Farming with trees: a potential 'win-win' for sustainable food production and biodiversity?

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A plain language summary of PhD thesis

Background. With the global population approaching 8 billion, we face an ever-increasing challenge to make efficient use of land for production of resources such as food and timber, while conserving biodiversity and safeguarding the environment for future generations. The practice of farming with trees, or agroforestry, could be one strategy to help meet this challenge, on the premise that trees make use of the space above and below annual crops while benefitting biodiversity. In this research project, we aimed to test this by collecting data from UK farms to explore the impact of in-field fruit and timber trees on biodiversity, services provided by biodiversity such as pollination and the natural regulation of pests, crop production, and farm income: do the benefits outweigh the costs?

Pests and weeds. We found strong evidence that agroforestry practices increase the diversity of plants and insects[1] compared with crop fields without trees. This is supported by previous evidence. Agroforestry fields had different weed and pest issues compared with treeless crop fields. For example, perennial creeping weeds and less mobile pests, such as slugs, were more prevalent in agroforestry fields. However, annual seed-spreading weeds and very mobile pests with specialist diets were more associated with treeless fields. We also found evidence for more effective natural control of pests in agroforestry fields, by calculating a functional diversity metric of the predator community.

Pollinators. The population and diversity of bees, which are useful crop pollinators, also benefitted from trees within crop fields. The bee community also had a much wider range of traits such as body sizes and tongue lengths in agroforestry fields. This indicates a more effective and resilient pollination service than in treeless fields.

Yields and income. Perhaps the greatest concern with planting trees in crop fields is the impact on food production. We found no evidence that yields of wheat and barley were affected by the presence of apple trees, but oat yields were reduced by 11% on average compared with treeless fields. However, our economic modelling predicted that planting apple trees can increase farm income in the long-term, because the reduction in cereal yields is more than compensated by producing a valuable fruit crop.

Management. One question raised by many agroforestry farmers is how to manage the space below the trees. We found that managing this space to encourage wildflowers increased populations of the predators of pests, while suppressing aphid colonies on apple trees and reducing fruit damage, compared with regularly mown vegetation. In addition, the flowering vegetation increased pollinator visitation to apple flowers, suggesting that this management practice can further enhance the benefits of agroforestry to beneficial insects.

Conclusion. This project provides evidence that agroforestry farming practices, when appropriately managed, can restore farmland biodiversity and improve agricultural sustainability with comparable productivity to conventional crop production, albeit with a different set of challenges.

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[1] Technically, we studied invertebrates, however the more accessible term 'insect' is used in this plain language summary.

Further reading:

This summary is based on the following PhD thesis: ‘Evaluating the effects of agroforestry versus arable systems on functional biodiversity and associated ecosystem services.’ University of Reading, November 2021.

The following scientific papers have been published from the project:

Staton, T., Walters, R.J., Smith, J. & Girling, R.D. (2019). Evaluating the effects of integrating trees into temperate arable systems on pest control and pollination. Agricultural Systems, 176, 102676. https://doi.org/10.1016/j.agsy.2019.102676

Staton, T., Walters, R.J., Smith, J., Breeze, T.D. & Girling, R.D. (2021). Evaluating a trait-based approach to compare natural enemy and pest communities in agroforestry vs. arable systems. Ecological Applications, 31: 1–12. https://doi.org/10.1002/eap.2294

Staton, T., Walters, R., Smith, J., Breeze, T. & Girling, R. (2021). Management to promote flowering understoreys benefits natural enemy diversity, aphid suppression and income in an agroforestry system. Agronomy, 11, 651. https://doi.org/10.3390/agronomy11040651

Staton, T., Breeze, T., Walters, R., Smith, J. & Girling, R (2022). Productivity, biodiversity trade-offs, and farm income in an agroforestry versus an arable system. Ecological Economics, 191: 107214. https://doi.org/10.1016/j.ecolecon.2021.107214

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