotoxin analyses: without risk to animal health
- No signs of appetite loss
- Experiment stopped after 58 days

FORAGES – A LOCAL PROTEIN SOURCE FOR GROWING PIGS

Feeding experiment



FORAGES – A LOCAL PROTEIN SOURCE FOR GROWING PIGS

Results

	Test	Control	SEM	*P*-value
Meat and fat quality				
Lean meat, %	60.6	60.5	0.28	NS
Omega-6:omega-3 ratio	8.58	9.69	0.12	<0.001
Stomach ulcer, number	1.53	1.45	0.26	NS
Intra muscular fat (NIR), %	2.08	1.69	0.16	NS
Fat colour L (whiteness)	77.1	77.2	0.24	NS
Fat colour a (redness)	3.72	3.35	0.19	NS
Fat colour b (yellowness)	5.29	5.15	0.13	NS

FORAGES – A LOCAL PROTEIN SOURCE FOR GROWING PIGS

Pulp silage

- Indicated good feeding value for dairy cows
- 32% DM, 14.6% crude protein, 62.7% NDF, 74.0% OMD, pH 5.2, NEL 6.36 MJ/kg of DM

FORAGES – A LOCAL PROTEIN SOURCE FOR GROWING PIGS

Conclusions

- Inclusion of 10% forage juice did not affect daily live weight gain in growing pigs,
  but reduced live weight gain with 38 g/day in finishers
- Forage juice gave a more beneficial omega-3:omega-6 ratio for human nutrition in fat
- Improved preservation methods for forage juice are needed

FORAGES – A LOCAL PROTEIN SOURCE FOR GROWING PIGS

Sustainability

- In this experiment only a minor part of the diet was replaced with grass juice
- Life Cycle Assessment (Johansen & Hjelkrem, 2018)
  - Production and use of home made grass juice may contribute to reduce global warming, use of fossil fuels and terrestrial pollution
  - Higher land use efficiency
  - Many challenges must be solved

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Refined forage legumes as local sources of protein feed for monogastrics and high quality fibre feed for ruminants in organic production

