No-till for growers:

Part 2 - Soil health practices for growers

Following on from the article in the last Organic Grower magazine, here are some of the ways that growers can apply the soil health principles in their operations to get improved soil crumb structure and better crops.

Reconsider options for raising a tilth

There's no doubt that transplanting into soil with a good tilth is much faster and more pleasant than where it is poor and for direct sowing, it is perhaps essential. However, the creation of that tilth can be incredibly destructive, especially where repeated, and it certainly delays the whole job of establishment. This can be a problem, especially as it would appear that the spring cultivation window is getting narrower each year. There are two distinct types of tilth: mechanical tilth that is generated through tillage, and biological tilth which is the kind of natural crumb structure that good organic soil becomes, otherwise known as aggregation. This is found around the roots of healthy plants, whether crop or cover crop and this structure is resistant to weathering and degradation. The trouble with mechanical tilth, raised by cultivation, is that it is short-lived. The seed bed may come up nicely, which is sufficient for planting but it doesn't last more than a few weeks or days before settling back into a packed, consolidated and homogeneous structure with little pore space. The picture below illustrates the aggregation visible around the roots of an over-wintered green manure.

Repeated tillage to prepare the soil for planting may therefore reduce structure and fertility thereby forcing the need for lengthy, fertility-building phases where the land is out of production. The trouble is that the tillage triggers the destructive digestion of soil organic matter (SOM) by particular soil organisms, which can give a yield boost - through a flush of newly available nutrients, known as mineralisation, but contributes to a net loss in SOM and in structure, tilth and aggregation over time.

In the end, this makes the soil hard and unworkable as well as resulting in a dense structure which requires further cultivation, and inhibits infiltration, requiring additional irrigation. Tilled soil is often the soil with the worst structure. This is not to say that cultivation isn't a useful, and in some cases essential tool, or that it does not provide a number of benefits, but it's important to be aware of the consequences of its usage. We'll consider ways to mitigate the negative effects of tillage and how to get improved results when necessary.

Recently tilled soil. Little evidence of aggregate structure or pore spaces

Use biology to improve tilth

Once again, soil structure is a product of the action of soil organisms. It's the production of gels and slimes (biotic glues) that serve to hold finer crumb structures between cultivations and to bind together disparate soil particles that would otherwise consolidate or pack into dense physically bonded structures. The application of the soil health principle of diversity in mixtures, and in rotations can bring improved tilth following cultivation. The example below compares the tilth following a spring cultivation – a standard rye/vetch overwinter green manure compared to a cocktail cover crop - with 8+ species (seeds kindly supplied by Cotswold Seeds).

The photos show soils following the standard spring cultivation of the whole horticultural block, with multiple passes of a power harrow. There's a marked difference in the fragment size between the two treatments. Which of these would need fewer passes to raise a seed bed and would be better for transplants? Thanks to grower, Adam Beer, for these pics and feedback on the trial.

Adam Beer

Pitney Farm - Spring cultivation. At left: cocktail cover crop. At right: rye vetch green manure

Another area for further exploration is the use of biological growth promoters like aerobic compost, composted manure, seaweed, humic acids, molasses, sugar or mulches. These can be applied to soils to engender microbial activity at the surface and should have a short-term tilth-creating effect, and when combined with applications of liquids, will increase the depth of activity.

Raise a tilth by hand

In the transition phase, to facilitate efficient planting as the biological tilth is building-up or developing, it is a good idea to find a means of loosening surface soil layers. On a small-scale, the most useful tool is a broad fork, which is a large two-handed fork. It is used to loosen soil prior to planting, once or twice per year. A sub-soiler may do the same job and other methods include sheeting down, overwintering e.g. with silage plastic and a top-dressing of mulch. In this case, growers have reported soil conditions suitable for direct planting, albeit with a few vole burrows to deal with but of course it will be weed-free.

