MIXED
EFFICIENT AND RESILIENT
MIXED FARMING & AGROFORESTRY

What interactions in mixed crop/livestock systems confer agronomic advantage and deliver ecosystem services?

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SRUC

Mixed farming is:

..a type of farming which involves both the growing of crops and the raising of livestock. (Wikipedia)

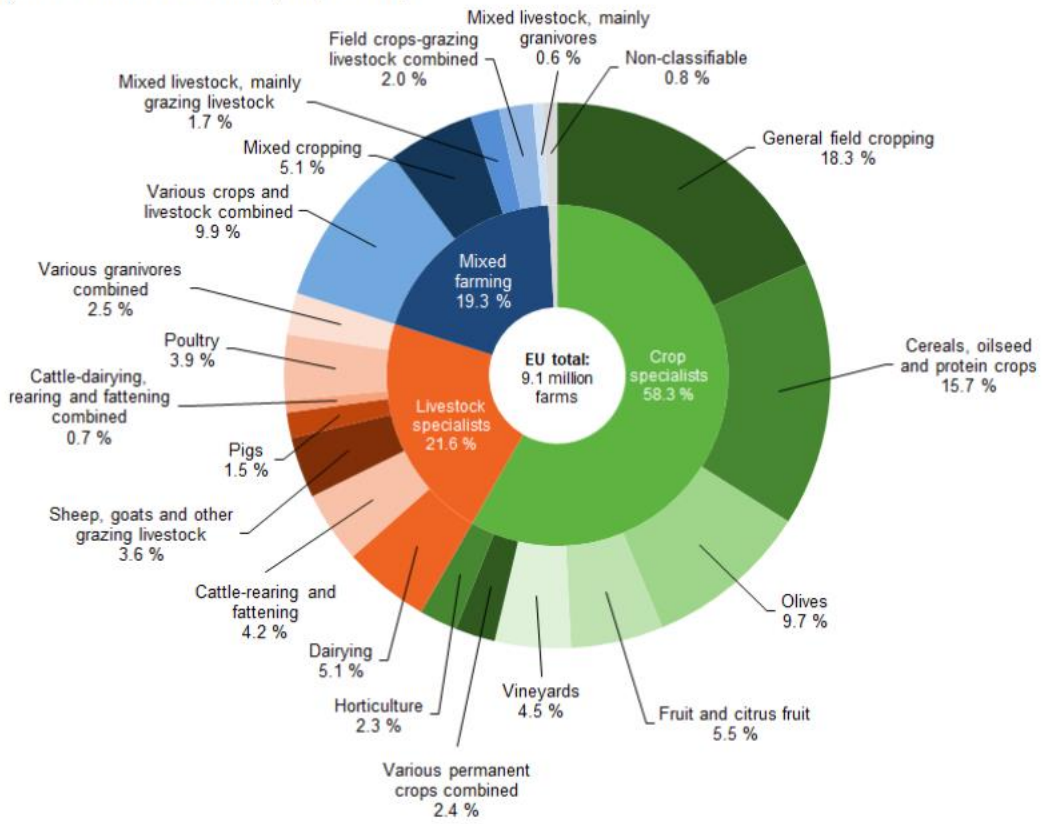
..the growing of food or cash crops, feed crops, and livestock on the same farm (Miriam Webster online dictionary)

…made up of farm-level combinations of annual crops, perennial crops, livestock, forestry, and fisheries (Baker et al. 2023)

……*Holdings in which none of the specialist categories is responsible for more than 2/3 of Standard Outputs. This category includes mixed pigs and poultry farms as well as farms with a mixture of crops and livestock (where neither accounts for more than 2/3 of SOs) (FADN/FBS)*

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 862357

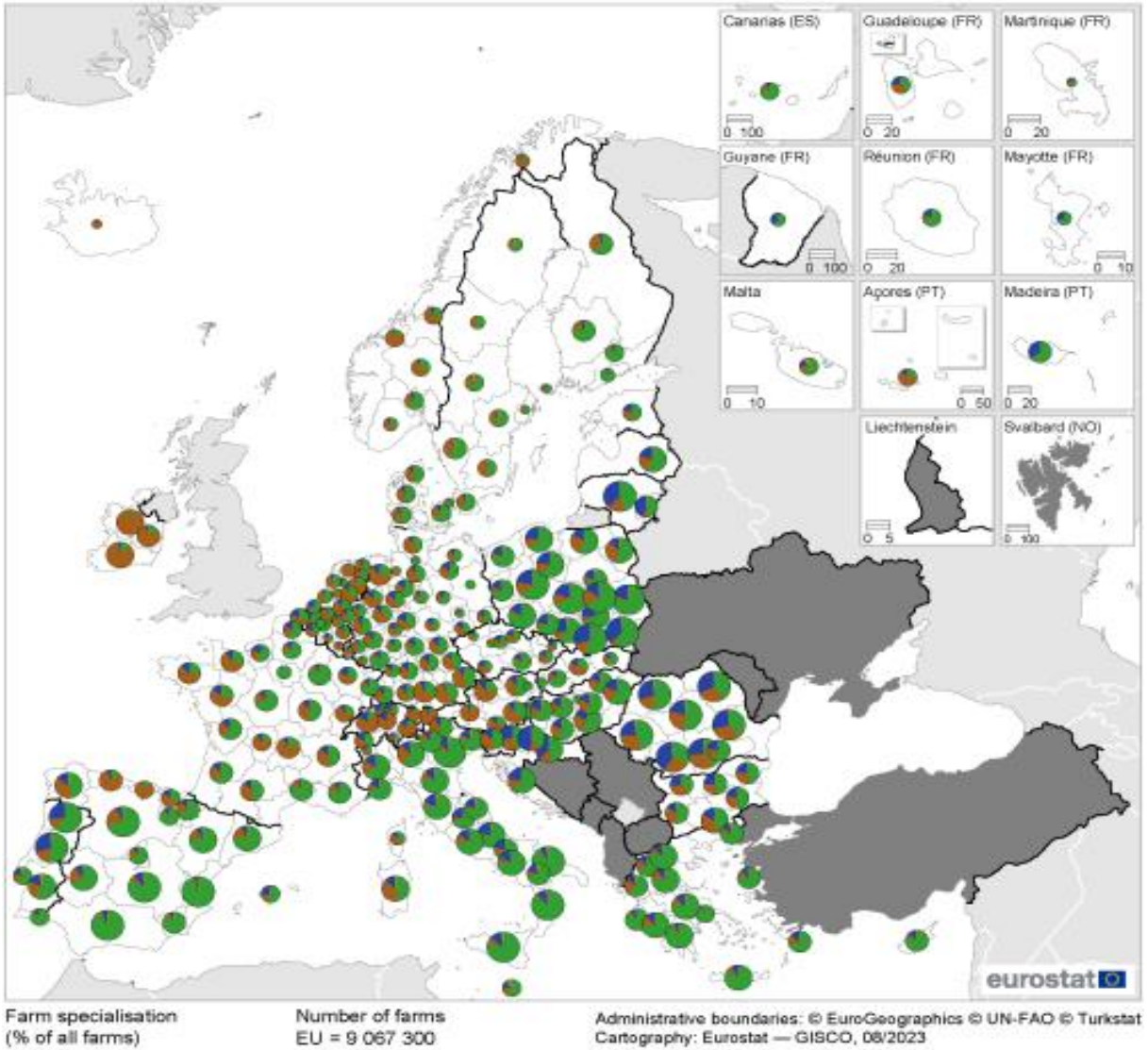
Farms by type of specialisation
(share of all EU farms, %, 2020)



