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INTRODUCTION

MIKE DONOVAN, EDITOR

Substituting the plough, power harrow, sub-soiler and cultivator for a one-pass machine makes sense for any farm. Creating a soil environment which allows nature to do the hard work is, as we all know, beneficial to farm profitability, farming lives, greenhouse gas emissions, birds and bees.

These benefits fit with the thinking of Defra minister George Eustice, the current incumbent of a job which has been one for sprinters rather than stayers. He followed Theresa Villiers, minister for 7 months, preceded by Michael Gove (2 years 1 month), Andrea Leadsom (11 months), Liz Truss (2 years), and Owen Paterson (1 year 10 months). Gove called for the Agriculture Bill creating the slogan 'public money for public good', and Eustice has the task of making this happen.

Though from a Cornish fruit farming family, Eustice is a politician through and through. Having served a five year stint in Defra he described the EU Common Agricultural Policy as "a basket case", and it is clear that the move to a better system which rewards environmental work is a priority, but not straightforward. There remains a lack of detail on what qualifies as public goods. A recent article in Politics Home magazine The House (March 9, 2021) explained

'...post-Brexit the (UK) government wants to see sustainable, subsidy-free farming, that only rewards people financially for improving so-called 'public goods'. This means reward for improving the environment, animal health and welfare, and reducing carbon emissions.'

Author Kate Proctor says the majority of farmers in England will see a 5% reduction in income in 2021/22. Basic Payment is being phased out and ELMs phased in. The CLA sees a gap in the middle, which they are calling a 'valley of death'. The newly created Sustainable Farming Incentive aims to reduce the impact.

Eustice is wanting older farmers out so new blood can come in, saying we have to design future farm policies for the farmers of tomorrow. Incentives to get the oldsters out sounds logical, but has the danger of inflicting damage by loading young people with debt. Buying the farm from the older generation is far more expensive than inheriting it once they have passed on, thanks to Agricultural Property Relief.

The minister appears to associate farm progress with technology and data - the province of young minds - whereas the really exciting revolution is the substitution of farming with chemicals to doing the job by biology, something that is understood by older and young farmers

to an equal degree. Eustice (49) must be careful not to become too ageist.

Defra has yet to set practical goals and outcomes; has yet to determine a farmer extension or education policy; remains unclear about cropping and many other issues that farmers have to decide on. Matching these to the environmental outcomes set for the industry to meet targets needs the involvement of many different stakeholders, and I include publications such as Direct Driller which I believe is one of the most important environmental publications in Britain.

The value of diversity and the dangers of a one-size-fits-all farming policy to food production need remembering. The Covid pandemic shows that biblical events are ready to strike. These might include the potato famine, the failure of the groundnut scheme in East Africa or collective farming in Russia and its satellites. The variability of UK farming methods, and the choice of individual farmers to do what they see best, is something to be applauded and maintained.

Mike Donovan

www.farmideas.co.uk



WORK FROM HOME?

We have featured articles on many different types of robots that will at some point influence the way we farm, but have the simple wins in the arable world have been ignored? Possibly because they don't benefit the trade, maybe they are simply a bad idea or maybe a bit of both.

However, if the pandemic has shown us one thing, working from home is possible for a lot of industries. But the agronomists among us have not had this luxury. They, like the farmers, still have to get dressed every day and drive somewhere. Apparently, nothing can compare to actually walking a field.

Except for the fact I am being told by every robot manufacturer and drone app company out there, that it can. Why are companies so slow to offer you a digital agronomist? A cheaper version of a walked agronomist, who you have to send the pictures and information to and they help you make decisions.

My feeling is that it's a liability problem. Someone is responsible for whether the crops in a field grow or not. If an agronomist is walking a field, they can make the decision to turn left or right based on what they are seeing right now. They take on the

responsibility. But if they aren't there, someone else has to feed them the information. Can they really zoom into one of 500 pictures you send them every week and do the same job. I'm not sure they can and even if it was possible, who knows if they have been sent the "right" pictures for analysis. The question then moves onto, who is at fault when something goes wrong. Do farmers really want the extra risk of something going wrong just to save a few £s per hectare walking fee? Agronomists, keep you wellies at the ready, we still need you on farm!

Written by Chris Fellows

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LIVING MULCHES FOR SUSTAINABLE CROPPING SYSTEMS: A STEP TOWARDS 'REGENERATIVE ORGANIC' AGRICULTURE IN THE UK?

Written by Dominic Amos, Crops Researcher at the Organic Research Centre

As based on information found on Agricollogy (www.agricollogy.co.uk)

Reducing tillage and chemical inputs can be beneficial for soil and the environment, so could a permanent clover understorey acting as a 'living mulch', moving towards a perennial soil cover, offer a practical solution to reducing inputs and having more sustainable cropping systems?

This is the question being investigated by a group of arable farmers attempting to implement the system for input reduction through an Innovative Farmers Field Lab. Inputs in this case could be agrochemicals and fertilisers or tillage and diesel, depending on the current farming system. These are the two starting points of the group who are either already practicing long term conventional no-till looking to reduce chemical inputs or established organic farmers looking to reduce tillage. There is an imperative from both perspectives but whilst both farming systems can learn from each other, the challenges for each of making an alternative system work are quite different due to the respective starting points.

What is a living mulch?

A living mulch (LM) system includes aspects of several common farming practices and concepts such as cover cropping, intercropping, undersowing, and mulching, with the system building upon these approaches with full integration as a cropping system. In practical terms it requires the establishment of a perennial forage legume to provide protection for the soil as a (semi-)permanent ground cover common to perennial cropping systems such as top fruit or viticulture. It is rarely used in annual cropping

systems due to the competition with the cash crop so the question is, is it compatible with annual arable cropping? The LM approach differs from the well-known organic reduced tillage systems with the roller crimper pioneered by Rodale where the idea is to terminate high biomass cover crops to provide a dead mulch that helps suppress weeds for establishing cash crops. In truth this system relies on certain climatic conditions generally not experienced in the UK.

Services and benefits

The LM system can be expected to deliver a number of key ecological services to the agroecosystem including nitrogen (N) accumulation, weed suppression, enhanced soil physical characteristics (and trafficability), soil protection, catch cropping function, self-regulation of pests and disease, increased soil fertility and increased biological diversity. At this stage it is also worth considering that many organic farms already have weeds that provide some of the ecosystem services but with less control over species, so the mulch could be thought of as a 'designated weed'.¹

The two key services that need to be delivered for a LM system to best contribute to agricultural productivity

are weed control and N supply. Living mulches offer a potential alternative and sustainable strategy for these two provisions, although the amount of N made available for the cash crop and level of weed control will be greatly influenced by management and by the season. Conventional no-till systems may require supplemental N fertiliser to maintain crop yields. These two services offer an insight into the complexity of the system and the trade-offs (not necessarily unavoidable). There is a strong correlation between the mulch biomass and weed suppression and N accumulation services but high biomass will offer stronger competition against the cash crop.



Mulch and oats November 2020, Green Acres Farm

This management balancing act between cash and cover crop

growth throughout the season is the fundamental challenge to a working LM system - in order to harness the benefits of this permanent cover whilst limiting the risks to productivity. If enhanced soil health, increased biodiversity (above and below ground) and reduced emissions can also be delivered, then a more sustainable and resilient farming system is the prize on offer. There is a word of warning at this point since much of the research already conducted in this area including recent work at Stockbridge Technology Centre through the DIVERSify and TRUE projects demonstrate large and potentially unsatisfactory grain yield losses from arable LM systems that will require careful thought and management to make successful.

Enhancing beneficial interactions and managing competition

The ecological concepts that underpin the cereal-forage legume system are known as niche complementarity and facilitation and the system works on the principle of functional diversity. In theory this means the two 'parts' of the system work in harmony but in practice, particularly from the organic perspective, making the system work has proved elusive. This is a complex issue but a key factor is the interactions of the cash and the cover crop, and the ability to manage and manipulate the competitive advantage of the cereal. In fact, from an agroecological perspective, boosting the cash crop and weakening the cover crop at key times in the growing season is a real challenge especially since, as previously mentioned, weakening the mulch actually contradicts its key service provisions. Small doses of N fertiliser and herbicides can selectively weaken the clover and hand the competitive advantage to the cereal but of course these options are unavailable for organic farmers.

Farmer-led trials with Innovative Farmers

There are several areas that are being explored by farmers through the field lab:

1. Mulch species and establishment
2. Cash crop species and establishment
3. Mulch management (both externally and in crop)

Mulch and crop species selection

Different combinations of approaches are being tested with the farmers - utilising their knowledge of the context of their farms and systems and taking wider considerations into account to choose the most appropriate options for them. This will facilitate the peer to peer exchange and progress on living mulch best practice.

In the field lab trials the farmers have used a mix of wild white and small-medium leaf clover recommended by Cotswold Seeds, that has been selected to remain prostrate and provide persistence but with limited longer term competition against the crop. The clovers were established through undersowing into cereal crops in spring 2020.



Mulch post spring barley harvest August 2020, Litchfield Farm

Direct drilling cereal crops into the pre-established stand of clover took place last October with winter oats and rye selected for their competitive abilities.

How and when, or even if, to manage the mulch is a key question being explored. There are opportunities to mow or graze before drilling the cash crop, or even during the foundation phase of cereal growth in the late winter. One of the most interesting



Drilling October 2020, Litchfield Farm

questions is whether the mulch needs to be selectively managed later during the growing season and how this might be done? An option being considered is inter-row mowing, though commercial equipment is not yet available.

In conclusion

This fine balance of managing and manipulating the dynamics of a cash and cover crop to the advantage of the cash crop whilst maximising the services from the cover crop is what in the end will determine the successful implementation of what is on paper a sustainable and resilient way to farm the land - albeit one that will require a system redesign approach. In the end the system will rely on the knowledge and ingenuity of the farmers and the peer to peer learning to turn the theory into successful practice.

Agricology is an independent collaboration of over 40 of the UK's leading farming organisations sharing ideas on sustainable farming practices. We feature farmers working with natural processes to enhance their farming system, and have a wide range of farmer videos on our YouTube page. We also share the latest scientific learnings on agroecology with the farming community from our network of researchers. Our website hosts over 400 articles on different agroecological practices. Subscribe to the newsletter or follow us on social media @agricology to keep up to date and share your questions and experiences with the Agricology community



WHERE THERE'S MUCK THERE'S BRASS!!

Written by Jon Williams from www.thesoilexpert.co.uk

An old adage of farming practice we need to pay attention to with our management of our slurry and manures for the benefit of the environment and our farm business.

With increasing attention focused on the environmental impact of food production methods currently in practice and the industrialisation of agriculture via the dependency on this development from synthetic fertilisers and chemical cocktails which can be considered as a chemical experiment, it is becoming increasingly clear that this form of food production is resulting in depleted soils, of soil life and nutrients with the result that the food produced no longer has the nutrient density or health benefits gained from a more balanced living soil system more in harmony with nature.

The current industrial model of agriculture must take a new more holistic approach considering not just the short term gains but also the longer-term impacts of such methods of production and one way to assist in this shift is to change our attitude toward slurry and manure, transforming this from a waste product into one that is an asset.

The good news is that Governments are prepared to back this with financial incentives under the heading of providing "Public Goods"

The science of slurry and manure

To achieve the best outcome an understanding of the science of slurry and manure is useful and this combined with its impact on the soil when it is applied in different forms such as anaerobic or aerobic or fermented products.

Slurry

Anaerobic digestate or slurry from a crusted or covered pit will be anaerobic and will have more volatile gases present such as Nitrous oxide, Methane, Ammonia and Hydrogen Sulphide and to overcome the

immediate environmental impact of these gases it is suggested that they must be injected into the soil to reduce the impact of these gasses in the air, some of which are being blamed for creating particulate matter damaging Human lung tissue. All injection of slurries must be done when soil conditions are such that they are not holding water which will result in further damage to soil life and also soil structure. However there is a more serious long term implication when such a product is injected into soil. Being anaerobic the pH of Digestate in particular is above 8 (ref Wrap digestate and compost use in agriculture Feb 2016) and so the product is caustic and is detrimental to soil life as it burns worms which happen to like to live in an aerobic soil and so they take a hit but can get out of the way when injected in slots. The overall impact is that the soil is flooded with available ammonia and there is a flush of Nitrogen similar to when large amounts of fertiliser Nitrogen is applied and Rothamstead have just released the results of 40 years of research showing that the more available N that is applied to soil the more it distorts the genetic expression of soil organisms. (ref Andrew W Neal) So the overall impact of anaerobic digestate or slurry from a crusted and untreated or covered store has a negative effect resulting in the soil becoming more dependent on brought in synthetic nutrients as most of the Nitrogen is immediately available.

One alternative to this is to render the slurry to being aerobic and this can be achieved in several ways with huge benefits to the environment as well as to soil life.

Firstly let's look at what is the product we are dealing with and to understand how to manage it for our

best advantage and to have the least impact on the environment.

Slurry generally has a low fibre content and a high Nitrogen to Carbon ratio and is bacteria dominated with little fungi present and so in that respect it is an imbalanced product as far as the soil is concerned, however we have to make the best use of it.

The nitrogen content can vary according to the amount of protein fed to the stock producing the slurry because livestock are fairly inefficient at converting protein into meat or milk and so the higher the protein diet can produce a higher value slurry and it is therefore more worthwhile to invest in stabilising the nutrients held within that particular slurry.

One of the amendments that can be used to retain this value in our slurry is to render the product to become aerobic and this can be achieved in several ways, such as a mechanical bubbler, or by adding a catalyst such as Plocher and the result of these amendments is that as the slurry becomes aerobic the pH is dropped towards neutral with the aerobic bugs creating Carbonic acid which in turn stabilises Ammonium which becomes available for plant use in a similar form as comes from fertiliser. However not all the nitrogen is in this available form as

there is a portion that is retained as Organic Nitrogen as the slurry has become a stable product and is now not breaking down further as it would in a digester. The organic Nitrogen is slowly released during the months following the application and so there is not the flush of available Nitrogen as seen from Anaerobic digestate and the plant is fed in a more natural way which can have the effect of reducing the incidence of disease and better performance if conditions become dry.

Other methods of lowering the pH of slurry are being carried out with the addition of sulphuric acid which does stabilise the nutrients via the same process of lowering the pH of the slurry but does not render the slurry to being aerobic and of course there is the health and safety issues of handling and applying such a product and its corrosive nature damaging concrete slats and retaining wall.

However there is a relatively new method of lowering the pH from about 7.2 to 6.8 which is done by the addition of "Effective Micro-organisms" which encourages a fermentation of the slurry. This concept was developed in Japan by a Professor Higa in 1982 who coined the term "Effective Micro-organisms" when he discovered the mix of 80 microbes which work synergistically to ferment organic matter retaining the nutrients in a stable form. The fermentation actually pre-digests the organic matter making it immediately available to the soil organisms and thus to the plants.

This product can be used with a covered slurry pit which I understand is the proposal for management of slurry stores in England. E.M. is based on the principal of anaerobic fermentation and by lowering the pH, can retain the value of the nutrients within the slurry which when applied to the soil is already in a more mature form which allows the soil organisms to utilise it without using a lot of energy and there is no loss of volatile gasses into the environment. This treated product might no longer mean that you will be required to inject it into the soil which reduces the fossil fuel use of slurry application as well as wear and

tare on machinery.

Manure Management.

Having a different Nitrogen to Carbon ratio this product has a higher fibre level and therefore is more conducive to the establishment of a more balanced product enhancing both the Bacteria and the Fungi within the product and consequently when applied to the soil creating a more balanced soil.

Currently on most farms this product is not amended in anyway and under the proposed new legislation may need to be incorporated into soil with 24 hours of application. This of itself has an environmental impact by the very nature of ploughing it in there will be a further release of CO₂ into the atmosphere but the aim of this protocol I suggest is to reduce the ammonia going off into the environment thus lowering its potential impact on Human health.

So from this we can assume that untreated manure releases volatile gasses including Ammonia and that there is considerable potential benefit in stabilising those nutrients. Most farms still leave manure in a heap outdoors and uncovered releasing volatile gasses and allowing nutrient run-off, and even if an element of aerobic composting is carried out there is a further release of CO₂ into the atmosphere with considerable losses. Therefore the way we currently manage manure needs to be considered.

These issues can all be dealt with by treating the manure with Effective

Micro-organisms, known as Bokashi, which again ferments the manure stabilising the valuable nutrients including the ammonia and so the need for ploughing after application will not be necessary and manure application can be carried out on Min-tilled soils which will have multiple environmental benefits, retaining carbon as well as enhancing soil life and crop performance.

The product can be applied to the manure as it builds up in the sheds layering it by spraying it on the fresh bedding when added and the animals will tread it in creating an anaerobic bed but stabilising the Ammonia reducing its potential impact on animals within the sheds. Alternatively the sheds can be emptied and as the pile builds up the product can be applied in layers and then covered with a silage sheet for the fermentation to take place which is completed within 6 to 8 weeks leaving a mature product which will be soon converted into soil as it is quickly utilised by the soil life. This having a further benefit in feeding the soil Micro-Biome with a balanced product having both beneficial bacteria and fungi present and so the soil becomes less reliant for cropping with synthetic fertilisers and plants are less stressed with the potential of reduced disease.

An added benefit is having more product to spread on the land because the losses are dramatically reduced with no CO₂ going off into the atmosphere during the process of maturation and there is more carbon entering the soil thus enhancing the nutrient and water holding capacity of the soil as well as achieving greater Carbon sequestration, a "Public Good."

The micro-organisms in Bokashi can be considered as the new meaning of culture in the word agriculture and is already used by 75% of all Dutch farmers and I see no reason why it cannot achieve similar levels of use here in the UK. So a mind shift in thinking and a new attitude towards slurry and manure can result in a win, win situation both for the environment and the farmer.

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WHEN THE MEDICINE FEEDS THE PROBLEM

Do synthetic fertilisers and pesticides exacerbate pest and disease threats? A session at the Oxford Real Farming Conference looked at the science behind the claim

Written by Mike Abram

The use of synthetic nitrogen fertilisers is increasingly under the microscope, driven mostly by its impact on the environment and as a major contributor to greenhouse gas emissions on arable farms.

But presentations at the Oxford Real Farming Conference also pointed how its use, and that of pesticides, might be exacerbating pest and disease problems by enhancing the nutritional quality of crops for those pests and pathogens.

Nitrogen is the nutrient required in the highest quantities for plants, and was vital for crop growth and development, explained Daisy Martinez, a researcher at the University of Edinburgh.

"Plants take up nitrogen from the soil, and use it to synthesise amino acids – small, molecular building blocks – and then use it to build proteins. Proteins are the stuff of life alongside carbohydrates."

But when the crop was flooded with too much soluble nitrogen, in the form of synthetic fertiliser, the concentration of amino acids expanded faster than the plant could make proteins, she said.

"So the plant is rich in amino acids, which are valuable nutrient sources for pests and pathogens. It's like saying welcome to the banquet."

A literature review of scientific papers found some insect pests laid more eggs on crops fertilised with high nitrogen rates, larvae developed more rapidly to a larger size and were more likely to survive and reproduce, she said.

"In the literature we found many examples of significantly denser populations of insect pests fertilised with high rates of nitrogen fertiliser compared with lower rates."

Similar was true of fungal and bacterial pathogens, where crop disease severity measured by things

like microbial colony-density, disease lesion area or spore production, increased where nitrogen was used at high rates, she said.

"These findings support the idea that intensive fertilisation with synthetic freely available nitrogen feed the problem with pest or pathogen damage by enriching the quality of our crops through the availability of nutrition."

These findings supported the conclusions of a relatively little-known French agronomist Francis Chaboussou (1908 - 1985).

But there was more to the story as just as humans have defences against diseases, so do plants, she said. These ranged from physical defences, such as waxy protected surface on leaves or strengthened cell walls, to producing defensive chemicals.

"Some of these chemicals are toxic and kill the pest or pathogen outright, while others make the crop less palatable, so the crop is not worth eating or impossible for the nutrients to be absorbed by the pathogen or pest."

The chemicals could be split into two broad groups – nitrogen-containing or carbon-based compounds, she said. "The natural production of these chemicals can be enhanced or suppressed in response to nitrogen fertilisation.

"High nitrogen availability typically decreased production of the carbon-based defences, while stimulating the production of nitrogen-based defences.

"But whether that is good or bad for

the crop depends on the context, and on the crop. There are many of these compounds, and particular chemicals can be more or less crucial in different crops.

"And it gets even more complicated as the pests or pathogens can be more or less sensitive to these chemicals as well so you might get an insect that is really deterred by one chemical but isn't sensitive to another. It's just a really complicated area," she said.

"But the main message is that nitrogen fertilisation doesn't only just affect the crop's nutritional quality, and therefore their susceptibility to pests and pathogens, it also affects their defences.

"It is not possible to say more N is good or bad for defence, it depends on context, but it is an area that needs more research," she concluded.

Do pesticides also enhance the nutritional quality of crops for pests and pathogens?

The research team also looked at whether applying pesticides also enhanced the nutritional quality of crops for their pests and pathogens. "This is a little paradoxical – pesticides are applied to crops to suppress, deter or kill pests or pathogens, and should be minimally harmful to crops in the process," Daisy said.

