Sowing and weeding robots

Technology fact sheet

What is a sowing and weeding robot?

Weeding robots are a subclass of field robots (autonomous agricultural vehicles working on the field) that are built and used for mechanical weed control. They usually travel along predefined tracks with the help of satellite navigation, some robots using camera systems with pattern recognition algorithms to distinguish between crops and weeds. Other systems, such as the FD20 by Farmdroid ApS, also sow and store the position of the seed to selectively hoe around it based on a satellite signal. In recent years, weeding robots have become somewhat common in (organic) horticulture and have spread to agricultural row crop production, both of which require considerable manual labour for weed control but also generate significant value. Examples include horticultural crops such as lettuce or onions or organic sugar beet cultivation in arable farming. Field robots have only been on the market for a few years. The Farmdroid FD20, which autonomously sows fine seeds (for example, sugar beet, rapeseed) and then performs hoeing for weed control, is one of such commercially available robots. A special state funding programme for farmers in Bavaria to invest in field robots has resulted in more than 60 of these robots being used already since 2020, primarily in organic sugar beet production.

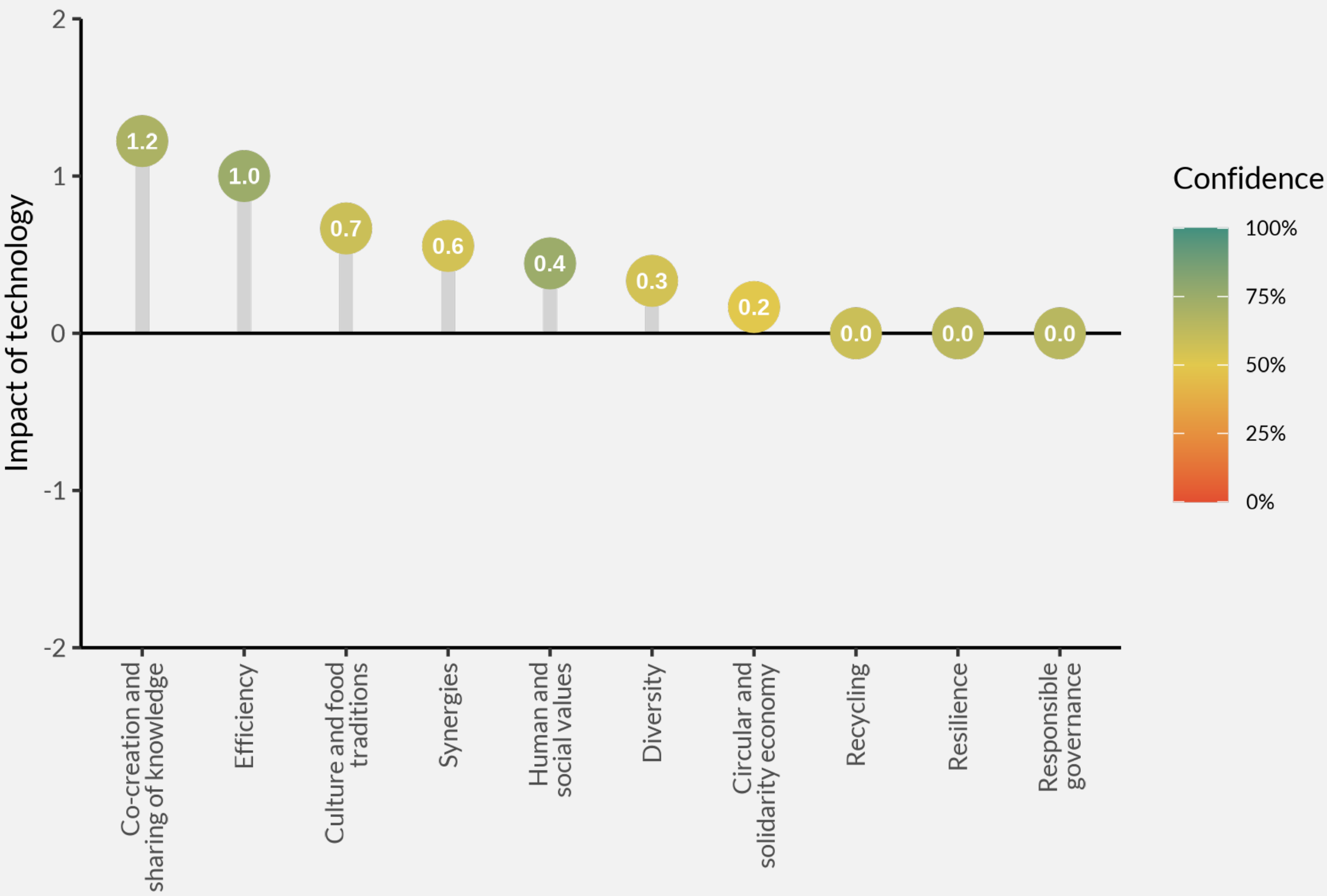
Farmdroid FD20. This robot is used to autonomously sow seeds and perform mechanical weeding on the field. Photo credit: Stefan Kopfinger.