Source: Eurostat (online data code: ef_m_farmleg)

https://ec.europa.eu/eurostat/statistics-explained/SEPDF/cache/73319.pdf

Farm specialisations, 2020
(by NUTS 2 regions)



https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Agriculture_statistics_at_regional_level#Farms

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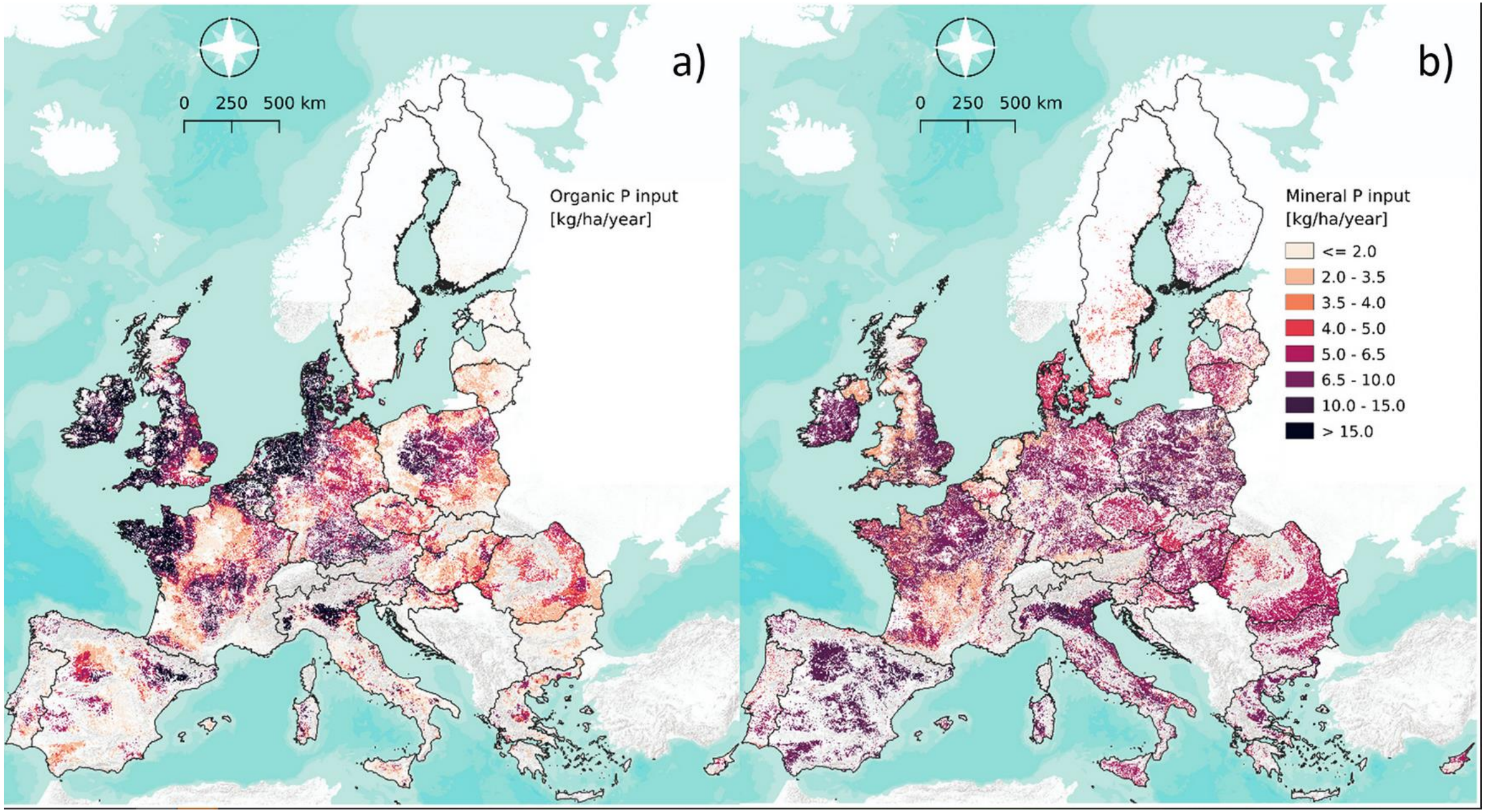

Fig. 2. Average yearly P inputs to agricultural soils from manure (a) and from mineral fertilizers application (b) in the decade 2010–2019. The legend refers to both maps. Muntwyler et al. 2024 https://doi.org/10.1016/j.scitotenv.2023.167143

The EIP-AGRI focus group report (2017)

‘Mixed farming systems can use resources more efficiently by using crops and grasslands to feed animals and fertilise their fields with manure from the animals.’

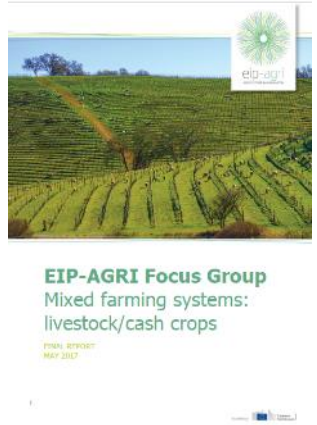

TABLE debates

“Crop-livestock integration refers to the practice of combining the cultivation of one or more crop with at least one type of livestock. This integration is designed to reduce reliance on external inputs, as the crops provide feed for the animals, and the animal manure provides nutrients that foster crop production.”
https://tabledebates.org/glossary/crop-livestock-integration

