



TILMAN – the final report

After five years, the TILMAN-ORG project has ended, and one of the researchers, **Julia Cooper** of Newcastle University, provides a final report

A front-mounted
roller-crimper in action
destroying a cover
crop of hairy vetch



The TILMAN-ORG project ran from 2009 to autumn 2014 and culminated in a final workshop at the Organic World Congress in Istanbul this past October. The project was inspired by the conservation agriculture movement within the conventional farming world; a system founded on the three pillars of minimal soil disturbance, permanent soil cover (mulch) and crop rotation. During its 36 months, the project generated an impressive volume of information on the pros and cons, and risks and benefits, of implementing conservation agriculture practices within organic farming systems. There is a common perception within the organic community that reducing tillage is not compatible with organic production systems. Concerns about weed pressure, issues with incorporation of fertility-building leys and compost, and the risk of slowing down the release of nutrients from soils, have all contributed to the low uptake of reduced tillage by organic farmers. In TILMAN-ORG many of these issues were investigated, with some surprising results!

Tillage and organic

Much of the work involved a meta-analysis of results from studies where reduced tillage has been implemented in organic systems. Tillage methods were categorized by level of intensity, with deep (>25cm depth) mould board ploughing considered the most intensive form of tillage, followed by double-layer ploughing (inversion of the soil to a depth of ~15cm and deeper loosening), shallow inversion (<25cm depth), deep non-inversion (10–25cm depth), shallow non-inversion (<10cm depth) and no-till. This analysis showed that yield reductions on average were not as great as expected when tillage intensity was

reduced. For example, simply opting for a shallower depth of inversion tillage resulted in no reductions in crop yield, but had benefits for soil quality, specifically soil carbon stocks. In some cases, reductions in tillage intensity increased weed populations, but this was not always the case, and there was no clear relationship between increases in weeds and decreases in crop yield. This indicated that, where yields were lower under reduced tillage, other factors besides weed competition were playing a role.

While some farmers might expect that sandy, light soils are most suited to reduced tillage systems, in fact, researchers reported that problems with soil structure

"Analysis showed that yield reductions on average were not as great as expected when tillage intensity was reduced"

can develop when lighter soils are managed with reduced tillage. Light, sandy soils lack the clay minerals needed to form organo-mineral complexes that lead to good soil aggregation and thus, the sandy soils can slump and become compacted under reduced tillage conditions.

There is a perception that over time a cropping system will 'adapt' to a new system of tillage, but the researchers found no clear relationship between the effect of reduced tillage on yields and the number of years since the reduced tillage system had been implemented.

Soil, carbon and microbes

While the meta-analysis focused on a review of previous

ABOVE:A roller-crimper cutting back spring growth of hairy vetch (*Vicia villosa* Roth)

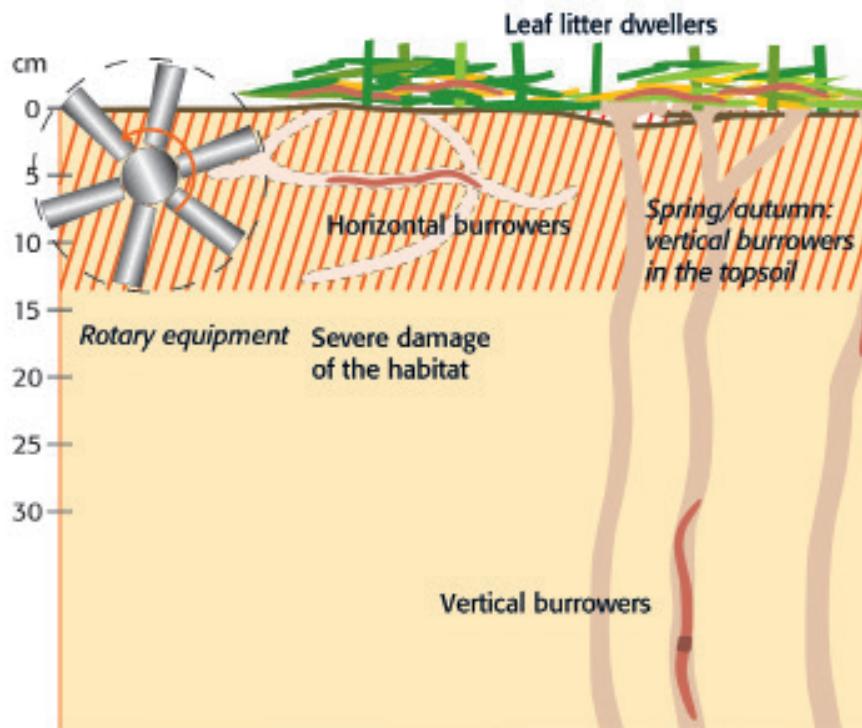
ABOVE RIGHT:A 'skimmer' plough suitable for shallow inversion tillage