The study's hypothesis was that pesticides counterintuitively by their impact on the crop's internal biochemistry might actually benefit pests and pathogens by improving their diet.

"We looked at several studies which

showed applying pesticides resulted in several significant biochemical changes in the crop's tissues. These changes are akin to others that are commonly seen in plants under stressful conditions.

"The crop is able to cope with the stress – it doesn't keel over, but the

outcome of these metabolic shifts is the accumulation of amino acids, especially nitrogen rich ones.

"And these are valuable, nitrogen-rich nutrition for pests and pathogens," she explained.

"While these studies were not designed to test the effect of the biochemical changes on crop susceptibility to pests and pathogens, our tentative hypothesis is they might make use of this pesticide-stressed biochemical state in the crop for their own benefit."

Who was Francis Chaboussou?

Francis Chaboussou is a relatively little-known French agronomist. But he was perhaps one of the first people to suggest that crop management could impact plant biochemistry and change how palatable they are to pests and diseases back in the 1980s.

His widely-ignored book, *Healthy Crops: A New Agricultural Revolution*, was first published in 1985 and offers a critical exploration of the plant science behind organic, agroecological and biodynamic agricultural approaches, according to the Gaia Foundation, which has recently republished an English translation.

The core theory in the book, known as trophobiosis, describes how and why on a biochemical level, healthy crops which are getting what they need from the surrounding environment makes them more resistant to pests and diseases.

The use of chemical pesticides, however, he argued undermined plant health and resilience made pest attacks more likely.

The book can be read for free online:

<https://www.gaiafoundation.org/healthy-crops-a-new-agricultural-revolution/>

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MY IPM AND NUFFIELD JOURNEY HAS STARTED...

Is the adoption of IPM (integrated pest management) a journey? A journey of change required to react to changing market demands; a journey of learning, stemming from wanting to do something different to protect natural beneficials and predators; a journey to increasing profitability from the production of a crop grown to an IPM enhanced standard? Teresa Meadows, Nuffield Scholar 2020, shares her thoughts as she sets out to look at this topic in more depth.

The start of my global Nuffield journey has shown these themes developing through the conversations held with farmers, growers, consultants, researchers, CEO's and organisations across the world. I am looking at how we can learn from these people and practices around the world to be able to increase the uptake of integrated pest management in the arable sector back here in the UK.

Embracing the virtual world over the last few months, I have had the pleasure of speaking to people both at home and abroad from the comfort of my home office. I have spoken to those who are long established IPM practitioners, such as Andrew Watson, cotton grower of Australia; those that are carrying out research so that an IPM approach can be adopted, such as Sarah Mansfield, researcher on pasture pests in New Zealand or those that are taking those practices out to the field, such as Vinod Pandit, running the Plantwise programme in Nepal.

The conversations from Bangladesh to Switzerland and the US to Germany have covered crops including leeks, cotton, pumpkins, tomatoes, onions, pasture,



The faces of Nuffield conversations, 2020

cut flowers; protected glasshouse and field crops and every conversation has been had with someone with an enthusiasm and a passion for the topic of IPM, in its different guises.

There have been so many highlights already and many conversations that have served to provoke or change thinking. A selection of these are included below...

Putting IPM at the start and heart of a programme

Fargro's IPM specialists, Neil Helyer and Ant Surrage (www.fargro.co.uk/) work hard with their horticulture growers on creating IPM programmes – putting cultural control and biological approaches first and at the heart of what they do...and only using chemical approaches as a last resort. Can we change our mindset in the arable sector to design an 'IPM programme' for our crops, rather than a 'fungicide/herbicide programme'? There are lots of good examples of IPM being employed across our sector, but do we bring this together as a holistic IPM programme at the centre of what we do for everything, and name it that? Perhaps not quite yet?

Monitoring to increase understanding

Andrew Watson, cotton and arable farmer in Australia (Twitter: @bugs_r_us) has driven the use of recording through the season, not solely of crop growth stages, but also of pests and natural enemy levels and has gained so



| Field | Pests | | | | | | | Beneficials | | | | | Crop Development and Health | | | | | | | | |
|-------|-----------------|-------------|-----------------|-----------|------------|----------------|---------------|---------------|---------------|------------|-----------------|--------|-----------------------------|-----------|--------------------|----------------------|------|-------------------|--------------------|----------------------------------|--|
| | Heliothi s/m | Mirid /m | Stink Bug /m | ADB /m | Mites % | White fly % | Other | Beetles /m | Spiders /m | Bugs /m | Lace wing /m | Others | Nodes | Nutrition | Retention FP-1% | Fruiting Branches | NAWF | Vigor / growth | Next Irrigation | Comment | |
| LatA | | 1a2n | | 2a | 20% | P | Pb,Js high | 14 | 7 | 1dm | | Thrip | 23-24' | | | | 0-3' | Hot | Soon | High shed, cav, boll stings | |
| | | | | | | | | | | | | | | | | | | | | | |
| N2 | | 4n1a | | 5n | 30% | P | Js | 20 | 5 | 2dm | | Thrip | 24-26' | | 75% | | 0-3' | Cout | Wet | High sting, bolls, shed, cav | |
| W4 | | 5n | | 3a | 25% | P | Js | 15 | 8 | | | Thrip | 24-25' | | 78% | | 2-4' | Gd | Soon | Shed, cav, loadg up, stung bolls | |
| W11 | | 3n | | 4n | 10% | P | Pb,Js | 12 | 6 | | | Thrip | 24-25' | | 83% | | 2-4' | Gd | Soon | Very, shed, gd boll size | |

Crop, pest and beneficial record sheet example

much value for the business from this approach. His weekly cotton recording data, consisting of plant mapping (height, number of branches, number of fruit) is collected alongside insect profiles and these are charted against the rising levels of pests and beneficials. The knowledge of this interaction has allowed an increased understanding of the levels and the natural fluxes, moving from an average of 3-4 insecticide sprays per year to only having one year that they have had to spray the farm since 2007 and trying new approaches and technology, such as releasing beneficials from drones above the crop. Could/should us as farmers or our agronomists or advisors be monitoring pest and natural enemy levels for our arable crops and using the outcomes to make decisions? We are good in many instances at monitoring the pests, but do we monitor the beneficials to the same degree?

A structured programme of advice and extension

Vinod Pandit who runs the Plantwise (<https://www.plantwise.org/>) programme across South East Asia, including Nepal, India and Bangladesh attributes much of the success of the initiative to the structured programme, formed of three main fields:

1. Plant health system – formed of the Plant Clinics run by their Plant Doctors at the forefront, where rural villagers can go to get their information, diagnosis of samples and advice.
2. Knowledge Bank – an online information system with the latest research, articles and tools to support those on the ground with technical information
3. Monitoring and evaluation – to see what actions have been successful and what has been delivered on the ground, which can then be used for continual improvement.

With Plantwise partners in 33 countries and 9,200 Plant Doctors based in these countries, the successful implementation is attributed by Vinod to the strong extension system and easy implementation using the knowledge system to back-up advice and guidance.

Can AHDB and others across the UK arable advice sector follow a similar structured programme, bringing together existing knowledge, information and programmes into something that is widely recognised as the “go-to” place for information, advisors running a structured programme of extension and the programme continually evaluated and improved?

The incentives

Abdullah al Shakib, an independent research consultant in Bangladesh, recently evaluated a behaviour change programme with 50,000 smallholders in rural communities in the country. The discussions about the main reasons for change through these programmes rang true for many of our experiences and discussions – the impact of effective knowledge sharing in communities, the need for independent advice, the use of ‘lead farmers’ in a community, but also the positive impact of a financial incentive.

Abdullah went to two districts as part of his work, where the programme was working to influence the introduction of integrated pest management. He found that in one area, the farmers had seen a 200-300% improvement in their practices. In the other area, this was only 30-40% increase above the baseline. Abdullah was very interested, why, with the same kind of interventions, one area performed so well against the other lower performing one.

In the area not performing well – they smallholders were selling to local traders and local fruit shops, so the prices were low and they weren't

receiving any agronomic information from the buyers.

In contrast, in the area with high performance levels, the smallholders were able to link with big buyers and big chain stores, such as Agola, who were purchasing their vegetables, as well as their milk. So, when purchasing, the buyers would say, “you can give me the pumpkin, but it has to be a weight of 1.5kg and this colour and if it reaches this specification, you will get 30-50% more price...”. This agronomic information helped with the growing of the product and these new practices were then implemented and rewarded by a higher price.

Abdullah's conclusions were that in every business, you need to show incentives – either a cost reduction, increase in productivity or increase in price...or a combination. Conversations with Abdullah and others surrounding incentives, centred on the financial reward, reduced business cost or increased market access from the use of IPM measures. Can this financial compensation be created in the UK arable sector to add extra incentive for the widespread uptake? How important is this factor vs others – I am interested in looking into this further as I proceed in the conversations.

The Nuffield journey has started, the conversations around integrated pest management and facilitating the widespread uptake of these practices have begun, themes are emerging and conversations naturally lead to more questions, avenues to investigate and more passionate, articulate and enthusiastic people to talk to. To follow my Nuffield journey, please see my blog posts on LinkedIn or keep a track via Twitter (@CerealsEA).



NUFFIELD
Farming Scholarships

A BLANK CANVAS

Written by Tom Chapman, Head of Regenerative at Innovation for Agriculture

How would we design agriculture now, in the 21st Century, if we were starting from scratch? What would we do differently, given what we know about regenerative agriculture and about farming with, not battling against, nature? Would we continue with the same cropping, the same machinery, the same fertiliser & spray regime and the same field layout or would things be radically different?

We should all know the five golden rules of soil health, but it never harms to reiterate them. They are:

1. Always keep the soil covered and protected from the elements
2. Keep a living root in the soil at all times
3. Avoid both chemical and physical disturbance of the soil
4. Avoid monocultures, diversity is essential
5. Integrate livestock into your system

Starting with a blank canvas, the farming system that most closely meets the above rules is a perennial crop of forage plants interspersed with trees and shrubs and grazed by a mixture of ruminants, monogastrics and poultry. However, humankind has a massive (and some would say disproportionate and unhealthy) demand for grains so we need to find a way of integrating the growing of these into our 'new' farming systems. Unfortunately, perennial grain crops still appear to be many years from commercial reality, so we need to find a different way to tick the soil health rules using annual cropping.

A number of farmers in Australia are growing crops drilled directly into long-term permanent pasture, giving it the obvious name of 'pasture cropping'. As the grasses start to slow in growth and become dormant in the autumn, these pasture croppers drill their cereal crops directly into the sward. In early spring the combinable crop grows away from the grass, shading the latter and slowing its growth. After the crop is harvested in mid to late summer, sunlight can,

once again, penetrate to the forage understorey and its growth accelerates.

They accept that the grain yields from the system will be lower than we currently achieve, but they also know they can, effectively, double-crop it, moving their grazing animals onto the grass understorey once the grain crop has been harvested. The wonderful thing about the system is that it captures much more sunlight: No more bare earth, lacking in green leaves to photosynthesise and produce sugars. Consequently, they are seeing tremendous improvements in soil health. Root exudates feed the soil life, year-round; grazing livestock convert the crop residue and forage plants into plant food; humus levels rise; and the land becomes vastly more fertile.

There are a number of farmers here in the UK who are experimenting with this technique. At the moment forage rye is most popular, so not strictly a standard combinable crop, but its ability to continue to grow at low temperatures and its tall growth habit, relative to the grasses, means they are having some success (I drilled a mixture of forage rye and vetches, last autumn, directly into permanent pasture and am watching its development with great interest).

If we were to adopt this practice more widely in the UK, and to do it with mainstream wheats, barleys and oats, would we see a return to the taller-growing varieties of yesteryear? Plants that could rise above the grasses growing at their base would capture more sunlight, as well as making harvest easier. They would also have to be deeper rooting, to out-compete the

grasses below ground. The improving natural fertility offered by the healthy soil is likely to lead to stronger plant stems which, combined with the slightly lower yields, means lodging risk would be lower than we experience with tall plants in our current farming regime.

There is a downside to the above plan, from a regenerative point of view, in that the annuals being sown are still a monoculture, albeit sown into a (hopefully) diverse sward. Would our 'designed from scratch' farm truly be drilling monoculture crops, or would it be drilling a range of different crops - grains, pulses and legumes, oilseeds and brassicas - into the same field? This would be the 'herbal ley' of the cropping world. The mixed crop would have a varied leaf architecture, to maximize the amount of sunlight it intercepts. The roots would differ too, with some surface feeders and some reaching deep down into the subsoil, bringing up water, minerals and other nutrients as well as adding organic matter at depth. The diversity would host an amazing array of beneficial organisms and fungi, all working to improve the soil still further.

Designing such a farm from scratch, though, would also mean designing from scratch the way we harvest our crops. A traditional combine harvester probably wouldn't be able to handle a range of different-sized seeds. Now I'm no mechanic - those who know me will ascertain that I'm a true 'dog and stick' farmer (though without the dog!) - so will leave predictions of what the new harvesting machine would look like to those with more of an engineering bent. Could such a machine do the harvesting, the cleaning and the sorting of seeds in one go, or would the mixed crop need transporting back to a specialised threshing and dressing machine at the farm?

Shrubs and trees would also feature in our 'new model farm'. Silviculture can already be seen on a number of farms with fruit and nut trees forming alleys wide enough to allow a sprayer

or fertiliser spreader to pass through. Typically these are in straight lines, though with GPS and autosteer, do they need to be? It would be much more natural to have sweeping curves to our cropped areas, reducing wind flow and creating microclimates across the land. There could be a mixture of hedges, grazeable shrubs and trees, some for firewood and some for fruit and nut production. Certain tree species even fix nitrogen!

Would we be able to throw away our sprayer and fertiliser spreader on our 'new' farm? Monocultures are like commuters on the London Tube: one person coughs and they all catch a cold. Likewise in your fields, a stray fungal spore, or a swarm of insects and the whole crop is decimated. Growing a 'herbal ley' of arable crops in a permanent pasture sward would mean disease would find it incredibly difficult to spread, just as insects would have a tough time targeting their preferred host plant.

The mixture of plant species, in conjunction with the animal

grazing, would mean the crop is also self-fertilising. We already see this with forage-based herbal leys and never seem to need artificial fertiliser to make them grow. Nitrates in water, nitrous oxide emissions polluting the air, such things could be consigned to the annals of history, were we to follow this path.

Putting the engineering challenges to one side, a mixture of crops, surrounded by trees and shrubs, all growing in a permanent pasture field that is grazed by cattle, sheep, pigs and poultry for part of the year ticks all the soil health rules. Soil is continually covered, there are always a diverse mixture of living roots in the ground, which isn't disturbed (either by machine or by chemical), and the livestock dung, urinate and salivate onto the fields to stimulate the soil biota. Cash crops are harvested each year and the land also produces beef

and lamb for sale.

Sunlight would be captured all year round, pumping energy into the system, minerals would be cycled and recycled, both in the acidic root zone and by the growing quantities of soil fungi and bacteria, and the water cycle would start to function properly, with surplus rain captured and held by the carbon in the soils to tide you over the dry periods, rather than running in sheets over the land and out to sea, carrying precious topsoil and nutrients as it goes.

We are all weighed down by the baggage of our existing paradigms, and many will say the above is just fanciful, but could it be the future, if we started with a blank canvas?

Do you have any suggestions for a Blank Canvas Farm? If so add them to this article on The Farming Forum. Follow the QR Code to add your suggestion.



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DOES PLOUGHING FIT IN **REGENERATIVE** **AGRICULTURE?**

Watching the live feed from NASA last week as the rover 'Perseverance' touched down on Mars was a quite spectacular achievement. A planetary alignment, or confluence, of millions of externalities came together to achieve something marvellous, along with a generous helping of rigorous planning and attention to detail.

Sometime a series of events can surprise you in every way. Just recently a series of events unfolded which form the basis of this article. The first instance was when someone posted on TFF a slide from a webinar which appeared to show that ploughing was good for the soil. Intrigued by this I found a recording of the webinar and proceeded to watch with interest. The researcher presenting the webinar made no such claims about ploughing, quite the opposite, it was suggested that to increase SOM we needed to move away from intensive cultivations. As per usual communication was the loser, and I suspect a lot of people went away feeling rosy as they knew that cultivation was again ok. A few days I was watching another webinar listening to notable practitioner and teacher of 'Regen Ag' espouse that ploughing in a regen ag system is ok because every farm and every situation is different. At this point I went and found something better to do than listen to pointless nonsense. I'll admit that the first pillar of Conservation Agriculture (CA) makes reference to 'minimal soil disturbance' and not 'no soil disturbance', but does it really allow for maximum disturbance? I know that we all want to be flexible. Flexibility within the confines of the system is allowed, but ploughing is well and truly stepping out of the system, and for what? I would argue there is no gain from rotational ploughing, in fact I would go further and suggest that each rotational ploughing destroys the very biologically active system we are trying to create. The clock has been reset to zero and you have to start all over again. It should be noted at this point when I refer to ploughing or cultivation I am referring to any intensive cultivation such as subsoiling, ploughing, combined single pass machines with legs and discs, powers-harrows etc.

The final event happened shortly after the aforementioned webinar where I happened to hear James Alexander of Primewest being interviewed on Radio 4's 'Farming Today' programme. James mentioned some research that had been carried out on his farm comparing the net carbon gains of his organic system compared to his Regen Ag system. Knowing James a little I contacted him to find out more about the work undertaken and the results. Upon speaking to James it became clear that the real eureka moment had been completely lost in the short clip played on Farming Today. Cultivation, as we all know, plays a considerable part in carbon release from the soil. The research, undertaken by Charlotte Cook of

Indigro Agronomy, using the Cool Farm Tool to calculate net carbon release and sequestration, revealed exactly what I was anticipating. It is important to note at this point that if you are not practising Conservation, or Regenerative Agriculture then cultivation is an important part of your overall establishment strategy. We are not against cultivation per se but are focused on achieving the benefits of optimising cultivation inputs.

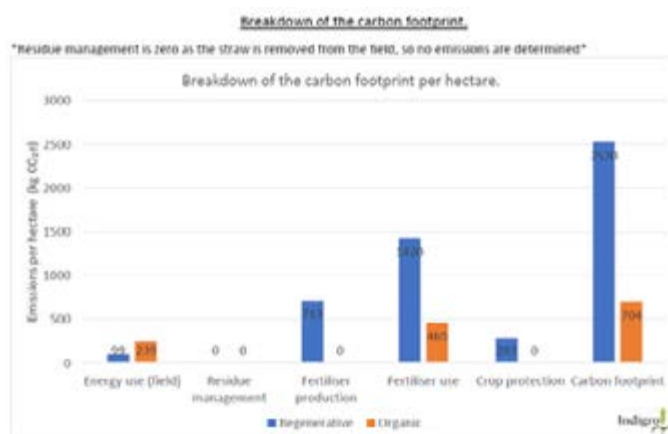


Table 1

From the data in table 1 it can be seen that for all metrics, except fuel use, the regen ag system has a higher carbon output than the corresponding organic, in particular the massive spikes from the manufacture and use of nitrogen fertilisers. This does not come as a surprise as I am sure we are all familiar with the large energy demand during manufacture of fertiliser N and resulting carbon-loss from soil once the nitrogen is applied. All of this does not paint Regen Ag in good light until we turn our attention to the broader picture with the inclusion of cover crops into the calculations, shown in table 2.

Here we can see that the action of including cover crops along with reduced soil movement through zero-till has significantly altered the picture. The carbon stock change per hectare now shows a large net sequestration of 8.7 tonnes/ha for the regen-ag system. This is over 3 times the sequestration achieved compared to a production system where intensive cultivation is employed. This tends to agree with some research from the US which showed that soil ploughed to 11 inches released 30 times more CO₂ than undisturbed soil in the following 24 hours.

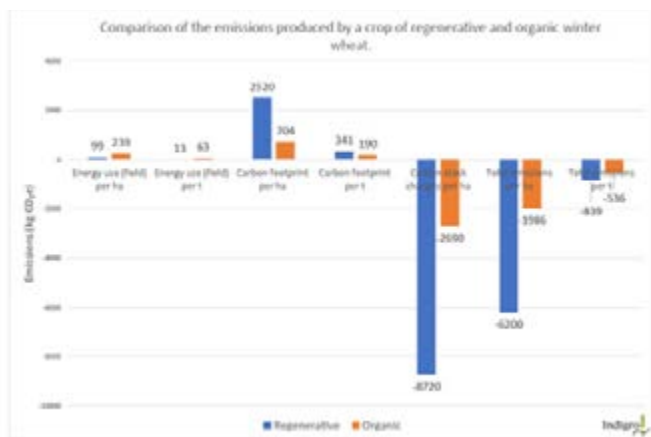


Table 2

I am not trying to pit organic against conventional production, far from it, but it's a useful comparison to show that our choices are not always straightforward. It also very much depends upon your viewpoint on the use of pesticides. The most important point of all of this is that we have to learn to reduce our tillage practices as much as possible if we really want to benefit our soils and the wider environment. Similarly we are going to have to become a lot more focused on our use of nitrogen fertilisers. While we may be able to reduce our dependence on them partially I am not certain we can ever maintain our current level of output without them in some degree. Our use of nitrogen fertiliser is probably on borrowed time, and we really need to focus on how we can use this resource much more efficiently, or at

the very least begin to cut N rates back. A production system based around CA principles should allow us to do this, for as we build soil carbon, we are naturally building soil nitrogen. We also need to 'grow' more of our own nitrogen through better rotations and better soil health.

