



Welcome to our trans4num.eu T3.4 Hackaton 2026

with team-players from many countries around the world!



By Tommy Dalgaard, Morten Graversgaard, Nele Lohrum, Trine Molin, Mette Vestergaard Odgaard, René Gislum, Maria Vesterdal, Morten Winter Vestenaa, Hanna Frick, Anton Rasmussen, Pia Strunge Folkmann, Elena Claudia Ion, Markéta Kollerová, Filip Leitner, František Zadražil, Karel Charvat, Tomas Mildorf and many others

Aarhus Institute of Advanced Studies, and hybrid, 22-23 October 2026



Programme

Day 1 – Explore & Create | 22 October

09:30-10:00: Registration and coffee

10:00–12:00 | Plenary session <https://teams.microsoft.com/meet/3736039687552142?p=MU8a1pxVSURuTadigz>

- 10:00 - 10:10 Welcome and introduction - Tommy Dalgaard
- 10:10 - 10:30 Inspiration from Nature-Based Solutions: Background & Vision - Morten Graversgaard & Tommy Dalgaard
- 10:30 - 11:00 The Limfjord challenge - Morten Winther Vestenaa & Morten Graversgaard
- 11:00 - 11:10 Canvas & Future landscape concept introduction - Markéta Kollerová
- 11:10 - 11:30 Introduction to the toolbox - Morten Birk & Filip Leitner
- 11:30 - 11:45 Extra tool - video by Geoffrey Groom
- Introduction to other possible materials - Tommy Dalgaard et al.

12:00–13:00 | Lunch

13:00–16:00 | Team work

- Explore the challenge
- Develop your future landscape
- Use the available tools and information where useful
- Discuss feasibility, impacts and implementation

Programme

Day 2 – Present & Reflect | 23 October

10:00–11:30 | Team presentations

- 8-minute presentation per team (5-10 teams)
- 2 minutes for questions

Around 11:30–12:00 | Jury deliberation & closing

- Jury discussion

12:00–12:30 | Lunch

12:30-13:00 | Award ceremony and concluding remarks

- Reflections
- Wrap-up



Design the Future Landscape of the Limfjord

22–23 October 2026 Aarhus, Denmark

[https://event.au.dk/
events/trans4num-
hackathon/](https://event.au.dk/events/trans4num-hackathon/)



WHY JOIN?

**Bring your perspective.
Challenge assumptions.
Design the future.**



Work in
interdisciplinary teams



Explore innovative
and realistic solutions



Get input from experts
and access to digital tools



Make a real contribution
to a sustainable future

You don't need to be a
programmer or an expert in
agriculture! Just be curious,
creative and open-minded!

THE CHALLENGE

**How can we continue to produce
food while also taking care of
the aquatic environment?**

Your task is to design a future agricultural
landscape for the Limfjord region that can:



Reduce nitrogen losses



Maintain productive and
economically viable farming



Improve biodiversity



Contribute to climate
mitigation and adaptation



Integrate Nature-Based Solutions



Be realistic and acceptable
for farmers and society

ABOUT TRANS4NUM

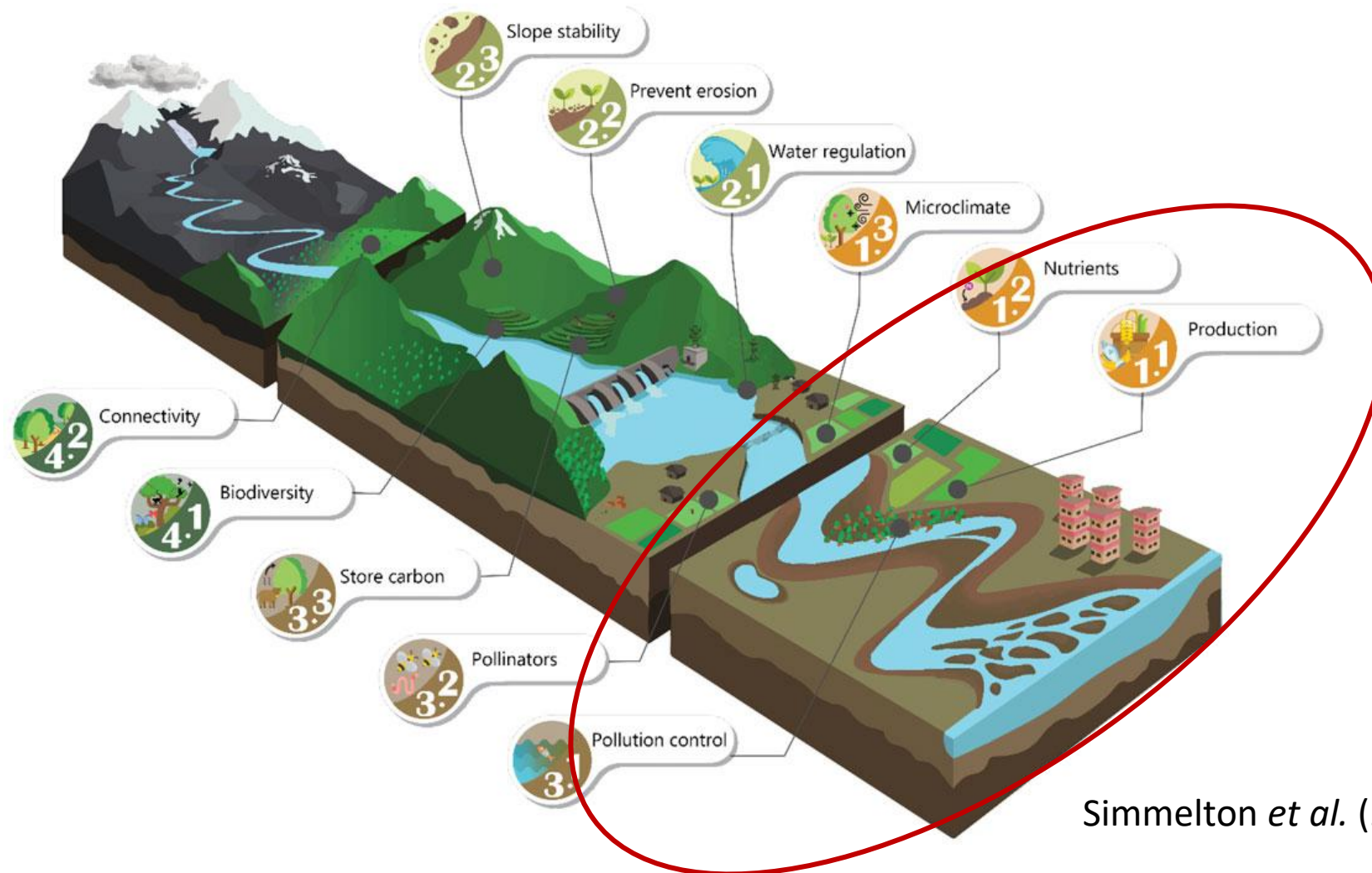
trans4num - Transformation for sustainable nutrient supply and management - is an EU-funded project exploring how Nature-Based Solutions can contribute to more sustainable nutrient management practices in agriculture.

The project works across European demonstration sites, including the Limfjord catchment region in Denmark.



Nature-based Solutions in focus

- Nutrients,
- Production,
- Pollution control
- related NBS in the agricultural system



Simmelton *et al.* (2021), Dalgaard *et al.* (2024)

trans4num.eu NBS cases

Examples on promising NBS cases	Trans4num site of implementation
Grass production with novel crop rotation for biorefinery purpose	Denmark, Limfjorden area
Crop rotation and plant-based fertilisers	Netherlands, Kollumerwaard
Plant-based fertilizer and natural crop protection	Netherlands, Kollumerwaard
Plant-based fertilizer obtained from crops in the crop rotation	Netherlands, Kollumerwaard
Lucerne and grass-clover pellets for fertilising winter wheat	Netherlands, Ebelsheerd
Grass-clover mixtures in rotation with organic winter wheat	Netherlands, Ebelsheerd
Multiple NbS in combination	Hungary, Szigetköz
Novel biobased fertilisers on crop and grass-clover ley production	United Kingdom, Devon
Multiple NbS in combination	United Kingdom, Harpenden

- Crop-rotations
- (incl. extensive grassland)
- Biobased fertilizers

Graversgaard *et al.* (2023) D1.3, D2.1

Why? How? for Whom? What and Where?

