



Breeding biodiversity

The importance of maintaining and increasing the use of biological diversity in crops and cropping systems in the face of climate change and pressure on non-renewable resources is increasingly recognised. Yet breeding for and management of high-biodiversity agriculture is neither well-established nor even well-studied. To fill this gap, an ambitious, large-scale EU research initiative has been launched which will integrate diversity at all levels into the breeding of agricultural plants. ORC is a partner in the project which is called SOLIBAM (“Strategies for Organic and Low-input Integrated Breeding and Management”). The project team – Sally Howlett, Thomas Döring, Louisa Winkler and Martin Wolfe – describe what is happening.

One of the most worrying developments of our time is the massive loss of biological diversity that is happening on a global scale and at an unprecedented rate. The public focus tends to be on endangered wildlife such as panda bears, tigers and blue whales; less well-known is the parallel loss of biodiversity among agricultural crops but this loss is hugely important (Fowler & Mooney 1990, Gao 2003).

Firstly, using only a few crop species, and few varieties of those species, on a large geographical scale makes crops more vulnerable to attack from pests and pathogens (Finckh & Wolfe 2006). Secondly, the destabilising effect of climate change is likely to be more damaging if we rely on a limited range of crops. Thirdly, losing diversity in crop plants results in less choice for both farmers and consumers in agriculture and food systems, for example, in crop rotations and diet. Finally, attempts to mitigate the effects of declining resources and a burgeoning food demand has fewer options if there is significantly less crop diversity available.

In addition to these negative effects from losing biodiversity, the focus of conventional plant breeding is mainly to breed varieties for the uniform conditions of high-input monoculture, relying heavily on pesticides and mineral fertilizers. These varieties are often less well adapted to variable environments and may be unable to cope efficiently with stress conditions or the unavailability of high inputs, including the conditions of organic and low-input systems (Jones et al., 2010).

SOLIBAM brings together 22 partners from the private and public sectors, representing 10 different EU countries and two African countries (Ethiopia and Mali), as well as one international research organisation (ICARDA). The involvement of such a large number of partners means that comparative trials can be coordinated within a single project across a wide range of geographical locations, covering the main agro-ecosystems of Europe as well as sub-Saharan Africa and the Middle East.

The project is funded for 4.5 years and is led by the French National Institute for Agricultural Research (INRA). It centres on the thesis that improving quality and stabilizing



For these reasons, the maintenance and increased use of biological diversity in crops and cropping systems is vital because it offers several key advantages: stabilised yields in the face of climate change, better consumer choice, and resilience in times of decreasing availability of non-renewable resources.

The challenge is that high-biodiversity agriculture requires a different approach, management and methodologies. Hence the SOLIBAM project which aims to provide practical and dynamic solutions to the problems of food production under the pressures of climate change and resource constraints. Specifically, its objectives include:

- characterisation of properties that help plants perform better in organic and low-input conditions;
- breeding and natural selection of highly diverse populations rather than monocultures in a wide range of crops;
- molecular analyses to monitor the evolution of crop adaptation at the genetic level;
- incorporation of crop populations into diversified cropping systems;
- development of participatory plant breeding to incorporate farmers’ knowledge and experiences;
- assessment of the effects of diversity-related innovations in breeding and management on the nutritional and end-use quality of crops; and
- evaluation of the socio-economic impacts of these innovations to identify factors that influence the adoption of increased diversity in breeding and agronomy.

yields in organic and low-input agriculture depends on increased diversity in cropping systems, and requires an integrated approach combining innovative breeding and crop management techniques. Dissemination of the project findings is of high importance and there will be a number of knowledge transfer events in different countries.

SOLIBAM was selected by the European Commission as part of the Foods, Fisheries, Agriculture and Biotechnologies theme. It is funded under the 7th Framework Programme for Research and Development. For more information, and a full list of partners, see the website <http://www.solibam.eu/>.



We are involved in several research activities within SOLIBAM, but our main contribution is to lead a range of internationally based trials which focus on the exploitation of diversity to improve crop performance. Various breeding approaches are being used to create novel diversity and develop existing diversity, mainly in cereal crops (winter wheat, barley and maize), but also in a range of vegetables (tomatoes, cabbages, beans and broccoli).

The research will draw on ORC's experience with evolutionary variety mixtures and composite cross populations (CCPs) in wheat (Wolfe and Döring 2010). These populations, which have extremely high within-crop diversity, have recently been shown to perform particularly well under variable, unpredictable and stressful environmental conditions (Döring et al. 2010). In SOLIBAM, we will compare the performance of crops with increasing degrees and forms of diversity, ranging from pedigree line varieties (monocultures), to landraces (wild-type varieties adapted to local conditions) and populations based on familiar varieties or less well-known relatives of wheat.

This season saw the start of common bean (*Phaseolus vulgaris*) and sprouting broccoli (*Brassica oleracea* var. *Italica*) trials at Wakelyns, our Suffolk site, with similar trials being carried out by partners in Italy and France. Our winter wheat trials, which are being compared with others in the north and south France, Hungary, Austria and Italy, have also been planted both at Wakelyns and at the NIAB TAG Morley Research Centre in Norfolk. Keep an eye on future editions of the Bulletin for updates on progress and for dates of opportunities to visit the trials.

Full of beans: Caged French bean plants at Wakelyns Agroforestry in Suffolk



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New projects to reduce farm emissions

Jim Paice, Minister of State for Agriculture, has recently announced £12 million funding for three research projects which will improve our understanding of how UK agriculture contributes to climate change. Researcher Laurence Smith reports that ORC is contributing knowledge and experience from past research within this area.

The way agricultural emissions are currently calculated fails to take into account differences between farming practices or the effects of innovative approaches to reducing GHG emissions. These projects, funded by Defra and the Devolved Administrations, seek to address this and help give farmers the evidence needed to take more effective steps to reduce emissions.

The current method for calculating agricultural emissions uses a simplified approach, which is the minimum required by the United Nation Framework Convention on Climate Change (UNFCCC), for the UK National Inventory. It relies on generic emission values and on national statistics such as livestock numbers and tonnes of fertiliser used. These new projects aim to strengthen our understanding of farm emissions and to achieve a greater degree of accuracy in measurement and reporting. For example, the projects may demonstrate that some livestock breeds produce less methane than others under different farming systems.

The projects, involving sixteen research organisations¹ from across the UK, will be closely linked and will focus on the following areas:

- Data management and modelling – bringing existing data together to create a new inventory model and a set of revised emission factors with an assessment of uncertainty.
- Methane (CH₄) emissions – discrimination between CH₄ emissions from different livestock species and breeds/genotypes under different farming systems and representative farm business structures.
- Nitrous Oxide (N₂O) emissions – understanding N₂O emissions as a function of N inputs through time, influence of climate, crop, soil types and conditions, and land management under different farming systems and representative farm business structures.

Knowing when and where actions make the most difference will improve the positive efforts that farmers are already making to reduce emissions.

¹ Research organisations across the three projects include: Aberdeen University, Aberystwyth University (IBERS) (leading the methane project), ADAS (leading the data management / modelling project), AFBI, CEDA, CEH, Cranfield University, MLURI, NPL, ORC, Rothamsted Research (leading the nitrous oxide project), SAC, The Met Office, the University of Nottingham, the University of East Anglia and the University of Reading.