Developing new cropping systems based around cover crops, catch crops and living mulches for use in low-tillage agriculture

Results from a major EU-funded project (OSCAR) suggest that systems built around cover crops, catch crops and living mulches can reduce the economic risk potential of crop production by stabilising crop yields. Any profit reductions due to yield drops are often counterbalanced by reduced production costs in low-tillage systems. However, longer term results are needed to improve the validity of this economic evaluation. ***Sally Westaway*** *and* ***Bruce Pearce*** *summarise some of the key results, outputs and recommendations from the project.*

OSCAR
Optimising Subsidiary Crop Application in Rotations

The four-year, EU-funded OSCAR project, *Optimising Subsidiary Crop Applications in Rotations*, finished in March this year and involved twenty partners from nine European countries, plus Morocco and Brazil. The project brought together scientific researchers, agronomists and small businesses with the aim of developing new cropping systems based around the use of cover crops, catch crops, living mulches and other subsidiary crops and optimising these systems for use in low-tillage agriculture.

Subsidiary crops are plants that are grown for the ecological services they provide rather than as a cash crop. They include cover crops, catch crops and living mulches and have multiple benefits including contributing to soil fertility, soil health, biodiversity and potentially the economic stability of a system.

The core of the project's experimental programme was a set of coordinated field trials in twelve different environments, ranging from Scandinavia, through central Europe and the Mediterranean, to North Africa. These experiments investigated the climatic and environmental conditions under which different subsidiary crop species are best suited and the best approaches for using such crops. In addition two key objectives were the identification of new species and genotypes of subsidiary crops and the development of new farm technology and machinery to facilitate their cultivation. Running alongside these trials was a screening programme carried out in two Mediterranean and one temperate environment, to test and identify novel species and genotypes for use as cover crops or living mulches. The trials aimed to increase the range of subsidiary crop species and the availability of more adapted species/varieties to fill niches in crop rotations.

ORC's role was to lead the dissemination activities in OSCAR and to develop a toolbox for using cover crops and living mulches. We also hosted trials at Wakelyns and on farms.

Undersown medic

In general subsidiary crops (see definition in OSCAR box) were found to promote soil microbial biomass and activity. There are direct and strong positive effects on soil life and high value soil organic matter (e.g. composts) as well as on soil structure and health and thus, the soil's ability to suppress disease. However, deteriorated soil structure (e.g. compaction, waterlogging) counteracts this suppressiveness in the field. Reduced tillage combined with the use of cover crops or living mulches clearly contribute to an increase in soil organic matter and improved soil structure and thus to the soil's potential to suppress pathogens. Subsidiary crops were found to interact with tillage, enhancing the benefits for soil aggregates. It was shown, that erosion control can be remarkably improved by choosing appropriate subsidiary crop species such as hairy vetch or subterranean clover, the latter especially if used as living mulch.

However, the performance of cover crop species on soil quality improvement was found to be strongly related to climate, hence choice of cover crop species based on environmental conditions is essential.

Technology in terms of availability of appropriate machinery is not generally a limiting factor for the application of subsidiary cropping systems; there is a wide choice of equipment on the market. The use of such machinery requires trained and experienced users and tractor operators, as there is no general or generic solution. Each situation is different, so training and extension is crucial for successful application. However, in spite of

this wide availability, results demonstrated a challenge in obtaining satisfactory weed control, without using herbicides, in reduced tillage systems. Although use of subsidiary crops in most cases reduced weed growth, results clearly showed the need for the development of innovative techniques for weed control in organic cropping systems based on reduced tillage and subsidiary crops. Two new prototype implements, that cut shallow growing roots or rhizomes of weeds either vertically or horizontally, were developed during the project period. Both implements cause minimal disturbance to the soil and to subsidiary crop growth. The effectiveness of control depended on weed species and conditions; both implements showed promise in the control of two significant perennial weeds, couch grass (*Elymus repens*) and perennial sow-thistle (*Sonchus arvensis*). These two new implements are not yet commercially available, but further development is continuing in a new follow-up project.

The screening trials identified several new *Vicia* and *Lathyrus* species which perform as well as or better than the current commercial varieties of *Vicia sativa* and *V. villosa,* in terms of biomass, N fixation, seed production and weed suppression. Both very early and very late flowering species and varieties were also identified. Traits such as early flowering are important if alternative means for cover crop control, such as use of the roller crimper, are to be explored.