Decision support Objectives

- Develop a dynamic and smart nutrient management decision support tool (DST) for optimum nutrient supply at farm, regional and watershed level.

Nature-based solutions (NbS) in agriculture are cost-effective interventions that can improve ecosystem functions of landscapes while enhancing resilience in agricultural food production [1,2].

[1] Iseman, T., & Miralles-Wilhelm, F. (2021). Nature-based solutions in agriculture: The case and pathway for adoption. Food & Agriculture Org..

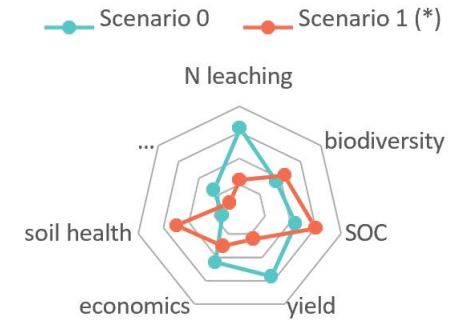
[2] Simelton et al. (2021). NBS framework for agricultural landscapes. Front. Environ. Sci., 9, 678367. <https://doi.org/10.3389/fenvs.2021.678367>

Why? - background

- Existing DSTs focus either on **farm level or regional** questions.
- In order to **close nutrient cycles** and make nutrient management more sustainable, **collaboration** beyond farm level is necessary.
- Environmental problems such as nitrate leaching require **regional solutions**.

HOW? – concept and approach

- **Spatially explicit**, incl. use of crop data from remote sensing with **satellites**
- Integration beyond farm level: **collaboration and exchange of nutrients** between farmers and bioindustry is facilitated
- Consider **multiple criteria** and visualization of **trade-offs and synergies**
- **Optimization model** for allocation of NbS.
- Development and visualization of **scenarios**
- Calculation of **regional nutrient balances**



FOR WHOM? –target users and their needs

Farmers

Farmers are mainly focussing on optimizing their fields and farm, often without regional or environmental perspective.

Bioindustry

Visibility and coordination of exchange of biomass and nutrients with farms.

Advisors

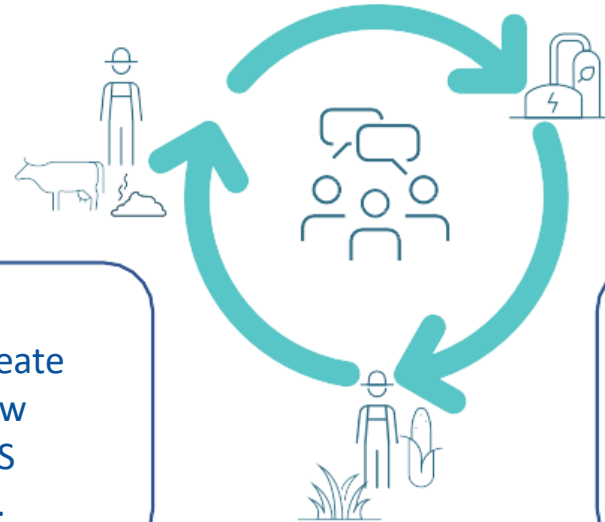
Cannot easily create scenarios to show outcomes of NbS implementation.

Regional planners and authorities

Lack of data to make informed decisions about future nutrient regulation.

Community

Market place for exchanging nutrients or biomass between farms or bioindustry.

