Natural England Commissioned Report NECR100

Managing soil biota to deliver ecosystem services

Annex C – Case study three: Chalk downland, arable cropping

First published 04 October 2012

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Chalk downland, arable cropping: Medium loamy soils with flints over chalk

- Integration of green manures into crop rotations.
- No till includes non-inversion tillage.
- Overwintered stubbles.

It's Spring and we are standing on top of the rolling chalk down 900 feet above sea level (300 m) and, even on a still day, the breeze is pushing us about. Under foot is wheat stubble, the remains of last year's wheat straw and evidence of sheep grazing. S explains "This is where it all began – **we'd let the land up here blow or run away**, it was like a sheet of stone and there was resistant blackgrass." Looking across the road at the neighbour's 'better ground' we can see the tell tale signs of water erosion channelling across the field and still plenty of bare ground between the winter wheat rows. We stopped cropping and put the land under grass. While the land was resting there was much discussion about what the next step would be.

Overall S agrees that the land had been overworked in the past: "In the bottoms where it was easier to work, we certainly overworked it, **when it is easy land to move you didn't think to move it less, you just went in deeper**". The farm had tried min-till approaches but they just seemed to release more weed seed and caused more problems with soil structure: "It certainly didn't solve anything for us".

Tillage often stimulates the activity of bacterial decomposers as there may be a burst of aeration and the structural reorganisation can bring new OM sources into the reach of the soil bacterial population; bacterial predators (nematodes, protozoa) may therefore also be stimulated in the short-term. Repeated tillage without residue returns tends to deplete soil OM content. Loss of OM, reduced soil biological activity tends to lead to weaker structure. Hence if the soil is uncovered in autumn soil erosion occurs most easily.

Reduced tillage systems have been developed, most commonly for the cultivation of cereal and oilseeds that use a sequence (often in a single pass) of tine and disc implements which lift and shatter the soil removing any shallow compaction (tines) and cut and mix any crop residue of soil clods (discs) to give a fine tilth. In reduced tillage systems a range of cultivation depths may be used, but depth of cultivation is usually shallower than in conventional tillage and there is no inversion. Positive benefits of reduced tillage systems have been seen on soil structure, biological activity and soil OM, for example, Terbrügge *et al.* (1999).

Looking around the farm staff were directed to look at zero till systems. S was surprised by what he found “No-one had explained the whole system of zero till to me. **It wasn’t just about the cultivations, it was about changing the whole system and looking to maintain good soil cover whether with green manures or crop residues**”. The more S read (mostly books from New Zealand and the US) the more he wanted to know, so he also started talking to the pool of people who have been using no-till in the UK for longer and attending open days such as those held by the No-Till Alliance. This allowed S to build his understanding and confidence: “Their systems often had very different (soils, crops etc), but I don’t want to copy- I’ve been encouraged to look and learn for myself. For me now **it’s about the whole system = Zero tillage + green manures + careful rotations**”.

So at the end of the 10 years, S just sprayed off the grass and planted wheat straight into the sward base. The machinery sheds were emptied: “5 artic loads of 2nd hand machinery left the farm – 2 of the four tractors went – and just two new drills came back!” The key piece of machinery is certainly now the drill – disc drills are what’s needed “tine drills add a cultivation step that we don’t want or need”. There is nothing bigger than a 180 horsepower tractor on the farm now – “We wouldn’t need that much power except for pulling grain trailers.” With fuel and fertiliser costs continuing to rise, S feels that the system is beginning to be future proofed – “The fuel tanker is no longer coming every 5 minutes to fill up the farm tank and I’ll have the system in balance if/when I need to cut back on fertiliser”.

No-till systems, often known as conservation tillage outside the UK, seek to cause the absolute minimal disturbance needed for successful crop establishment and ideally no soil disturbance at all. They consequently also lead to increased periods of crop cover and/or soil mulching with residues.

Large farms are the main adopters of zero-till systems in Europe.

The farm has an arable rotation and a large sheep enterprise. The arable land is now 50% is first wheat, early drilling varieties selected to suit the new system. The rest is spring sown - half linseed and half fallow with a mustard green manure. The stubble of the wheat stands over winter and regrowth in the wheat stubbles can also give bite for the sheep. For S it's the fallow that's the most important part of his rotation; "**the green cover through the fallow keeps the soil alive and active – and on windy days no soil moves**". Mustard seed is spun out into the overwintered stubble in spring – it comes into flower, and then is sprayed back with glyphosate – leaving root structure intact. "I've been drilling with the mustard stems still standing – it wasn't a problem". The proof of the drilling is in the even ankle deep wheat where we stand. As we walk on through the wheat S points down at our feet at the soil covered with a crumbly top ½ cm of weathering worm casts. "**I'm just amazed how quickly it's regenerating. We're letting the soil rekindle itself. It is happy looking after itself**." Wheat straw doesn't hang around; it has disappeared within the year without any mechanical soil disturbance: "You can almost watch the worms gathering it up and taking it away underground".

S smiles a lot as he shows me round. His wheat has won prizes and his first wheat yields are up. But he's happy to admit that it hasn't all been plain sailing: "As well as the signs of improvement, you can also see where there are more deep-seated problems we used to cover up. In each field we are showing up areas of poorer soil quality and **the system is challenging us to think about our soils in a different way**."

Increased periods of crop cover and/or soil mulching with residues leads to the increased duration of active root biomass within the rotation, as well as increased soil cover – by weeds, as well as crops and residues. The increased duration of active root biomass has been linked to increasing colonisation effectiveness and increased biomass of AM fungi in no-till systems (Gosling *et al*. 2006).

Adl *et al*. (2006) showed that during the first 8 years of no-tillage there was an increase in the abundance of all soil organisms, with larger organisms responding more quickly to the no-till management. Anecic earthworms which come to the soil surface to feed on plant litter and create deep vertical burrows (Cheng *et al*., 1990) increase most rapidly when tillage ceases. They create distinctive middens at the soil surface that contain a mix of soil, shredded organic materials and worm castings.