# Balruddery Farm :
## arable sustainability in theory and practice

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Over the past half a century intensification of crop production, often solely for economic gain, has led to the systematic erosion of arable biodiversity and the degradation of arable habitats in many parts of the world. This has raised serious concerns about sustainability and long term food security, particularly where intensive management has had negative impacts on the functioning of agricultural systems.

Arable sustainability is the ability of a system to maintain stable levels of food production and quality in the long term without escalating requirements for agrochemical inputs to regulate the system. To achieve this, the within field arable habitat should be able to support stable populations of a range of organisms that regulate key system processes (primary production, nutrient cycling, decomposition, predation and pollination). Management for arable sustainability must therefore allow coexistence of different functional groups of plants and animals, and the use of crop varieties that can tolerate a degree of weed, pest and disease pressure.

Balancing food production and environmental sustainability is central to the principles of the LEAF (Linking Environment and Farming) organisation. SCRI has been a LEAF Innovation Centre since 2004 and is one of only two such centres in Scotland. The purchase of Balruddery Farm represents a unique opportunity to expand and develop SCRI's role as an Innovation Centre. LEAF is "committed to a viable agriculture which is environmentally and socially acceptable and ensures the continuity of supply of wholesome, affordable food while conserving and enhancing the fabric and wildlife of the countryside for future generations" (www.leafuk.org).

Balruddery Farm is an 118 ha arable farm located seven miles west of Dundee and between 70 and 160m above sea level on the lower slopes of the Sidlaw Hills. There are 17 fields varying in size from 2.0 ha to 11 ha. The soil is a sandy loam, slightly shallow in depth on the eastern fringes adjacent to Balruddery Den. The farm is fairly typical of the area, with field boundaries being marked by drystone dykes and the wooded den of the Balruddery Burn on the eastern boundary. There are mature tree lines and an old hedgerow along some of the dykes and two smaller watercourses that run west to east across the farm and feed into the West Den of Balruddery. The farm has previously grown oilseed rape, potatoes, barley, wheat and grass.


Plans for developing Balruddery Farm as a LEAF Innovation Centre include: regenerating existing hedgerows to provide a wildlife corridor running east-west across the farm, linking with woodland habitats on either side; increasing margin widths to at least 2m to buffer farm habitats from field operations; increasing buffer strips along water courses to 6m (a current Government proposal with the ending of set aside), and; establishing wildflower populations in field corners and edges to encourage pollinators and natural enemies.

SCRI can contribute to these goals through specific sustainability research programmes and through the adoption of LEAF recommendations for environmental management of the marginal land and the non-trial break crops within the rotation. A plant and invertebrate monitoring programme will be established in 2009

Within-field habitats are as important as the field margins for arable biodiversity and ecosystem functioning. Opportunities to follow LEAF guidelines for the management of these habitats at Balruddery Farm include leaving over-wintering stubbles to provide feeding areas for farmland birds, establishing conservation headlands on one side of each field during the break years between barley and potato trials, introducing beetle banks to encourage predators and planting bird cover crops.

