Autonomous intercropping

Technology fact sheet

What is autonomous intercropping?

Intercropping, or the simultaneous cultivation of multiple crops together, is one of the most studied agroecological farming practices and a way of promoting in-field biodiversity. Strip intercropping, in which the different crops alternate in rows, is the most technically feasible intercropping system. However, it still faces technical and economic challenges, and as result, its adoption in modern agriculture remains limited. Autonomous strip intercropping enables the practice of intercropping while potentially reducing labour requirements compared to managing separate single-crop fields. The equipment shown below includes a 28-kW ISEKI tractor and standard tractor implements (for example, no-till planter, sprayer and mower) and a 2-m-head Claas combine harvester built for the Asian market. The tractor and the combine harvester were retrofitted for autonomous operation as part of a collaboration between Harper Adams University, Farmscan AG UK, the Agri-EPI Centre and Precision Decisions. This equipment set has been used on the Hands Free Farm at Harper Adams University for over six years and first implemented for autonomous strip intercropping in Spring 2023.

Retrofitted autonomous tractor mowing clover ley strips in between winter wheat strips. The tractor has been trialled for autonomous intercropping on the Hands Free Farm since 2023. Photo credit: Elias Maritan.

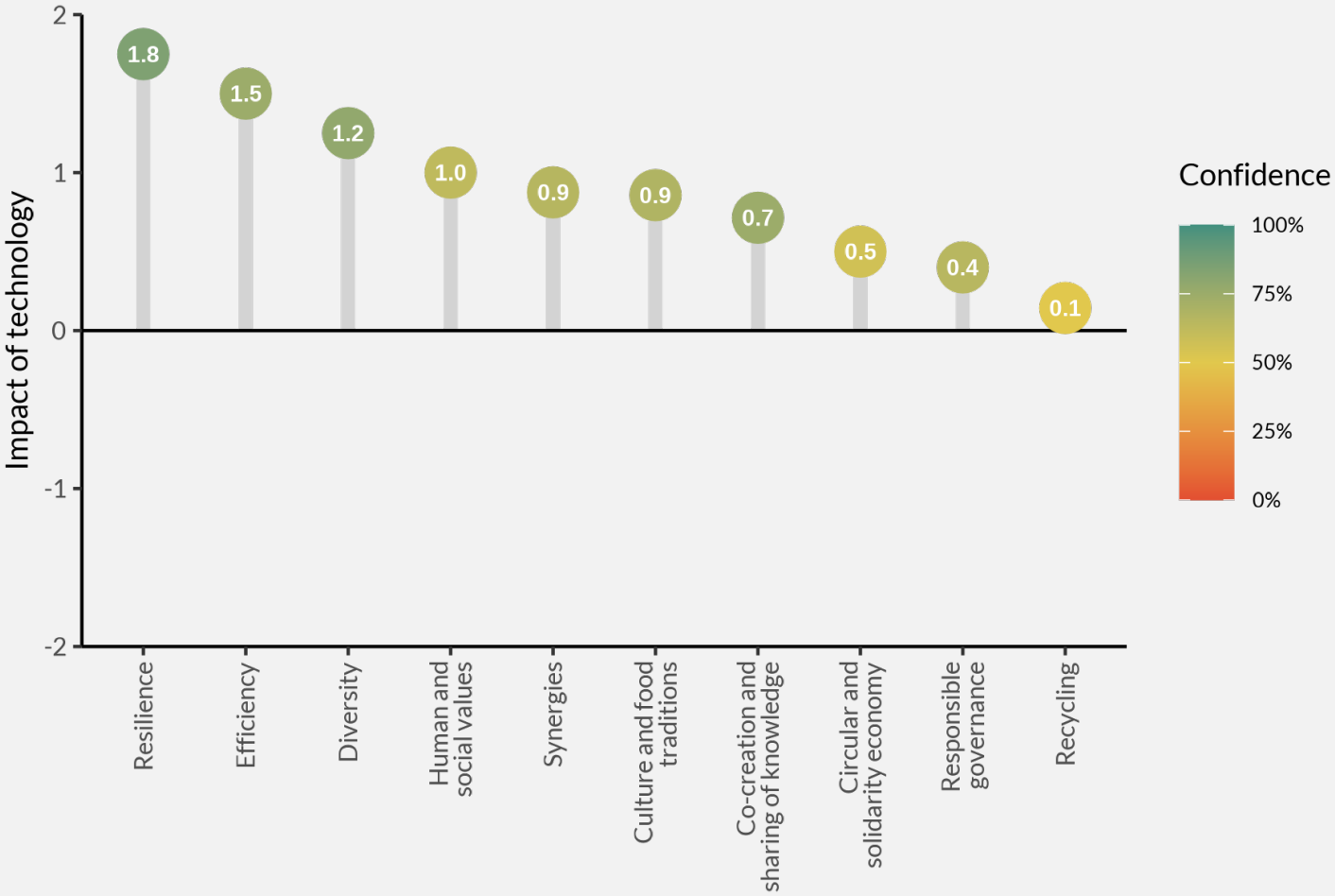
What is agroecology?