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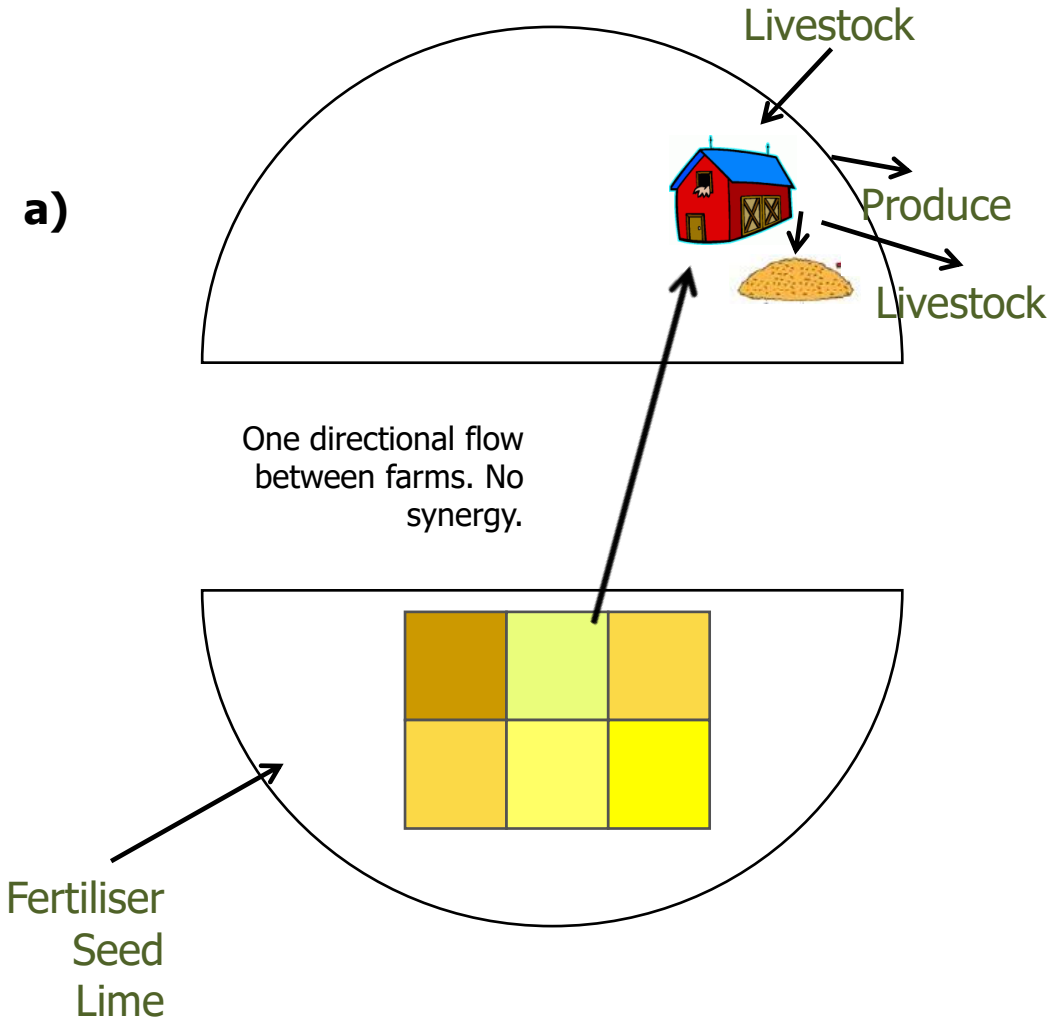
Going beyond risk-sharing - what interactions are needed between components to confer resource use efficiency?

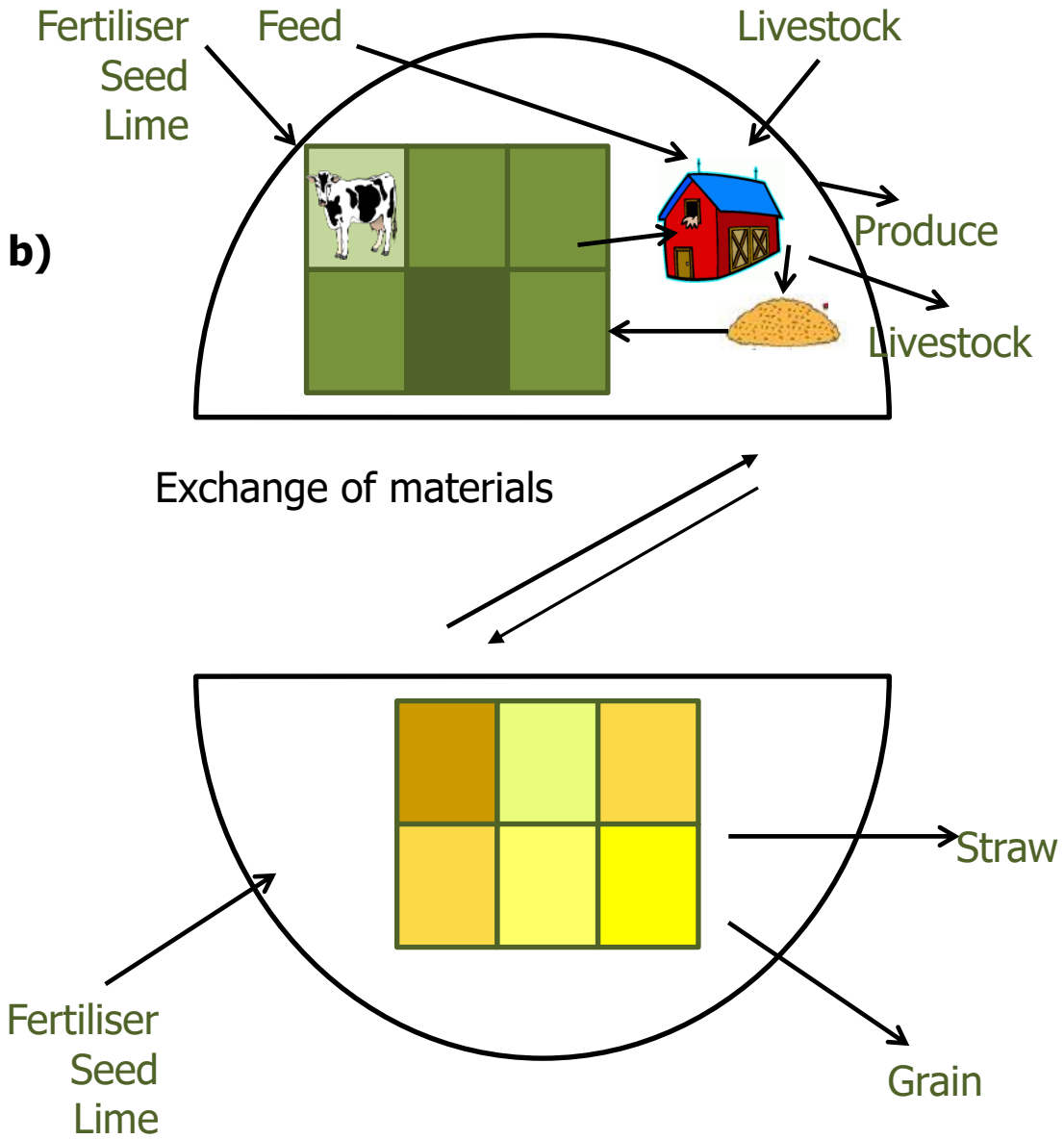
- Mixed systems are characterised by integration of enterprises
- But enterprise choice determined by many things including pedoclimatic conditions, history, infrastructure and prices
- Are they also based on synergies?
- Does the degree of synergy between enterprises determine the efficiency? How much is enough?

a)