CORE organic

PROREFINE

AARHUS UNIVERSITY

IARTC International Agricultural Research and Training Center

INRA SCIENCE & IMPACT

NIBIO NORWEGIAN INSTITUTE OF BIOECONOMY RESEARCH

Ruralis Institute for rural and regional research and forestry

SLU Swedish University of Agricultural Sciences

Trust'Ing

UNIVERSITÀ CATTOLICA del Sacro Cuore

NEW METHODS FOR PRODUCING HIGH QUALITY FEED LOCALLY

PROREFINE

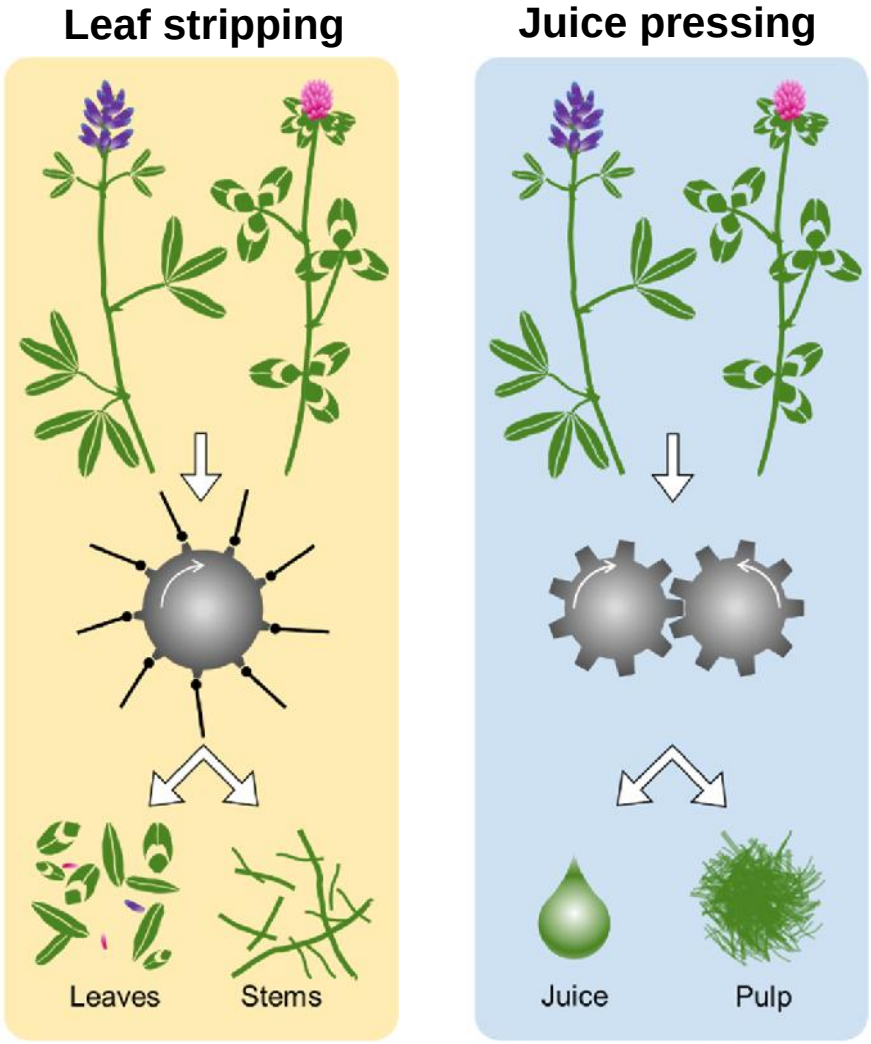
Eric Juncker (F), Paolo Bani (I), Søren K. Jensen (DK), Jaakko Nuutila (CORE Organic, FIN), David Parsons (S)
Håvard Steinshamn (N), Brit Logstein (N), Lene Stødkilde-Jørgensen (DK), Ülfet Erdal (TUR), Honoré Labanca (F)
Divina G. P. Rodriguez (N), Mariem Baccar (F), Steffen Adler (N), David Renaudeau (F)
Not present Gunn-Turid Kvam (N)

NEW METHODS FOR PRODUCING HIGH QUALITY FEED LOCALLY

PROREFINE

Objective

To improve local food systems in organic farming based on fractionation of plant parts of forage legumes



