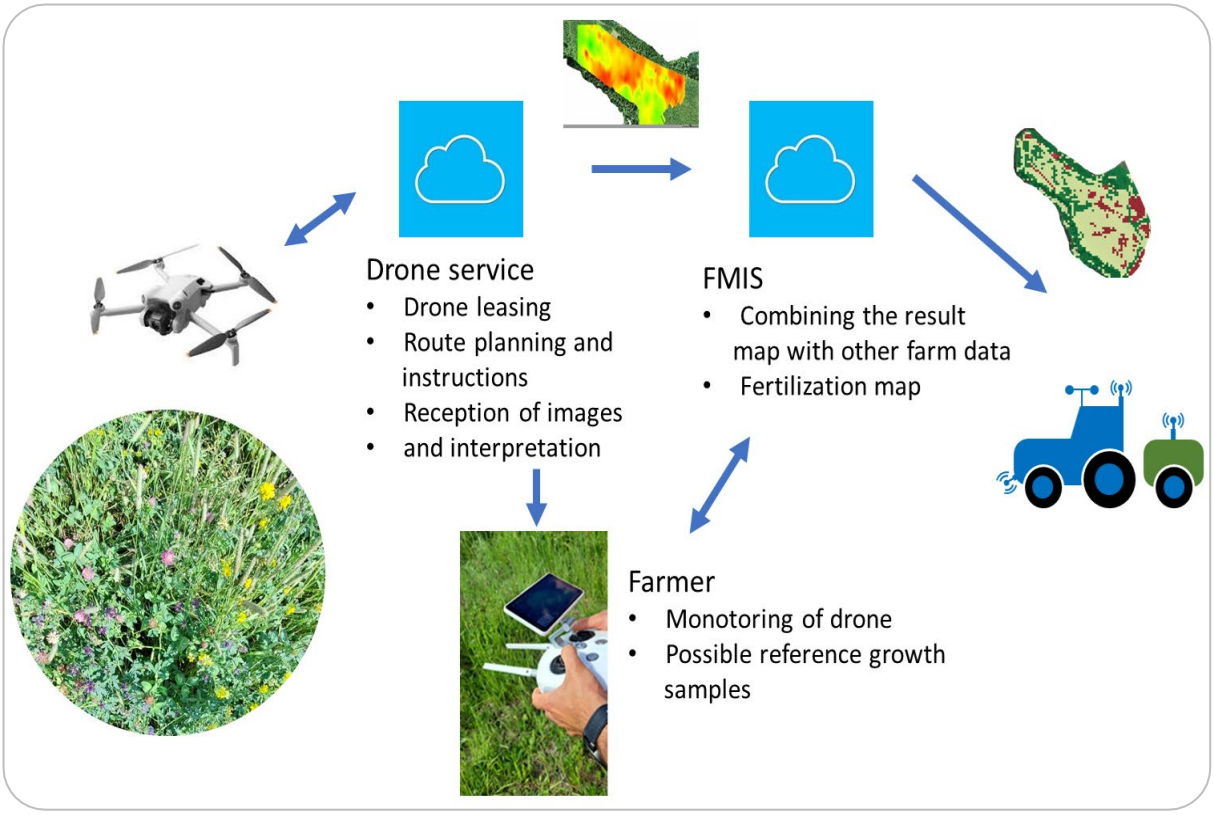
UAV-based fertiliser mapping

Technology fact sheet

What is UAV-based green fertiliser mapping?

Green fertiliser mapping aims to quantify the nitrogen fixed by legume plants in the field to help farmers optimise fertiliser use. To do this, an unmanned aerial vehicle (UAV), also known as a drone, is flown over a field at different altitudes to take images. The images are used for various purposes: those of the entire field, taken at a higher altitude, can be used for biomass estimation, while low-altitude images aid in estimating the growth density of legume plants by using AI-assisted recognition to count their flowers. The amount of fixed nitrogen at a specific site is then calculated using mathematical models adjusted for different types of legume plant. To validate the biomass estimation, some samples are also measured manually for reference. Green fertiliser mapping can be offered as a service to farmers, where the role of the farmer is to take a leased drone to the target field and oversee its safety during flights; the rest is done automatically. The service concept was developed in response to the growing need for integrating green fertilisers into precision farming. While the concept of green fertiliser mapping is new, it combines several well-known technologies. The service described here, however, is not yet available on the market.