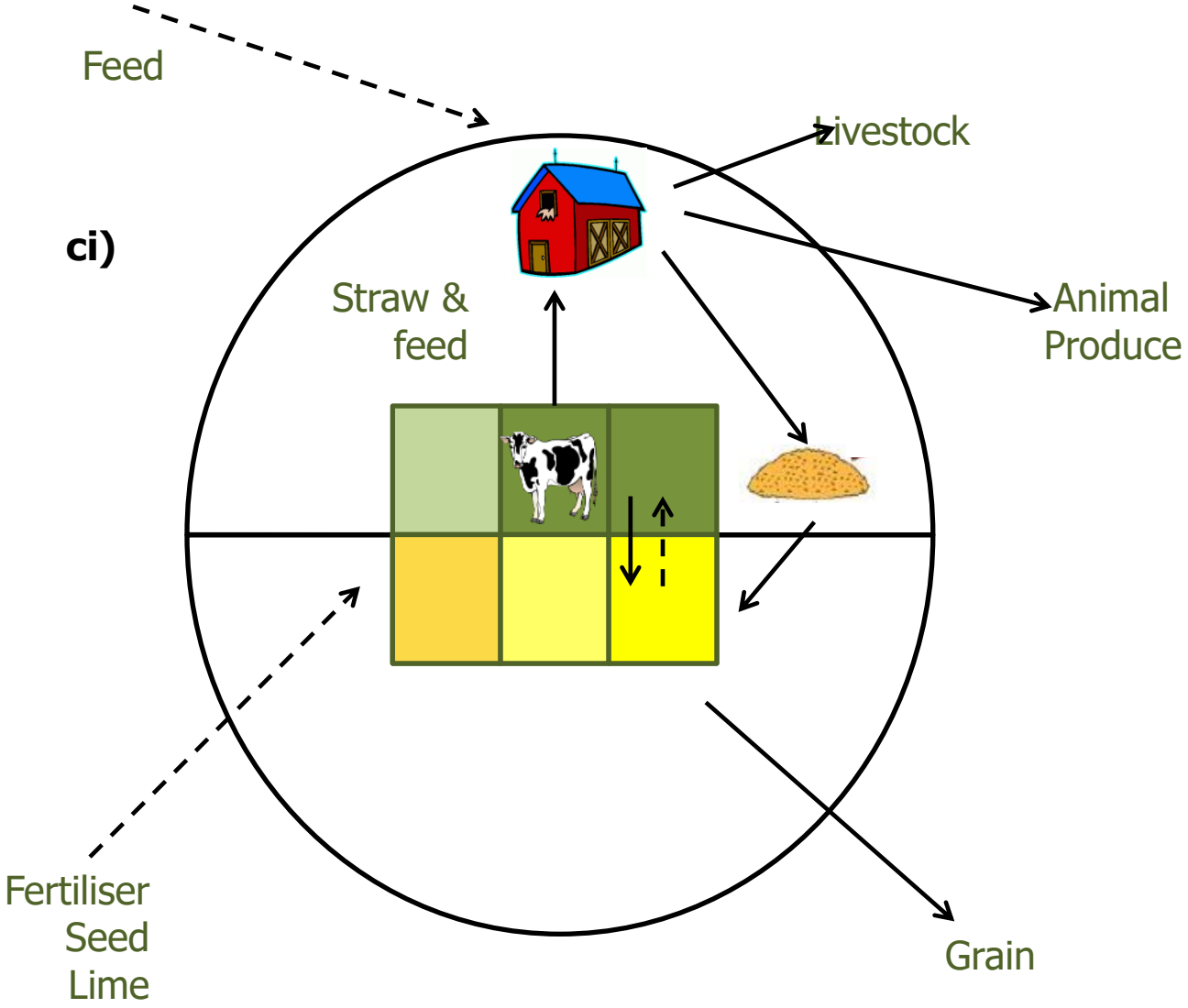
Watson et al. (2019)

b)



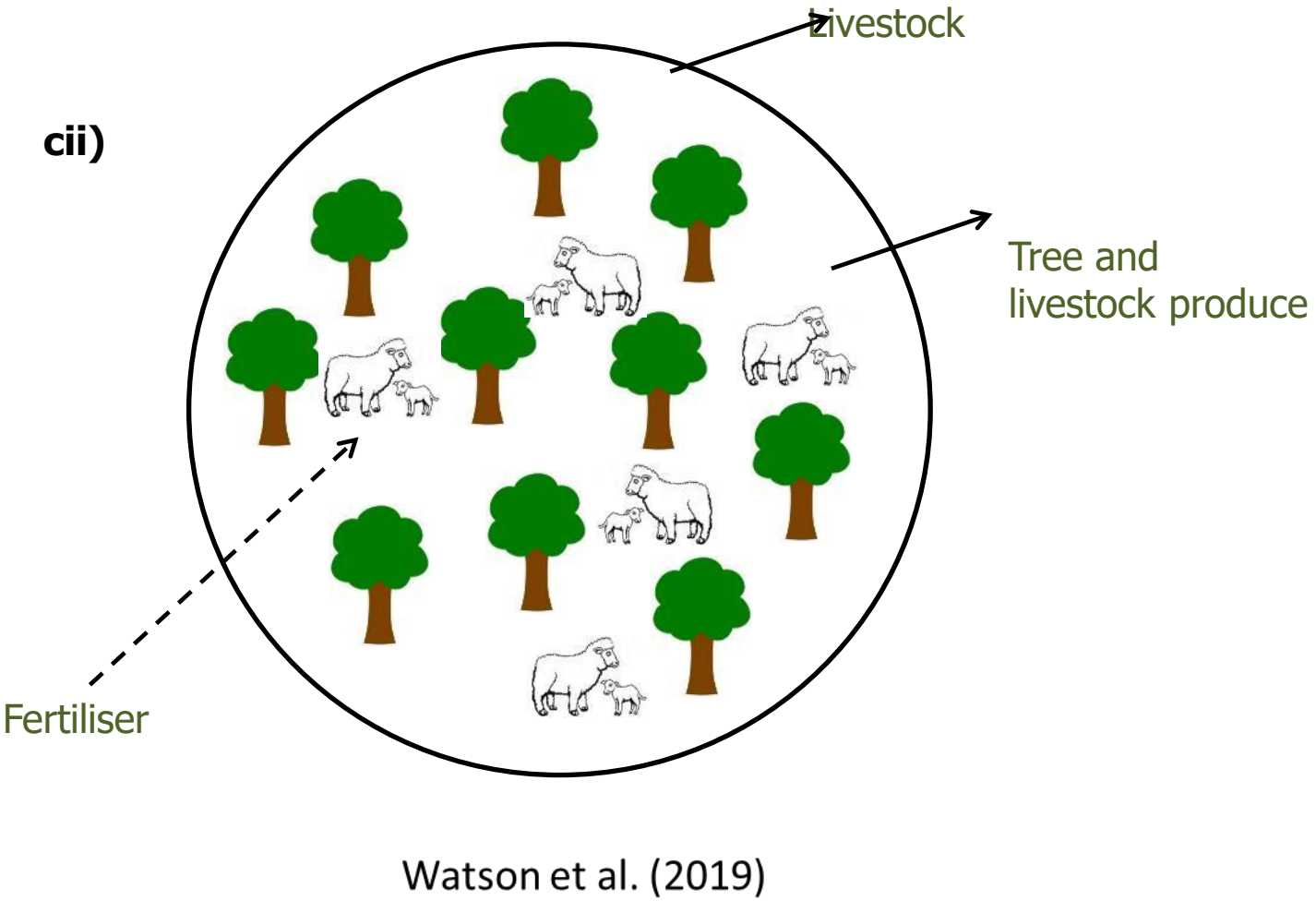
Watson et al. (2019)

ci)

