UAV-based weed mapping

Technology fact sheet

What is UAV-based weed mapping?

Unmanned aerial vehicles (UAVs), or drones, can be used to monitor crops or apply inputs such as fertilisers or pesticides. The Thistle Tool, which is being developed by the University of Copenhagen, uses high-resolution drone images to identify root weeds like thistles in the field. The identification is based on colour differences between crops and weeds, and it is currently not possible with satellite images. Based on these data, a weed map can be generated for targeted application of herbicides, spraying only the areas with weeds and avoiding unnecessary spraying elsewhere. The weed map is georeferenced and can also be used to guide a self-driving robot, allowing the entire spraying process to be automatised with a high level of precision. As a result, farmers can reduce the use of plant protection products for pre-harvest weed control, particularly if the invasive weed is only found in small patches across the field. The Thistle Tool, however, is only the first part of the whole precision application system (mapping and spraying). The tool has been commercially available for a couple of years, although the number of users is unknown. The technology is also being further developed, especially to test the potential for monitoring other aspects of crops.

Drone used for field imaging. The Thistle Tool is the first part of a precision application system, creating georefrenced weed maps based on drone images. Photo credit: Søren Marcus Pedersen.

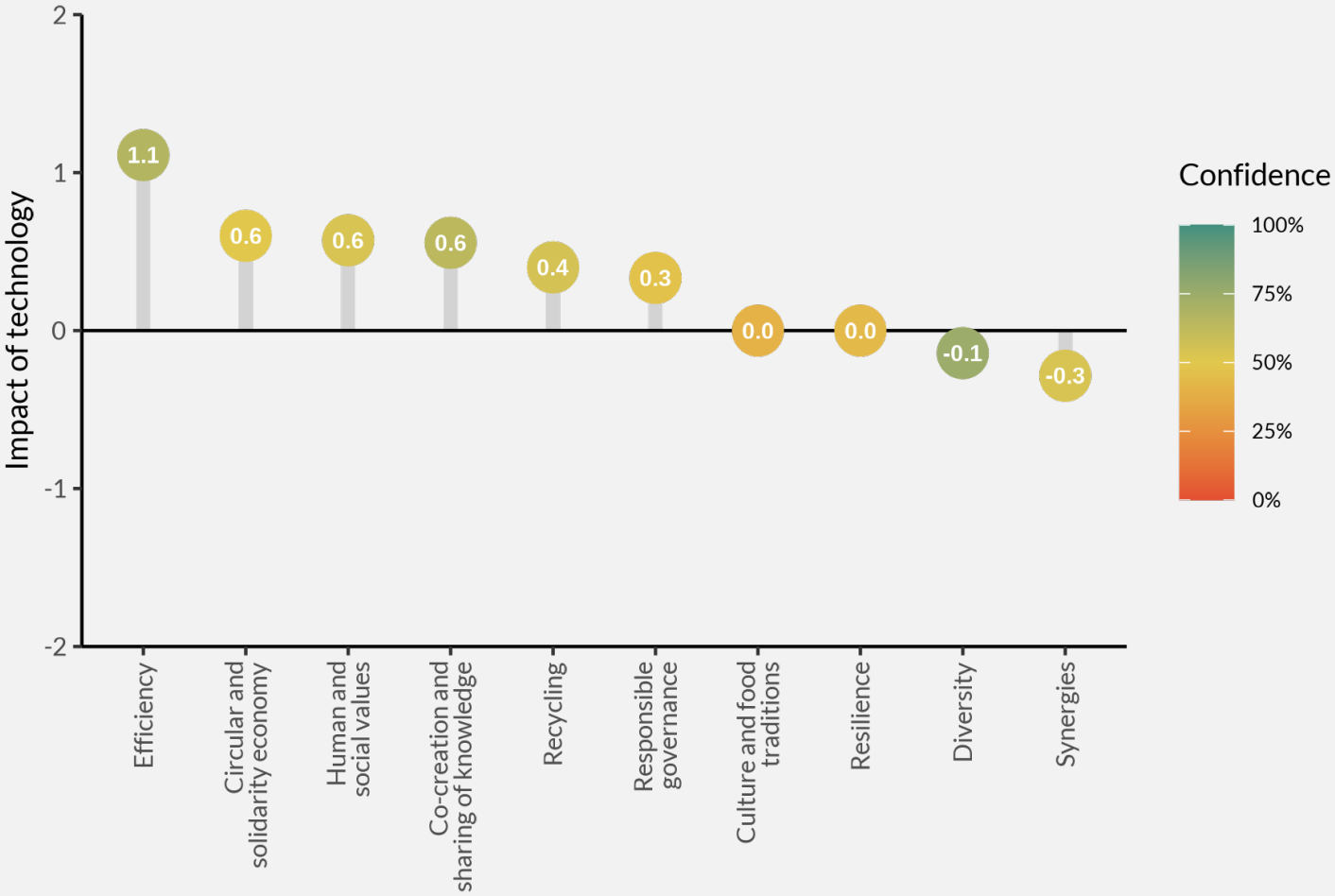
What is agroecology?

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 weed 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 main likely effect of using the Thistle Tool coupled with a precision-spraying system is improved **efficiency** through reduced pesticide inputs (by up to 50-70%). There is potential for monitoring other characteristics of crops, which would further increase farm profitability and efficiency. The impacts on other elements were considered somewhat less positive and were often also seen as less certain. By making farming less physically demanding and embracing innovative approaches, the technology has a high potential for engaging young, educated people in farming, which would contribute positively to **human and social values**, although there is a risk of dividing younger and older farmers. Full data access would also enable **co-creation and sharing of knowledge**, an element that the workshop participants considered very important to farmers, potentially increasing participation and opening new methods for crop management. Farmers could also take part in the future development of such tools, if the data are freely available. At the same time, participants highlighted the loss of control over data as the greatest risk associated with this technology. Data availability, protection, and ownership are the main issues affecting **synergies**: the tool has a high potential to support synergies, but the positive or negative effects on things like compatibility with other digital tools depend on access to data and the costs of using it. Similarly, if the technology can be used for more broadly—for example, to monitor water stress—it can increase farm **resilience**. However, this is only possible if the farmers have full access to data. While the technology is not directly contributing to **diversity**, future developments might allow the data to be used to support practices like intercropping, thereby increasing diversity in the field.

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 could significantly reduce herbicide inputs, thereby increasing the farm's efficiency and profitability
- Potential for monitoring other characteristics of crops, which could contribute to farm resilience and sharing of knowledge
- The tool has a high potential for engaging young, educated people in farming

CHALLENGES 🧩

- Data availability, protection, and ownership needs to be ensured, as losing control over data is seen as the greatest risk
- Developing new functions could create a trade-off with user-friendliness, potentially widening the gap between younger and older farmers
- Farmers need to have control over business models to decrease the risk of a farm's finances being exploited and profitability reduced

Workshop context

Importantly, the results in this fact sheet reflect the regional context of our assessment. The workshop to evaluate the Thistle Tool was organised by the University of Copenhagen at the Taastrup campus (Højbakkegård) on 29 September 2023. The campus is a research centre of the Faculty of Science with lecture halls, laboratories, greenhouses, stables, and experimental open fields for arable and perennial crops. The participants came from across Denmark, representing different agricultural stakeholders, and had personal knowledge and experience in crop production. The focus of the workshop was conventional grain (barley, rye and wheat) production in East Denmark, although examples were drawn from agriculture in Denmark as a whole.

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