UAV-based green fertiliser mapping. The service, consisting of a drone for taking images of the field and a cloud system for estimating the amount of green fertiliser, helps farmers optimise fertiliser use. Figure credit: Liisa Pesonen.

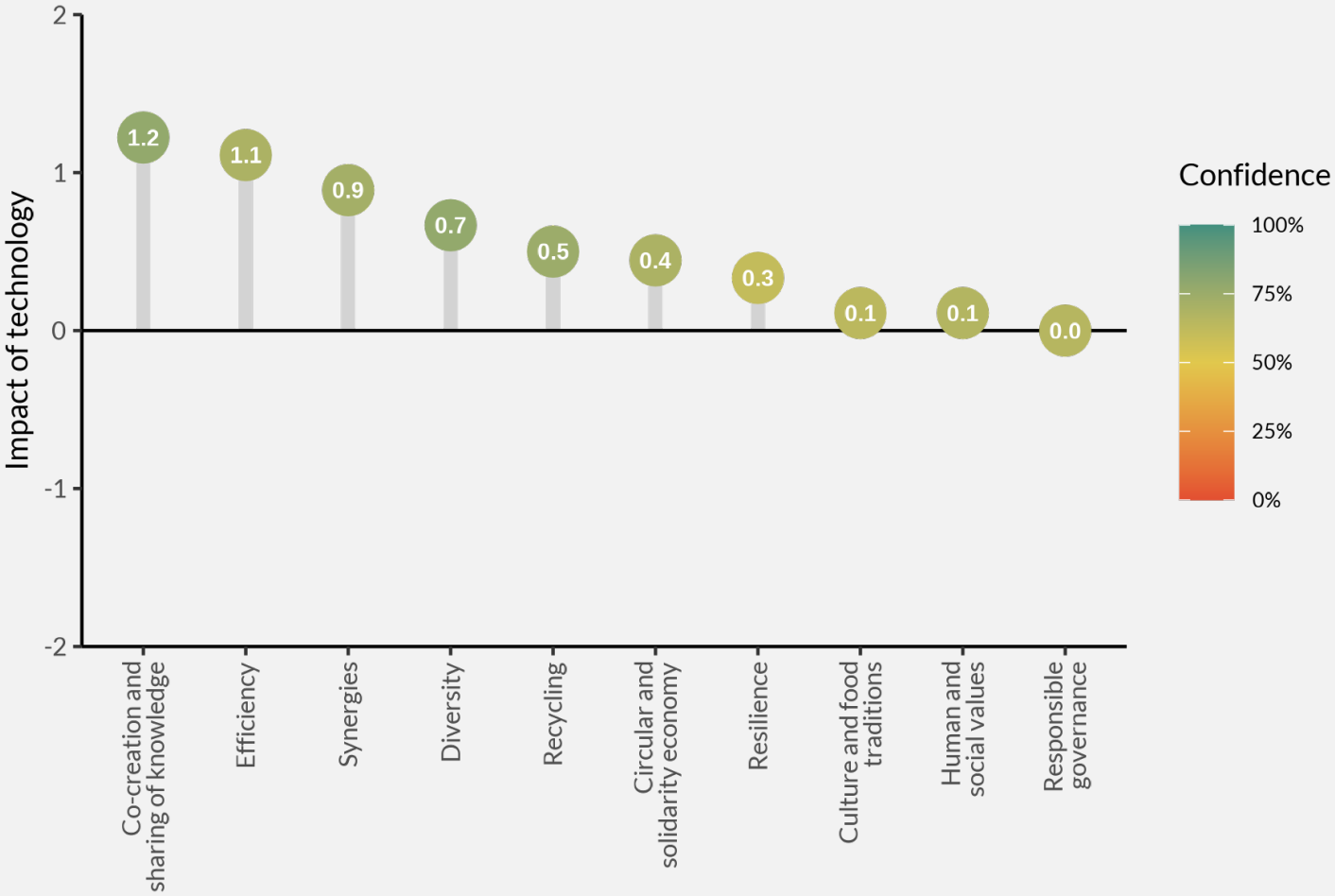
What is agroecology?

Agroecology is broadly defined as a way of managing food systems more sustainably by following different environmental, economic and social principles. The assessment here is based on the **Food and Agriculture Organization's 10 elements of agroecology**, one of the most important recent frameworks for agroecology.

