Precision fertiliser application

Technology fact sheet

What are nitrogen sensors?

Nitrogen sensors can be used to estimate the amount of nitrogen needed in different parts of the field and thereby help farmers optimise fertiliser use. The sensors are mounted on the roof of a tractor and connected to a terminal in the driver's cab. As the tractor drives across the field, the sensor quickly and with a high spatial resolution records the crop biomass based on its light reflection properties. The newer sensors also have their own light source, making it possible to use them at any time of day. The data collected by the sensors and specific algorithms are then used to calculate the exact amount of fertiliser needed at any given site based on the crops' specific nitrogen requirements. The specific technology assessed here was developed by Yara, a company that was founded in Norway in 1905 and primarily focuses on fertiliser production. Nitrogen sensors can be used in most common crops in arable farming and grassland, as well as in some speciality crops such as asparagus or cherry, among others.

Tractor equipped with the Yara nitrogen sensor. Mounted on the roof of the tractor, these sensors measure nitrogen content in the crop and allow for site-specific nitrogen application. Photo credit: Yara International ASA.

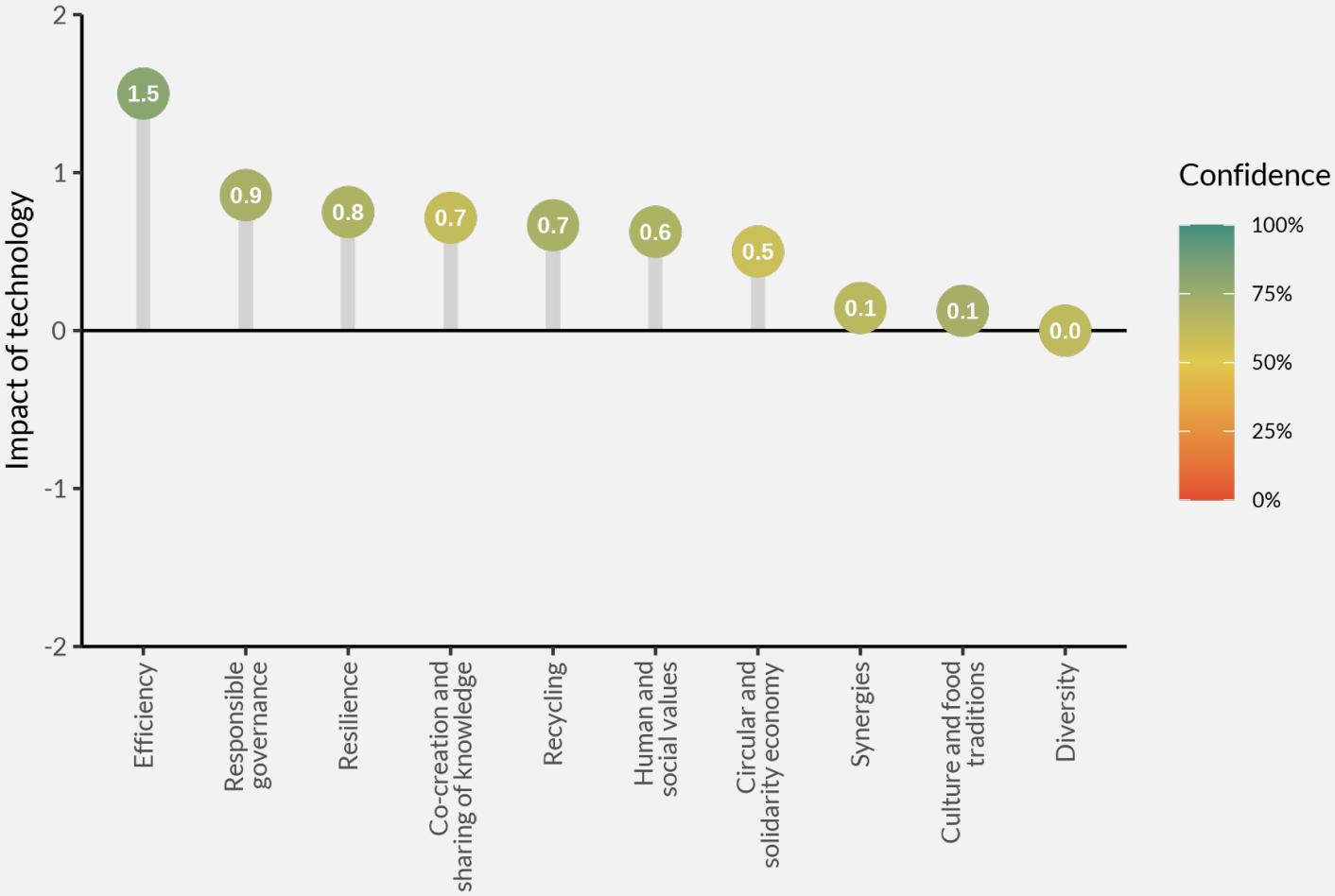
What is agroecology?

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 the Yara nitrogen sensor 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

The overall expected impacts of the nitrogen sensor on different elements of agroecology vary. By helping to optimise fertiliser use, the sensors are likely to have the greatest positive impact on **efficiency**. In addition to reducing fertiliser inputs, the sensor can contribute to more uniform crops, improved soil nitrogen balance and higher yields, among other benefits. Regarding **responsible governance**, the sensor could make it possible to determine the needs of farmers and adapt regulations accordingly. On the downside, legal requirements can also limit needs-based fertilisation and the potential of the technology. By lowering fungal pressure through optimal nutrient supply, reducing lodging or leaching in heavy rain, and stabilising farmers' incomes, the technology can increase the **resilience** of farms. If the farmer owns all the data collected by the sensor and manufacturers respond to users' requirements, the technology can boost the **co-creation and sharing of knowledge**. In practice, however, these effects can be limited due to sparse connections between farmers and other relevant actors. The sensors are produced in Germany and can be easily repaired by the manufacturer, while the software is supported for a long time, reinforcing the principle of **recycling**. At the same time, the servers used by the technology also consume a lot of energy over time. The effects are likely to be mixed for elements like **cultural and food traditions**. Although the sensors can be used on traditional crop varieties, they must first be calibrated for that. This requires time and workers, as well as extensive data collection. While using the sensors can introduce new skills to farmers, it could also lead to alienation and loss of traditional knowledge.

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 🚀

- Nitrogen use efficiency can be improved in crop farm systems, which can lead to more even yields (increasing food security) and reduced income fluctuations
- The application is relatively self-explanatory and easy to use and can particularly motivate younger farmers
- The technology can be used in combination with other digital methods such as soil maps

CHALLENGES 🧩

- The costs for licenses and maintenance contracts are high
- Profits are maximized when single crops are cultivated, which would reduce the biodiversity and resilience of farms
- Ethical data use by manufacturers needs to be ensured, while farmers should not become overly reliant on technology and forget other useful skills

Workshop context

Importantly, the results in this fact sheet reflect the regional context of our assessment. The workshop to assess the Yara nitrogen sensor took place at the Leibniz Institute for Agricultural Engineering and Bioeconomy (ATB) Field Lab for Digital Agriculture on 19 June 2024. The 20-hectare experimental station in which the workshop was organised is located in Marquardt, Potsdam. Research at the field lab is specifically focussed on the use of novel digital solutions in agriculture. On the day of the workshop, the institute's current field trials and technology projects were presented to the public, followed by the workshop including participants from academia, technology development, and farming.

ATB

BOKU UNIVERSITY

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DIGITALISATION FOR AGROECOLOGY

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