Saving fuel with non-inversion tillage

The mouldboard plough is the traditional and proven method of preparing a seedbed for drilling and controlling arable weeds. However there is a downside; trials have shown deterioration in structural stability, losses of soil organic matter, poor moisture retention and infiltration rates (Riley et al 2008). Farmers have long been aware of these adverse impacts of mouldboard ploughing, but concerns over the greenhouse gas emissions associated with tractor usage have prompted a fresh look at cultivations. ORC researchers, Oliver Crowley, Jemima Showering and Thomas F. Döring consider the case for non-inversion tillage.

Non-inversion tillage (NIT) is a method of cultivation that reduces the intensity of tillage and, it is argued, is a more sustainable alternative to mouldboard ploughing. This approach, combining in one pass both primary and secondary seed-bed preparations with drilling of the crop, can reduce production costs and have environmental benefits. Research on farms in Europe has shown that NIT can increase levels of soil organic matter, improve aggregate stability, increase microbial and soil invertebrate biomass (Lehocká et al 2009; Krauss et al 2010) and improve soil moisture conservation (Vakali et al 2002).

Even so, there are a number of questions to answer before abandoning the mouldboard plough – crucially about the ability of NIT to adequately control arable weeds.

The plough is a key part of organic weed control and, when not used, increases in the biomass and density of annual and perennial weeds have been widely documented (Peigné et al 2007). As a result, NIT may be advantageous in some environments, for example where soil moisture is a limiting factor for crop growth, but the plough may still be more important when weed pressure is high.

Concern over increased weed problems has meant organic farmers have been reluctant to reduce the intensity of tillage. However, there is evidence that under NIT weeds can be kept at an acceptable level and, even where they do become troublesome, crops can achieve yields comparable to those found on ploughed fields (Krauss et al 2010; Kouwenhoven et al 2002; Gruber and Claupein, 2009).

Interactions between tillage intensity and other farm management practices can also have an effect. NIT has been shown to work well in a diverse rotation including grass-clover leys and crops with high competitive ability such as oats (Cardina et al 2002; Gruber and Claupein, 2009; Verschwele & Häusler 2004; Measures 2010).

The benefits of NIT potentially make it an attractive option for organic agriculture, but its value on UK organic farms is still unclear as there has been limited experience of NIT machines designed or adapted to our conditions.

To address this, the Eco-Dyn cultivator, an NIT machine developed by an organic farmer in Germany, is currently being trialled in the UK. In collaboration with Duchy Home Farm, the Institute of Organic Training and Advice (IOTA), and the Royal Agricultural College in Cirencester; Organic Research Centre is studying its agronomic, economic and environmental performance. Results from the first year of the trial are presented below.

A randomized trial with three replicates was conducted this year at Duchy Home Farm in Gloucestershire, comparing the performance of the Eco-Dyn cultivator with mouldboard ploughing. Three fields on a clay/clay-loam soil were split into the two tillage treatments and each drilled with the Spring Oat variety 'Husky'. The plough treatment consisted of post harvest rolling, ploughing and power harrowing. The NIT treatment comprised one single pass that combined tillage with crop drilling. Seeding density was 190 kg/ha and drill depth was 3.5cm on the plough treatment and 5cm on the NIT treatment.

Due to some technical problems with the Eco-Dyn, drilling of the oats in both tillage treatments was delayed until after optimal conditions, so the seed experienced unfavourably dry conditions after drilling. Seed drilled with the Eco-Dyn established adequately, but early crop cover and headcount and crop height at harvest were significantly lower in ploughed plots suggesting poor crop establishment.

Plate 1: Weeds and crop residues. 90% or more of crop residues left on the soil surface help supply organic matter and retain soil structural stability after NIT.