Good soil health can be measured by indicators such as soil bulk density and porosity, water infiltration and air movement, good levels of soil organic matter and biological activity, reduced loss of soil, nitrogen and phosphorus into ground and surface waters. We know intensive tillage negatively affects all of these parameters and every time we plough we effectively reset the clock on achieving the aim of functioning soil. It could also be argued that by doing this you are never going to see the real financial benefits of regen ag and functioning soil biology if you cannot reduce the level of cultivation you employ. So with good planning and attention to detail it is possible to employ a production system which does not rely on the damaging effects of cultivation, and the wider environmental issues that cultivation can create. But ultimately are we happy to allow the promotion of #ploughing in conjunction with #regenag? Or does this detract from the message we are trying to convey?

My warmest thanks must go to James Alexander of Primewest & Charlotte Cook of Indigro for allowing me to use their research. I must also stress that I have used their research to support my own particular viewpoint and may not necessarily be what the authors were intending to show.

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GROUNDSWELL 2021

CHANGE THE WAY YOU SEE THINGS

Gabe Brown often quotes his friend Don Campbell's aphorism: 'If you want to make small changes, change the way you do things. If you want to make major changes, then change the way you see things.' This nutty little saying encapsulates so much wisdom, but it is much easier said than done. We all have our own little prejudices or theories about how the world works, or more crucially about why we farm the way we do. It is surprisingly hard to stand back and look at our operations and really see what is going on and how it could change for the better.

The great thing about the whole Regenerative Agriculture movement is that it is almost completely farmer-led. There are plenty of suppliers who are now producing drills and other products which the pioneer farmers have created a demand for. There are also more than enough suppliers trying to jump on the bandwagon and flog us stuff that we don't need. The habit of looking for solutions in bottles and bags seems to be ingrained in farmers, but, as readers of this publication will know, most of us need fewer inputs the longer we direct drill and we have resigned from the More-on club.

All that we need to do now on our farm, is ramp our yields up a bit, without 'buying' them and we'll be even better off. Or...we could take advantage of some of the lessons that Lockdown has taught us and work at growing crops and other produce that local people want to buy and sell direct to them. Grow less and sell for more.



The trouble with trying to increase production is that we keep making mistakes, like ignoring the golden rule that no-tilled crops want to go in a fortnight earlier than with 'conventional' establishment in the autumn and a fortnight later in the spring. Last autumn we held off drilling oats until the wheat volunteers had chitted...and then it started raining. A bit like the year before. We

eventually sowed them on a frost in mid February (it's kind ground where they've gone) and it looks like we've got away with it, as the weather post-drilling has been kind to the seeds.

As I'm writing this, at the end of February, we're drilling Mulika spring wheat into the remnants of a cover crop on more kind ground. The soil is in fantastic condition and the forecast is good, so the seed should be able to get away before any horrific rain event tries to drown it. Some of our later drilled winter wheats spent most of the winter looking a bit miserable with wet feet. Some patches we'll end up having to redrill or over-drill with Mulika.

Time will tell if we will pay for this



Affinity Water Catchment Hub



Jay Fuhrer, USDA, presents the damaging effects of rainfall on bare soil

'Inspirational speakers and a great way to meet up with like minded farmers.'
2019 attendee



Groundswell

'The highlight of the show calendar, and the future of agriculture.'
2019 delegate

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Still "By Farmers, For Farmers"



Compaction trial at Groundswell

rule breaking, but we've had our fingers burnt too often by waiting until late March or April for spring sowing, this is too often followed by a long cold dry spell, which sets the crop off to a rotten start and ends with disappointing yields. The trouble with this being a farmer-led revolution is that farmers are the only ones doing meaningful trial work on this. Some of our trials, if we're being honest, are just a polite way of describing mistakes.

We've had a lot of feedback from attendees at the Groundswell Show saying that they want to change their system but don't know how to set about it, or that their agronomist/father/husband or whoever tells them it won't work on their land. So we've set up Groundswell Agronomy. It's basically a dating agency: you get in touch with us, we'll have a talk and then put you in touch with an agronomist who should be able to help you out. We've got a selection of wonderful and open-minded agronomists to put your way. It's proving popular, we'll be needing more soon so we don't wear out the ones we've got.

As I often point out to people, we are, to an extent, making it up as we go along. We are not a demonstration farm exhibiting best practice, but we are still very excited about the potential we have, as farmers, of growing good food to sell, at the same

time as improving our soils, the local environment and our bank balance. This enthusiasm for different ways of doing things is why we started the Groundswell Show

We've been very relieved to hear the Government saying that by the end of June lockdown should be properly over. Which means we're going full-steam ahead with organising this year's Show (23/24th June 2021). We've shifted the site to a nearby field and all the talks etc will be in tents rather than barns, which means we should be able to ventilate and socially distance if needed. As usual, it'll be a nightmare trying to juggle

which talks to attend. We've had so many interesting ideas for subjects to discuss put to us, that we don't want to turn any of them away. It is such an exciting time to be a farmer.

At the moment it still looks doubtful that we can fly many, or indeed any, high-profile speakers in from abroad, but it may work well as we can put on many more homegrown speakers who are all doing fascinating things around the UK. See box for some details. We'll have a new trial plot for the direct drills to work in, with plenty of space and more exhibitors bringing more ideas in. For those who fancy a walk, there's an agroforestry experiment nearby, coupled with a no-input heritage wheat with clover understory experiment as well as the mob-grazing demo.



We're not sure exactly how many people we can host each day, we'll start selling tickets when we know... it won't quite be like Glastonbury so you won't have to go online at midnight, but it does sound like we'll sell out pretty quick, so don't hang about if you want to secure a place.



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FARMER FOCUS

JOHN PAWSEY



I was kindly featured in the January 2020 issue of Direct Driller magazine under the Agricology umbrella which was really an overview of the farm, where we had come from and where we were now as regards to our predominately, although diversified, farming business. Being asked again for a contribution is a great opportunity to give you an update and be more specific about how we are evolving along our organic farming journey.

For those of you whose blood runs cold at the mention of cold steel interacting with soil, I suggest that you move swiftly on to another page and embed yourself in the perfect aggregation of undisturbed seedbeds, because in the absence of pesticides and chemical fertilisers, some form of tillage is needed to feed and weed crops. We all know that the evil trilogy in terms of damage to soil health are embodied in those three interventions, and although scoring well in terms of non-chemical usage, less tillage is still top of our organic ambition.

We, along with others, have been venturing down the living mulch route. Our aim is to keep a low growing clover in the soil throughout our rotation to provide soil cover, smother weeds, feed the soil, encourage multi-species interaction with a harvestable crop and do less tillage.

Our mulch at present is the Cotswold Seeds mix of Aber Ace wild white clover (80%) and Aber Herald white clover (20%) under-sown at 7.5kg/ha. We have grown it for two years now and to date the crop has outcompeted it which gives us some confidence that the mix will do its intended job. It would be great to get more species into the mix, but I'm keen to keep it simple at the moment.

Other trialists are direct drilling straight into the living mulch sown broadly across the field, but having been under-sowing leys and fertility builders into our soils for over twenty years I do have concerns about this approach.

In my experience, clovers take a huge amount of water out of the soil and although you may get away with allowing the



A picture of our living mulch

white clover to run free over a number of years in the damp West, in the drier East we have suffered considerable yield loss through those leys over-competing with our cash crops for water. I feel that we will have to contain the clover to lessen that effect as well as finding a mechanism to control its lateral growth and mineralise a small amount of nutrients to get an autumn or spring crop going.

We currently under-sow leys in 200 mm bands with our System Cameleon drill/inter-row hoe in-between our crop bands of 120 mm. My idea is to strip-till those 120 mm stubble rows at a depth of 40 to 60 mm to break the lateral white clover roots, do some weeding within the crop row and use some of the nutrients built up during the year by the living mulch. There is obviously some tillage going on there, but in essence only at a shallow depth and in less than half the field, just under 38% of the ground.

The difficulty is finding a strip-till cultivator that will do the job. There are plenty of machines born out of the wide row world of maize, sunflowers and sugar beet that will till at 450 to 500 mm, but having searched the world's websites for a machine that will till at 320 mm centres and in a 120 mm width, I have drawn a blank.

We would require a nine meter machine to fit our controlled traffic system which would mean twenty eight units and some pretty clever engineering to make sure that as little soil as possible is disturbed and that the living mulch is cleanly cut.

I'm currently working with a Dutch company who specialise in weeding equipment to build a machine to fit that specification to trial this autumn.



System Cameleon hoeing organic quinoa



Our usual fertility leys coming through some spring barley

It seems to me that vertical discs or cutters will be crucial to cut the clover as well as contain any moved soil in that 120 mm band. I would assume enough variable pressure (to take into account soil type or condition) on a low disturbance tine would also be key.

The intention would be to strip-till the 120 mm cropped rows in appropriate conditions after harvest. Sowing will be done with our System Cameleon which can also hoe any weeds germinated in the tilled row at sowing time, with the seeds benefiting from some mineralised nutrients from the moved soil. A natural starter fertiliser if you like.

Autumn sown crops and the living mulch could be grazed

over-winter by our New Zealand Romney ewes if conditions allowed - the Golden Hoof!

For spring grown crops timing of that strip-till would be more crucial, but hopefully the clover extracting water, the benefits of undisturbed soils within the living mulch, should provide a better opportunity for success than our present system. Again, our sheep could be used over-winter to lightly graze the clover and to keep it in check pre spring sowing.

Although at present I am still intending to run the living mulch within our current six/seven year rotation of two/three year leys for the sheep and building fertility followed by four years of combinable crops including a legume crop, it could revolutionise the way we farm.

If successful can we throw a set rotation out of the window? If we are building fertility annually within a cropping system, dealing with weeds through minimal tillage or through competition will we actually need a dedicated fertility building period or even a break crop? Will animals' numbers and cropped areas be able to fluctuate depending on the market be it the combinable crop market or meat market?

Could we be looking at a completely fluid system?

There are so many things going for this approach and we haven't even started on carbon capture.

I'm sure that you have spotted some agronomic schoolboy errors, but it ticks many of the boxes of the challenges we all face if we can make it work.

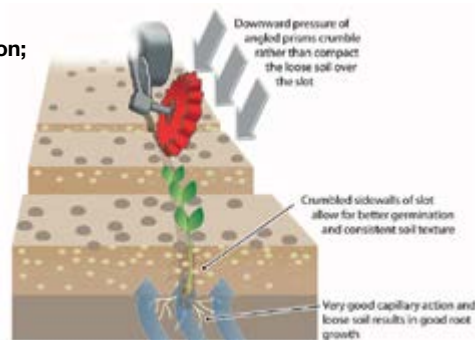
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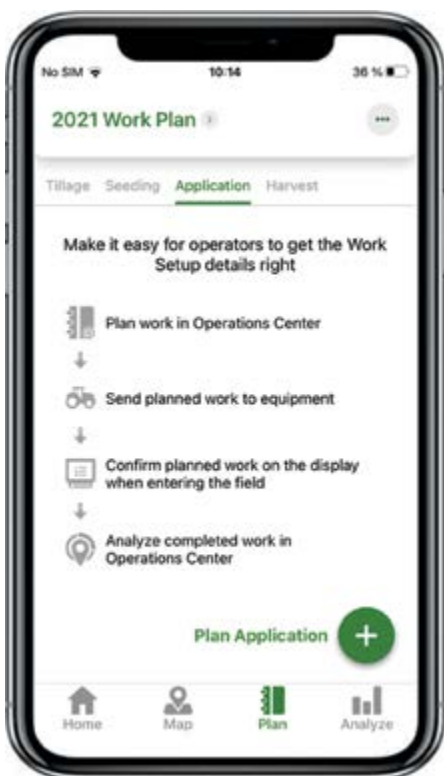
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DRILL MANUFACTURERS IN FOCUS...



JOHN DEERE SIMPLIFIES OPERATIONS CENTER

The new look, feel and navigation of the John Deere Operations Center make it easier to use and provide a more consistent user experience with the latest mobile version.



The established MyOperations App for smartphones and tablets has been renamed Operations Center mobile and pairs well with the Operations Center web version. Both provide users with an all-inclusive farm management tool. Another improvement is the addition of Work Planner, which is now a key feature of the new AutoSetup system that allows farmers to streamline their work set-up and help operators start working more quickly in the field.

Farmers already use the popular Operations Center to collect and securely store their field, crop and machine data from their connected machines for easy analysis and to aid decision making. To meet the constantly changing demands of the business of farming, the improved

Operations Center is designed to bring more clarity and organisation to farm data management.

It can help farmers set up, plan, monitor and analyse their data to make sound business decisions using the following features:

- Setup uses a JDLink connection and the Operations Center to synchronise the farm's data, saving time while eliminating possible data entry errors.
- Plan uses a Generation 4 Display with the Work Planner feature to improve efficiency through increased accuracy.
- Monitor, with a JDLink connection and the new Home and Map tabs, helps farmers keep a watchful eye on their entire operation to ensure quality and efficiency, even when they're away from the farm.
- The new Analyze tab in the Operations Center helps farmers turn this year's results into next year's decisions.

"We know today's farmers are always on the move, which makes the app version of Operations Center more important than ever," says Peter Koch, John Deere's Digital Technology Marketing Manager. "That's why John Deere has improved both web and mobile versions, to make them look more alike and function in a

similar manner."

To get the most from John Deere Precision Ag technologies, Peter Koch suggests farmers need the following:

- a Generation 4 CommandCenter display that gives farmers more precise control of machine functions from the cab;
- a StarFire receiver to ensure accurate positioning;
- JDLink telematics, which serves as the wireless connection between machines and streams data from the Gen4 display to the Operations Center.

Using the Operations Center's new Work Planner feature, farmers can now preload all their display information so operators no longer need to complete this step once they are in the cab.

The improved Operations Center is now live, and new customers can create an account online or download the Operations Center mobile app from the Google Play or Apple App Stores. Existing users will automatically receive all updates in both Operations Center web and mobile versions. More information about the new Operations Center is available from John Deere dealers or by visiting John Deere Operations Center.

| Field | Area (ha) | Crop | Variety/Product | Rate | Guide | Equip | Work Order |
|---|-----------|-----------------------|-----------------|--------------------------|-------|-------|------------|
| 00125-0 Herwigis Josef ... (Josef Sch...) | 16.38 | Corn (Europe) | GoldenHarvest | 10 seeds/m ² | 1 | 1 | |
| 00075-0 Ketzine Josef ... (Josef Sch...) | 38.18 | Corn (Europe) | LG 30.215 | 9 seeds/m ² | 1 | 1 | |
| 00033-0 Am Bien Josef ... (Josef Sch...) | 11.63 | Corn (Europe) | LG 30.215 | 9 seeds/m ² | 1 | 1 | |
| 00038-1 Gengenb Josef ... (Josef Sch...) | 14.55 | Barley (Europe Spr... | RGT Planet | 320 seeds/m ² | 1 | 1 | |
| 00003-0 Plauer Bräunel ... (Bräunel ...) | 3.86 | Barley (Europe Spr... | RGT Planet | 300 seeds/m ² | 1 | 1 | |
| 00004-1 Am Buss ... | | | Adexar | | | | |

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Stealth (leg and point) kits are available to retro-fit to existing HE-VA Subsoilers, Combi-Discs and come as standard on the Evolution OSR seeder.



INCORPORATING LIVESTOCK INTO A REGENERATIVE ARABLE SYSTEM

Written by William Waterfield FBIAC NFSc. from the Farm Consultancy Group

Are grazing livestock a prerequisite of regenerative farming systems? Whilst this is a common thought and perhaps the holy grail for some regenerative farmers, there is little evidence to support this claim. Livestock certainly bring an extra dimension to the diversity of the system and an additional bacterial flora to the soil biota. Many arable farms have no experience of, or facilities for livestock, so do you really need to and if so why and how do you introduce livestock to your arable enterprises?

The why is perhaps the easier of the three questions to answer. Livestock introduce completely different fresh biota to the soils which may be good to the below ground eco system. Livestock, especially larger ones or those that dig are disrupters of the soil by either causing localised trampling or digging whose action creates space for new organisms to thrive. More importantly the stock enterprise should bring with it an income stream that is completely divorced from the vagaries of arable farming. By introducing grass, a new season long crop into the rotation will have benefits for the existing arable

enterprise. This maybe from more first cereal or reduced costs in terms of weed and disease control and perhaps a reduction in fertiliser costs.

Assuming that one can obtain composts / bio solids, manures or slurries these may go some way to introducing new biology to the system but are probably not as effective as fresh manure. Having said that, there is some work to show that remial woodchip (un-composted fine woodchip) improves soil health and yield. The one area that is very difficult to imitate is the effect of trampling on both the above ground material and on the soil surface below. Trampling has the effect of bringing plant material into contact with the ground and accelerating the decomposition of material into new plant food.

Having decided that your system will benefit from livestock and that they will contribute to the business both directly and in the round which enterprise do you start with? Suitable livestock enterprises range from simple fattening of store lambs on cover and catch crops to a complete breeding beef cow enterprise based on complex multiyear diverse swards selling finished cattle. Selecting the correct enterprise will depend on several factors including where the farm and farmer is on the regenerative journey, the scale of and the available facilities on the farm the skills available to the farmer either from within the business or by a partner organisation.

The introduction of short term catch crops is often the first step on the regenerative journey and grazing these



Outwinter cattle on a straw pad

mixtures with fattening lambs or overwintering ewes would seem to make logical starting point. If a suitable grazier can be found, with a rent charged on a headage basis this is a fairly low risk entry point for many arable farmers.

The introduction of yearlong grass leys does not necessarily mean that a full-time livestock enterprise is required summer grazing licences may be available offering the grazier the opportunity of some fresh and clean grazing with reduction in the need for anthelmintics and lower cost.

Alternatively, short term leys of one or two years may simply be cut and made into haulage or hay and sold. For that arable farmer, the key point will most probably be that the ley has to improve soil structure and contribute to the fight against grass weeds.

A season long fodder crop such as fodder beet or kale may be a suitable providing a livestock farmer with a large amount of forage for a short period and this might be fattening cattle or dry stock.

Including a legume-based leys may



Dairy cattle can be outwintered on fodder beet or kale



Hay bales in situ require planning but avoids damaging the soil in the winter

form part of a Countryside Stewardship Schemes where the payments for AB15, a two year sown legume fallow are £522 / ha but needs to be in place for two years and has cutting requirements. Other stewardship options that might be of assistance to regenerative farmers include GS3: Ryegrass seed-set as winter food for birds which pays £331 / ha, this will provide hay or silage and might enable some grazing opportunities. SW6: Winter cover crops which £115 / ha but is only available on soils identified as at risk of runoff in the Farm Environmental Plan.

It is important that the grazer, if one is being used, understands what the arable farmer is trying to achieve. It is no good if the sheep on winter keep delays spring crop establishment or the leys are over stocked and persistently grazed to the floor, resulting in none of the desired trampling of grass being achieved. For these reasons it is often best if the rent is based on a headage rate and the number of stock and the period is agreed before the season starts.

A common concern for many arable farmers is the lack of infrastructure and winter accommodation and on very heavy ground or exceptionally wet sites out wintering is probably not a starter. Out-wintering of cattle on straw pads can be an option for some. A more permanent low cost solution is to install a permanent bark pad or corral.

Many graziers are utilising techniques to enable out wintering of cattle for a much longer period than previously. This nearly always combines regular (daily) moves to fresh ground.

Grazing of standing hay, the use of baled haulage left in the field from the summer and in a few cases a straw lie back pads and shelter belts. In most cases temporary electric fencing is sufficient to keep the stock in the correct place, especially where plenty of grass is available.

Hay bales in situ require planning but avoids damaging the soil in the winter.

The provision of water is one key consideration, but mobile drinkers and above ground systems can normally provide a low cost solution to the problem.

The idea that regenerative farming requires a mob grazed herd of cattle kept on diverse and herbal swards is perhaps the idealistic and aspirational end point for some farmers. In which case there is a whole new range of things to be considered. Including breed and breeding, markets, workload and additional skills, combining with potentially more infrastructure.

However, such a system might open up premium markets such as pasture fed, native breeds or local outlets and then become a diversified enterprise in its own right bring a new profit stream as well as more resilient arable enterprises.

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AGRONOMIST IN FOCUS

MARK DEWES



Stones or Beatles? Oasis or Blur? Cereals or Groundswell?

It's a lazy way to categorise farmers but I'm not the first person to compare and contrast the diversity of ideas showcased at the two leading events for arable farming. An even cruder test would be to ask if our farming problems will be solved by the wizardry of gene editing or by following the prophecy of a soil health guru?