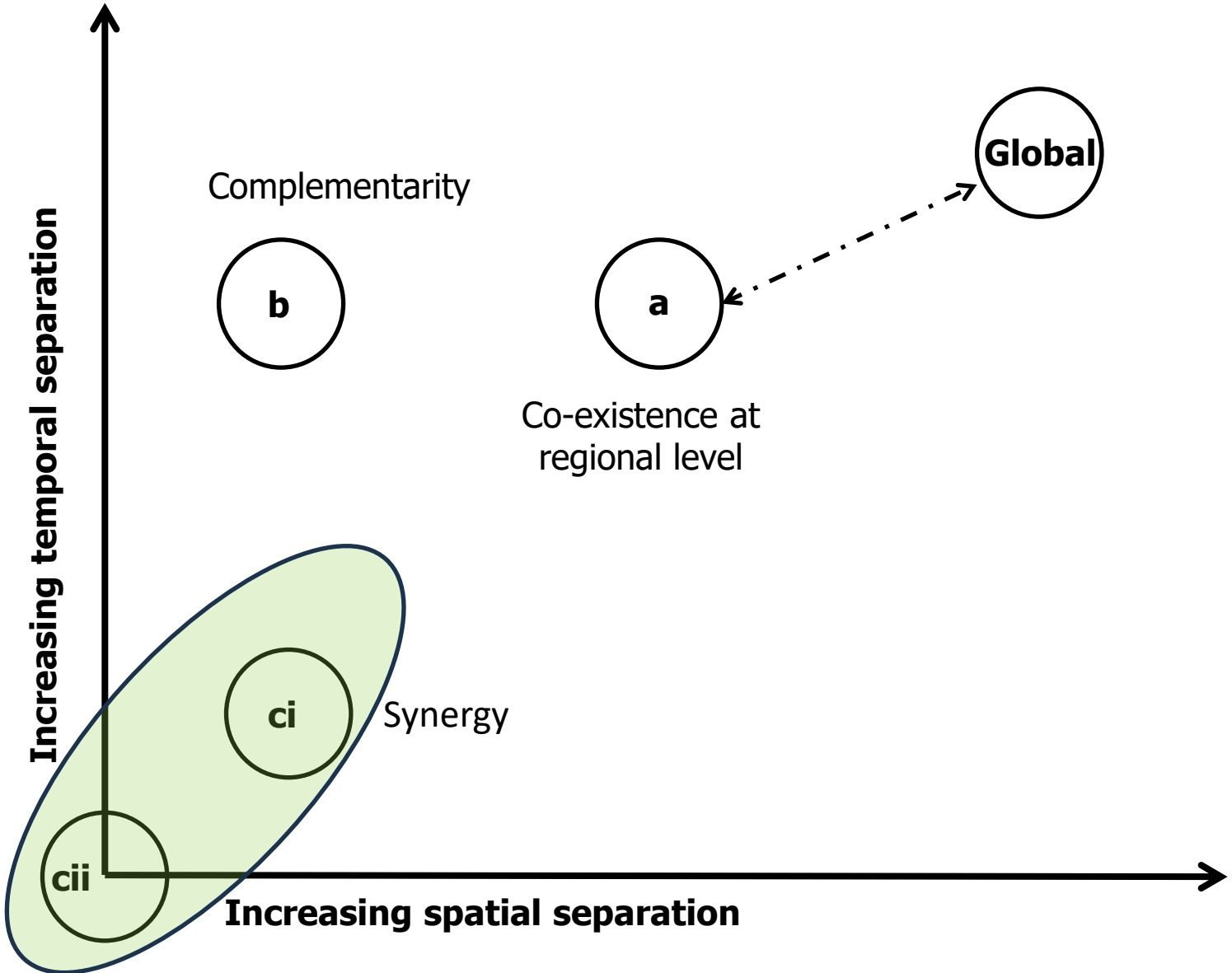


Watson et al. (2019)

cii)

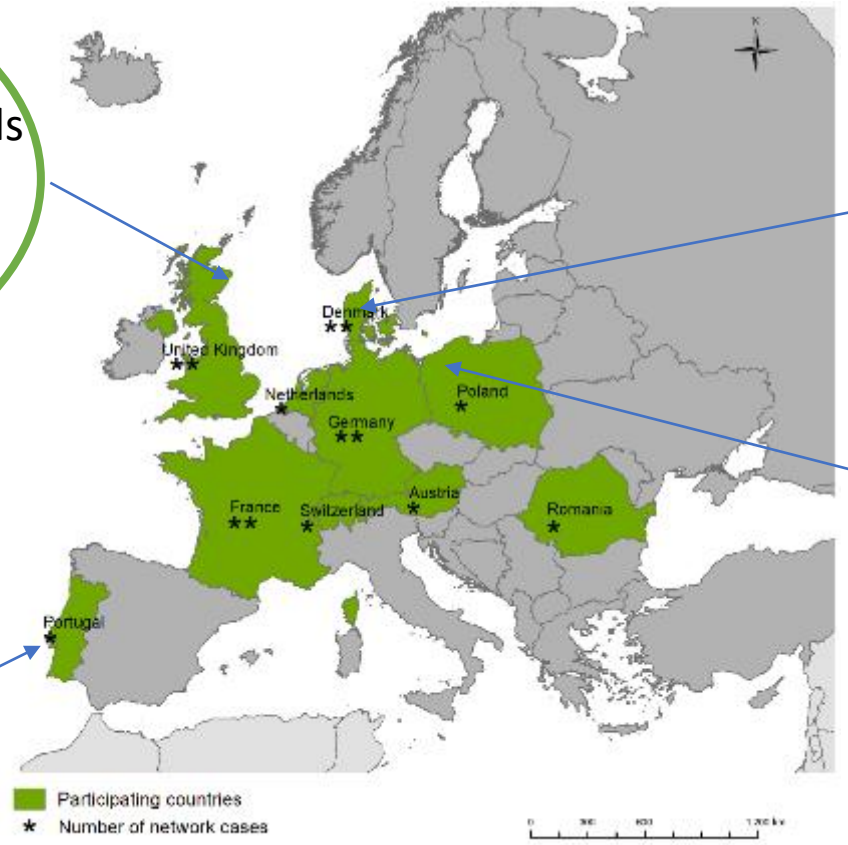


Watson et al. (2019)


Increasing temporal separation
Complementarity
b
Global
a
Co-existence at
regional level
ci
Synergy
cii
Increasing spatial separation

EU MIXED project - Field testing strategies for increased integration - on farm/station