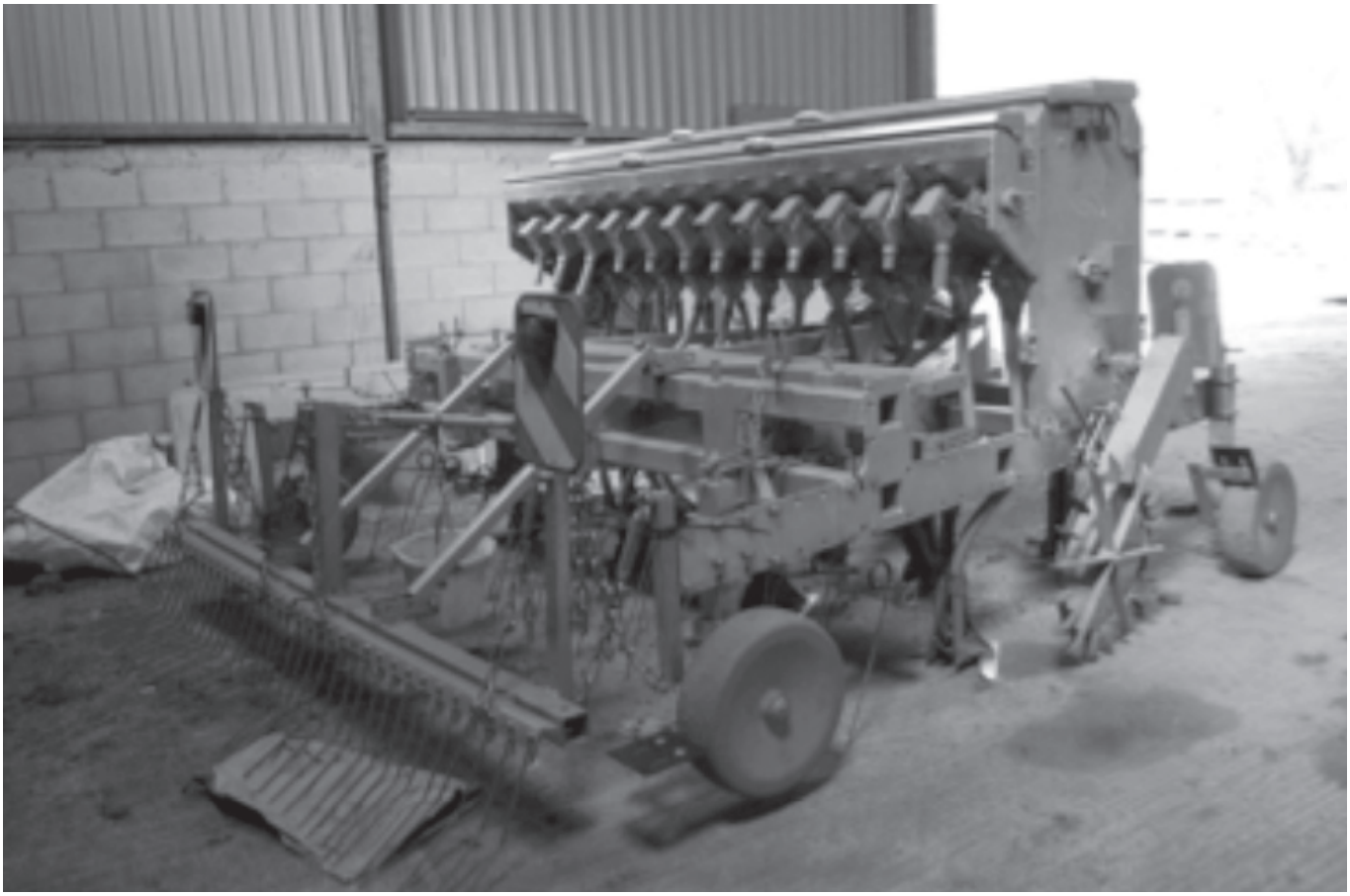

Plate 2 : The Eco-Dyn cultivator. Duck feet set at 3 inches are combined with a combination of tines to loosen the seed bed and a roller to consolidate the soil.

One month after sowing, weed cover and weed biomass were greater in Eco-Dyn plots. Later in the season, however, weed biomass was not significantly different between the two treatments, with creeping thistles (*Cirsium arvense*) appearing in greater numbers in the ploughed than in the Eco-Dyn treatment.

At harvest, there was no statistical difference in crop yield between the two tillage treatments. Krauss et al (2010) and Vakali et al (2002) both reported greater cereal yields after NIT when soil moisture was limited. Therefore, the Eco-Dyn may have compensated for a greater weed burden by creating conditions more favourable for crop establishment in the dry conditions. The results may have been different if drilling conditions had been optimal for the plough.

Another notable result is the fuel consumption associated with the two tillage regimes. The plough used 48.18 litres of fuel/ha, and the Eco-Dyn used 14.04 litres/ha. This is a considerable saving in production costs which in many circumstances might be enough to offset a reduction in yield caused by weeds.

We intend to continue the trial at Duchy Home Farm for up to one full rotation, following the development of soil parameters, weed burden and agronomic performance under the two contrasting cultivation treatments. No doubt we will see a dynamic picture with changes in soil conditions and weed populations over time. We may also witness overriding changes in the economic viability of NIT as fuel costs continue to rise.

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