In most previous winters I've been like most agronomists who sit through presentations on fungicide responses and resistance shifts. This winter Bill Clarke slipped off the top spot in the charts and there won't be many agronomists who haven't been engaging with webinars on soil microbiology and regen ag. Many of us are re-learning the empathy for soil and crops which had been demoted during a time when synthetic interventions have ruled. We've been busy putting names to things we thought we knew but couldn't explain or quantify. Whether an understanding of concepts like the effects of arbuscular mycorrhizal fungus on soil aggregation will help us to achieve more resilient soils remains to be seen. The language may be new to some of us, but the practices have their origins in good farming, and what has been will be again. Amongst this excellent work is some material which I have found much more challenging. Having listened to John Kempf's webinar on total immunity of healthy plants to pest and disease attack, I found myself trying to keep my mind open without letting my brain fall out.

We are on a more determined route to a more sustainable future now than at any time in my career, precisely because the systems which we have adopted are falling down more frequently. It's easy to be hard on your younger self and I now look back with a wry smile to 1997 when I discovered that all I needed to do was get drilled up by the end of September and pick an appropriate programme of sprays to deal with any problems. In fairness to that arrogant youth I was right for a few years, but a system propped up on inputs has started to crumble very quickly, particularly when rainfall distribution has challenged the system further. It seems appropriate that the word humility is derived from the Latin humus for earth. Humility is perhaps something we should apply to our farming now to balance some of the hubris of recent decades.

The species diversity that is part of many farmers' approach to more sustainable farming is not the only diversity worth considering. I've been lucky to have the opportunity to look around at worldwide agronomy through a Nuffield Farming Scholarship study tour and taking influence from a diversity of sources has been a good experience. One that sticks in my mind was at the United Nations Committee on World Food Security where I heard a delegate from Rwanda describe farmers as priests in the marriage between food security and climate change. If I could live up to that description, it may be as close as I get to working in the clergy, but it reminded me



that not all the answers will come from middle-aged white blokes in checked shirts like me.

Sustainability is defined for my purposes as those methods with which we can continue into the future, profitably and with acceptable external costs. Farmers had been adapting their systems for a long time before they discovered the need for an agronomist to navigate the complexity of crop protection choice. Agronomists play a part in the decision-making on farms but the principal role for which we originally trained and took instructions from our clients is diminishing; we need to continue to bring something to the table before our chair is removed. There is still a job to be done in organising a sensible crop protection programme, but as that programme becomes simpler and less effective, our skill set needs to evolve. I was humbled last autumn as I realised that some of the most important decisions my customers were making were those which I'm not well qualified to help make. In two situations a few days apart, I contributed to the decision on whether or not to drill in poor conditions. In one case I said drill and the other I said don't. As you might have predicted, both were drilled and, on reflection, I think I was wrong in both cases. It demonstrated to me that some of the things I need to do now are different from those I needed 20 years ago and I'm better qualified for the latter than the former.

So, an agronomist needs to adapt just like our customers do. This realisation seems to have hit home recently, and it's been rewarding to see agronomists from the independent and trade sector alike raising their game regarding training and application to a rapidly evolving reality. Our customers want as much input from us on the way to integrate stewardship scheme options to their arable rotation as they do on herbicide regimes. Advising customers to build more resilient systems by growing fewer cash crops and more species rich pasture doesn't come easily to all agronomists but alongside the adoption of new technologies and conventional chemistry it's the blend between Cereals and Groundswell which will be increasingly important to get right.



At Agrii we have been developing an approach to this new normal, pulled together by our Green Horizons manifesto. It's an umbrella which covers our commitments to sustainability, balancing the external costs of how we farm with the essential work of producing food. Of course, the answers aren't simple or complete but in providing an over-arching direction for our work it will guide what we do. Examples include the commitment for 100% of research to be based on Integrated Pest Management principles, the introduction of Variety Sustainability Ratings based on genetic resilience and work to improve Nutrient Use Efficiency. All this is done with a continuing focus on productivity, as it is still the case

that high yields usually maximise resource efficiency. Green Horizons is Agrii's framework to address these issues and I expect to see more of the same from all sorts of agronomy businesses.

One element of this conversation which affects the whole industry is the unintended impact of agrochemical use. This elephant has been in the room for some time. We have been adopting Integrated Pest Management for many years but one of the indicators of success is the trend in agrochemical use. Results from the most recently published Pesticide Use Survey conducted by FERA don't tell the story we would like. There is mounting pressure to reduce the unintended impact of plant protection products through legislation. The National Action Plan for the Sustainable Use of Pesticides and part two of the National Food Strategy are just two of the trains coming down those tracks. It's time for us to grasp the nettle. Agrii have now made a commitment to measure and reduce the negative impacts caused by our use of PPPs. That might not be what was expected a few years ago and shows how far we have come and how quickly things are changing.

The blend of conventional, newer and re-discovered approaches will be what defines the future of the support that agronomists provide, and whether the technologies are showcased at Cereals or Groundswell, they will need to be considered in concert. I'm still only part way through my apprenticeship to this trade so I don't want to pick a favourite just yet.



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HIGH QUALITY FOOD WITH A POSITIVE ENVIRONMENTAL IMPACT

Selling organic, 'Pasture for Life' food directly to consumers brings dividends for one farming family. *Sara Gregson reports...*

First generation farmers Chris and Denise Walton have, over the past 40 years built an award-winning sustainable farm and butchery business, operating close to the Berwickshire coast in the Scottish Borders.

"We always wanted to sell our beef, lamb and pork directly to consumers," says Denise. "We strive to produce the highest quality food, whilst also having a positive environmental impact. We are organic and certified Pasture for Life (guaranteed 100% grass-fed with no grain ever fed), which we believe is the Gold Standard for land and animal welfare management and completely fits with our business ethos."

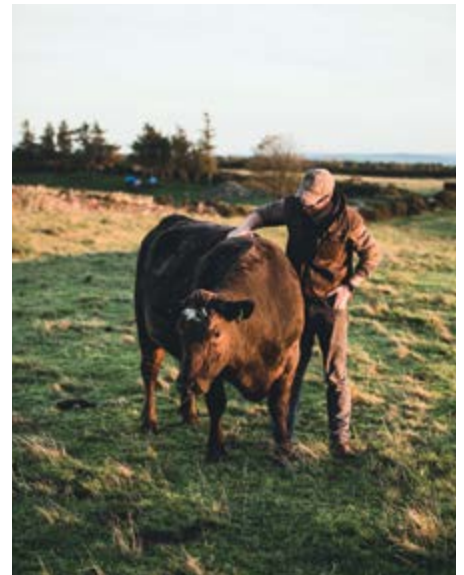
Neither Denise or Chris come from farming backgrounds; Chris has accountancy qualifications and Denise trained in environmental and land management. Moving to Scotland and starting with a 20-acre smallholding in 1989, they increased their acreage to 250 acres by working in partnership with neighbour Amanda Cayley. In 1993, together they took the opportunity to buy the nearby arable unit of Peelham Farm, bringing the landholding up to 670 acres.

"The farm was pretty run-down, farmed for the short term, had no hedges and was ecologically poor. The land rises to 700ft and comprises some heathland and acidic grassland," says Denise. "As new entrants, Chris had to work off the farm in the early days and making a profit has been central to what we do. But farming with nature was also a primary driver for the business from the very start."

Twenty-seven years later, their son Angus and his wife Helen have joined the business and they have now started the third generation by having two young children. Amanda, now retired, is still very much involved in the life of the farm and the butchery.

The couple started making charcuterie from their pork, mutton and beef in 2005 and then developed an on-farm butchery for their cattle, sheep and pigs in 2008. The aim was to become price-makers rather than just price-takers. They started attending farmers markets in local towns and cities such as Edinburgh and Glasgow and supplying independent retailers and restaurants.

"We talk to our consumers a lot



Angus with one of his cows

and to local chefs to gain feedback about our products. We tell them how we aspire to excellence in land management, animal care and environmental stewardship. We are spreading messages of agroecological land regeneration and the production of healthy, grass-fed meat. It really fits in with consumer thinking at the moment – people want healthy, environmentally-sound food."

Livestock

Peelham now has a herd of 150 Aberdeen Angus suckler cows. There are four Aberdeen Angus bulls, selected for breeding attributes of ease of calving, good depths of sirloin and high levels of intramuscular fat.

Ninety per cent of the livestock is born and reared on the farm. The rest come from a small network of other organic and Pasture for Life farmers whom Denise and Chris work closely with in neighbouring counties, including 100% grass-fed dairies which supply rose veal from 'unwanted' male dairy calves.

Sheep numbers have fallen in the past couple of years and now comprise a rolling flock of 60 to 100 cull ewes and store lambs to supply



Three generations at Peelham Farm



Peelham Farm from above

the butchery with lamb, hogget and mutton.

"A few years ago we were trying to manage three breeding enterprises all at the same time," Denise admits. "We were all exhausted at the end of calving and lambing. So we have reduced the number of Red Duroc x Tamworth sows down to 50 and Angus is now focussing on the cattle. We have moved away from set-stocking and he is installing fencing and water supply to the fields to allow long-rotation grazing."

Winters can be harsh with temperatures averaging around 1 degree centigrade for three to four months and average annual rainfall of 1,000mm. The cattle calve indoors in March and April and are out grazing by the end of April. There is good housing and the heavy soils have so far limited outwintering possibilities.



Peelham Farm sign

The cows are fed only grass silage.

Calves stay with their mothers all summer and are weaned at housing. The poorer performing beef calves are kept back and reared and sold as ruby veal. All the calves are tagged with electronic tags and their growth rates are measured constantly. The beef calves finish at 24 months at 500 to 600kg liveweight on just silage and grazed grass.



Organic beef in the on-farm hanging room

Adding value

There are three full time butchers and a full time help with the charcuterie, making a wide range of air-dried and fermented meats including prosciutto ham, smoked juniper mutton, pancetta, salami, chorizo and smoked nduja.

"We try to add value to everything we produce and sell as much as every animal that we can, including liver, cheeks, trotters and marrow bones,"

says Denise. "We have just started selling Auld prime – native cow beef that has been hung for at least six weeks.

"Curing is a good way of adding value to an animal. For example, you can sell as ewe for £18 a head, or cure one of its legs and sell it sliced for £55/kg.

"Having the butchery helps us see what effect any changes in management out in the fields is having. For example, we can see how much better native breeds are at converting grass into saleable meat compared to some continentals we once dabbled with. And we can see how the levels of intramuscular fat alter too."

Coronavirus

The pandemic has had a significant impact on the business at Peelham Farm.

"Covid knocked us sideways for the first ten days of lockdown back in March, but since then demand has been five times what it normally is at the Christmas peak and interest has remained high," says Denise.

"We are reaching many more customers online, website traffic has increased by 170%, and we have upped our game considerably on social media. We have engaged a brilliant photographer to take photos of us working and we do lots on twitter, Facebook and Instagram – telling potential and existing customers what it is we do and why we are doing it.

"In essence, we are showing them how their purchasing decisions are affecting every stage of the production process – through the butchers, the farmers, the livestock, the grassland and the soils. They are an intrinsic part of an agroecological system which is bringing health and balance to every element of that chain."

For more information on how to join the Pasture-Fed Livestock Association (PFLA) and to have your meat and dairy products certified 'Pasture for Life' – which means it was 100% grass or pasture-fed, visit www.pastureforlife.org or email: membership@pfla.org.uk for more details.

FARMER FOCUS

ANDY HOWARD



As I write at the end of February it is finally starting to feel like spring. I have even managed to go out without wellies and a coat for the first time in months. Since my last article in September, we have had rain, lots of it! 650mm since 24th of September. Parts of the farm have flooded 4 times since Christmas but after all that, the majority of our crops look well. A couple exceptions of late drilled wheat on heavy clay have suffered but we are in a lot better position compared to last year.

Since my last article I have built 4 Johnson-Su bioreactors with the aim of applying compost extract next autumn with our drill. To be able to check the quality of the compost extract I have bought a microscope, so far, I have looked at a tick off our pet cat and my daughter's blood with it. My aim is to add a wide diversity of biology into our soil to improve nutrient cycling and plant health. How well it works only time will tell!

Recently I purchased a second-hand Claydon Terrablade Inter Row Hoe. Our grass weed issues are mainly in patches or at low levels. Recently the efficacy of Spring SU herbicides has slid to almost useless with the price staying the same, so any leftover weeds have been hand rogued or spot sprayed. This is very time consuming and I feel if I can get 70% of the patches with the hoe it will make hand roguing quicker and overall cheaper. This first year with the hoe is going to be a steep learning curve.



The last 6 months has also seen the start of a robotic development project (UKRI funded) where I am a collaborator <https://n2visionai.wordpress.com/>. The aim of this project to use a robotic platform, with various cameras onboard, to capture image data of a crop of winter wheat and analysis how the crop reacts to different rates of nitrogen fertiliser and correlate this to soil data. This image data will be run through deep learning analytics at Manchester Met Uni. The long term aim of this project is to develop the software and hardware to measure at a plant scale the Nitrogen status and treat the plants with fertiliser individually, if fertiliser is needed. This will be real precision farming.

Robotics and AI seem to be a hot topic in agriculture at the moment. I believe it has a key role to play in solving challenges we face in agriculture. One concern that people seem to have with this technology is that it will mean a loss of jobs in agriculture, there is little evidence of this in past technology revolutions. Jobs change and are created in different areas; this I believe will happen in agriculture. One of my major concerns for the future is finding decent skilled labour and being able to pay them a decent wage. A question I ask is why would anyone want to work on a modern arable farm? Why would you work for a relatively low wage, working very unsociable long hours at the time of year everyone else is on holiday or going to festivals and have to handle potentially toxic chemicals? Not a great job advert! There seems to be a badge of honour in farming for people to work longer and longer hours, if you don't you aren't a proper farmer. Personally, I do not mind working long hours, but I also want to spend time with my friends and family. I hope to be the last generation of my family that sits on a tractor for 100 hours a week just to get crops planted. If we want to encourage new young blood into the industry, we need to have jobs and wages to attract them. I believe Robotics and AI can help with this issue.

Good luck to all with the rest of the season, let us hope the taps have not been turned off completely again like last year!!

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THE FUTURE OF EFFICIENT CROP ESTABLISHMENT

A Food Processor's View...

REGENERATIVE AGRICULTURE - THE NEXT STEP FOR THE WHOLE SUPPLY CHAIN

Written by Rebecca Hesketh, Agriculture Manager for Fresh Produce at Waitrose & Partners

Many of us are asking whether this point in history is one we will look back on as when a 'shift' occurred in our system that changed the course of lives and the agricultural industry. There are many aspects of the agricultural world that may feel like they are on shifting sands at the moment, but the opportunity that presents itself through regenerative agriculture may just have some of the answers we need when facing the challenges ahead of this industry.

Whilst regenerative agriculture may feel familiar to many of the readers of Direct Driller Magazine whom I'm sure have long been farming with soil health in mind, we have found it helpful to further define what this means to us, drawing upon the number of definitions out there at the moment. To us, regenerative agriculture is a system of farming that increases biodiversity and enriches soils, therefore improving water quality, enhancing ecosystem services and capturing carbon in the soil. This definition allows us to bring this concept to life within our business and supply chains, to set ambitions and to build a plan to achieve them. There are many different ways we would look to work with our farmers to put this into practice on farm, but whatever we ask our farmers to do, it is important to us to ensure it's meaningful and relevant to their farming business. There is no one size fits all! One area of focus will be building the health of our soils, which may be achieved through practices such as using cover crops and minimising soil disturbance. Importantly, through the practical application of regenerative agriculture through practices such as these, the benefits are seen not only in the improvement of our soil, but also in the quality of our water, the health of our surrounding ecosystems and just quite possibly the wider planet's health too.

It is this that particularly draws us to regenerative agriculture, a movement that was built upon the foundations of conservation agriculture and has grown up from the grassroots movement started by the Rodale Institute and the revered Gabe Brown's of this world. Through the lens of regenerative agriculture, healthy soil is seen as not a happy by-product in a supply chain, but as a core part of what farming achieves alongside the supply of food and a healthy ecosystem with thriving biodiversity. Seeing those vital parts of farming as just as important as what is produced to be sold. It can be best explained as a holistic framework through which to view farming and food supply in the future with the dual purpose of producing food that is both good for us and also the environment, doing more than just maintaining the current state of our planet, but enhancing it. Surely regeneration feels like the right path for us to be taking in a post-lockdown world with the looming challenges of the climate and biodiversity crises ahead.

These challenges require our system to evolve. The UN warns that we only have until the end of this decade to act

against the climate crisis. The World Economic Forum warns that 'biodiversity is declining globally, faster than at any other time in human history.' Alongside this soil degradation is rightly causing concern to many, with recent studies finding that 16% of the conventionally managed soils looked at in the research had lifespans of less than a century. This gloomy picture has led influential thinkers within the business and agriculture communities to state that all businesses in the future will need to become regenerative. The key in this is ALL businesses - from the farmer to the retailer - we all need to be part of this progression towards becoming regenerative and to work as partners to make changes. This is why we want to start a conversation with our growers about the future of regenerative agriculture on our farms.

We at Waitrose have long worked closely with our suppliers and our growers to create finely tuned supply chains in order to make sure that food can arrive safely onto our customer's plates. Over these past twelve months, we have seen an incredible amount of pressure applied to our carefully constructed supply chains. When you consider the possibility that the world may become yet more volatile and uncertain with the impact of environmental degradation and the increasing frequency of extreme weather events, it is difficult not to argue for an even stronger system of supply for the future. This is one of the areas where regenerative agriculture offers potential for our food system. A healthy soil can be more resilient to environmental shocks, protecting this asset and its yield capacity for years to come, whilst thriving biodiversity on farm provides a wealth of ecosystem services. Underpinning our food supply with healthy, regenerating natural resources ensures a reliable base for food production for the future, benefitting a whole supply system on which it is based. Therefore we must work together to realise these benefits. Working in partnership with our farmers and the wider agriculture system is a key part of the way we work at Waitrose and Partners. The vast majority of our growers have been supplying Waitrose for multiple years and, through our suppliers, work in partnership with us to face the challenges ahead. Waitrose was founded over 100 years ago and in 100 years time we still want to be providing healthy food from flourishing farms. This is why as part of our Waitrose Agriculture Strategy we intend to embrace regenerative agriculture and play our part in regenerating the natural resources on which we rely. Through sequestering carbon into the soil and keeping it there, we are sure that regenerative agriculture will also play a key role in helping us to achieve our target of net zero across our UK farming base by 2035. We recognise the important role that knowledge plays in bringing regenerative agriculture to life and this is why alongside these ambitions, we will aim to lead by example on our own farm, the Leckford Estate, innovating, learning and sharing new ways of farming. Alongside this we

will continue to strengthen the partnerships we have built with organisations such as LEAF and Innovative Farmers. These partners work closely with us and our farmers to help us to farm with nature. They help us to ensure the right environmental approaches are in place on farm and bring agricultural research to life practically.

Customers are at the heart of every decision we make at Waitrose and the consideration of regenerative agriculture is no exception. The UK has seen an exponential growth in spending on ethically sourced goods over the past two decades, with figures showing spending by consumers on sustainable products reached £29.7bn in 2018, up from £3.1bn in 1999. It is arguable that the last year will have accelerated this trend. Alongside this, the presence of documentaries such as the inspirational *Kiss the Ground* on the popular streaming site Netflix demonstrates our customers' interest in farming to regenerate. This is an opportunity to show farming can be a positive force in the action against environmental crises. Over in the US, regenerative agriculture has been taken up by household names, including Walmart and General Mills, both of whom have made commitments to advance regenerative agriculture where they farm. Clearly these companies, their farmers and their customers see the benefits of a regenerative system.

Our customers make it clear to us that they want us to act in the face of the climate crisis and those crises facing the natural world. Regenerative agriculture could be the solution we need, offering a stronger system through which to supply food, whilst acting to mitigate climate change, biodiversity

loss and soil degradation. As a business with customers at its heart and a mission to 'do the right thing', applying regenerative thinking to the way we work feels like the right path to take for a responsible business that cares about our planet. This is a path that requires the support of the whole supply chain to make it a success, from the farmer to the retailer and all the businesses both between and around them. To me it's clear that this step is in all of our best interests to take and it might just be in our planet's best interest too.

As a retailer that prides itself on working together with our suppliers, we welcome your thoughts on regenerative agriculture and would love for you to get in touch to share your views. You can contact me via LinkedIn.

Waitrose

Biography

Rebecca Hesketh is the Agriculture Manager for Fresh Produce at Waitrose & Partners. As part of this role, she works with suppliers and farmers to implement Waitrose & Partner's ethics and sustainability standards and supports them to achieve the stretching ambitions laid out in their new Agriculture Strategy.

Farming is a home from home for Rebecca, having grown up on a family farm, and now helping out in her spare time on her partner's farm on the Isle of Wight.



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DRILL MANUFACTURERS IN FOCUS...



SUBMISSION TO FARM CONTRACTOR & LARGE SCALE FARMER

Customer-first philosophy sustains fifty years of growth

UK agriculture has seen considerable change in the past fifty years, with advances in farm machinery technology arguably one of the greatest examples of progress.

Alongside massively increased working widths and capacities, the industry has seen innovation in techniques, significant automation, and new levels of precision application that would have been unimaginable half a century ago.

Manufacturers have come and gone within this timeframe, but one that has endured and adapted – going from strength to strength – is KUHN Farm Machinery, which celebrates its 50th anniversary in the UK in 2020.