2.4a sheep grazing winter cereals
Network Theme 1
NW Europe



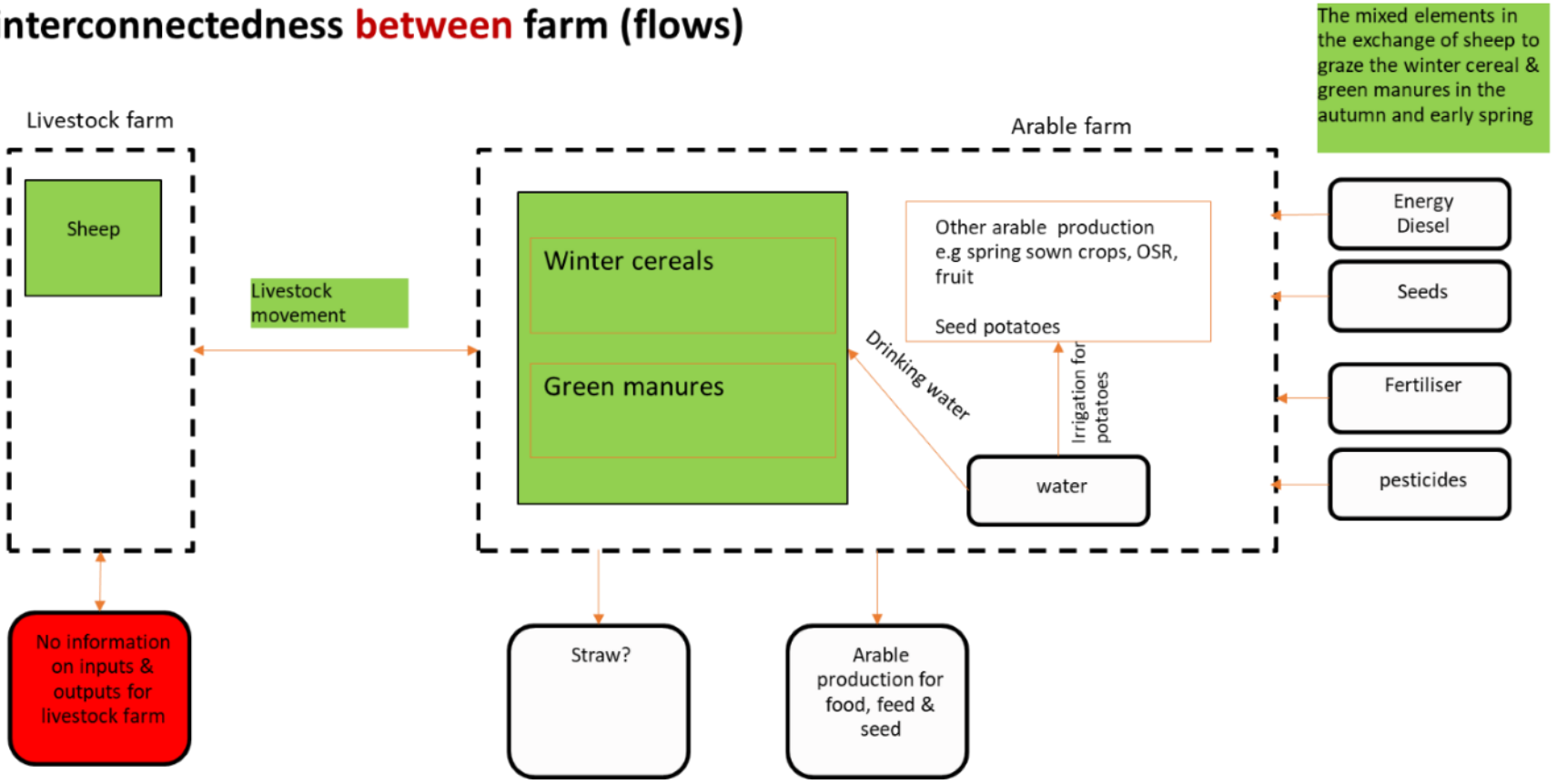
2.4b animal welfare and environmental impact of pigs/willow
Network Theme 1
N Europe

2.4c Conservation agriculture in Agro-forest-pastoral systems
Network Theme 2
SW Europe

2.4d Impact of hedgerows on arable productivity
Network Theme 3
E Europe

Example of Nutrient and energy flow diagram

Scotland Winter grazing of cereal by sheep - interconnectedness between farm (flows)



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Sheep grazing winter cereals for winter fodder and soil quality UK

March 2021

June 2021

Hypothesis: Grazing of winter cereals can provide a valuable late winter feed source for ruminants, as well as maintain acceptable grain and straw yields, while maintaining soil “health”

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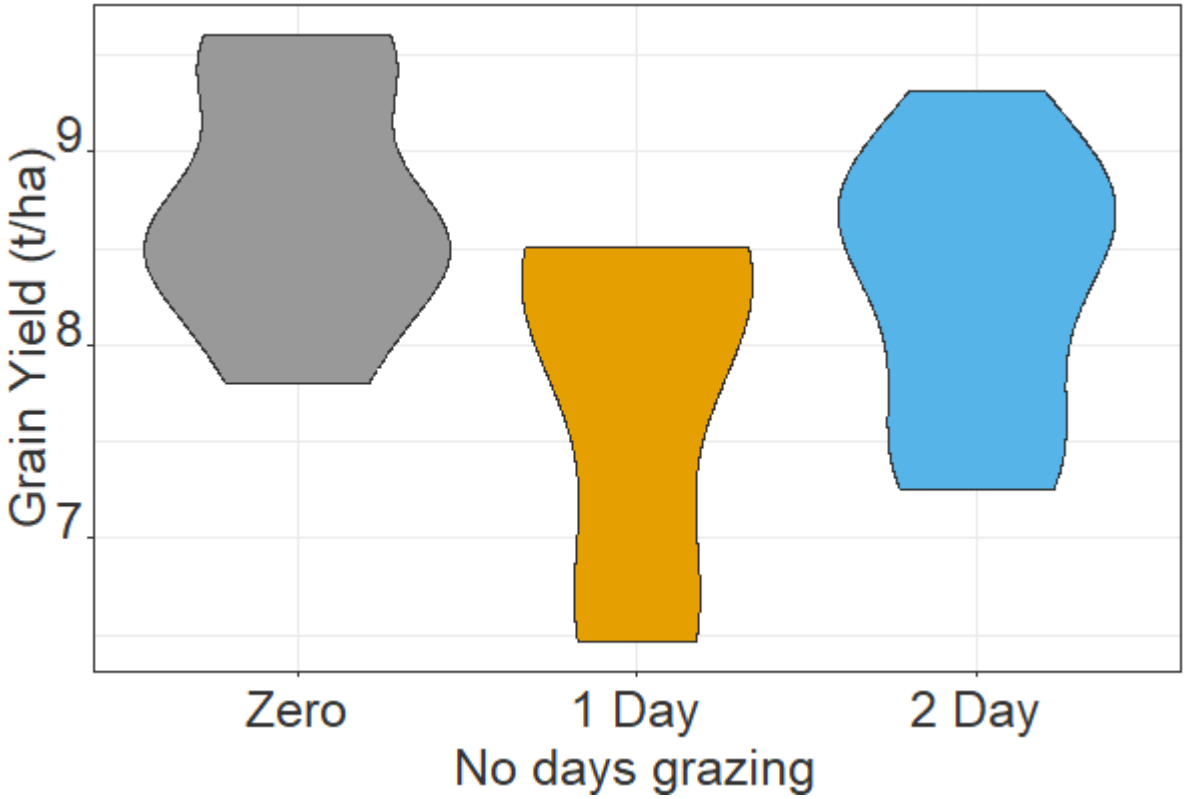
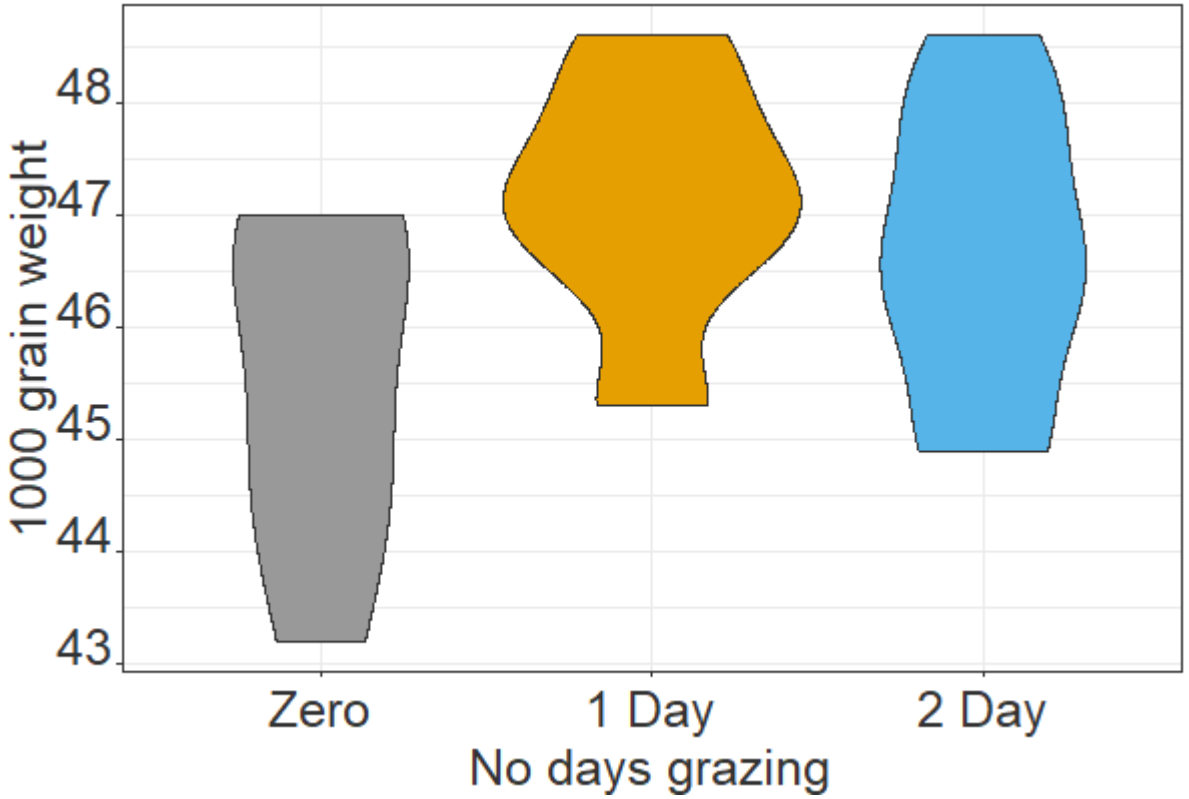
Grain yield & Quality