FAR RIGHT:The damage that can be caused by tillage with rotary tillers, particularly when earthworms are active in the top layer of soil



Intensive soil tillage

Up to ca. 70% earthworm losses



experimental results, new experiments were also conducted in the project. Project trials in Germany and Switzerland showed that carbon stocks tended to increase under reduced tillage, but N_2O emissions were higher. Measurements over whole cropping sequences will be needed for a complete assessment of carbon footprints of the different tillage systems. Studies on soil biology showed that reducing tillage intensity increased soil microbial activity and diversity, especially in the uppermost soil layer. Mycorrhizal fungi that form beneficial associations with crop roots were enhanced when tillage was minimised.

Avoiding worm damage

The project produced several useful advisory tools, including a series of videos and factsheets. One factsheet focused on strategies to encourage earthworm activity, highlighting the importance of timing and type of tillage when trying to promote earthworms. Rotary tillers can reduce populations by as much as 70 per cent and all tillage is most damaging in March/April and Sept/Oct, when earthworms are most actively reproducing. Of course, this is when most cultivations are carried out, so changes to rotation design that involve cultivations when the soil is dry and cold and the worms have moved deeper into the soil can reduce these losses (see above right).

Green manures

A real challenge for organic farmers is the management of soils so that nutrients are mineralised from organic pools and released for plant uptake when they are most needed. Tillage at critical stages of production has been used in the past to stimulate biological activity and the

breakdown of organic matter. In reduced tillage systems this is not an option, so farmers need to adopt other strategies to ensure adequate nutrient supply to growing crops. In the TILMAN-ORG project, researchers in The Netherlands found that yield losses under reduced tillage could be compensated by growth of a green manure before the main crop. Innovative organic systems that use green manures and reduced tillage are being developed by researchers at the Rodale Institute in Pennsylvania and the USDA in Beltsville, Maryland. These systems rely on timely destruction of green manures such as hairy vetch by a 'roller-crimper' and can be effective at limiting annual weed growth in the subsequent crop. However, control of perennial weeds remains a challenge. Some European organic farmers are also experimenting with roller-crimpers for green manure destruction. Optimizing green manure-reduced tillage systems for vegetable growers using innovations like the roller-crimper will be the focus of a new CORE ORGANIC II Plus ERA-NET project (SOILVEG) led by researchers at Consiglio per la Ricerca e la Sperimentazione in Agricoltura in Italy. Further research on reduced tillage systems for organic farming will be conducted in another new CORE ORGANIC II project led by researchers at the Research Institute of Organic Agriculture in Switzerland. In this project (FertilCrop) soil biological and physical properties under various tillage and rotation systems will be studied to address the challenges with maintaining good structure, especially in the light soils identified as problematic by the TILMAN-ORG project.

Julia Cooper is a soil lecturer at the School of Agriculture, Food and Rural Development at Newcastle University

FIND OUT MORE

You can read more about the outcomes of TILMAN-ORG and view the project videos by linking to the project website www.tilmans.org.net/

Julia Cooper can be contacted on 01661 830222 or 0191 208 6932 www.ncl.ac.uk/afrd/staff/profile/julia.cooper