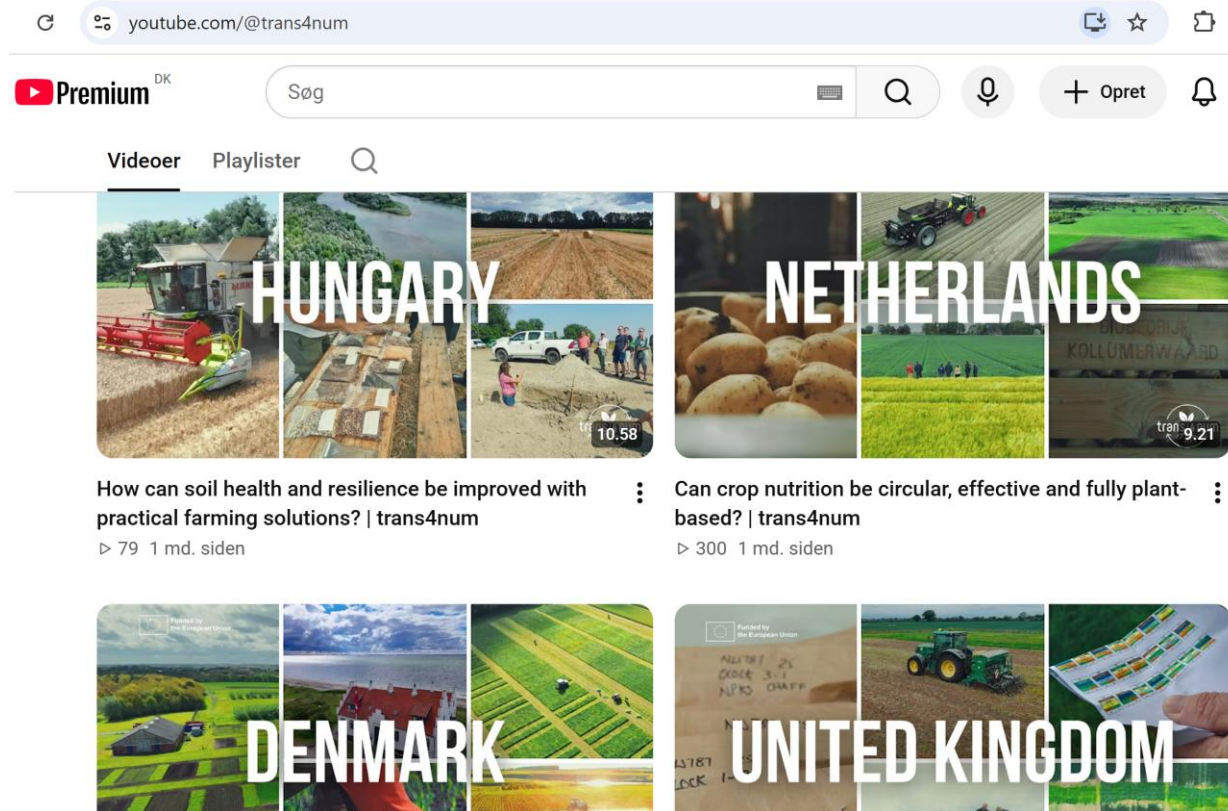


Thank you for your attention –
questions?



Additional materials

- https://www.youtube.com/watch?v=1trX4_612oE



<https://www.youtube.com/watch?v=6SfhGMkn5DY>

Additional materials

- Agent-based modelling results
- Satellite-based observations

Integrated Remote sensing and machine learning modeling of crop productivity and ecological risk for the sustainable agriculture in the Limfjord catchment, Denmark

Komal Choudhary, Mette Vestergaard Odgaard, Tommy Dalgaard

¹Pioneer Center Land-CRAFT, Department of Agroecology, Aarhus University, C. F. Møllers Allé 4, Building 1171, Aarhus 8000, Denmark

Abstract

The Limfjord basin is a heterogeneous agricultural region characterized by high crop production, dense hydrology, and fragile coastal environments. This research develops an integrated remote-sensing and machine-learning outline to create a new essential result at farm to sub catchments levels such as early crop yield prediction, biomass maps, irrigation mapping and detection, agricultural land suitability maps, and ecological risk assessments for sustainable ecosystems. Our results will support water management, precision agriculture systems, and ecology protection across the Limfjord catchment. By providing spatial precise maps, time series indices, and a consistent processing pipeline for transparent and interoperable datasets which align with INSPIRE principles.

Keywords

Heterogeneous agricultural, Remote-sensing, Machine-learning, sustainable ecosystems.