Winter barley Scotland 2021 (SG)
Average yield 8.08 t/ha
11% total crop production
57% malting, 35% animal feed

Winter barley Auchnagatt (AHDB)
Average yield 7.95 t/ha





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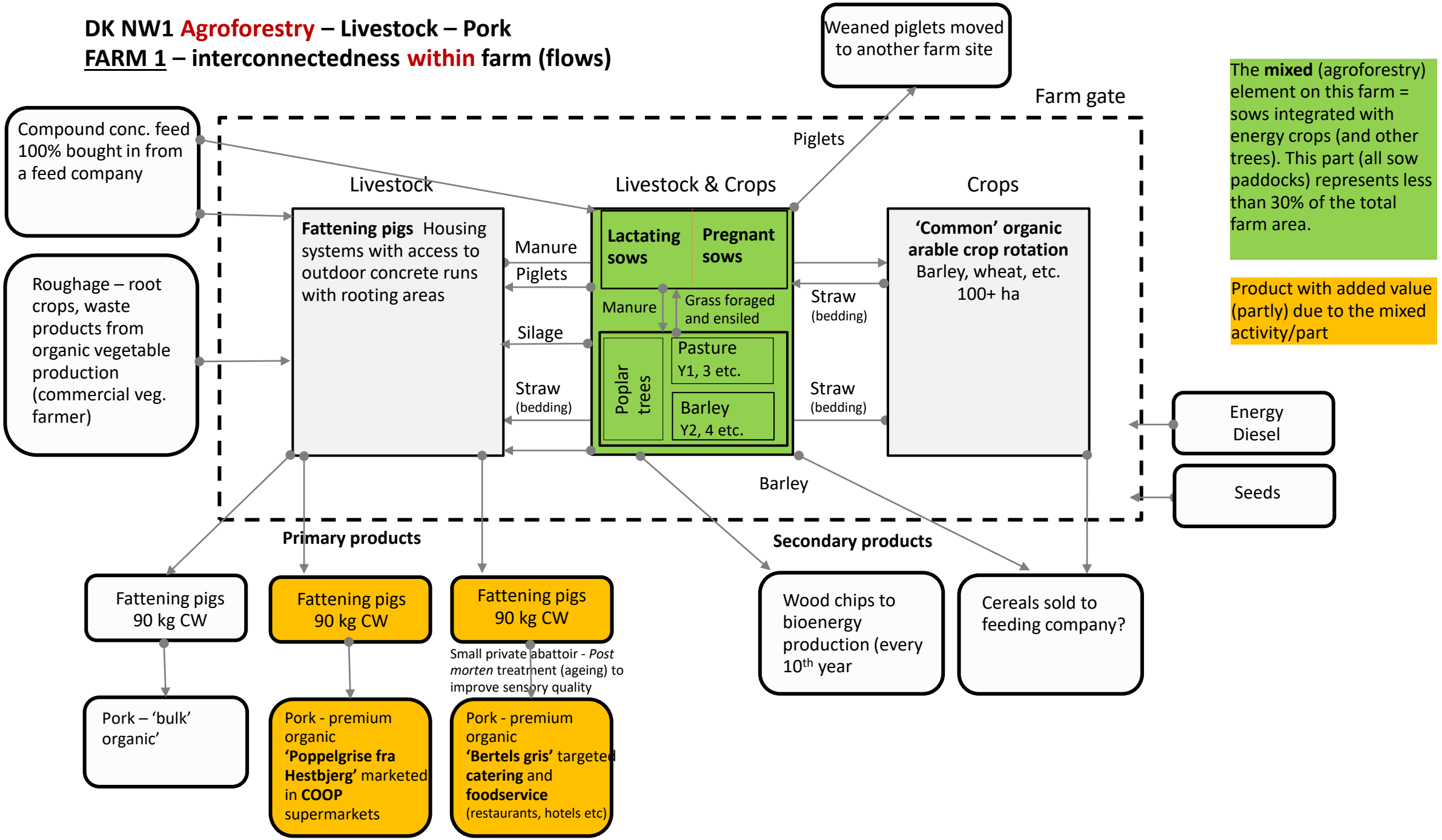
DK NW1 Agroforestry – Livestock – Pork
FARM 1 – interconnectedness within farm (flows)



The **mixed** (agroforestry) element on this farm = sows integrated with energy crops (and other trees). This part (all sow paddocks) represents less than 30% of the total farm area.