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 autonomous strip intercropping 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 likely effects of autonomous strip intercropping on agroecology range from highly positive to mixed. There is potential for a strong positive impact on **resilience** due to protection against extreme weather events thanks to reduced soil compaction, increased crop diversity that may reduce pest and disease attacks, as well as the opportunity to let the machines treat crops round the clock. The technology can enable a more **efficient** use of light and nutrients and may thus lower input requirements. In addition to increasing crop **diversity** on the farm, intercropping can improve soil health and increase carbon sequestration in the soil. However, integrating livestock into intercropping systems poses challenges, while more diverse crops may also be more difficult to sell. Regarding **human and social values**, the technology may improve the work-life balance of farmers, reduce labour inputs and thus mitigate the impacts of labour shortages, as well as create new job opportunities and a sense of community among technology users. On the downside, certain jobs might be replaced and the specific skills required to use such machinery might exclude some farmers. Mixed cropping practices may improve the nutritional value and other qualities of crops, which can support **culture and food traditions**. However, the technology is currently hard to adapt to some local systems, such as those dependent on extensive grazing or long-term perennials. Certain skills might also be lost, although this is expected to only affect more routine and manual tasks such as tractor driving, rather than more specialised skills. The effects on **recycling** largely depend on the technology manufacturer and how robust and repairable the specific model is. The use of batteries, which is enabled by smaller equipment size of these tools, can be seen both positively and negatively.

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 🚀

- Autonomous strip intercropping makes it easier to increase the diversity of crops in the field, which can boost biodiversity and soil health while reducing income fluctuations
- Pesticide and fertiliser requirements could be lowered, and the overall productivity of the field could be increased
- Can lower labour needs and improve the economic viability of small- and medium-scale farms

CHALLENGES 🧩

- Some jobs might be lost or become less accessible due to requiring new specific skills, while farmers may also lose some of their current skills (such as tractor driving)
- Finding small equipment that fits intercropping rows can be challenging since the market has been increasingly supplying large-scale equipment
- Adaptability to local food systems (for example, long-term perennials) is low in some regions

Workshop context

Importantly, the results in this fact sheet reflect the regional context of our assessment. The workshop to evaluate autonomous strip cropping was organised at the Harper Adams University on 18 April 2024. The university campus is located in the West Midlands of the UK, surrounded by agricultural land where several living labs are established. Autonomous strip intercropping has been tested on the Hands Free Farm since 2023. The crop portfolio of the test field currently includes winter and spring cereal, spring field bean, and clover ley strips. The workshop was attended by participants with diverse backgrounds, including farmers, farm advisors, digitalisation experts, and academics from different fields, such as agroecology, agronomy, ecology and economics.

Harper Adams University

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