Founded by Dennis and Cath Hollins in 1970 as the UK subsidiary of the French company KUHN SA, based in Saverne, the business began as a modest operation with limited premises in Wellington, Shropshire. The initial offering to the UK market comprised a small range of grass machinery and some power tillers – a far cry from today's extensive range that encompasses arable and livestock sectors and includes just about everything from primary cultivations through to crop protection.

The company's longest standing employee is Peter Morris. He joined as



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parts manager in 1976 and has been integral to so much of KUHN UK's progression over his 44 years, holding a variety of roles.

"Supplying spare parts always has been an essential element of the business and this has been transformed over the years," says Peter. "In the early days, urgent orders would come in by phone to Mrs Hollins' home, which was about a mile from the depot. We would travel to and from the Hollins' house, twice a day, to pick up urgent parts orders and then despatch them through 'weigh and pay' at the railway station, or on Securicor. Less urgent parts orders came in by post and packages were sent out via the Post Office, using Data Post. As the business grew KUHN was at one point the biggest user of Data Post in Telford."

Maintaining parts supply efficiency has always been a priority for KUHN, and the company pioneered online ordering in the UK in 2005 with its dealer network. During 2015 and 2016, the department underwent a major refurb, modernising its fully dedicated parts facility at its current seven-acre site in Telford. KUHN UK now has just over 6,500 parts lines in stock, despatching 70-100 orders on average per day to customers with an

average annual pick rate of 97% being maintained.

"The system we have today, with the capability of next day and through the night delivery services for a huge range of components, is a long way from the six wooden racks and manually recorded system of the 1970s," adds Peter. "Nevertheless, the philosophy of delivering what the customer needs, as fast as possible, has remained constant."

KUHN UK parts manager, Daniel Banks adds: "It is now possible for us to supply 95% of parts to KUHN dealerships across the country before 8am, offering dealers and farmers the best possible service."

Being customer-led is a theme that perpetuates throughout KUHN UK's history, with landmark developments such as the introduction of power harrows being a good example of how the company has responded to farmer demands.

The company sold its first power harrows in 1980 and by 1996 was delivering over 1,000 units per year onto UK farms.

"Power harrows provided a major breakthrough for KUHN through the 1980s and 1990s," says the company's national sales manager Duncan

McLeish, who joined as an area sales manager in 1985. "The KUHN machine has always been built to last and went a long way to establishing our reputation for strength and reliability.

"There was significant demand for four metre machines in the 1990s, and we developed a transport kit for these wider machines to allow UK farmers to have the working capacity they wanted whilst still being able to comply with road transport regulations. KUHN UK was also directly involved in the development of the first six metre folding power harrow, again being responsive to farmer demand."

Sales of power harrows continue, with combination units incorporating the Venta pneumatic drill remaining a sector-leading implement, but KUHN has also embraced the move towards minimum tillage. The company now includes a range of minimum tillage cultivators and drills, alongside its more conventional soil preparation and crop establishment range.

Growth of the KUHN UK business over the fifty years has been a combination of organic development, partnerships and acquisitions.

Fertiliser spreaders first came into the KUHN UK range in 1985 through the partnership with the German manufacturer Rauch, with this continuing to the present day with the highly successful MDS and Axis machines leading the market. 1987 saw

the introduction of KUHN ploughs for the first time, following the acquisition of Huard, and the take-over of Audureau in 1990 further strengthened KUHN's offering in the livestock sector with the introduction of bedding and feeding equipment. More recently, KUHN has entered the crop protection sector, with the acquisition of the sprayer company Blanchard in 2008. Balers and wrappers entered the range a year later when the company took over the baler division of Kverneland Group, complete with the factory at Geldrop in the Netherlands.

To support its expanding product range, KUHN UK has invested in a high level of support to its dealers and end customers. This took a significant step with the establishment of a technical and service department in 1984, and this has grown significantly in more recent years with the appointment of regionally based product support engineers, product specialists and a dedicated marketing department.

Managing director Siân Pritchard instigated the expansion of the product support function around ten years ago as part of a wider recruitment drive that has in the past three years seen a 25% increase in the headcount for KUHN UK.

"We're continuing with our commitment to deliver the very best technical support back-up to our customers," she explains. "Our investment in people is consistent with our success in increasing sales and a

continuing drive to grow market share in priority product areas.

"Having more people on the ground is being noticed by our dealer network and is becoming an important differentiator for the business. It's a crucial factor in ensuring we achieve our goal to push UK sales figures to new heights and to provide a more complete, efficient and thorough service to our UK customers."

Since its humble beginnings in 1970, KUHN UK has been part of a rapidly developing agricultural industry. The company has stayed relevant, and maintained growth, through innovation and continuing product development, and the aim is to continue the upward curve with an ever-improving offer.

"Strength and reliability have been core values for KUHN since the start, and these principles have led to strong relationships with dealers and end customers," says Siân Pritchard. "Going forward, it's essential that we maintain these principles and lead the way in electronics and precision agriculture. We also need to continue to offer the best in terms of servicing, warranty and finance, and ensure we maintain the very best customer communications.

"I believe that with new initiatives like the MyKUHN customer portal, and innovations like our Click & Collect feature for ordering parts from the dealer, we are fit for the future and ready for the next phase of the agricultural revolution."

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MONITOR FARMING AND MANAGING AHDB REDUCED CULTIVATIONS

(while listening to Radio 1)

John Aynsley, runs a 1,302ha mixed farm near Saltburn-by-the-Sea in the north east of England. Barn Farm with 566 ha of arable cropping in a predominantly cereals rotation has recently seen a system change to direct drilling. The transition has been followed and directed by the local AHDB Monitor Farm programme group. Read on to hear about this journey and John's early conclusions...

Looking back through the mists of time to the 1970/80's, when as a young man, ploughing was just what you did to start to prepare a seed bed to plant a crop. This was followed by double discing, harrowing, drilling and finally if it had not all got too wet, rolling. Radios were blaring out Radio 1 that you could not really hear above the noise of the tractor, while you were bouncing around in basic cabs. Happy days.

The soils turned over beautifully, smelled wonderful and earthy, loads of worms and seagulls munching their way through them. Then power harrows appeared, WOW, one pass following the plough then drill and roll. Then we got really clever and put the drill on top of the power harrow, the combination was born. We thought we were really good then, more hp, more weight, better radios and CD's and cab suspension. The halcyon days.

And it all worked well and still does for many businesses, drilling seeds/sq.m a lot more accurately, with more even crop emergence and establishment, and lower labour and fuel costs.

It was only moving from energetic and naïve youthfulness into middle age, that I saw that the very soils that we once turned over so beautifully, that were so fibrous with organic matter and worms, had become depleted into poorer soils that with the first shower of rain became more difficult to work. How had this crept up behind me without really being aware of it? That was the light bulb moment when I knew we had to start to change.

Starting out on the journey to change

Our rotations had become too short and relied too much on OSR to be our saviour, there was no grass or livestock in the rotation. What would previous generations have made of this I wonder, probably already knowing the answer.

So, the journey to direct drilling had started, but like a lot of things in life it is never a straight or smooth road. It was



certainly helped by attending a conference at Driffield in 2011 and listening to different people share their knowledge and experience of the move toward min till, direct drilling or regen agriculture, whatever you want to call it. It was at this point that I met Steve Townsend, who started to help us make that transition to better soils and different establishment methods. At first my agronomist David Coates and I had many discussions and brain storming sessions around the kitchen table, to try to understand exactly what Steve was advising us to look at and move towards.

To start with we did more soil sampling looking at a wider analysis, and in our case, it was showing an imbalance between the magnesium and calcium ratios. Once we started to correct this imbalance our soils have become easier to work with, had a bit more tilth in the top few inches and didn't revert to a plasticine consistency when things get a bit wet. It will always be work in progress, but you have to start somewhere.

The transition to min till is fairly easy and straightforward once you figure out which cultivator and drill suits the farm and system you want to adopt. The next stage however is a bit trickier, this is when the mindset and focus are really challenged.

Monitor Farm programme opportunity

I was given the opportunity to become a monitor farmer as part of the AHDB programme. This gave me the chance to move from min till to direct drilling on 260 acres as part of a 3-year project. Once I had committed to that there was no going back, we would find out whether we could make it work or not. As part of the project, I had to form a Steering Group and we agreed our aims would be to include winter beans and cover crops in the rotation, try to control sterile brome which is our biggest grass weed problem, direct drill all beans and cereals, to see whether the effect of these changes starts to improve the soil and ask whether it can all be profitable.





We bought a second hand Horsch CO6 drill to do the direct drilling for £10,500. This has proved to be more than adequate for the job, it only needs 150hp on the front travelling at 7/8kph. One of the things that I have learned since we started min tilling and direct drilling is that the earlier we get the crops in the ground with a higher than normal seed rate the better they are. The one discipline that we try very hard to stick to is if the soil starts sticking to the tractor tyres get out of the field as it is too wet, and we will be doing more damage than good, hence the need to get on early.

We have been benchmarking the whole arable area through AHDB for several years now, so it is interesting to compare the different costs/income from min till and direct drilling. The 3-year Monitor Farm project is not really long enough to come to any firm conclusions about whether we have managed to achieve all our objectives, but we will continue to monitor the changes over the years ahead.

Early conclusions

What I can say with some certainty however is that direct drilling does work, it uses a lot less labour and fuel. First wheat and bean yields are equally as good as min till. The inclusion of winter beans into a wider rotation is helping improve the soil structure, where we have severe brome the use of cover crops and glyphosate followed by minimal soil disturbance drilling is certainly working. As to the profitability, I think the weather still has probably the biggest influence over both systems.

We are doing more direct drilling year on year and I am fairly sure that we are seeing the benefits of this through better tilth, increased worm numbers and soil smelling a lot better, although as it took some time for the soils to become depleted, it will take time for them to repair. We will have to allow mother nature to do her bit unimpeded by poor practice and hopefully this will help accelerate the process.

Moving to direct drilling I feel that we now have a better understanding of our soils and of what we should and should not do to them, but it is and always will be, work in progress. It does require more attention to detail and it certainly does not look as good to the eye until it gets above the stubble, but as long as it delivers profitability then the soils will improve and we will be able to lower our input costs.

For more information, please visit:
ahdb.org.uk/farm-excellence/saltburn.



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HOW TO COUNT EARTHWORMS

Importance

Earthworms improve plant productivity, are principally responsible for engineering the soil environment and are an important food source for native birds such as the song thrush. There are up to 10 common earthworm species in agricultural soils and these can be grouped into three ecological types: epigeic, endogeic and anecic earthworms – each group having a unique and important function. Earthworms are an indicator of soil health, being impacted by pH, waterlogging, compaction, tillage, rotation and organic matter management.

What do earthworms tell us?

- A good presence of earthworms across a field means the benefits are likely to be widespread
- High numbers of earthworms indicate the potential for significant benefits to plant productivity
- The presence of each ecological group indicates the potential for specific earthworm benefits, such as carbon cycling, nutrient mobilisation and/or water infiltration

How to identify earthworms

Epigeic (litter-dwelling earthworms)

- Dark red-headed worms
- Small (<8cm) in size, typically about the length of a matchstick
- Often fast-moving (most likely to escape from the worm pot!)

Sensitive to: Tillage (detrimental) and organic matter management such as manure applications (beneficial)

Roles: Carbon cycling and prey for native birds



Endogeic (topsoil earthworms)

- Pale-coloured and green worms (not red)
- Small to medium size
- Often curl up when handled, and green worms may emit a yellow fluid

- The most common earthworm group found in arable fields

Sensitive to: Organic matter management (beneficial)

Roles: Soil aggregation and nutrient mobilisation for plants



Anecic (deep burrowing earthworms)

- Dark red or black-headed worms
- Large size (>8cm), typically similar size to a pencil
- Make deep vertical tunnels, up to 2m
- Often found below surface earthworm casts or midden residue piles
- Feed at night, foraging the soil surface around their burrow for litter
- Commonly found in grassland but often absent from ploughed fields and where there is no surface litter

Sensitive to: Tillage (detrimental) and organic matter management such as manure applications and straw return (beneficial)

Roles: Deep burrows that improve aeration, water infiltration and root development



Identifying adults and juveniles

Adult earthworms have a clearly developed saddle (reproductive ring) and juveniles do not. You may need to rinse worms with water to determine if a saddle is present. Size is not a good indicator of maturity as adult earthworms typically range in size from 2cm to 15cm, depending on species.



When is it best to count earthworms?

Spring and autumn are the best times to carry out earthworm assessments. Timing the sampling after warm, wet conditions often provides the best earthworm population estimates.

How to assess the earthworm populations

Tools: Spade, pot, bottle of water, mat and a record sheet

Procedure:

1. Dig out a soil pit (20cm x 20cm x 20cm) and place soil on mat
2. Hand-sort the soil (aiming to spend 5 minutes sorting), placing each whole earthworm into the pot
3. Count and record the total number of earthworms
4. Separate earthworms into adults and juveniles (see above)
5. Return juveniles to the soil pit
6. Count and record the number of each type of adult earthworm (see overleaf)

7. Repeat steps 1–7, until 10 soil pits per field have been assessed following a standard W-shape field-sampling pattern.

What does this mean?

- **RED** = If 3 or fewer of the ten pits have 16 or more worms, this suggests suboptimal earthworm populations, which can indicate problems with the soil's physical or chemical properties
- **YELLOW** = If 16 or more worms are found in 4 to 6 pits, this suggests a patchy presence of earthworms. With this number, you could make improvements in the parts of the field where earthworms are not currently present
- **GREEN** = If you have 7-10 pits containing 16 or more earthworms (of any type). The most significant benefits to plant productivity are more likely in fields where you find high numbers of earthworms
- If you are unlikely to find epigeic, endogeic or anecic earthworms, you are unlikely to be benefiting from their specific actions

Further information

To download the earthworm information and recording sheets or for more information on soil management and increasing earthworm numbers, visit ahdb.org.uk/greatsoils.



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HAMPSHIRE FARMER REAPS **REGEN REWARDS**



Last autumn, the annual Agri-TechE REAP conference was held virtually, sharing technological ideas from people and companies innovating at the frontier of agriculture. The keynote speaker, supported by AHDB, at the event was David R. Montgomery, whose remit was to discuss how soil linked into the conference theme of “From micro-scape to landscape – innovating at the frontier”. David’s talk showcased how, when thinking about soils, we need to be looking at both of these scales.

An author and professor of geomorphology at the University of Washington, David has travelled the world to hear how farmers have reversed the fortunes of their soils. Numerous conversations later, he now believes soil-health nirvana can be achieved through the adoption of three general principles of conservation agriculture:

1. No or minimal soil disturbance to help soil life flourish
2. Growing ground cover to lock in nutrients and protect the land
3. Using a diverse rotation (three or more crops) to promote life and avoid nutrient over-extraction

The approach, alongside integrated pest management (IPM), provides an opportunity for farmers. However, as David concluded: “There is no ‘easy button’, when it comes to implementing regenerative farming”. Those who use their independence, intelligence and ingenuity to learn from their own experiences and those of others are most likely to thrive.

One such farmer, David Miller of the Wheatsheaf Farming Company near Basingstoke, has worked with the three regenerative agricultural principles for decades – long before the term gained traction. A recent AHDB podcast featured machinery expert Harry Henderson, who discussed these principles with David and unearthed the secrets of the company’s success.

Regenerative agriculture in Hampshire

In the early 2000s, the company’s land was plagued with plateauing yields and rising costs. In 2010, the mission was to regain control of the soil and help it look after itself with minimum inputs. By working closer with nature, David wanted to bring back the feel-good element of farming.

The 700 farmed hectares is situated mainly on grade 3 land, with drainage occurring naturally through the dominant chalky, stony and flinty soils.

Use of cover

They experimented with cover crops, starting with a single species (crimson clover), followed by a trial-and-error approach that now sees fairly diverse mixtures deployed. The mix is tailored to the situation (e.g. larger seed mixes used toward the end of autumn) with brassica species avoided – due to their bridging potential for slugs and diseases. They use species that succumb to frost, so the standing cover is not too thick and sucking up all the nutrition. They roll after any frost to tackle the remaining cover, although glyphosate is still needed for complete kill. By around 2014, all spring cereal crops followed an over-winter cover.



Minimal soil disturbance

The on-farm default for cultivation and establishment is minimal disturbance methods. However, the use of more disruptive forms of cultivation are used, when the situation demands it. For establishment, a cross-slot drill was purchased in 2015. Since then, the land has become easier to work – and the heavier cross-slot has gone, replaced by a more nimble disc-drill system. It is important to get the drill right at the start, David says. In the last five years, the choice and experience has exploded in the UK. It is important to explore the options and make the right choice for your system. Most straw on the farm is chopped at harvest and raked to even the distribution. As the soils are fairly resilient to compaction, self-restructuring, and all effort is made to avoid working the soil in suboptimal conditions, there is never the need to mechanically restructure them.

David has found that weeds now only tend to come up where the soil has been disturbed and what’s on the

surface lose viability or are eaten by birds. However, the weed population has changed. Now there is less black-grass and more brome.

Rotational diversity

In addition to the use of cover crops, the cash crops in the rotation add diversity and flexibility, with a third of the land down to spring crops (barley and wheat). The winter crops include wheat, barley, oilseed rape, rye and, crucially, beans. Livestock are not a part of the system. Although they bring many benefits, they also bring risks, such as compaction in a bad winter.

Yielding success

David is a member of his local Arable Business Group, which helps him maintain a firm grip on production costs. From a labour and machinery perspective, the system is now simple and relatively low cost. There are big savings to be made. Dependence on plant protection and fertiliser products has reduced and there are more beneficial insects on the farm. Environmental schemes also help pay for the cover crop seeds.

David believes that doing nothing is not an option. With knowledge and experience of regen approaches exploding in the last decade, the risks of entering such systems are now much lower now than a decade back.

Knowledge exchange

With no blueprint available for regenerative agriculture in the UK, the sharing of locally relevant experiences is essential – and this is where our AHDB Monitor Farm and Strategic Farm networks come in.

We are delighted to announce that David has been selected as AHDB's fourth Strategic Cereal Farm, with the official launch in June 2021. The Strategic Farms promote the uptake of knowledge and provide a platform for farmers to explore new ideas that can have an impact on their business. David will represent the South, with Strategic Cereal Farms already established in Scotland, East and West.

David's aim for the programme is to find a responsible pathway to reduce inputs. He said: "We are very pleased to have been chosen as the 4th AHDB Strategic Farm. Our vision for the next 6 years is to trial and prove various scenarios to ease the journey into regenerative agriculture. We aim to look at ways of quantifying the results of our actions in growing crops in a more biological way with less reliance on chemicals and inorganic fertilisers. The end result will, hopefully, give a reliable path of principles for others to follow."

For more information, please visit:
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AGRI-ENVIRONMENT SUBSIDIES PROVIDE MORE STABLE FARM INCOMES THAN DIRECT PAYMENTS

Full Paper published by Caroline Harkness, Francisco J. Areal, Mikhail A. Semeno, Nimai Senapati, Ian F. Shield, Jacob Bishop

Subsidies paid to farmers for protecting the environment lead to more stable incomes compared with payments based purely on the number of hectares being farmed, according to a new study of farms in England and Wales.

The findings are of great relevance as, post-Brexit, the UK moves to the new Environmental Land Management subsidy system.

The research, from Rothamsted Research, the University of Reading and Newcastle University, also shows that farmers shouldn't put all their eggs in one basket, as those diversifying into a wider variety of crops or livestock receive more consistent year-to-year incomes - as do those who reduce their use of fertiliser and pesticides.

Lead author and PhD student, Caroline Harkness said: "Farmers are facing increasing pressures due to changes in climate, government policy and prices. Instability in farm income can be a real challenge. It was interesting, and encouraging, to find that farms adopting environmentally friendly practices also had more stable incomes.

"Farmers may be benefiting financially from their environmental management, while in contrast an increase in direct payments per hectare was associated with less stable farm income.

"Environmentally friendly farming practices including engaging in agri-environment schemes, diversifying outputs, and reducing the use of chemical inputs such as fertiliser and pesticides, are associated with ecological and environmental benefits and importantly could also increase the stability of farm income."

The researchers examined data from the Farm Business Survey for 2333 farms in England and Wales, between 2007-2015, for a range of different farm types.



Diversifying farm outputs also makes farms more resilient

Using statistical models, the team examined the effect of farming practices and subsidies on the stability of farm income, and their relative importance over the nine-year period.

An increase in direct subsidies paid to farmers based on the area farmed was associated with less stable farm income, across most farm types.

In contrast, dairy, general cropping and mixed farms that received more agri-environmental payments had more stable incomes in the short and medium-term. However, farms in the so called Less Favoured Areas - predominantly upland farms who graze sheep or cattle, do not see the same stability benefits from agri-environmental payments.

Ms Harkness said: "Farms in the uplands are already operating in challenging environments and many of the options in agri-environment schemes may not be available or well suited to deliver ecosystem service benefits in these landscapes."

The results also showed that greater diversity in crop and livestock activities increased the stability of farm income, in dairy, general cropping, cereal and mixed farms - but this was not an important factor for farms that primarily graze livestock.

"Increasing diversity of outputs could

make farm businesses more resilient to economic shocks or price fluctuations," says Ms Harkness.