Who delivers the grass? An agent-based model of grass-clover for green biorefining in the Limfjord catchment

Background material for the trans4num INSPIRE Hackathon, Aarhus, 22–23 October 2026
Anke Möhring¹, Christian Grovermann², Mette Vestergaard Odgaard³, Tommy Dalgaard²

¹Research Institute of Organic Agriculture FIBL, Switzerland. ²Aarhus University

The challenge

The Limfjord receives more nitrogen from its catchment area than good water quality allows. One option being discussed in the region is replacing part of the arable crop rotation with a grass-clover mix. A perennial ley leaches much less nitrogen than cereals, maize or potatoes. However, the grass needs an outlet: a green biorefinery could process it into a protein concentrate for animal feed. The residues, such as the fibre fraction and the brown juice, could then be used to produce biogas. Whether this works across the landscape depends on farmers' decisions and processing capacity, which influence each other. This is what our model simulates.

What is an agent-based model?

An agent-based model (ABM) is a computer simulation in which individual decision makers, the agents, are represented explicitly. Each agent has its own attributes, follows simple rules and reacts to its environment and to other agents. Patterns such as the speed of adoption or the location of processing plants are not prescribed; they emerge from the decisions of farmers and processors and their interactions. ABMs are therefore well suited to answering "what-if" questions, such as what would happen if a payment were introduced or if processing plants could source grass from further away. Our model does not forecast the future in absolute terms; it assesses scenarios ex ante, and the information lies in the comparison between them.

ADAPTES: our model of the Limfjord catchment

ADAPTES covers the sub-catchments 157 and 158 in Northern Jutland (2,621 km², 416 parishes). It is built on the Danish field and farm registers: 57,422 fields belonging to 2,426 farms, of which 23,111 fields are suitable for grass-clover. The agents are farmers and processors. Decisions are taken field by field, because two fields of the same farm can differ in their distance to a plant. Every four years, each farm agent goes through four questions for each field (Figure 1). A farm agent becomes willing to convert a field only if three conditions hold together: the field is suitable and within reach of a processor, grass-clover is more profitable than the current rotation, and enough neighbours have already converted to meet the farmer's adoption threshold. Innovators start first; the late majority waits. These adopter types are estimated from farm characteristics. A biorefinery opens at one of the 55 existing biogas sites once enough fields of willing farms lie within its trading radius to supply at least 20,000 t of fresh grass per year. The model runs for 28 simulated years. Each scenario is repeated 100 times, because prices and yields are drawn at random in each period. The scenarios vary the processing route (biorefinery with biogas, or biogas only), the trading radius of the plants (5, 10 or 20 km) and an area payment for grass-clover (0, 100 or 200 EUR per hectare and year) (Möhring et al., 2026).

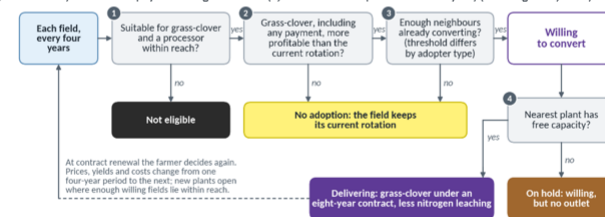


Figure 1: Decision steps for each field in each four-year period (simplified). The colours of the outcomes are those of the maps in Figure 2.

What the model shows

Figure 2 shows the status of every field at the end of one simulation run; Figure 3 summarises 100 runs at a payment of 200 EUR per hectare. Five results stand out.

1. **Willing is not the same as delivering.** In every scenario, more farmers are willing to convert than can deliver. At a trading radius of 20 km, farm agents are willing to convert 6,729 fields, but only 3,801 deliver, because the nearest biorefinery plant has no free capacity or none is within reach (Figure 3a). Doubling the capacity of each plant raises the number of delivering fields by 53 %.
2. **Many medium plants do better than a few large ones.** At 10 km, 16 plants convert 35,719 ha; at 20 km, 11 plants with larger sourcing areas convert 28,050 ha (Figure 3b). This difference appears only with a payment of 200 EUR per hectare.

