Centre for Agri-Environmental Research

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Ecosystem services in UK agroforestry

ORGANIC RESEARCH CENTRE ELM FARM

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Context

Population pressures

- 9 billion people by 2050[1]
- Food production must increase by up to 100% [2]

Sustainable Intensification

Environmental issues

- High species extinction rate & loss of biodiversity[3]
- Land use & greenhouse gas issues

Aims

This study is investigating whether agroforestry can reconcile conflicting demands for food production, biodiversity and other ecosystem services. Are there trade-offs between yield and other services? If so, to what extent?

To assess service provision and trade-offs, four services are being measured:

Productivity

Biodiversity

Carbon stocks

Pollination

These services are measured in two treatments: organic agroforestry (experimental) and organic monoculture (control).

We hypothesise that agroforestry may help resolve both food production and environmental pressures. It harnesses benefits from species interactions, leading to more efficient resource use.

Methods

We are using six agroforestry systems across the south of the UK. They are all either silvoarable (trees combined with crops, Fig. 1) or silvopasture (trees combined with livestock, Fig. 2).

Figure 1 Silvoarable (poplar) in France

Figure 2 Silvopasture (ash) in Devon

Productivity
- **Pasture** Herbage cuts 4x a year
- **Crops** Yield samples taken pre harvest
- **Timber trees** Allometric equations.
- **Fruit trees** Yield samples taken pre harvest

Carbon
- **Pasture & crops** Yield samples ground and analysed for carbon content
- **Trees** Carbon taken to be half of the biomass

Pollination
- Pan traps and standardised transect walks to measure abundance & diversity of solitary bees, bumblebees & hoverflies as a proxy for the service

Biodiversity
- Pan traps and standardised transect walks to measure abundance & diversity of butterflies as a proxy for biodiversity
- Vegetation transects for plant species diversity

Results

Biodiversity

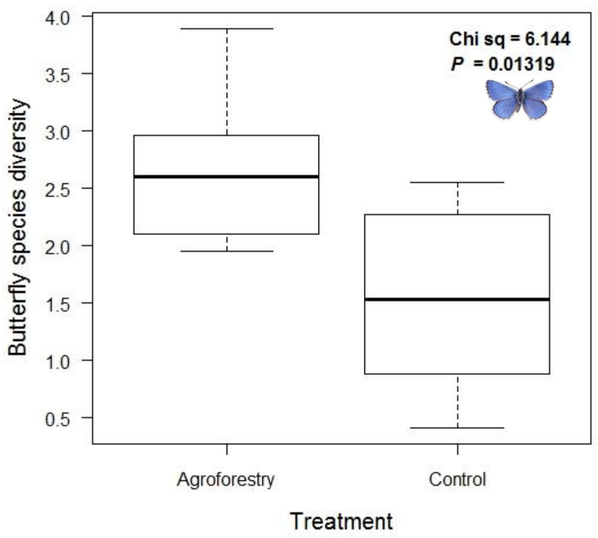

Figure 3 Butterfly species diversity using Margalef's diversity index

Figure 4 Pan trapping in silvoarable (barley and apples)

- Biodiversity (using butterflies as a proxy, Fig. 3) was higher in the agroforestry than the control treatments.

Pollinators

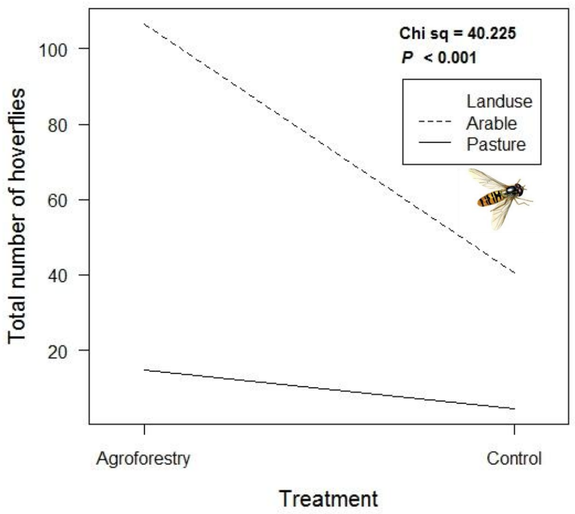

Figure 5 Hoverfly abundance: land use modifies treatment effect†

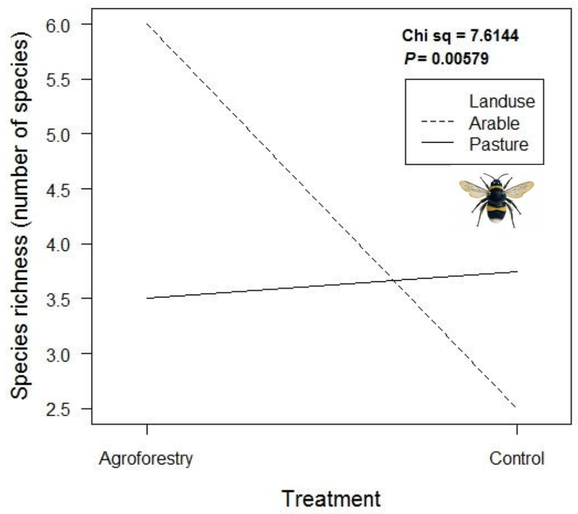

Figure 6 *Bombus* species richness: land use modifies treatment effect†

† lines are added to emphasise contrast and do not represent a direct relationship

The two types of agroforestry affect pollinators differently:
- Silvoarable agroforestry had higher abundance (Fig.5) and higher diversity (Fig.6) of pollinator taxa than monoculture.
- Silvopasture agroforestry showed either a slight increase (Fig.5) or no significant difference (Fig. 6) in pollinator taxa abundance and diversity.

Initial conclusions

- Both silvoarable and silvopasture systems provide biodiversity benefits compared to monoculture systems.
- Initial results indicate that silvoarable systems provide greater benefits in terms of pollination services than silvopasture systems.
- Early yield data indicates that silvopasture systems may give greater yield and carbon benefits than silvoarable systems.

Further work

- Phytometer experiments to measure pollination services directly.
- Further yield, pollinator and biodiversity data collection is on-going.
- Calculation of a monetary value for service provision and investigation of any trade-offs between the services.

References

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3. S. Butchart, M. Walpole, et al. Science ***328***,*1164-1168*.(2010)

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