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.

Agroecological performance

The figure below shows how sowing and weeding robots affect 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

Autonomous field robots are likely to bring a range of positive effects to agriculture. Through extensive data collection, these robots can bring new job opportunities to skilled farmers, promoting the **co-creation and sharing of knowledge**. The robots can also introduce new market participants and support connections between technology companies. The need among farmers, scientists, and technology companies to ensure societal acceptance of these tools can also promote knowledge sharing and exchange. At the same time, appropriate use of data needs to be guaranteed. There is likely to be a positive effect on **efficiency**, as the need for physical human labour is decreased, and there is potential for better material, water and fertiliser use. However, the efficiency of mechanical weed control increases as rainfall decreases, and the benefits also depend on crop type and region. Regarding **culture and food traditions**, the technology is seen as an opportunity to promote farming even when human labour is scarce. At the same time, there is a risk of reduced contact between neighbouring farmers and alienation between agriculture and the society. The robots can have mixed effects on **circular and solidarity economy**, as they have the potential to make products cheaper for consumers but also reduce human presence in food production. When it comes to **responsible governance**, there are currently challenges related to out-of-date or lacking regulation, and it remains uncertain how much sowing and weeding robots will help to eventually close those gaps. The robots also increase the risk of soil erosion as they leave the upper layers of soil loose, which can undermine farm **resilience**. This currently missing ecological aspect in the design of these robots is a significant shortcoming that needs further attention from technology developers and producers.

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 🚀

- Potential for new jobs that are particularly attractive to young farmers, as well as for keeping agriculture alive in areas with labour shortages
- Increased efficiency and potential for higher wages, particularly by reducing the need for physical human labour
- Potential to prevent harvest losses, ensuring food security (although it is important to avoid overdependence on the technology)

CHALLENGES 🧩

- Risk of alienation between production and population because farmers are not in the field themselves
- Problems with increased erosion potential need to be solved, as the technology is currently not recommended for areas prone to erosion
- Regulations regarding agricultural robots in Germany are currently not up to date and targeted enough

Workshop context

Importantly, the results in this fact sheet reflect the regional context of our assessment. The workshop to assess robot-assisted sowing and weed control for row crops was organised by the LfL Living Lab 'Future Crop Farming', an innovative, small-scale, diversified and digitalised crop farming project, on 28 November 2023. The Farmdroid FD20 was used as a reference for a market-ready and already implemented technology. While the FD20 can be applied to other crops, the discussions during the workshop focused exclusively on its use in conventional and organic sugar beet production in Eastern Bavaria, for which the technology is mainly used. The workshop included stakeholders with backgrounds in farm advising, digitalisation, academia and policymaking.

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