Source: Möhring, A., Grovermann, C., Chaitoglou, A., Möller, A., Vestergaard Odgaard, M., Grønborg, M., Rasmussen, A., Winther Vestenaa, M., Strunge Folkmann, P., Dalgaard, T., Wilcock, S., 2026. Map on value-chain level impacts of NRE across scenarios Deliverable No. D4.3. trans4num, FIBL, Switzerland. Contact: Anke Möhring, FIBL, anke.moehring@fibl.org. trans4num has received funding from the European Union's Horizon Europe research and innovation programme under Grant Agreement No. 101081847.

3. **Grass-clover pays only narrowly.** Without a payment, it earns 55 to 74 EUR per hectare and year more than the arable rotation, and few farmers are willing to convert. At 200 EUR per hectare, about a third of the delivering fields depend on the payment.
4. **Contract renewal is a critical moment.** The converted area reaches its final level after about twelve simulated years, when the first eight-year contracts expire. From then on, supply rises and falls, because farmers decide again at each renewal.
5. **A contribution, not the whole solution.** In the best scenario, grass-clover reduces the nitrogen load by about 280 t per year, about 15 % of the 1,815 t per year required in the two sub-catchments. The biogas route converts far less land, because Danish law caps energy crops at 4 % of the input of a biogas plant.

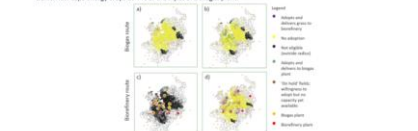


Figure 2: Status of every field at the end of one simulation run (simulation years 25 to 28), at 200 EUR per hectare. Top: biogas route, (a) with and (b) without the energy crop cap. Bottom: biorefinery route with a trading radius of 5 km and 20 km. A small radius leaves most fields out of reach (black), a wide radius reaches most fields, but many do not convert or find no free capacity. One run only: the maps show the spatial pattern, not the quantities.

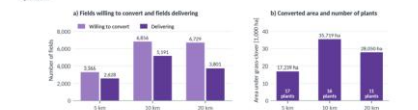


Figure 3: a) Fields that farm agents are willing to convert and fields that deliver, and b) converted area and number of biorefineries, by trading radius, at 200 EUR per hectare. Numbers of 100 runs at the end of the simulation, numbers of different quantities do not add up.

Save the Limfjord: where could farmers work together?

The model contains no cooperatives: every farmer decides alone, and supply groups only form around plants. Its results nevertheless show where collaboration could make a difference.

- **Pooling supply.** A plant opens only when enough grass is available within reach. Neighbours who convert together could make a plant viable earlier.
- **Learning from neighbours.** Most farm agents convert only after some neighbours have done so. Visible early adopters make it easier for others to follow.
- **Organizing transport jointly.** Lower haulage costs, as with contracted lorries instead of tractors, raised the converted area by 54 %, without public money.
- **Planning contracts together.** When many contracts end in the same year, supply drops at once. Permanent contracts raised the converted area by 44 %, staggered start dates (not simulated) would spread the risk.

Questions for your team

- Which constraint would your landscape design tackle first: profitability, processing capacity or reach?
- How would a farmer cooperative change the decision steps in Figure 1?
- Where in the catchment would you place a plant, and how large should it be?
- Which benefits of grass-clover, such as biodiversity, soil carbon or climate resilience, do you think should be a priority when considering further development of the ABM?

Source: Möhring, A., Grovermann, C., Chaitoglou, A., Möller, A., Vestergaard Odgaard, M., Grønborg, M., Rasmussen, A., Winther Vestenaa, M., Strunge Folkmann, P., Dalgaard, T., Wilcock, S., 2026. Map on value-chain level impacts of NRE across scenarios Deliverable No. D4.3. trans4num, FIBL, Switzerland. Contact: Anke Möhring, FIBL, anke.moehring@fibl.org. trans4num has received funding from the European Union's Horizon Europe research and innovation programme under Grant Agreement No. 101081847.



What and where?

Crop rotation change: more perennial grass; biorefinery



Plant-based nutrient pellets for winter wheat fertilization



Straw/grassclover mulch in seed potato production



«Regenerative agriculture»; crop rotation; compost



Bio-based fertilizer from abattoir by-products



Diversified crop rotation; bio-based fertilizers; no till