Reducing the input intensity also seems to be an important factor increasing the stability of income for all farm types, she added.

"With rising input prices, a concern of many farmers is to control the use of expensive inputs. Whilst farms with higher input costs are more likely to have higher outputs this does not always translate to a higher farm business income, and these farms also saw larger fluctuations in income."

Dr Jake Bishop, Lecturer in Crop Science and Production from the University of Reading's School of Agriculture, Policy & Development said: "Our latest research is interesting as it shows that farms that were adopting environmental management actually benefitted financially from their stewardship. This is encouraging news for farmers as the UK moves to the Environmental Land Management scheme.

"Diversifying outputs and more efficient use of agrochemicals is also associated with environmental and ecological benefits, including for soils and pollinators, these benefits may have translated into more stable farm incomes over the nine years we examined."

The full paper can be read in *Agricultural Systems* Volume 187, February 2021 and purchased via the QR Code.



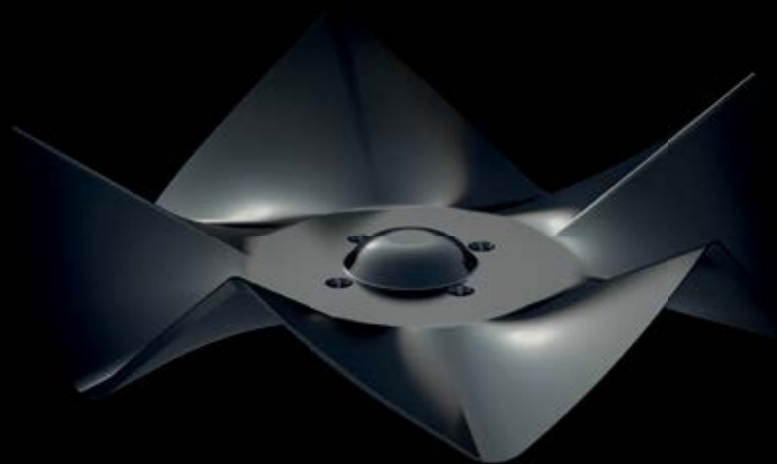


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ANOTHER EXCEPTIONALLY WET WINTER HIGHLIGHTS THE BENEFITS OF GOOD SOIL STRUCTURE AND DRAINAGE.

Following another extremely wet winter Jeff Claydon, a Suffolk farmer and inventor of the Opti-Till® direct strip seeding system, talks about the importance of good soil structure and drainage. He also discusses the initial results of stubble management and cover crop trials on E. T. Claydon & Sons' arable enterprise.



20 February 2021

Following the extremes of weather and associated challenges which most farmers had to deal with during 2019/20, one might have hoped that the law of averages would mean that this season was easier. So far at least, that has not been the case. With such extremes becoming increasingly frequent, clearly, we must position ourselves to deal with them by ensuring that our soils are in optimum condition and that we use an establishment system which significantly reduces our exposure to weather risk.

Statistically, Suffolk is one of the driest counties in the UK, but even here, after a scorching summer when temperatures peaked at 36°C, we still ended 2020 with 700mm of rain. Of that, over 400mm fell between harvest and the end of December, which has been a challenge on our very heavy Hanslope series chalky boulder clay soils that are notoriously difficult to manage. When wet, they can become impossibly sticky, unfriendly, and slow to drain, but when dry set like concrete. At either extreme they are impossible to work, so all field operations must be carried out within a very narrow time window and when conditions are

exactly right.

Until mid-October, our soils remained dry enough to absorb the persistent and often heavy rainfall, but the wet weather continued throughout the autumn and winter. Our weather station next to the Claydon offices recorded another 146mm during January and 46mm in the first two weeks of February, making this one of the wettest winters on record.

Driving around the area over the last few weeks I have passed many fields that are in poor condition after being over-worked, or where inappropriate machinery was used at the wrong time. Some were waterlogged, slumped, and capped, worm activity was minimal, crops which had been drilled were stressed and even weeds refused to grow in some areas. Elsewhere, topsoil had been washed off fields, causing crop loss and polluting water courses.

As I write this during the third week of February, we have experienced two weeks of extremely cold weather. The plume of Arctic air that the media dubbed 'The Beast From The East' caused temperatures to plummet to a low of -15°C with the windchill factor. The cold snap may have passed, but the wet weather shows no signs of abating and our crops are at their most depressed point in the growing cycle. However, unlike many, they are all set to flourish once the mercury starts to rise.

Every week I talk to existing and prospective Claydon customers throughout the UK and overseas, so I know that many of you also operate in extremely challenging situations and need a robust establishment system. Because of the Claydon Opti-Till® System's ability to establish any seed that can be air-sown, in all soils and conditions, using around 16l/ha of diesel even on our heavy clay soils – about 10% of that required for a plough-based system – it is now being adopted not just by arable producers

but increasingly those in the dairy sector for crops like grass, maize and stubble turnips. With the current talks of reducing CO2 to much lower levels and increasing carbon capture, we are ahead in this field.

When you next have a few minutes to spare you might like to watch 'The first year of Claydon direct drilling on a UK dairy farm', an excellent video which Charlie Eaton, Claydon's Territory Manager for the South and West of England, made over several months on a farm in the Cotswolds. Visit the Wiltshire section of the UK video gallery on our website www.claydondrill.com – it's well worth a look.

Our website video galleries also have numerous videos on soil health and resilience, as well as of the Claydon Opti-Till® System being used to establish all types of crops, in all situations, both in the UK and overseas. You can also keep up with the latest posts, photographs, and videos from Claydon and our customers through the Claydon Facebook page (www.facebook.com/Claydondrill). It's also a great place to share, discuss and question what you are seeing on your farm with other like-minded individuals.

Time to check soils

Extremes of weather such as we have experienced during the last two seasons highlight the importance of having resilient soils with excellent structure, supported by an effective drainage system to take water away.

Spring is the ideal time to take stock of your soils, test how good they are, look for signs of compaction, and check that the drainage system is operating correctly. This can be done easily and cheaply using nothing more complicated than a fork, penetrometer, water infiltration tray and a couple of jam jars if you really feel like pushing the boat out to do a Slake Test! With this information you can then plan to correct any deficiencies.

When assessing soil condition, the first thing I do is to carry out several penetrometer tests across the field to check there are no soil pans, as these will severely limit drainage and root development. If they are present, the probe becomes much more difficult to push into the ground and the indicator needle swings into the red. Pans are not caused solely by compaction from heavy machinery or working when conditions are unfavourable but can result from the sedimentation of soils that have been over-cultivated and 'settled out' over the winter.



Jeff Claydon tests for compaction in a field of winter wheat during February. Even when inserted to full depth, around 60cm, the penetrometer reading remained in the green, indicating a lack of compaction.

This is clearly demonstrated with the Slake Test, which provides an excellent indication of a soil's resilience and health, is easy to do and costs nothing. Briefly, it assesses the stability of soil aggregates when exposed to rapid wetting, as in the case of heavy or prolonged rainfall. The slower the soil breaks up the better as this indicates that it contains a high degree of organic matter which helps to bind it together. You can see this simple yet important test being carried out on the Claydon farm by Dick Neale, Technical Manager for Hutchinsons, in a short video on the 'Soil' page of our website.



The Slake Test in action. The wire mesh in the jar on the right contains a sample of soil from a field on the Claydon farm which held together firmly even over a prolonged period, so little fell to the bottom and the water remained clear. In contrast, the sample of silt soil in the other jar quickly fell apart and dropped to the bottom, clouding the water.

Good drainage is essential

One cannot talk about soil health and resilience without discussing drainage, an area of soil management that is fundamental to good soil structure but often neglected. You don't need me to tell you that well-drained soils go hand in hand with healthy soils and high yields. The key is to ensure that drains are adequate to cope with the highest flows and well maintained so they don't become blocked or have their capacity reduced and become overwhelmed during periods of heavy, prolonged rain.

Since land drainage grants finished in the 1970s many farms have been unwilling or unable to invest in new schemes. Four decades on, many existing ones have become obsolete and ineffective, which is a major blow because effective drainage helps soils to dry out and improves timeliness. It also makes them easier to manage, enables fertilisers and ag-chemicals to work most efficiently and minimises leaching, not forgetting that it also typically leads to yield improvements of 25%-30%. Recent studies have confirmed that new land drainage systems on average can start to pay for themselves after eight years.



Drains should flow freely, and the water should be clear.

If, after heavy rainfall, the water flowing from field drains is dirty this indicates that it is full of sediment, so your valuable soils are literally going down the drain, increasing the risks of soil erosion and flooding. This sediment will also block worm holes and capillaries, killing worms, starving the crop's roots of essential air and nutrients, reducing yield potential, and ultimately increasing the cost-per-tonne of production.

Most of the Claydon farm is drained and after two decades of using Opti-Till® our soils are very well structured, so water permeates freely. Nevertheless, the drainage system has been pushed to its limits this season. In January, for example, we had one day when over



This was how the cover crop looked eight weeks later.

35mm of rain fell, which overburdened the field drains and water coming out of the pipes ran cloudy. A small amount of overnight surface ponding was also evident in a couple of areas, so I will want to address this in the months ahead by installing additional laterals.

Some have the fear that well drained land increases the flow rates, which to a point it does, but they do not consider the sponge effect of well drained land, where the water is gently filtered through the soil and released steadily, unlike waterlogged soil which washes off the top at a time when we need to achieve clean water to drain and a healthy environment. Healthy soil copes better with these extremes due to the increased presence of soil biota, and our high organic scores on the farm have certainly proved their worth in recent weeks.

Driving past some fields where conventional full cultivations and min-till systems have been used, you can see the results of overworked soil which has had its structure destroyed and worm populations adversely affected. It can easily be seen in the last two years where the wrong equipment has been used in wet, adverse conditions. Degrading the soil in this way also reduces its ability to drain water away during extended periods of wet weather and increases capillary action moisture losses in dry conditions.

Given increasing public interest in countryside and environmental issues, including soil erosion, Defra would do well to reinstate drainage grants and fund attenuation ponds to catch sedimentation, as well as to control the release/flow of water. This could be a base for future management strategies considering the weather patterns of the last couple of years. Their work should also address both the capacity and condition of river systems, the need for adequate maintenance of ditches, and give more recognition to the role of correctly structured and managed

farmland in holding water and releasing it gradually to prevent water courses from being overwhelmed, leading to flooding.

Stubble management and cover crops

In the last issue of Direct Driller, I outlined the trials we are conducting to evaluate different approaches to stubble management and cover crops, in the same field, under the same conditions. Even at this early stage they have provided plenty of food for thought.

The field next to the Claydon factory which we allocated for this is part of 55ha destined for sowing with WPB Elyann (KWS) spring oats, a crop which is easy and relatively inexpensive to grow but often produces a margin on a par with winter wheat. Some of the area was straw harrowed up to four times then left, while on 10ha we drilled a cover crop using different methods to see if, and by how much, it improves the yield and overall margin from following crops. The yield from each area will be measured so we can assess the agronomic and financial impact.

Cover crops are still relatively new in the UK, with most farmers and agronomists still learning about what does and does not work. The trials have been very revealing, but as the lockdowns, sadly, have greatly restricted travel and prevented us all from holding public events you can watch a video of Dick Neale, Technical Manager for Hutchinsons, discussing our cover crops on the video gallery of the Claydon website at www.claydondrill.com

We used Hutchinsons MaxiCover, a general-purpose over-winter cover crop mix containing linseed, buckwheat, phacelia, daikon radish, fodder radish, brown mustard, hairy vetch, and crimson clover. Costing £35/ha, it was drilled at 12.5kg/ha on 9 August using three seeding options on our 3m Claydon Hybrid test drill. With a few simple, quick, low-cost modifications any new or existing Hybrid drill can be used for conventional sowing, lower disturbance establishment and zero-till seeding, with or without fertiliser placement between or in the seeded rows, directly into stubbles, chopped straw, cover crops and grassland. This makes it a versatile, cost-effective solution.

In one area we used the standard Claydon Opti-Till® set-up comprising the leading tine which relieves compaction

and aerates the soil, followed by a seeding tine with a 20cm A-share. In another we used the leading tine followed by our twin-tine kit. The third was drilled with the new lower-disturbance 'LD' twin-tine kit preceded by double front cutting discs which reduce power requirement and minimise soil disturbance. In all cases the cover crop produced a mass of roots.

The diversity of species in these mixes means that, regardless of weather, soil conditions, field aspect and establishment methods, it produces a viable cover crop, because even if a couple of species do not thrive because conditions are not right for them in that situation others will grow. Having various plant canopy profiles provides good soil armour and weather protection which has a positive effect in terms of controlling grassweeds, as well as further improving soil condition.

The heavy calcareous clay soil on the Claydon farm has a high calcium base which attracts phosphate and locks it up, so crop roots can have difficulty in accessing this vital nutrient. Buckwheat, one of the species in the MaxiCover mix, produces acids which help to release phosphate and so it plays a valuable role in achieving a correct soil nutrient balance.

Ideally, we want the cover crop to be in the ground long enough to gain maximum advantage from the rooting structures, but not so long so that it generates excessive stick-like biomass. The original idea was that cover crops would be sprayed off at the end of November and those areas left until spring, when we will drill spring oats directly as soon as conditions allow. However, we decided instead to graze some off with a neighbour's small flock of sheep and then rolled the cover crop area with our 12m Cambridge rolls around Christmas on a small frost.

The cold weather of recent weeks has broken down almost all the top biomass, so we will have no issues with it shielding

grass weeds from an application of glyphosate applied before drilling. Neither will we have any problems sowing spring oats into the heavy soil, which can be very wet and cold with too much green cover, and this should allow a perfect seedbed environment. The cover rooting has been retained with high levels of worms, so it will be interesting to see how the different areas behave in the following crop.

Obvious differences

With our rotation having changed from wheat and oilseed rape to include more spring-sown and break crops, the aim is to use land destined for spring drilling to help reduce the weed burden and seed bank using Opti-Till® stubble management techniques which move no more than 2cm of topsoil. This will enable us to control weed seeds and volunteers without herbicides, other than one full-rate application of glyphosate just prior to drilling.

Effective stubble management has become particularly important following the loss of neonicotinoid seed treatments and some products to control grassweeds as there is a fear that the aphid vectors of Barley Yellow Dwarf Virus (BYDV) will increase significantly. This can be reduced considerably by using Opti-Till® to manage stubbles and eliminate the green bridge effect. It also enables drilling to be delayed, but to do that with any degree of certainty you must be able to get the crop in the ground quickly, which means not having too many operations before sowing.

It has been fascinating to compare the effects of two, three and four passes with the Straw Harrow, a fast, low-cost operation, under identical conditions. This has highlighted the effectiveness of this technique and the significant benefit of using more passes. The differences are as clear as day, as can be seen from the accompanying photographs. We also have numerous videos about stubble management on the Claydon website.

In the next issue of Direct Driller, I will look at how each of the trial areas drilled in the spring and talk through any differences that were apparent at that time.



A section of the cover crop in mid-November.

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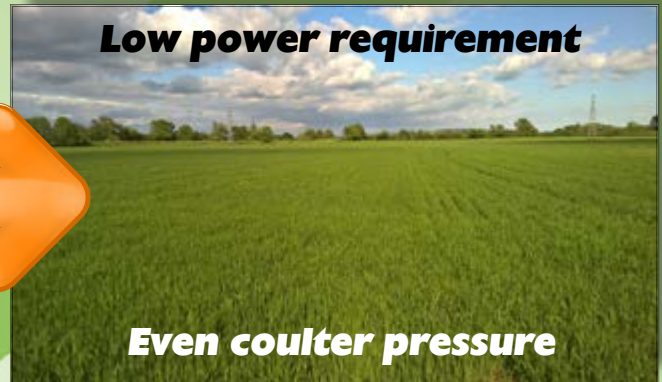
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FARMER FOCUS

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A global pandemic has few positives, but if I were asked for any I would say the rise of the webinar. As soon as the first lockdown was imposed physical farm events were ended. Participation and involvement in farm shows, auctions and meetings could only be done by farmers and others using software applications such as Zoom, Teams and other programs they had never used before. Over the time they have become so familiar even grandparents are using them to keep in touch with friends and family. While it may be a poor substitute for face-to-face human contact provides, online has become remarkably popular.

Lockdown was as if someone had pressed 'fast forward' on the internet. Websites like The Farming Forum, Farm Marketplace and Farm Classifieds with which I'm involved suddenly saw a big increase in traffic. Farmers and others who previously were not interested in digital coms were forced to try - and liked the experience.

Meeting online has its problems - broadband connections which let users down at a critical moment; people talking over one another; or that funny moment when a meeting participant speaks up... with microphone still on mute!

But these downsides are heavily outweighed by the accessibility that the almost limitless geography of the internet offers. Attending a meeting or event prior to Covid Lockdown often involved a full day, travelling (with environmental impact of course), small talk before and after, lunch and multiple coffee breaks. All reduce the efficient uptake of the information you had really come to digest.

In contrast an online event allows you to turn up just moments before proceedings start. There's no travel time and cost. But most importantly the internet allows an infinitely wide range of both speakers and participants. As a BASE UK committee member, I have been involved in helping organise speakers for the group over several years, and our choices have often been limited by both the speaker's diary and more often geography.

Flying in speakers from New Zealand, Australia or the Americas is simply just too expensive, yet these are some of the most knowledgeable soil and No-till people in the world and ones which BASE members want to learn from. Online meetings have made such speakers accessible. In a year when BASE and others might be expected to struggle to do its work, it has in fact done more than ever and membership has grown to new highs as a result. Hopefully we will not abandon Zoom when lockdown and travel restrictions become distant memory.

Farming and carbon trading

Some of the most exciting meetings I have attended have been based around carbon sequestration and storage, and how farmers will be able to sell this and other ecosystem capital benefits in the future. While DEFRA's ELMS scheme (now known as the Sustainable Farming Incentive "SFI") has

bold vision to pivot production-based subsidies to natural capital and public goods payments, the complexities of creating trading systems for Carbon seems now to be a step too far for them to get involved in. This has created an opportunity for the private sector to provide certification and trading of this farming asset.



The first point of difficulty when selling Carbon is working out how much (if any) you have available for sale. This is anything but easy. The current debate involves the way carbon is accounted. It's been suggested that a farmer using synthetic fertiliser should have all the Carbon produced in its manufacturer on his balance sheet. To me this is an utter nonsense. Are we really suggesting that Yara, Europe's biggest user of natural gas, is carbon neutral? If a fertiliser manufacturer is going to push its carbon footprint onto me then I'm going to push mine on to my grain customers, and logically they then will pass it to theirs'. So the entire carbon footprint of everything ends up with the consumer, who can do little about it.

Far more logical and consistent is for each part of the chain to take responsibility for the carbon they directly produce. Removing the crazy idea that a farmer is responsible for carbon involved in the production of synthetic fertilisers makes UK agriculture suddenly look a lot more like a net zero, and those of us in regenerative farming have a new product to sell.

So far the official focus is on the sequestration of carbon, - its removal from the atmosphere is what we all want. But of equal yet often neglected importance is the storage service that farmers and land managers provide. A scheme that currently pays to plant a tree is only positive while the tree is growing. Cut it down, use it for fuel, and the saving is all lost! How do we sell and guarantee both future storage as well as the tools for carbon removal?

Measuring carbon quantities

Then there is measurement - how much carbon do you

have in your soil? Soil sampling is a huge can of worms (pun intended) with so many different opinions and issues around consistency. Right now soil sampling has very little to offer to quantification. Then there are the "desktop" assessments. Back in 2016 when I won the Farm Carbon Toolkit Soil farmer of the year, I used their excellent carbon calculator tool (an exercise I would recommend to all). It gives an excellent value for an individual impact and indicates where improvements can be made. These simple tools sadly lack the ISO accreditation that buyers of carbon require to have confidence to purchase. More complex ISO certified desktop quantification models exist, but are expensive and complex to use. Currently I am trailing and helping adapt a system already in use in other countries. If successful it will become the backbone of the Gentle Farming programme which aims to sell ISO certified carbon as a premium brand. It recognises the ecosystem gains of regenerative agriculture, and not simply the carbon sequestration and storage. My fear is that carbon trading may ultimately become a race to the bottom with carbon brands that fit well with buyers' corporate responsibility but which provide farmers with a poor return for the valuable environmental service they provide. Carbon markets are simply not going to grow until credible assurance exists that makes purchase possible now or in the future when incentivised through offsetting taxation.

Following 20 years of Red Tractor's complete failure to make the UK food assurance scheme into anything which provides UK farmers with a premium, 'assurance' is a word that fills me and many other UK farmers with fear. Food

assurance has instead just become another unwelcome cost that places us at a competitive disadvantage to imports with no farm level assurance at all. As well as being at the centre of various food safety scandals itself, Red Tractor often confuses consumers with its inconsistent and complex standards, and, as the logo is rarely if ever used on bakery and cereal products, Red Tractor is of no value whatsoever to grain producers.

Another positive of the pandemic surfaced when farmers put their new found use of social media and online meetings to use in making their feelings clear. I have no doubt that changes originally intended will now be very difficult to make, and the entire value of keeping the scheme is now under question. It has been fantastic to see farmers represent themselves in this way.