Trial alternative tillage practices

There are a number of options for applying the minimal disturbance principle including reducing the number of tillage passes, reducing the amount of land tilled in one go, altering the depth or method of tillage, as well as leaving strips untilled. Each one has benefits and limitations. Firstly, strip or zone tillage can be a simple method, where alternate strips of a biennial based cover crop are rotovated in and planted with a cash crop. This means that half of the land is down to green manure at any one time and half the land is out of production. But it also has a real rationale in terms of the soil food web, as the untilled strips provide a 'refuge' for mycorrhizal fungi, that would otherwise be denied a food source by the loss of living roots with which to associate. After having their hyphal networks completely rearranged, the established mycorrhizae can quickly grow outwards and colonise the newly planted cash crop from this refuge. They continue to produce glomalin and fix stable carbon into soil organic matter or humus. Together with alley cropping, this refuge principle is, I think one of the secrets behind Mark Shepard's impressive results over 10 years in soil improvement.

Mark Shepard. Strip-till sweet clover & courgette

Use mulches where possible

Mulches can specifically feed soil organisms, creating crumb structure and protecting soil from rain and sun, as well as preserving surface tilths and improving infiltration, thus reducing the need for irrigation. However, they tend to be bulky and can be difficult to handle and apply. Where mulching is considered, trials should be carried out to assess practicalities as well as impacts on slug populations etc. And, where widespread mulching is adopted, it is helpful to streamline application with spreaders, loaders, two-wheeled barrows etc.

Implementing new cropping systems

The soil health principles are primarily a strategic tool, helping to inform management choices and the simplest way to put them to work is through an analysis of existing crop rotation. Each change-over or break is a possible point of intervention. You can therefore identify these points and compare your management options, ranking them based on the number of principles they meet. Over a year, there may be a dozen or more points of intervention.

Analyse your rotation

Complex problems are hard to manage, so make them more manageable by using a design approach, as with permaculture. In this case we can deconstruct or analyse the production system,

finding points of intervention within the rotation where we can apply the soil health principles. Good record-keeping is another way - we know we need to record crop failures and yield in order to outline the management activities we carry out as standard. The creation of a detailed rotation plan, in addition to a cropping plan, is essential and this should ideally have rows or columns for:

- Crop, indicating first and last planting dates
- Intercrops or under-sowing
- Green manures or cover crops can be included, especially where they are under sown,
- Ground preparation or cultivation work, it could be in the same row as the crop•
- Weed control operations, when they are carried-out, together with the method used,. This is especially important where cultivation is utilised.

This may seem an onerous task but once created, a good template will help everyone review the work carried out and make judgements on the different practices, as well as acting as guide to future planning.

Step-by-step, and identify easy wins

By analysing the rotation it is possible to isolate each one of the existing management practices, looking at opportunities to substitute or eliminate them one by one. Identify the simplest first and look to implement them in year one. If one tillage pass can be removed every year, by the end of five years, you'll have eliminated most or all of them. If you currently do a lot of direct sowing, you might consider transplanting more crops, as this doesn't require a seed bed and then possibly consider investing in a mechanical transplanter.

Review land under management

It has been shown over time that it is possible to get more production from the same land when it is managed better or more intensively. So, if you're struggling to keep on top of the weeds and are experiencing repeated crop failures, it is possible you've got too much of your land down to cropping. This can be addressed by taking land out of production, at least temporarily. Consider putting more beds down to cover crops or longer-term cover crops, and as long as they are properly established, this will free you up to focus more of your time and attention on the remaining areas. It will also enable you to apply relay-cropping, intercropping and successional production more thoroughly, and whilst there may be a net drop in output in the short-term, as you master the system this should take up the slack. You are more likely to grow healthier, better looking crops with less out-grading and less stress and if you have commitments to CSA members, ask for their buy-in. It is a big ask but, if you want to see results you need to make radical changes and I know of one example where net receipts increased significantly when a problem part of the field was taken out of production

Optimise propagation capacity

The key to keeping ahead of the weeds and maintaining living root is being able to transplant directly into a newly cleared bed, or between a standing crop and to be able to close-plant - for additional weed-suppression and output. You will need a ready supply of decent quality and potentially well established transplants and plenty of propagation space. Larger module cell sizes are beneficial— anything up to 75mm. This can result in a real bottleneck or a significant financial burden and for this reason, designing and installing efficient propagation facilities of appropriate size is important. Two-tier propagation benches as well as bottom-heat, tenting and potentially space heat for night time in critical tunnels. This could be solved by rocket mass heater or by air through convoluted subterranean pipes.