DIGITALISATION FOR AGROECOLOGY

Agroecological performance

The figure below shows how UAV-based fertiliser mapping affects the FAO's 10 elements of agroecology, based on discussions between farmers, academics and digitalisation experts during our workshop. The height of each bubble represents the average impact ranging from strongly negative (-2) to strongly positive (+2), with the exact score inside the bubble. The bubble colours reflect how confident participants were in their evaluations on average (0% - not confident at all, 100% - highly confident). Note that the figure only shows averages and does not reflect variation in individual assessments.



Examples of potential effects on agroecology

As shown in the figure above, the potential impacts of green fertiliser mapping on agroecology vary from largely positive to neutral. By using crowdsourcing to teach AI algorithms used in drone image analysis, the technology can support the **co-creation and sharing of knowledge**. However, it is important that data be used with farmers' consent and that farmers are included in the development of the service. Since green fertiliser mapping can be used to optimise fertiliser use, it has the potential to increase the **efficiency** of farms. It could also be used to map weeds, allowing for precision application of herbicides. In addition, by encouraging the use of green fertiliser in crop rotation, the technology can support new business concepts like 'carbon farming'. The data collected by the drones could be used for multiple purposes, including documenting biodiversity and quantifying of ecosystem services, thereby supporting **synergies** between different tasks. **Diversity** can also be boosted by the promotion of green fertiliser, which can lead to more grass, flowers, and pollinators in the landscape. Importantly, the impact here depends on how the farmers use the collected data. Information provided by the drones can help to improve soil quality and protect fields against extreme weather events, boosting **resilience**. It also makes it possible to identify safe crops for cultivation site-specifically. The effects on **human and social values** are likely to be more moderate, as green fertiliser mapping can streamline work and improve efficiency but may not provide other significant benefits. Regarding **responsible governance**, the technology can be used to verify regulations on land use or farmer subsidies based on cultivation practices. However, further discussions and transparency must ensure that the technology is used appropriately.

Why does digitalisation matter?

Agriculture in Europe and globally is digitalising rapidly. While digital tools often aim to enhance farming efficiency, they bring a variety of environmental, economic and social effects ranging from changes to fertiliser use to data privacy. Digitalising agriculture can therefore enable a sustainable transition and boost the resilience of food systems, but it also introduces new challenges and risks.

OPPORTUNITIES 🚀

- The technology has broad applications, such as weed mapping or documenting biodiversity, which can support new business approaches, ecosystem services and subsidy verification
- It can help to increase the efficiency of farms and avoid nutrient leaching
- The technology can help farmers gather more information about their fields, allowing to identify potential problems and boost resilience

CHALLENGES 🧩

- While the service is based on leasing, the technology concept is new and unknown factors may emerge regarding recycling
- Data collected by the drones needs to be protected and used appropriately, while both AI algorithms and data may sometimes need to be verified
- Governance can hinder the service concept if it is overly prescriptive and limiting

Workshop context

Importantly, the results in this fact sheet reflect the regional context of our assessment. The workshop to evaluate green fertiliser mapping was held in The Knehtilä Farm, in Hyvinkää, Southern Finland on 16 February 2024. The Knehtilä Farm, which is part of the Palopuro agroecological symbiosis, is an organic crop production farm using digital technologies. The impact of green fertiliser mapping on agroecology was evaluated by various participants representing education, research, policy, farmers and NGOs. The farmers at the workshop represented regenerative or organic crop production farms, and most of them had experience with precision farming. Since cereal production is typical in the area, this farming system was the focus of the assessment.

Luke LUONNONVARAKESKUS

BOKU UNIVERSITY

D4AgEcol DIGITALISATION FOR AGROECOLOGY

This project has received funding from the European Union's Horizon Europe research and innovation programme under grant agreement No. 101060759. The project is co-funded by UK Research and Innovation (UKRI Reference No. 10037994). The views and opinions expressed here, however, are those of the authors only and do not necessarily reflect those of the European Union, the Research Executive Agency or UK Research and Innovation. The European Union, the Research Executive Agency or UK Research and Innovation cannot be held responsible for them. The authors of this fact sheet may not be held liable for any consequences arising from the use of the information contained in the fact sheet.

Funded by the European Union