Cover crop and Living Mulch Species database

A major project output is a database detailing the results of the screening trials as well as currently used commercial species and varieties of cover crops and living mulches. Using individual species/accessions as entries, this database was explored. Relationships between plant traits were investigated, traits were plotted against one another to look for patterns and identify gaps in our current knowledge. Traits investigated included biomass, weed suppression, canopy height, flowering time, determinateness. This analysis has identified some interesting relationships and gaps in our current knowledge and in the availability of cover crop species. It has also revealed some species and cultivars with potential for improving cropping systems that might be of value to develop as commercial seed. Key conclusions and recommendations include:

- Species which showed good potential in the screening trials and may be worthy of further commercial development include *Lathyrus clymenum*, *Lathyrus ochrus*, *Vicia benghalensis* and *Vicia villosa* and the cultivar Bernina of *Vicia sativa*.
- There appeared to be a gap, with fewer commercially available cover crop species in Southern Europe compared to the other geographic regions considered. A closer look at the market would confirm this.
- A potential gap was identified for species with low canopy height but high biomass production; this is particularly important when considering cover crop species suitable for undersowing.
- A slight negative relationship between biomass and persistence suggests there may be a gap for a species with high biomass and high persistence. *Trifolium repens* and *Medicago sativa* score relatively highly for both traits and could fill this gap.

Lathyrus clymenum, one of the species showing good potential

Conclusions

There is a need to actively support the use of subsidiary crops and the breeding and selection for new subsidiary crops to increase overall system biodiversity and resilience. The overall benefits of such practices go beyond agriculture, as this will reduce dependence on external inputs, soil erosion, and problems with surface and ground water quality, which are clearly benefits to society. Specific recommendations are;

- The use of subsidiary and cover crops should be encouraged as their use can result in a reduction in fertilizer and herbicide use as well as enhance soil microbial biomass and improve soil erosion control.
- Obstacles to the introduction of new legume crop species need to be addressed, for example the list of admissible legume species for the current 'EU greening' programme currently contains only a few species, thus impeding biological diversification, and needs expanding.
- Support breeding of cover crop species with focus on the selection for disease resistance and for combining ability of main crops with living mulches.
- Support training for farmers. The use of machinery requires trained and experienced operators, as there is no general or generic solution. So training and extension is crucial for successful application.
- Make information easily available to farmers, which could be addressed by maintenance and further development of the toolbox.
- Research in the field of automation, sensor technology and robotization should be supported.
- Raise the minimum requirements concerning the use of subsidiary crops (especially legumes) in organic farming and conventional farming.

Project team visit to screening trials at Technical University, Munich

The OSCAR Cover Crop and Living Mulch Toolbox

The performance of different cover crop and living mulch species will vary according to geographic location and on-farm growing conditions (soil type and fertility status, rainfall, previous crops etc.). One challenge farmers face in planning diverse cover crop systems is this variable performance of subsidiary crop species according to conditions. To address this challenge and to summarise the results of the OSCAR project the Cover Crop and Living Mulch Toolbox has been developed by the Organic Research Centre, together with the Technical University of Munich, Germany, who gave technical assistance and led the development of the cover crop database. All Partners of the OSCAR project contributed with their results.

The Toolbox aims to present the results of the OSCAR screening trials and to help improve knowledge and drive the use of Conservation Agriculture practices and subsidiary cropping systems throughout Europe.
The Toolbox will help you to:

- Identify suitable cover crop and living mulch species, varieties and appropriate species mixtures.
- Access the best current practical advice about management issues.
- Identify economic considerations when planning cover crop and living mulch-based systems.

It provides tools for everyone; from farmers, scientists and advisors, to seed producers, plant breeders, NGOs, manufacturers of agricultural equipment and members of the general public. The Cover Crop and Living Mulch Toolbox content draws on scientific literature, technical information and results from the field trials. It is presented as a series of web based tools: a Wiki; a Decision Support Tool; and a Species Database

1. The Wiki

This OSCAR Wiki is an interactive user-fed knowledge source of regionally relevant information concerning leguminous and non-leguminous cover crop and living mulch species, machinery and farm case studies. Information can be in the form of text, images, videos and links to other relevant webpages.

Information included in this Wiki comes from a variety of sources including personal experience, advisory services, scientific literature, and from the experiments conducted in the OSCAR project. The Wiki is a living document that evolves through input from participants. It depends upon contributions from registered users modifying and adding new entries. The OSCAR Wiki can be accessed via the Cover Crop and Living Mulch Toolbox or directly here:

http://web3.wzw.tum.de/oscar/wiki/index.php/Main_Page

2. The Decision Support Tool

This tool, aimed at farmers, researchers and other stakeholders, allows you to search the cover crop and living mulch database for information on leguminous and non-leguminous species throughout Europe. The Tool aims to assist with the decision making process and enables you to discover cover crop and living mulch species on the basis of characteristics that fit with your own site specific cropping systems.

3. The Subsidiary Crop Database

This interactive database allows you to search for information on leguminous and non-leguminous cover crop and living mulch species throughout Europe. It includes detailed information on new species and accessions trialled during the OSCAR project screening programme. You can search for information on species by scientific name, or by the common name in either English or German.

The Cover Crop and Living Mulch Toolbox is available at www.covercrops.eu

Accompanying the Toolbox the OSCAR Project Facebook page (www.facebook.com/The-OSCAR-Project-643571612380744/) has up to date information on related events, news items and links to relevant reports from other projects.

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