NEW METHODS FOR PRODUCING HIGH QUALITY FEED LOCALLY

PROREFINE

Field trials and feeding experiments

Sweden

Norway

Denmark

France

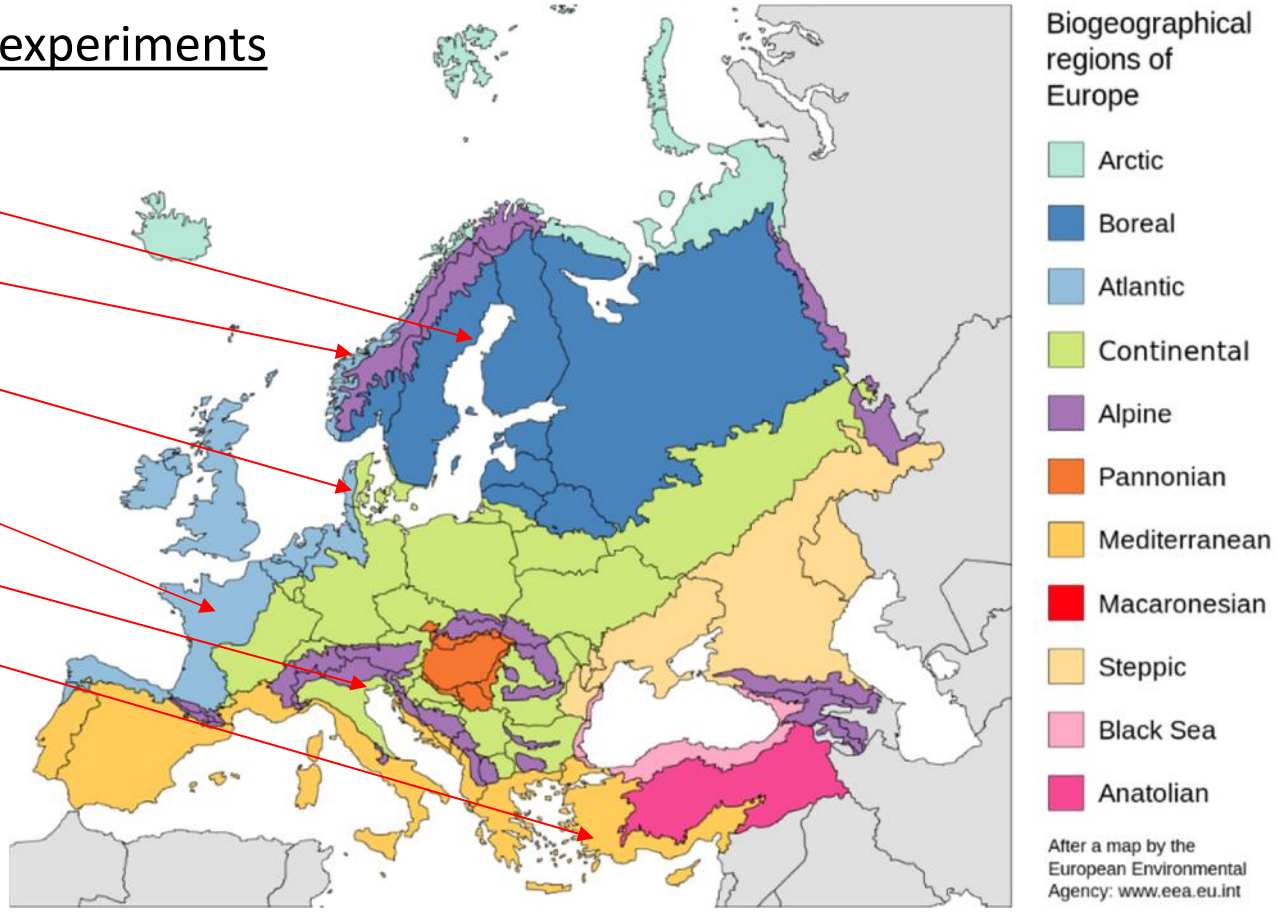
Italy

Turkey

Feeding experiments

France: Swine

Italy: Sheep



NEW METHODS FOR PRODUCING FEED LOCALLY

PROREFINE

Field trial

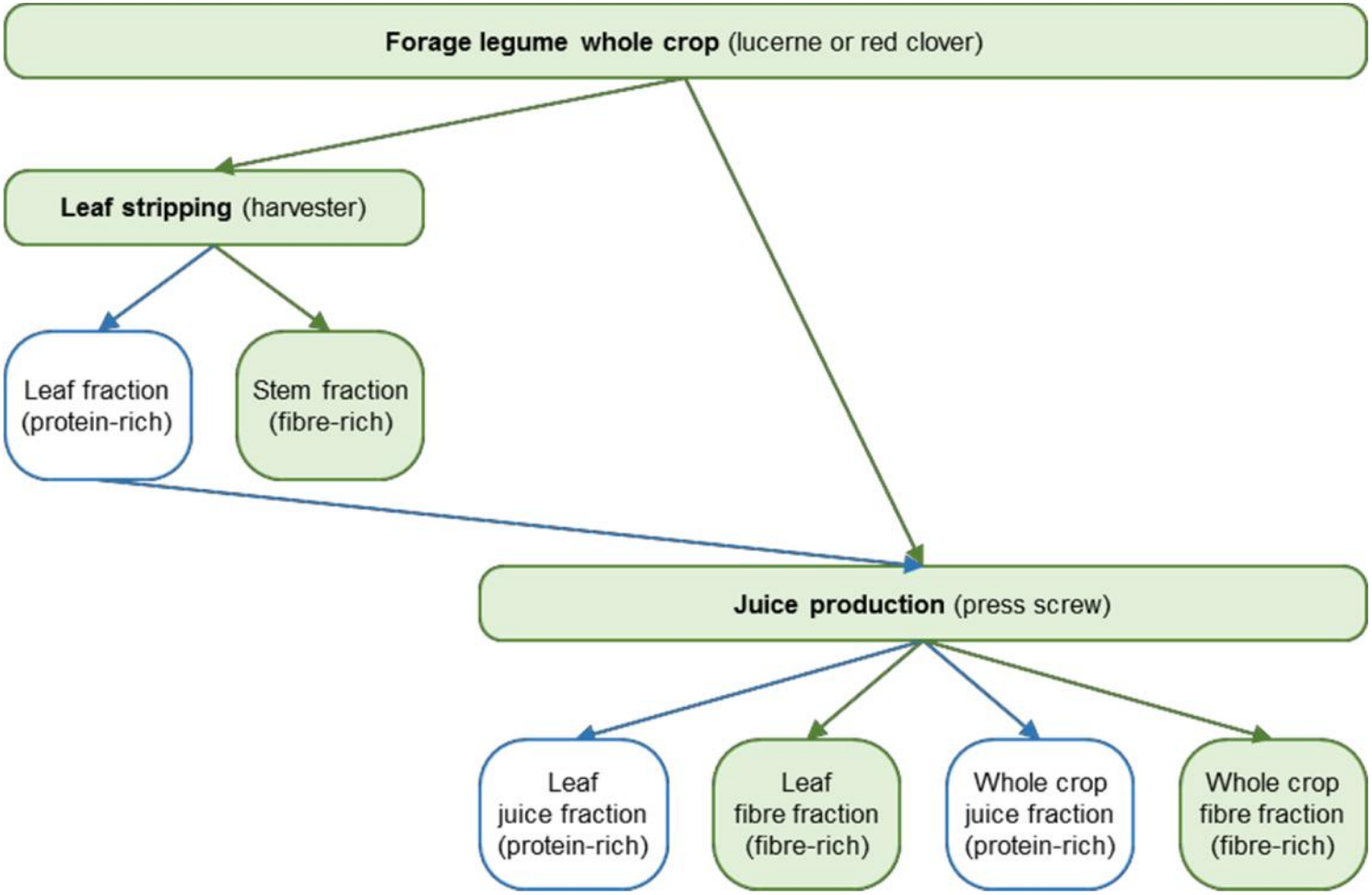
Tingvoll,
20.09.2018

NEW METHODS FOR PRODUCING FEED LOCALLY

Field trial
Umeå,
16.08.2018

Photo: David Parsons, SLU

NEW METHODS FOR PRODUCING HIGH QUALITY FEED LOCALLY



PROREFINE

Technology

Leaf stripper MRF1 prototype (TRUST'ING – ALF'ING)

Lucerne leaves ensiled with crushed triticale grains

Photos: Eric Juncker

PROREFINE

Technology

Press screw (Angel)