Be ready to market extra produce

The up-shot of these systems is, hopefully, more production. But over-production can be as much of a problem as under-production, with the additional picking and handling. Once the cultivation periods have been removed from the operation, that time is then substituted with longer cropping periods and coupled with the intercropping of main crop plants, this all means more crops per year and more crops of fast growing plants like lettuce. So, it's important to have an outlet for this produce, ensuring that it doesn't go to waste or cause a backlog in picking. Therefore, it's probably a good idea to have a short-term wholesale buyer who can make use of the continuous supply of the high quality salads you'll be producing. This is another reason to review the production area, as if you can maintain existing supply on less land and then scale-up, all the better.

Convince yourself - do some trials

Many of those who have carried out side-by-side operations have seen clear differences between the various treatments. In one case, in the US, the production from the no-till portion significantly outstripped the tilled portion in just the first season, and as the result was clear they have been no-till ever since. The same may not be true in your case, but with this in mind, it's important when transitioning to new management practices to set up small in-field trials and test these practices *in-situ*, before rolling-out site-wide. When setting-up a trial, it's important to select a crop that is fairly straightforward to husband, perhaps one where you already have an excess of transplants, and to establish a clear metric for quantifying success. The most obvious option would be identifying marketable yield but it's also prudent to have a separate line in the accounts, for each plot when harvesting, to ensure that each pick gets weighed and logged separately. However, estimating grade outs as a proportion of the crop might also be worth considering, as well as potentially quantifying savings, in time, from weeding and prepping.

Additionally, 'get technical' by measuring plant performance, and soil health directly using visual assessments, all these work particularly well in side-by-side trials. For example, refractometers

(Brix meters) give an indication of plant health and how it is responding in real-time to management treatments. This shows the amount of dissolved solids in the sap, which is a measure of both the level of photosynthetic activity (% Brix value) and the degree to which the plant is converting those sugars to more complex and useful compounds. One test that I think is essential is the "spade test", to visually investigate the soil structure and aggregation and this can often be radically different between plots and is an indicator of future plant health and cropping success. It's good to know that what you're doing or not doing is actually making a difference, down below.

A list of tests and instructions of how to carry them out can be found at the Sectormentor for Soil website: https://soils.sectormentor.com/soil-tests/. When accompanied by the app it makes the work of monitoring soils and crops greatly more pleasant and actually manageable.

A question of scale: find the solution that best fits

Most of the examples given here are appropriate for smaller-scale operations that are not mechanised or have little use for machinery. This is not to say that the soil health principles can't be applied at scale, this is certainly not the case but the solutions isolated will simply be different. With this in mind, specialist equipment like transplanters, under-cutting weeders are heavily indicated. Faced with the challenge of implementing these practices, some growers have gone the other way and just increased the labour force, which compensate for the additional production. There is obviously a marketing implication in all of this. The opportunities are accessible, but eventually, the object is to create a bespoke set of solutions that apply the soil health principles that fit your situation and scale.

Final thoughts

As I mentioned in Part 1 of this article in OG42, advice like this can seem somewhat glib or patronising but I feel that there are some real opportunities for growers at any scale in the UK. Once again, the steady and on-going application of the soil health principles will lead to cumulative gains and ultimately the complete solution is an accumulation of small changes that accrue over time. If in each year you can improve or eliminate one or two practices, your soil will steadily move to a healthier state. In turn this will bring benefits to the crops and the production which will mean that implementing more soil health practices will become easier year-on-year. Starting with a rigorous analysis of current practices and mapping these out in a detailed crop rotation plan and then substitute the existing management practices with ones that tick the most soil health principles, for a given point in the rotation.

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Niels Corfield is an independent advisor, specialising in soil health, agroforestry and whole-farm planning. Look out for his courses and talks in 2018. Next one: https://www.facebook.com/events/152898018767970/

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