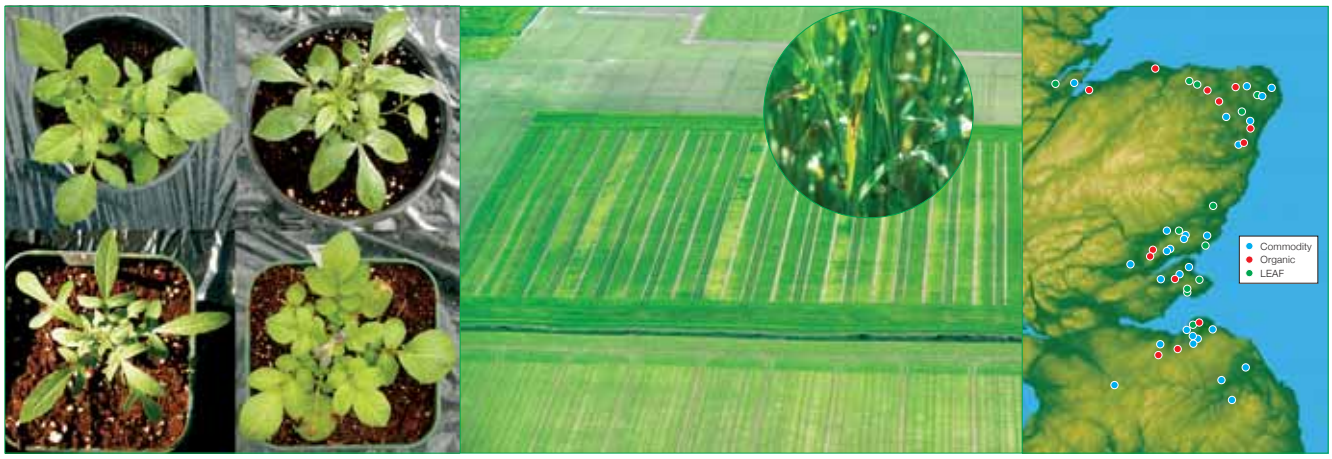


Figure 1 Current research at SCRI on sustainability includes screening crop varieties for nutrient use efficiency (left: potatoes in the Commonwealth Potato Collection show variation in micro-nutrient use efficiency), developing methods for enhancing resistance to pests and diseases (middle: barley cultivar diversity is used to reduce the spread of *Rynchosporium*), and assessing management impacts on biodiversity and resilience (right: surveys of LEAF, organic and conventional farms with different levels of management intensity).

to assess the efficacy of these LEAF management guidelines on long term trends in biodiversity at the farm.

Research at SCRI focuses on developing crops and crop management to enhance the sustainability of food production (Fig. 1). Crop traits are being identified that can improve stress tolerance and the efficiency of water, light and nutrient resource use, all of which result in the opportunity for reducing inputs and improving environmental and economic sustainability. Sustainable crop protection practices are also being developed that focus on environmentally benign and cost effective ways to reduce the incidence and severity of crop pests and diseases. Finally, soil and weed management strategies are being investigated to determine the optimal combination of management and crop variety for high yields whilst maintaining the biophysical resilience and ecological sustainability of arable systems.

We are now in a strong position to build on this research and develop an integrated approach for testing the results and hypotheses arising from these studies within the context of the whole within field arable ecosystem.

To do this, a research platform will be established at Balruddery Farm for long term studies on arable sustainability. The overall goal is to test whether or not potential solutions for sustainable agriculture arising from the current RERAD research programme, actually result in improved arable biodiversity, resilience, crop productivity and yield stability at a commercial field scale over at least four rotation cycles. A 'sustainable' cropping system will be designed that we predict will optimise inputs, yield, biodiversity and ecosystem processes. The effect of this 'sustainable' system on long term trends in yield and system health will be tested by comparison with current commercial practice. This research platform will provide a test-bed for new crop varieties with traits for enhanced nutrient and water use efficiency, weed suppression, and pest and disease resistance. The performance of these varieties in terms of crop yield and quality will be assessed under both management systems.

A contiguous block of five fields, covering 35 ha, has been set aside for the experimental platform. The rotation will include potatoes, winter wheat, two years of spring barley and beans. The conventional treatment will reflect current commercial practice. The sustainable treatment will include reduced herbicide and pesticide inputs, reduced tillage where appropriate and legume undersowing, compost additions and green manures to replace inorganic fertiliser applications. Both conventional and sustainable treatments will be flexible enough to track changes in commercial management practices and developments in sustainable technologies over time.

The general hypotheses are that 'sustainable' management, in combination with new crop varieties, will (i) maintain yield quality and yield stability at lower levels of agrochemical inputs, (ii) reduce greenhouse gas

(GHG) emissions and nutrient leaching from the system, and (iii) enhance soil quality and arable biodiversity. To test these hypotheses we will measure the responses of the whole system to sustainable management over a range of different crop varieties throughout each growing season over the course of at least four rotation cycles. Assessments will cover six main research areas: carbon and nutrient dynamics, soil biophysics, community dynamics, pest and pathogen populations, crop yield and quality, and field margin biodiversity. Trade-offs between these components of the system will be assessed through empirical and mathematical modelling.

The platform will provide a demonstration site for knowledge transfer, exchange and education activities, including specifically a resource for university undergraduate Honours and Masters projects. Three joint University of Dundee/SCRI PhD projects have already been proposed that are linked with the Sustainability Research Platform and will make use of and contribute to the data generated. There is also a unique opportunity to engage with the UK farming community through LEAF. LEAF members will be given the opportunity to suggest novel management practices that they consider are likely to enhance environmental sustainability but are perhaps not sufficiently tried and tested for them to risk applying in a commercial situation. These practices can be incorporated into the sustainable treatment and their effects on crop production and the environment can be reported back to the LEAF membership via e-briefs, the LEAF newsletter, SCRI open days and Open Farm Sunday. Finally, the site will form part of a network of similar long term experimental platforms throughout Europe through the proposed FP7 Analysis and Experimentation on Ecosystems (ANAEE) design study, and through other EU funding opportunities including two further FP 7 collaborative projects currently in preparation.