Photo: Erik Fog

NEW METHODS FOR PRODUCING HIGH QUALITY FEED LOCALLY

PROREFINE

Organic farming

Forage legumes

Lucerne

Red clover

Fractionation

Leaf stripper

Press screw

Protein-rich
Juice and leaves

Fibre-rich
Pulp and stems

Local feeds

Foto: Norsvin

Monogastrics

Ruminants

Sustainability

Farmer attitudes towards self-sufficiency

Economy

Society

Environ-ment

NEW METHODS FOR PRODUCING FEED LOCALLY

Social aspects

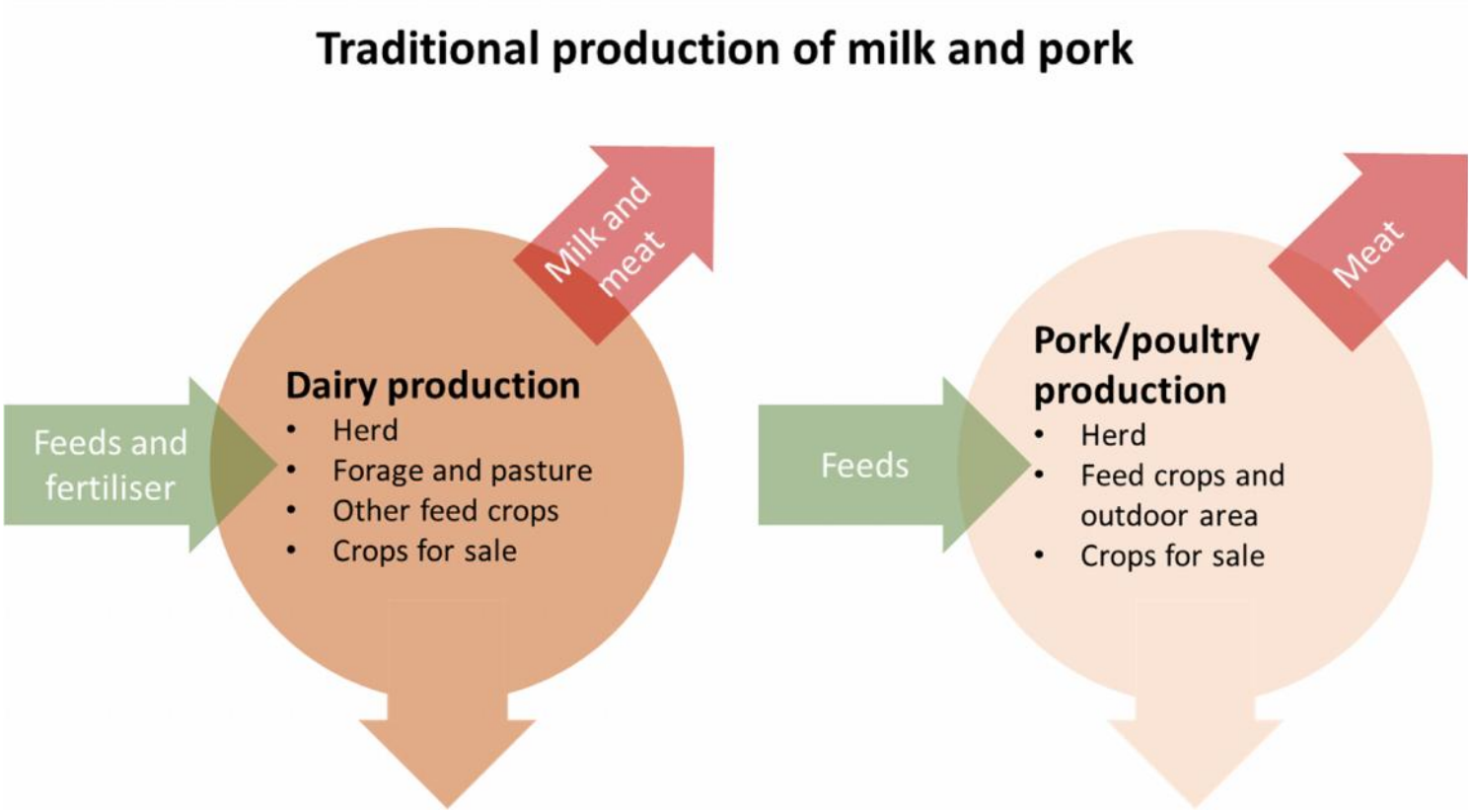
Stakeholder group meetings

- Focus group interviews

Farmer interviews

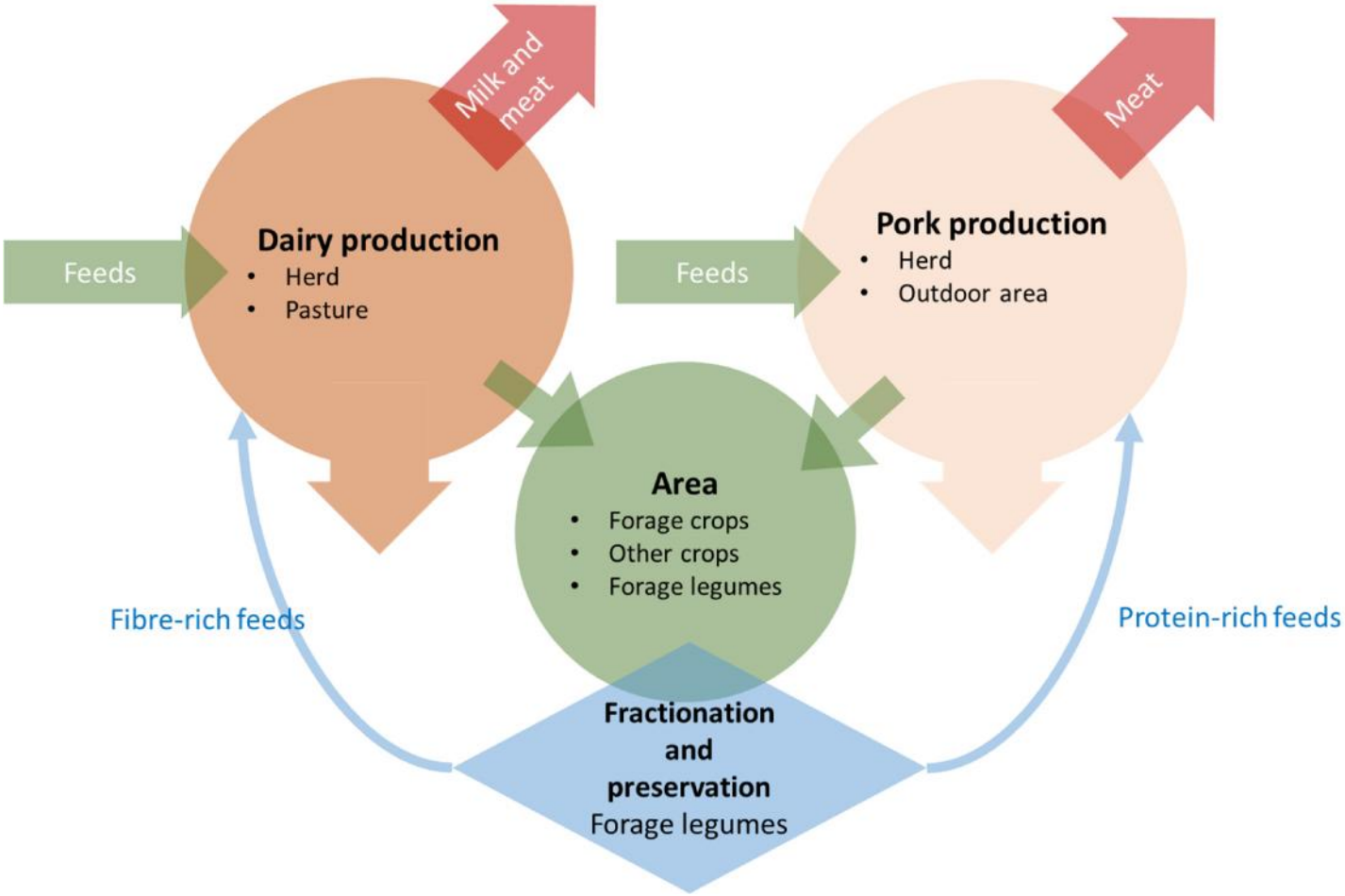
- Attitudes towards local food systems, motivation, cooperation, risk management