If Carbon has the potential to be farming's 'gold rush' we must vigorously resist those with such a proven track record of failure getting involved. It was alarming to hear Red Tractor CEO Jim Mosley talk about their ambition to become a condition of, or the 'assurance' behind, ELMS. Carbon storage and sequestration will be inevitably be linked to future environmental schemes and farmers should develop this new product themselves and let markets decide its value. The last thing we need is more costly assurance that comes without securing a premium.



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HARDWOOD INTERCROPPING SYSTEMS

Authors: David Rivest, Ing. F., Ph.D., Université Laval, Olivier, Ph.D., Université Laval and Andrew M. Gordon, B.Sc.F., Ph.D., R.P.F., University of Guelph. Published under licence from Agriculture and Agri-Food Canada and the Government of Canada.

Combining wood and agricultural production while delivering environmental services

Introduction

The evolution of agriculture in eastern Canada over the past half-century has been characterized by a spectacular gain in productivity with, in many cases, a concurrent but gradual exclusion of trees from croplands, particularly because of large farm mechanization. Combined with the intensification of agriculture, this decrease in forest area has resulted in a variety of environmental problems, including decreases in soil fertility, soil erosion, an increase in diffuse pollution and a reduction in biodiversity, all of which has resulted in an overall loss in terms of the quality of the rural landscape. In this context, the re-establishment of the tree as a fundamental element of the agricultural agro-ecosystem seems like one judicious solution to mitigating the impacts of intensive agriculture. Experiments conducted in eastern Canada and other temperate regions of the world have shown that intercropping systems (ICS) constitute a promising avenue for strategically reintroducing the ecological functions of the tree into an agricultural environment (Photo 1). Planting hardwood trees in such systems can also meet the need to increase the production of quality wood that is indispensable to the wood-processing and furniture-manufacturing industries, while at the same time delivering a variety of positive environmental services.

This factsheet provides an overview of various types of temperate ICS observed



Photo 1: Intercropping systems consist of planting rows of widely spaced trees and cultivating agricultural crops in the 'alleys' between the tree rows.

in Canada and around the world and an account of current knowledge with respect to their productivity and associated environmental benefits. The technical itinerary necessary for the development of a successful intercropping system is then discussed: choice of tree species, their spacing, maintenance, and choice of crops and their management.

Modernization of traditional types of association between trees and crops



Photo 2: Soybean-walnut intercropping at Dauphine, France. In this region, the practice of intercropping systems dates back to antiquity.

In temperate regions of the world, various traditional types of tree-crop associations have remained very much alive. In some countries, such as Italy, France and Greece, intercropping extends over several tens of thousands of hectares. Generally, 'intercropped' crops are cereal crops (e.g. corn, wheat, barley) and oilseed crops (e.g. soybean, sunflower); these crops are grown in the 'alleys' between the tree rows while the trees (e.g. walnut) are cultivated in linear hardwood plantations. Crops and plantations can share the same physical space until shade production from the tree inhibits crop growth (up to 15 to 20 years (Photo 2)), although in some systems (e.g. winter wheat - Paulownia in China (Wu and Zhu, 1997); cotton - pecan in southern United States (Zamora et al., 2008)), this is not a major problem.

Recently, various initiatives aimed at increasing hardwood production while maintaining farming activity on rural

lands have enabled new systems to be developed. In Europe, and especially in France, trees such as walnut and hybrid poplar have been grown in association with crops such as wheat, colza and various forage species (Photo 3). In Canada, the first experimental trials were established almost 25 years ago at Guelph, Ontario. A variety of hardwood trees (red oak, silver maple, sugar maple, American ash, black walnut, hybrid poplar) continue to be grown with a variety of crops (e.g. corn, beans, wheat) (Photo 4). In Quebec, the first experimental field plots were established six years ago. Soybeans, canola, buckwheat and a variety of cereal plants such as barley, oats, rye and wheat have been intercropped in mixed



Photo 3: Intercropping hybrid walnut and colza at the experimental station at Restinclières, Hérault, France.



Photo 4: Intercropping American white ash trees with wheat at the agroforestry research station at Guelph, Ontario.



Photo 5: Intercropping hybrid poplar with oats at St-Paulin, Quebec.

Trees and intercrops: do they work well together?

The effect of intercropping on tree growth

For foresters, associating crop production with tree production is not a common custom. Can trees take advantage of their proximity to intercrops and benefit indirectly from the care (e.g. weeding, fertilization) that these crops receive? Although focused only on young trees, recent experiments conducted in Quebec seem to indicate that this is the case. It was observed that after three to four years of growth, above-ground biomass of various hybrid poplar clones associated with various annual intercrops was, on average, 40% greater than that observed when repeated harrowing was undertaken between tree rows, a practice commonly used in intensive poplar monoculture (Rivest et al., 2009) (Photo 6). According to this study, improved tree growth comes notably: i) from stimulating the soil microbial biomass and mineralizing nitrogen through intercropping; and ii) from recovery by the tree roots of a significant proportion of fertilizer residues used in intercropping, which improves their mineral nutrition. Similar results have been found in France (Chiffolle et al., 2006).



Photo 6: On this experimental site at St-Remi, Quebec, hybrid poplars grown with a soybean intercrop for 3 years (left) have higher biomass than hybrid poplars grown in a non-intercropped condition (right). Note that the system also included other hardwood trees (centre).

The type of crop associated with the trees is very significant, however. For example, research conducted in Ontario showed that young trees were taller in the presence of corn or soybeans than in that of barley, a crop that creates competition for water early in the growing season (Williams and Gordon, 1992). Nevertheless, when associated plants are well chosen, all indications are that trees planted in ICS generally

have somewhat shorter rotations than those in forest stands. As they are planted in large competition-free zones, trees planted in an ICS develop more extended canopies, which accelerates their stem radial growth. If they are not pruned regularly, butt logs at final harvest could therefore be shorter, but of greater volume than those harvested in natural forests (Cabanettes et al. 1999).

The effect of trees on intercrop yield

Farmers are often more familiar than foresters with tree-crop associations (e.g. shelterbelts and wind-breaks). However, to date, the development of ICS whereby rows of trees are 'inserted' into crop production areas remains a rare practice in the agriculture sector. It is a well-known fact that young hardwoods generally cause only a negligible loss of productivity in associated crops; this effect could even be beneficial in some cases. However, as time passes, intercrops could suffer from competition with trees for light, water and nutrients in the soil. In Quebec and Ontario, studies have shown that the yield losses of crops such as soybeans and corn are generally a result of tree shade (Reynolds et al. 2007; Rivest et al. 2009). Several options can help to control competition for light. These include: i) giving preference, from the planting stage onward, to wide spacing between trees and within and between rows; ii) opting for tree species and clones that minimize shade (high porosity and low canopy width); iii) giving preference to thinning and continued pruning; and iv) positioning the tree rows along a north-south axis.

The effect of shade is not always a decrease in the yield of the associated crop. Some forage plants (e.g. tall fescue) can, under partial shade (i.e. 50%), produce a total biomass and protein content greater than those observed in full light (Lin et al. 1999). In Ontario, Clinch et al. (2009) also observed improved performance of a willow crop under moderate shade compared with the same crop grown in monoculture (Photo 7).

In the United States, some research has shown that tree competition for water can become critical to the point of significantly decreasing the productivity of the associated crops



Photo 7: On this experimental site in Guelph, Ontario, it was observed that the biomass of a short rotation willow intercrop associated with 20-year-old trees was 45% higher than that of willow observed in open fields.

(Jose et al., 2004). However, it is possible to neutralize this competition by undertaking tree root-pruning; i.e. by mechanically controlling tree roots to prevent them from extending into the crop area (Photo 8). The few trials that have studied competition for nutrients in the soil have proven this competition to be generally negligible in that the nutritional requirements of intercrops are normally met through standard fertilization practices (Miller and Pallardy, 2001).



Photo 8: Research has shown that root-pruning (e.g. with the aid of a chisel plow) can limit underground competition between trees and crops.

Are intercropping systems profitable?

Because they are new, limited data is available about the actual profitability of ICS. Various economic studies, including those of a modelling nature, have shown that ICS compare favourably with monocultures and conventional plantations (Graves et al., 2007). The choice of tree species and the associated crop have a great influence on the profitability of ICS, however. Generally, profitability is favoured by:

- i) low interest rates (such as those that exist today);
- ii) choice of sites with a high fertility;
- iii) use of silvi-culture management and spacings that maximize crop yield and tree growth;
- iv) production of quality rotary-cut

veneer wood, sold when market prices are at their highest;

v) choice of tree species that also yield an annual product (e.g. berry, nut, maple syrup) of some value; and

vi) contribution of financial incentives recognizing the positive externalities of trees from an environmental perspective (e.g. sequestration of carbon, lowered soil erosion)

Trees serving the environment

ICS are agro-ecosystems that address numerous environmental issues. Their particular structure, halfway between that of intensive monoculture agricultural systems and complex natural ecosystems, enables better exploitation of resources because of the complementarity of trees and crops in using water, nutrients and light as well as their beneficial impacts on the physical, chemical and biological properties of the soil.

Trees improve soil fertility

ICS, in comparison with agricultural systems, can contribute substantially to increasing the return of organic matter to the soil as a result of residues (litterfall) from aboveground tree biomass and in situ decomposition of tree roots, especially those of the fine root fraction. Humus from hardwood litters is often of excellent quality and can therefore be managed like a true fertilizer, which could translate into a decreased reliance on commercial inorganic fertilizer. Organic matter from

trees generally results in an increase in soil microbial biomass and earthworm populations (Price et al., 1999), contributing to the improvement of soil fertility.

Trees stop soil erosion and diffuse pollution

In ICS, the presence of tree roots limits surface run-off and soil erosion. Deep tree roots can also recover soil nutrients, especially nitrates that escape the crop through leaching, which mitigates groundwater pollution. This is the aptly-named ‘safety net hypothesis’ (Allen et al., 2004). This was illustrated in a Quebec study in a hybrid poplar ICS: from May to mid-October there was a decrease of close to 80% of the quantity of nitrates leached in the ground-water, as a result of the buffering capacity of the tree roots (Lacombe, 2007). A study in Ontario suggested that ICS can also mitigate migration of some bacteria that are hazardous to human health, such as Escherichia coli (Dougherty et al., 2009).

Trees fix atmospheric carbon

As trees fix CO2 and generally tend to increase the quantity of organic matter in the soil, ICS can also play a major role in the sequestering of carbon and the offsetting of other greenhouse gas emissions such as N2O. Use of fast-growing tree species such as hybrid poplar can increase the potential for atmospheric carbon fixation in ICS. In Ontario, Peichl et al. (2006) estimated that in the 13th year of tree growth,

the net annual carbon flux in an ICS (hybrid poplar - barley) was 13 tons C per hectare, compared with 1 ton C per hectare in an alternative ICS (Norway spruce - barley) and -3 tons per hectare in a barley monoculture system.

Trees improve landscape quality and biodiversity

Studies conducted in eastern North America have shown that the diversity and abundance of predators of agricultural pests was higher in ICS than in agricultural monocultures, which could ultimately reduce dependence on pesticides (Stamps and Linit, 1998; Howell, 2001). In Quebec, a greater diversity of microbial populations, especially those of arbuscular mycorrhizae, has been observed in the soil of an ICS (hybrid poplar - soybeans), in comparison with soybean and hybrid poplar monocultures (Chiffolleau et al. 2009; Lacombe et al. 2009). Since they form a more complex and diversified mosaic of habitats than conventional agricultural systems, ICS also attract a greater quantity and variety of birds, as observed in Ontario (Thevathasan and Gordon, 2004). They can also foster the ease with which wildlife can migrate to connecting forest patches. ICS therefore constitute an obvious alternative to the normal spatial separation of agriculture and forestry practices. They can create original, attractive landscapes that are favourable to recreational activities. For that reason, their adoption appears especially advisable in areas where the

Table 1: Grid for choice of hardwood species in six soil conditions in Quebec (Cogliastro et al. 1998, with permission)

| Species | CLASSIFICATION OF SOIL CONDITIONS | | | | | |
|--------------------|-----------------------------------|----------|-------------------------|-------|----------|----------|
| | SOIL TEXTURE | | | | | |
| | LOAM | | LOAMY SAND & SANDY LOAM | | | |
| | DRAINAGE | | DRAINAGE | | | |
| | goodm | oderatef | ast | goodm | oderatei | mperfect |
| Bur oak | 33 | | 2231 | | | |
| Red oak | 44 | | 124 | | | 3 |
| Silver maple2 | | 2222 | | | | 1 |
| Sugar maple1 | | 1212 | | | | NR |
| American white ash | 12 | | 2222 | | | |
| Green ash | 22 | | 4431 | | | |
| Black walnut | 12 | | NR | 2N | RN | R |

■ pH 5.9-6.4 □ pH 7.4-7.6

1) Best performance of species under these conditions
4) Worst performance of species under these conditions
NR) soil conditions not recommended for species

landscape quality has been strongly influenced by historical agricultural practices (Photo 9).



Photo 9: Intercropping systems beautify landscapes, as depicted on this field plot where black walnut is intercropped with buckwheat at Poitou-Charentes, France.

Implementation and maintenance of intercropping systems

What to choose for tree species?

In planning ICS, the tree species is generally chosen in accordance with: i) its growth rate; ii) its commercial or environmental value; iii) its adaptation to the site's ecological conditions (soil and climate); iv) its resistance to disturbance; and v) its interaction with the intercrop. Agroforestry plantations may fail because the choice of tree species is inappropriate for the planting site. Table 1 illustrates the ideal soil conditions for planting valuable hardwoods adapted to the St. Lawrence Plain in Quebec and for which there is high demand from the forest industry (especially sawtimber and rotary cutting). In the table, the various texture, drainage and soil pH conditions were ranked according to their potential for accommodating these tree species. Several local experts are of the opinion that on good sites, these tree species can produce quality wood for rotary cutting in 50 or 60 years, whereas projections for natural forests are more often in the range of 80 to 100 years.

It can also be beneficial to combine valuable hardwoods with fast-growing hybrid poplars, as studied in some trials in Quebec and Ontario (Photo 10). Such an association, inspired by the natural succession of some forest ecosystems where poplar dominates the more shade-tolerant and long-lived hardwoods that succeed it, specifically offers the following advantages: i) creation of a microclimate favourable to hardwood growth; ii) availability of short-term income from harvesting

hybrid poplar (removal age must be 15 to 20 years for the production of high-quality veneer wood); iii) rapid improvement of the agro-environment and landscape quality; and iv) restitution of some open areas when and where the hybrid poplar is harvested, which is favourable to a variety of crops.

Although intercropping conifers with crops is possible, this type of ICS is not widely employed in temperate regions. Generally, the quality of hardwood litter is better than that of conifers, which can result in higher nitrogen mineralization rates, and faster incorporation of nitrogen into the soil profile.



Photo 10: Intercropping hybrid poplar (left and right), and other hardwoods (black walnut and American white ash, centre) with soybean at St-Rémi, Quebec.

How far apart should trees be planted?

Contrary to hardwood forest plantations on farmlands, which are planted at densities of 800 to 1,500 trees per hectare, trees planted in ICS take up only a small proportion of the utilized space (40 to 160 trees per hectare), which corresponds roughly to a distance of 12 to 50 meters between rows, with trees spaced at 5 meters within rows. Generally, the density of the trees is adjusted in accordance with the balance sought between trees and crops. With a low tree density, sustained intercrop production is assured. With higher densities, priority is given to wood production. Between trees in the same row, spacing is generally from 3 to 6 meters to enable thinning, whereas between rows, where crop mechanization, and especially spray booms, must be accommodated, it is often wider (Photo 11). Experience in France shows that the best compromise between wood and crop production is often obtained with an alley of 25 to 35 meters for hardwoods that reach 15 to 20 meters in height after the final harvest.



Photo 11: On this field plot in France, the alley between the rows of trees is 14 m, which enables the farmer to operate easily with a 12-m spray boom.

Must a strip of untilled land be maintained?

In associations with annual intercrops, a strip of untilled land 1 to 3 meters in width is normally maintained under the tree rows (Photo 12). If the strip of untilled land is too narrow, the risk of mechanical damage to the trees is increased, as are the effects of competition for light, water and mineral elements between trees and crops. On the other hand, the wider the strip of untilled land, the greater the loss of area for crops. Several methods for controlling weeds in the tree rows may be used, including the application of herbicides or the use of plastic mulch. In the research plots at Guelph, Ontario, weeds were only controlled for the first decade; studies indicated that weed populations in the untilled land did not contribute to weed problems in the crop alleys, and that they could be used by small mammals for habitat (Kotey, 1996).



Photo 12: On this field plot at St-Paulin, Quebec, where organic crop production is practiced, the strip of untilled land is covered with plastic mulch and flanked by two straight vegetated areas that are mown mechanically.

How to care for trees in order to obtain quality wood: pruning and thinning

Trees planted with wide spacing tend to develop large, dense canopies, with branches low on their trunks, and this may compromise the quality of the wood production. Consequently, pruning remains essential to favouring formation of a straight, knot-free



Photo 13: On this field plot at St-Rémi, Quebec, six-year-old hybrid poplars were thinned and pruned to a height of 4 m. By increasing the availability of light for a short time, these treatments resulted in greater consistency in soybean yield in the crop alleys.

stem, enabling passage of machinery through the alleys, and reducing shading to intercrops. As for row thinning, it stimulates future tree growth for quality wood production and increases luminosity for the intercrop (Photo 13). Generally, thinning once or twice in the 25 to 30 years following planting will bring the stand to a final density of 20 to 80 trees per hectare. The thinning time and intensity can be adjusted in accordance with the intercrop's need for light. Early thinning is recommended for demanding crops such as corn, whereas later thinning will suffice for more shade-tolerant crops.

Intercrop choice and behaviour

The choice of crops depends first and foremost on the producer's needs and knowhow. In general, any type of intercrop (tall crops, forage crops, vegetable crops, other small fruits, ornamental plants, etc.) is possible (Photo 14). In general, annual crops pose more constraints than perennial crops: a greater frequency of more expensive mechanical operations, a greater risk of harming trees, incompatibility of some herbicide treatments with the trees, the obligation to remove or chip debris from tree pruning, and irregularity (usually delayed) in crop development in the proximity of the tree. Nevertheless, annual crops, especially those with a slower growth cycle than that of trees (e.g. winter cereal crops) may prove to be less competitive than perennial crops.

In low-density planting systems (30 to 50 trees per hectare), it is possible to continue intercropping until the tree harvest. At higher densities, agricultural plant yields will probably

diminish to the point that they are no longer profitable as trees approach maturity, and it will therefore be necessary to choose crops that are adapted to shade. In such a case, two options are possible: gradually introduce shade-tolerant crops (e.g. forage crops and pastures) as trees age or reduce the planted area between tree rows so that the associated crop will still benefit from the necessary resources to obtain an acceptable yield.



Photo 14: It is entirely possible to associate trees with specialized crops, as shown in this example from France, where asparagus was planted between rows of hybrid poplars.

Conclusion

Over the past several decades, research conducted in North America and Europe has demonstrated the performance of ICS from a productivity perspective and for their environmental benefits. Several tree-crop associations are possible as long as species are adapted to the conditions of the site and products (from both crops and trees) can be readily marketed or offer a potential for niche market development. It

must also be considered that trees and crops have an influence on each other. Interventions must therefore be judiciously positioned to optimize positive interactions while minimizing those that are negative. For example, as trees age, owner-operators may need to opt for crop production that develops well in a semi-shaded environment, or resort to a regular regimen of pruning.

In the Canadian agricultural context, adopting ICSs nevertheless requires a significant adaptation effort from producers, the industry and governments. A recent survey of Quebec landowners showed that very few of them are familiar with these systems; the same is true of producers (Marchand and Masse, 2008). According to the survey, the lack of technical and financial incentives and a regulatory framework specific to ICS constitute a major roadblock to their development. In France for example, over 2,000 hectares of new ICS field plots have been established by producers in the past few years, in large part due to the improvement of agricultural, agri-environmental and forestry regulations. Intercropping systems therefore represent sustainable agricultural production models that require both practices and programs to be adapted. Because they contribute to the revitalization of marginal cropland and to the improvement of the agri-environmental performance of more fertile land, they are a prime solution for maintaining agricultural land capability for future generations.

Land Equivalent Ratio (LER)

The land equivalent ratio (LER) (SEA, or Surface équivalente de l'association, in French) compares the biological efficiency of ICS to that of agricultural and forest monocultures. It is used for determining whether or not it is more beneficial to associate trees with crops than to produce them separately. The LER corresponds to the required land for obtaining production equivalent to one hectare using an ICS if trees and crops are produced separately. An LER greater than 1 therefore indicates that the ICS is more productive. With the help of modelling, Graves et al. (2007) estimated that the LER of several dozens of ICS scenarios integrating valuable hardwoods or hybrid poplar was, with a select few exceptions, greater than 1 and could even reach 1.4. In such cases, this means that 1 hectare using an ICS produces as much as 1.4 hectare where trees and crops would be produced separately.