Product with added value (partly) due to the mixed activity/part

Integrating pigs and energy crops DK

- **Aim to reduce nutrient losses and improve animal welfare in pasture-based pig systems**

- Experimental system and design
  Willow, Salix sp.(2019; 6,370 trees/ha)
- Pruned in February 2022 (approx. 15 cm)
- Production period
  21. april-30. June,2022
- 4 groups of low density
  (100 m^2 paddock/pig)
- 4 groups of high density
  (50 m^2 paddock/pigs)

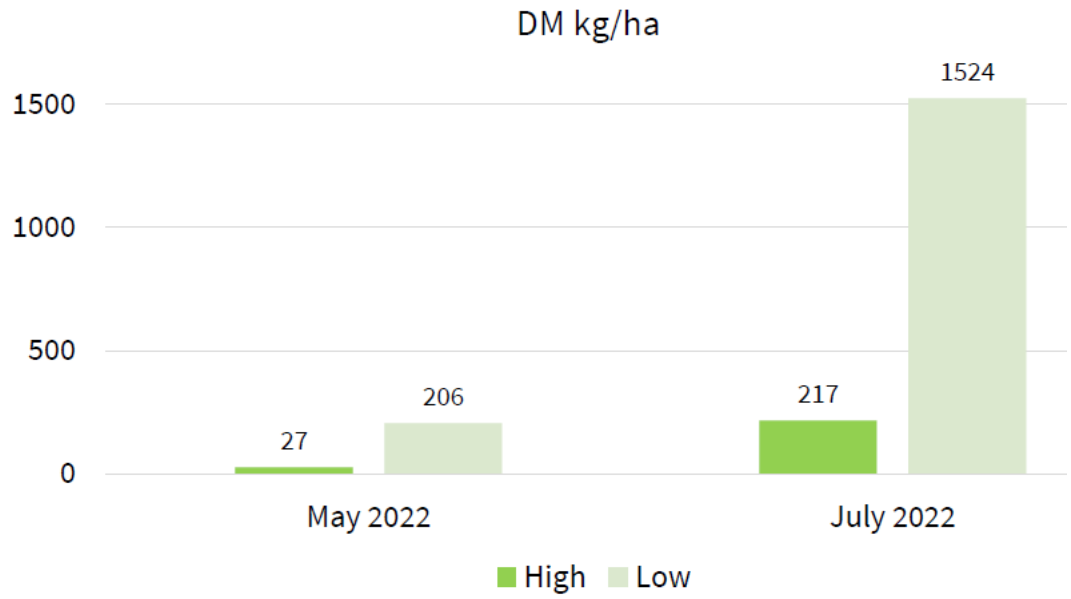
Pig performance and tree regrowth

Pig performance

	High density	Low density	Organic pigs DK, 2021
N	24 pigs	12 pigs	28 herds*
Initial LW, kg	31	31	30
Final LW, kg	111	111**	115
Daily gain, g	1,153	1,158**	920
Meat%	62.1	62.3	61
Feed conversion F:G (compound feed), kg	2.5	2.5	2.8

* With a median of 3,379 fattening pigs/farm/year
** One pig euthanized at day 63 included

Willow regrowth

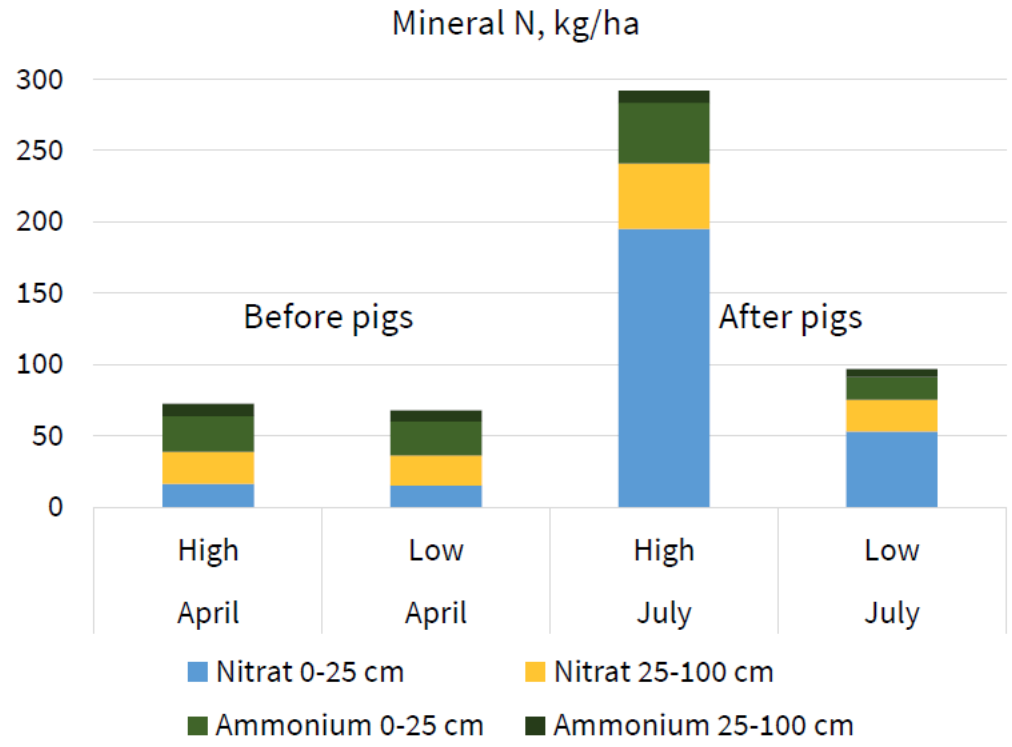


Horizon 2020 Programme

AARHUS UNIVERSITY

Denmark continued

Mineral N in the soil



Key findings

- Very high pig performance is achievable in this novel mixed farming concept.
- Stocking density is key for the willow regrowth and for the potential risk of nitrogen losses.
- The willow paddock supports natural behaviours such as rooting, browsing and natural shade

A mixed concept combining fattening pigs and willow during the summer supports high pig performance, animal welfare, and nutrient recycling.
However, further regulations standards need to be developed to encourage implementation.

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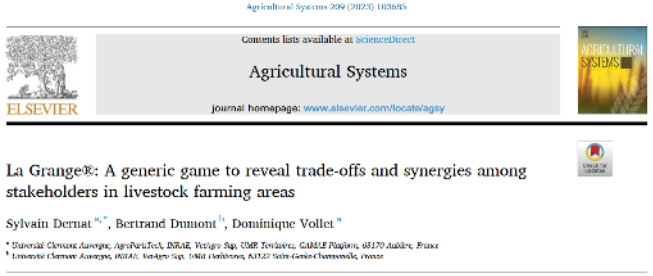
Using “La Grange” to understand, discuss and redesign systems

Baseline situation in the Scottish case. Land use is as follows; purple: potatoes, dark green: permanent pastures, light green: temporary pastures, orange: oat and barley, grey: oilseed.

Alternative configuration relying on a reduction in livestock numbers in the Scottish case


Contents lists available at ScienceDirect

Agricultural Systems

journal homepage: www.elsevier.com/locate/agsy

La Grange®: A generic game to reveal trade-offs and synergies among stakeholders in livestock farming areas

Sylvain Dernat, Bertrand Dumont, Dominique Vollet

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Take away thoughts

- Integration of crops and livestock can occur within and between farms in the landscape.
- “Nutrient conservation” is a key feature of Integrated Crop Livestock Systems (ICLS).
- Functional complementarity – technological progress may aid system design and advantages e.g. grain and graze.
- Outcomes of interactions between crops and livestock can include water use efficiency and biodiversity.
- Need to think about policy support for systems supporting multiple functions.
- For mixed systems between farms, you need socio-economic interactions but not all socioeconomic interactions result in biological resource use efficiency.

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THANK YOU!

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