NEW METHODS FOR PRODUCING FEED LOCALLY



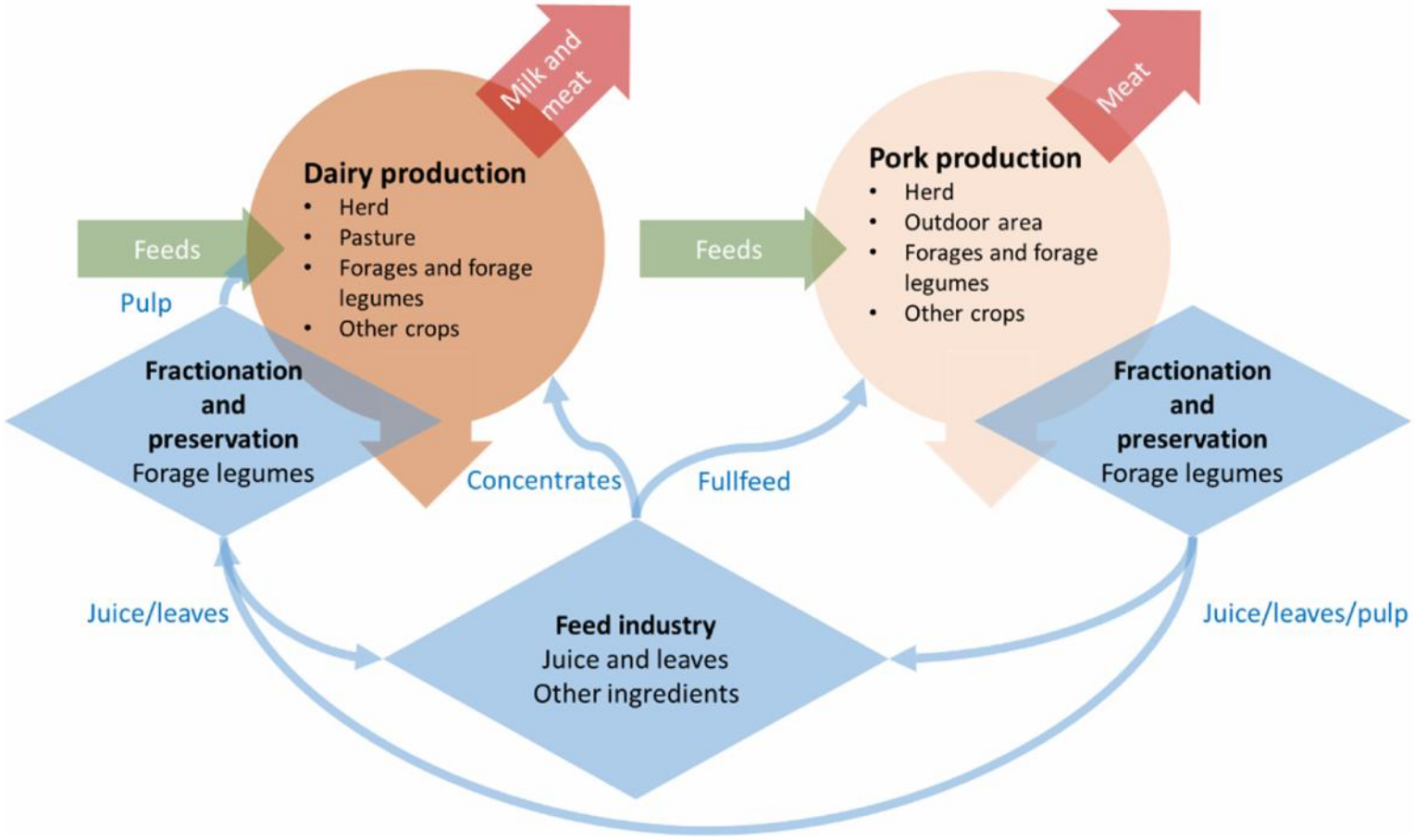
NEW METHODS FOR PRODUCING FEED LOCALLY

Concept 1: Cooperation between dairy and pork farm



NEW METHODS FOR PRODUCING FEED LOCALLY

Concept 2: Sale of fractionated forage legumes to the feed industry



BIOREFINING OF FORAGES

Strengths

Biorefining	Current practice	Grassfed
Fractions for monogastrics	Supplements for varying forage qualities	Animal does the «work»
Lower wilting losses		No arable land outside the farm

Weaknesses

Biorefining	Current practice	Grassfed
Fractionation is resource demanding	Inefficient land use?	Low milk yield
Preservation of protein-rich fractions is challenging	No feeds for monogastrics from grasslands	No feeds for monogastrics
Preparing protein-rich fractions for monogastrics decreases forage area for ruminants	Import of protein feeds	

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Summary

Biorefining of forages may contribute to more sustainable animal production, but there are still many challenges to be solved.

- Technical issues and logistics
- Land use
- Processing costs and economy
- Preservation methods
- Attitudes, motivation and cooperation