A win-win for legume mixtures

A countrywide research project demonstrates how the productivity of fertility building leys can be increased with a diverse range of legume and grass species

The inter-relationship between food production and biodiversity is now well established. The ecosystem services provided by the organisms within the environment include, for example, nutrient cycling, pest regulation and pollination, to name but a few. However, perhaps the greatest challenge now facing agricultural production is to find ways of enhancing these ecosystem services, while at the same time increasing food production – particularly in light of food security issues.

A range of farm and landscape management options include 'setting aside' land for wildlife. However, some proponents argue that such land should be used for food production. While the debate continues, there is no doubt that a large body of scientific evidence from the last three decades highlights the wildlife benefits of organic farming. This article will describe how the Legume LINK project has identified a win-win system for biodiversity conservation and increased productivity through legume-base fertility building. Although this project has focused on organic farming systems, it is of direct relevance to non-organic production, particularly with the increasing interest in legumes across the industry.

Beyond grass clover leys

Current organic rotations rely predominantly on red and white clover leys fertility building, usually mixed with ryegrasses. While these leys have a significant potential for nitrogen fixation under optimal conditions, the establishment of simple grass clover leys can be risky under dry conditions. The idea of adding more legume species with different tolerances to environmental factors such as drought, water logging and acidity therefore promises to increase the reliability of ley establishment.

At the same time, some landmark studies in ecological research show that increasing the species diversity in grasslands tends to increase overall grassland productivity, because the different plant species complement each other. Together, the mixed species make better use of the available resources such as water, light or nutrients. But can this principle be applied to agricultural production systems?

On-farm trials

To test the potential of using diverse mixtures in the ley we assessed the performance of a highly diverse ley mixture on a large number of farms throughout the UK. These on-farm trials are part of the Defra-funded Legume LINK project (see right). Here we report the results from 12 organic farms and one non-organic farm in the south and east of England.

The tested mixture, called the All Species Mix, composed of 10 legume species and four grass species (see Table, opposite). In 2009, the mix was sown on each farm in a 0.5ha strip alongside a control ley. The species composition of the control ley was chosen by the participating farmer. Both the All Species Mix and the control ley were sown at the same time and treated equally throughout the trial period. On some of the farms the leys were grazed by sheep or cattle; on others the leys were only cut.

FIND OUT MORE

The project is led by the Organic Research Centre and aims to improve fertility building using green manures. Research partners are Duchy College, IBERS Aberystwyth, The Arable Group, Rothamsted Research, and the Scottish Agricultural College. Industry partners are Abacus Organic Services, HGCA, the Institute for Organic Training and Advice, Organic Farmers & Growers, the Organic Seed Producers, the Scottish Organic Producers Association and the Soil Association. The project is funded by Defra through the Sustainable Arable LINK programme and industry partners. Thanks to participating producers and funding from BBSRC LINK for Rob Brown's PhD project.

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OPPOSITE: Birdsfoot trefoil **TOP:** Lucerne **ABOVE:** Crimson clover

Legume and grass species included in the All Species Mixture of Legume LINK	
GROUP	**SPECIES**
Clover	Alsike clover
	Crimson clover
	Red clover
	White clover
Other legumes	Birdsfoot trefoil
	Black medic
	Large birdsfoot trefoil
	Lucerne
	Meadow pea
	Sainfoin
Grasses	Italian ryegrass
	Meadow fescue
	Perennial ryegrass
	Timothy

Throughout the trial period we repeatedly assessed the presence and cover of the various sown plant species and weeds. In spring 2011, we took samples of both the All Species Mix and the control ley to determine its productivity, measured as dry matter (DM) yield on four sample quadrats per ley. Results from these field experiments reveal that, in the second year of the ley (2010), the number of crop species found in the mix was on average twice as large as the control ley (10 vs. 5). At the same time, the total DM yield in 2011 was 22% higher in the mixture than in the farmer-chosen control ley. The results show that the All Species Mixture was not only more diverse but also more productive than the control leys. As research at Rothamsted Research within the Legume LINK project shows, this increase in DM biomass of the ley is likely to be translated into higher yields of a following winter cereal.

More benefits

An ongoing PhD project at the University of Reading further indicates that the higher diversity in the All Species Mixture supports more wildlife than simpler leys. In particular, growing legume species together that have different flowering times extends the availability of nectar for key pollinator species such as bumblebees. For example, including early flowering species such as crimson clover helps pollinators establish their colonies in the critical early spring phase.

Multi-species leys offer even more potential advantages. Once the ley is incorporated into the soil, the residues of the legumes and grasses break down and release nitrogen which can be taken up by the following crop. Normally, the timing of the nitrogen release from the ley residues does not perfectly match the nitrogen demand by the following crop, with the consequent risk of nutrient loss either through leaching or in gaseous form. However, a mixture of species that have different decomposition rates means the release of nitrogen can be spread out over time, which potentially allows a higher proportion of nitrogen to be taken up by the following crop.

Plant decomposition rates depend, for example, on lignin and phenolic contents. Mixing species with different lignin and phenolic profiles may therefore provide opportunities for improving the synchrony between nitrogen release and demand. The various legume species trialled in the Legume LINK project are currently being analysed for the chemical composition of their above and below-ground residues. Results will then be used to put together tailored species mixtures with optimal decomposition properties.

The research concludes that both productivity and the diversity in the farmed landscape can be increased by including species-rich legume-based leys in the rotation. Look out for a second article from the Legume LINK project in the next issue of *Organic Farming*.

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