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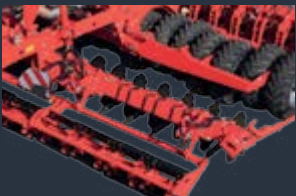
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Written by Shaun Dowman, Agricultural Advisor at Affinity Water

Cover crops are very popular at the moment and for good reason. As readers of *Direct Driller* you will be more likely than most to grow cover crops on your farm and may well be convinced to invest the time and money needed to grow them successfully. Cover crops can do many good things for your soil and the range of species available is almost endless, each one doing something a little different for the biological, chemical and structural health of the soil. Coupled with other regenerative methods such as direct drilling and grazing, cover crops really can be restorative for soils and can form an essential part of a regenerative farming system.

So why are some water companies like Affinity Water jumping on the bandwagon and extolling the virtues of cover crops as well? Talk to a water company Catchment Advisor about cover crops and very soon you will be talking about nitrogen, specifically its soluble form: nitrate. Nitrate is a big issue for some water companies including Affinity Water. Nitrate occurs naturally in water but, as a result of human activity such as agriculture and wastewater effluent, concentrations of nitrate in many rivers and groundwaters are much higher than they should be. This is a problem for both the ecology of freshwater environments, causing algal blooms that can suffocate river systems, and for the supply of drinking water. There is a drinking water standard for nitrate which stands at 50 mg/l and it is the responsibility of water companies to ensure that the drinking water they supply does not contain more nitrate than the permitted standard.

But nutrient management on farms is much better these days, right? Yes, it certainly is. Greater regulation, better



Mixed species cover crop in North Hertfordshire, part of our EnTrade cover crop scheme

understanding of nutritional need, and precision farming have all contributed towards a reduction in nitrate leaching on farms when compared to the post-war period up to the 1980's when we reached our peak for nitrogen usage in the UK. Unfortunately, as a legacy of the excessive leaching over the past half century, some of our groundwaters today, specifically those in chalk areas, store high concentrations of nitrate. This means for some of these water sources, Affinity Water have had to install nitrate treatment plants, or blend the water with a source that contains lower nitrate or, in the worst-case scenario, we lose the water source altogether. Treatment and blending cost time, money and energy which, when added to the high carbon footprint of producing and using nitrogen fertiliser, is deeply concerning from a climate change perspective.

Autumn and winter are the high-risk periods of the year when it comes to

nitrate leaching; residual nitrate left in the soil after harvest is at risk of being lost to groundwater. Even with the best nutrient management planning there will always be some nitrate left in the soil after a cash crop which, if not managed correctly, can leach. One of the best ways of retaining this residual nitrate is to plant a cover crop, especially species such as oil radish or turnip rape which are particularly hungry for nitrate, although any cover crop is better than none. When I walk in a cover crop in the autumn, it always amazes me how well the Brassica cover crop species respond to areas of the field with excess nitrate perhaps from an overlap of the sprayer or on headlands.

You could argue that we should focus our resources into building treatment works for these high nitrate waters but, as I explained earlier, this is energy intensive, comes with an additional carbon footprint and furthermore

we are challenged by our regulators, the Environment Agency, to think of and fund other solutions that do not require water treatment. It is much better to invest in catchment solutions that involve working with farmers to encourage practices such as cover crops, to both reduce nitrate losses at source and provide a whole host of other benefits without the concrete and carbon footprint that comes with grey infrastructure. Each cover crop plant is a natural mini water treatment works that actually captures carbon from, rather than adding carbon to, the atmosphere. The aim is to encourage more cover crops in our target catchments to complement our existing water treatment and hopefully delay, or reduce the need altogether, installation of further water treatment works.

So, with all this enthusiasm towards cover crops, we need to put our money where our mouth is, and that is exactly what we're doing. Since 2019 we have been running a scheme, in collaboration with Cambridge Water, to encourage more cover cropping across a target

area that covers several groundwater catchments. We have used the on-line environmental trading platform EnTrade to run a reverse auction asking farmers to bid their price for growing cover crops. The farmer chooses from a predefined list which species of cover crops to grow and when to drill them. Earlier drilling dates and certain species, such as oil radish, typically retain more nitrogen in the field and prevent it being lost to groundwater. The auction format means farmers have to consider the cost and value of a cover crop and price competitively for their farm business. At the same time they are rewarded for cover crops which optimise nutrient retention in the areas water companies need it. The scheme has worked well and last year we supported over 800 ha of cover crops and estimated that nearly 40 tonnes of nitrogen was retained in fields. We plan to repeat the scheme this year in areas of North Hertfordshire and South Cambridgeshire around Royston.

We are not the only ones at it either. Other water companies such

as United Utilities, Southern Water, Yorkshire Water, South-East Water and Portsmouth Water have their own funding schemes for cover crops. Each water company area has its own specifics of geography, geology, soils and surrounding land-use so funding cover crops might not be appropriate for every company; involvement in these schemes will depend on where your farm is located. It is also worth noting that funding for cover crops is also available through Countryside Stewardship and it will be interesting to see what support ELMs will give towards cover cropping in the future.

I have focused on nitrogen, and touched on carbon, but cover crops do so much more for the environment and soil health as well. Covering the soil over winter will slow overland flow of water and reduce soil run-off, subsequently protecting our water courses. They can also help increase infiltration and also benefit overall farm biodiversity. I would argue that few water company investments deliver so many benefits for a such a modest spend.

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We are the Slow Farming Company, a fifth generation farming family outside Castle Cary in South Somerset. The farm is run by my stepfather Rob and mother Sally, and I work here part time along with my wife Camilla – our three young children like to get involved too! We are on a regenerative journey with the aim of creating nutrient rich food from diverse cropping, with the added benefit of carbon capture. The farm is on medium to heavy clay, and runs to approximately 160 acres.



We have a herd of 180 head of beef cattle, running an Aberdeen Angus bull on mainly Hereford cross British Friesian cows with a few Limosian and Belgian blue crosses for good measure. Our oldest cow is 16 years old and still producing a calf a year. We deliberately moved over to a spring calving regime in 2017 to take advantage of the spring grass and milder weather.

Our move into regenerative farming has been gradual, over the last seven years or so. We reduced and then dropped artificial fertilizer on our pasture ground five years ago, and ceased the pure arable rotation four years ago. We were driven to do this by the lack of life in our soil and the loss in wildlife in our fields.

We were spurred on by Tim, a neighbouring farmer, who introduced us to the likes of Gabe Brown and Joel Salatin. Between Rob and me many hours of YouTube talks were consumed. Regenerative farming was probably the most talked about subject around our kitchen tables between 2013 and 2016 – also the period in which our two of our three children were born and we obtained planning permission to convert a traditional barn into a home for our family. We were lucky enough to hear a talk by Joel at Bristol University in 2016 and for us both it was a bit of an epiphany moment.



If he could do it in America, why couldn't we do it here?

A couple of years before, Rob had ploughed up two small fields and planted a herbal ley mix undersown with spring barley. When we cut off the barley for wholecrop, the herbal ley carried on with gusto. Following on from those initial trial plots, we Min Tilled 30 acres of former arable land and seeded in the crop with a Wox GreenMaster. Later that year we were mob grazing through the herbal ley with Chicory at up to ten foot tall. Driving the buggy through it to set the fences was a particular skill. The cattle did very well on it and showed good growth rates. In 2016 we stopped adding any cereal to the diet, although we had only been feeding the equivalent of a pound a head. We wanted to move to a pure grass fed diet, not least for the emerging nutritional benefits of 100% pasture fed beef, but we also just felt it was the right thing to do.

Alongside the beef, in July 2017 we converted a mobile home into a pastured egg-mobile with 300 laying hens. These eggs were initially sold through a local pack house, under the brand Birds and Herds. The hens followed the cows scratching through and spreading the dung, as well as producing their own source of nitrogen. Unfortunately, this partnership came to an end when the packer went into administration. We had a hectic six weeks of building a packing room, getting an egg packing licence and finding customers for all the eggs. However now, most weeks, we have more customers than we have eggs.





In 2017 we took the decision not to use the plough on the farm again. Again, this was a course of action that just made sense to us. We were looking to build our soil and prevent erosion, not least because on our clay soils we're at risk of significant poaching. Since then we have changed to Min Til to terminate grass in the spring prior to sowing or direct drilling.

In 2018 we carried out several experiments, direct drilling a mix of oats, beans and vetch straight into permanent grassland after the last grazing in the autumn. By this time, the grass has gone into senescence and so doesn't compete against the winter sown cereals. We both grazed and silaged

this successfully. This year we did 25 acres of oats and vetch for grazing.

In spring 2019 we entered the Mid-Tier scheme, as well as going into organic conversion via Organic Farmers and Growers. We have planted five hectares of wild bird seed mix and Bumble Bird mix. We have seen a big boost in the number of birds on the farm as a result, including a big group of gold finches that seem to hang around all year. We have planted an additional 30 acres of herbal ley that fits in well to our mob grazing rotation, providing high quality food for finishing the cattle. The fact that the herbal leys are almost always in a stage of flowering has led to a tie up with a local



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honey company to put their hives here, which we're really excited about.

Organic conversion led us to even greater consideration of our soil and what we are doing with it. Rob got caught in a tremendous rain storm one afternoon when moving the cattle fences. He was amazed to see that, whilst the rain initially travelled across the ground, as soon as it stopped raining the water disappeared into the soil, not sitting on the surface. When I moved the fences that weekend, you wouldn't have realised we had had been one and a half inches in an hour.

Our manure handling has also taken a turn, quite literally. We now empty the sheds in the spring into windrows in the

fields, where we turn it with the telehandler to encourage composting. The volume that we then get to spread is much reduced, but is readily available to the plant. It also means fewer wheelings on the field, as spread rates are down to approx 2 tons per acre.



Alongside our Pasture for Life, Red Tractor and Organic certification we also wanted to find a marque that would reflect the regenerative aspect of the way that we farm. On our local Regen Ag WhatsApp group, the Greener World Regenerative certified pilot scheme came up. We were lucky to be accepted at the beginning of the year, and are well on the way to finishing drawing up our 5 year plan for improvements to farm operations, biodiversity and the general environment in which we live. In conjunction with this we are also working towards certification for Grass Fed Beef, Non GMO Eggs and High Animal Welfare as part of the Greener World system.

We have big plans for 2021/22 - we are clearing out old ponds on the farm and looking to replace some of our mob grazing paddock fences with new hedgerows and fruit trees in some fields. Along with hopefully moving in to our barn conversion!

We look forward to sharing this journey with you.



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We have a small scale trial farm close by which we are now entering our 3rd year of direct drilling with the Ma/Ag, overnight the change was made and all crops have been direct drilled ever since. We have just completed spring drilling of Oats and Barley which went well, but we don't recommend pre germination of seed before drilling!

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Last backend was an interesting time again for drilling, and we had the usual rush of conventional drilling farmers calling for a "demo" to see if a direct drill could rescue their autumn drilling campaign when all else had failed. How do we address this view that direct drilling "can't work on our land", what is the obstacle to reducing costs and inputs that some farmers are struggling to grasp, there aren't many farmers who won't save a few £100's or £1000's on a piece of equipment or on the spray bill but look at the possible savings over the whole farm with a change of system and there are suddenly many obstacles.

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or conventionally which allows for small famers to completely change of larger farmers to dip a toe in the water, it provides all the benefits of the larger Ma/Ag trailed drills but will a much lower ticket price. Ideal for cover crop establishment and the following main crops as well in an easy to use and compact unit with mechanical or electronic seed metering.



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CARBON CAPTURE TECHNOLOGY FACES A DIFFICULT FEW YEARS

Written by IDTechEx Research

Carbon capture, utilization, and storage (CCUS), or carbon capture and storage (CCS), is a set of technologies used to strip carbon dioxide from industrial waste gases or directly from the atmosphere. Once the carbon dioxide is captured, it is either stored permanently underground (carbon storage) or it is used for a range of industrial applications (carbon utilization), such as CO₂-derived fuels or building materials. CCUS technologies are likely to play a key role in the fight against climate change, with the UN estimating that CCUS could mitigate between 1.5 and 6.3 gigatonnes of CO₂ equivalents per year by 2050.

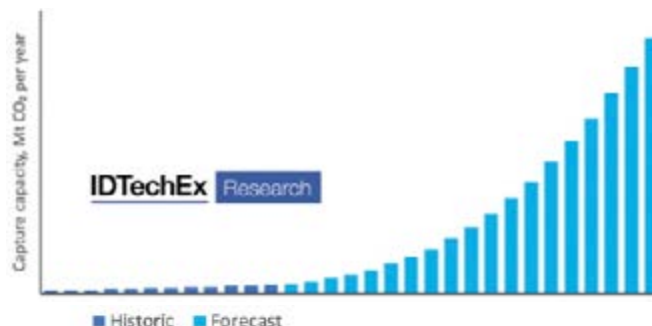
The world has already taken its steps along this pathway. Over the last decade, the deployment of carbon capture technology has been steadily scaling up, with global carbon capture capacity reaching 40 million tonnes in 2020. Plans for more than 30 new CCUS facilities have been announced since 2017. If all these projects proceeded, global capture capacity would triple to around 140 million tonnes per year.

However, this is a drop in the ocean compared with global CO₂ emissions, which reached 36 billion tonnes in 2019. Although global emissions are believed to have dropped to around 31 billion tonnes in 2020, stemming from the global slowdown in the wake of COVID-19, this is probably a blip in the wider picture, and global CO₂ emissions are likely to continue growing over the next few years. For CCUS to have a meaningful impact on emissions in a timely manner, it will need to scale up hundreds of times compared with today's levels.

CCUS technologies also face some major challenges that could hamper widespread deployment. Although each aspect of CO₂ capture, utilization, and storage faces its own challenges, a common challenge facing all aspects of the industry is that of economics.

Separating out CO₂ from a mixture of gases is costly. Although separation is fairly straightforward for waste streams with high concentrations of CO₂, such as in natural gas processing or ammonia production, it becomes costlier as the relative amount of CO₂ in the stream decreases. Capturing one tonne of CO₂ from a flue gas stream in an average coal-fired power plant currently costs around \$40-80. Capturing CO₂ directly from the atmosphere can cost around \$600. The energy requirements to capture the CO₂ are also an issue – a coal plant equipped with CO₂-capturing equipment can require about 25% more fuel to generate the same amount of power as one without it.

Once the carbon has been captured, there's the challenge of what to do with it. Captured CO₂ can either be stored



Caption: IDTechEx forecasts global carbon capture capacity to reach 1.27 gigatonnes per year by 2040

underground or utilized for various industrial applications. Underground storage is by far the most widely used option, with most industrial-scale CCUS facilities using captured CO₂ for enhanced oil recovery (EOR), where CO₂ is injected into oil wells to boost productivity. This is somewhat problematic in its own sense, as it is essentially using CO₂ to access more oil which will then be burned to give out CO₂, but it also requires high oil prices to be commercially viable. The drop in oil prices stemming from the COVID-19 pandemic made EOR less viable in 2020, resulting in the Petra Nova facility's closure in Texas, which was the world's largest installation of CO₂ capture on a power plant. Carbon pricing schemes and tax credits such as the 45Q scheme in the US can help make CO₂ storage more viable, although such schemes are still in their early stages across much of the world.

Despite these challenges, progress in CCUS may be something the world can't afford to ignore. Innovative companies across the world are working to overcome the challenges associated with CCUS, for example, through improved capture technology and the development of catalysts that can quickly and cheaply convert CO₂ molecules into useful chemicals and fuels. The next few years could be essential in ensuring the future success of the industry. "Carbon Capture, Utilization and Storage 2021-2040", a new report from IDTechEx, explores the technical and commercial factors that are key to ensuring the success of the industry.

This report provides a comprehensive view of the global CCUS industry, providing a detailed analysis of both the technological and economic factors that are set to shape the industry over the next twenty years. The report considers carbon capture, carbon utilization, and carbon storage individually, discussing the technology innovations, key players, and opportunities within each area, alongside a twenty-year forecast for the deployment of carbon capture technology.

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SOIL HEALTH MATTERS

Soil health is a product of interactions between plant roots and the living fraction of the soil, operating within the constraints of the physical, chemical and climatic parameters of the soil environment, writes Neil Douglas Fuller of the Atlas Sustainable Soil Programme.

In part, soil health is determined by the inherent, effectively fixed, properties of underlying geology, topography and landscape processes. Of equal importance are the dynamic soil properties that are influenced by land use and soil management practices, each of which can induce incremental changes to the functional characteristics of soil. Defining those characteristics, and developing the associated metrics and measurements required to effectively monitor and manage them, is fundamental to achieving sustainable farming and food production.

Soil: the foundation of society

Soil is often considered to be the foundation for agricultural productivity, food security and environmental integrity. The majority of our air, water, fibre and nutrition is derived from soil-based eco-systems.

History illustrates the social, economic and political importance of soil, and the role that soil degradation has played in the downfall of many a civilisation, both ancient and modern. Right now, soil provides a cornerstone for the global response to climate change and occupies the centre-ground for strategies designed to reverse global warming.

UK strategies

In 2019 the UK became the first major economy to declare a “Net Zero Carbon” agenda, to be realised by 2050. Coupled with the promise of a “Green Brexit”, the requirements of the “25 year plan” and the clear intent to replace Common Agricultural Policy support mechanisms with an Environmental Land Management Scheme, that fully integrates the twin objectives of food production and environmental protection, soil health is now firmly in the political spotlight.

Yet despite all this, the wonderfully diverse, intricate and incredibly complex array of soil-based ecosystems that constitute the agricultural and environmental heart of the United Kingdom are in steady decline. On average, the total carbon reservoir in

arable soils in England has been returning to the atmosphere at rate of around 0.6% per annum since the introduction of artificial nitrogen fertiliser and the four-furrow reversible plough.

Global issue

The global situation is very similar, with some studies estimating that the carbon stocks of agricultural soils have reduced by half, releasing around 140 billion tonnes CO₂ back into the atmosphere. As carbon is synonymous with life on this planet, the implications for this, in terms of soil life processes and the degradation of soil health, could be considerable.

This loss of soil carbon presents a major threat, both directly, on farm performance, food quality and soil resilience. Indirectly it impacts biodiversity, natural capital and eco-system service provision and regulation. Land managers, strategists and policy-makers are becoming more aware of this, and a whole suite of regenerative soil and crop management practices, have been designed to move carbon from the atmosphere, where it is causing problems, and place it safely into the soil, where it belongs. However, their deployment is being delayed, frustrated and compromised by one overarching limitation – the measurement, evaluation and quantification of soil health.

Soil health

Essentially, health is a function of life processes. As such, associating the concept of health to soil, implies that this vital, but fragile, global resource is, in fact, alive. This is in stark contrast to the more mechanistic view that soil is basically a mix of weathered rock and plant residue; or the pragmatic belief that soil is primarily a growing media, the functionality of which depends on the need for soil to be cultivated, fertilised, tempered and conditioned.

Classifying soil as a living eco-system is a paradigm shift for many agronomists, farmers and land managers. And with this shift comes a knowledge gap, both in terms of quantifying appropriate soil

life processes and in evaluating the incremental impact that discriminatory management practices may transfer onto those processes.

Classification

Traditionally, focus has been placed on inherent soil qualities; the content of sand, silt and clay; the effect of underlying geology on acidity, nutrient status and water movement; the impact of aspect, topography and climate on plant performance.

As a result, the success of land management practices was most often noted in terms of biomass production, soil nutrient status, alkalinity and conductivity. More recently, soil quality metrics have been introduced as part of the evaluation process, incorporating factors such as visual assessments of soil structure and earthworm populations; observational assessment of compaction and erosion risk; in-field measures for water infiltration, aggregate stability and soil bulk density.

Carbon measurement

One fundamental component, routinely omitted from soil analysis and quality metrics, is measurement of one of the building blocks of terrestrial life processes – carbon. Despite the requirement under Cross Compliance, routine soil testing in the UK continues to omit any direct or indirect measurement of this vital soil constituent. The situation is further compounded by the current lack of any standardised analytical procedure for the basic metric, soil organic matter content, as determined by the most commonly used method, Loss on Ignition (LOI).

With a large coefficient of variation, dependent on protocol, even the best laboratories may struggle to deliver suitably repeatable results using LOI. With the Action Plan of the Paris Agreement only seeking to achieve an annual increase in soil Carbon of 0.4% in order to halt climate change, it is possible that current soil analytics will be unable to detect positive, or negative, change sufficiently accurately to be able to

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inform, monitor, validated or reward the regenerative Carbon Farming practices that are now forming agriculture's Net Zero Initiative.

If soil health is going to inform agricultural policy and influence farm management practices, decision-makers need to have access to robust, reproducible, reliable systems of measurement that can detect the incremental changes that land management practices have on the dynamics and functionality of individual soil systems.

Defining the soil health space

A brief literature search will reveal a wide range of terms and definitions used to outline the working premise of "soil health" and "soil quality". These two terms appear to be interchangeable, although they do convey different operational parameters. In simplest form, health equates to absence of illness, while quality equates to specific attributes, one of which could be health. While both terms relate to functionality, soil health implies that the physical, chemical and biological components of soil combine to create dynamic, living, processes.

The Journal of Environmental Quality (Meanings of Environmental Terms) describes soil quality as "a measure of the condition of soil relative to the requirements of one or more biotic species and/or to any human need or purpose". This is taken a stage further by Doran and Zeiss (2000), who define Soil health as, "the capacity of a specific kind of soil to function, within natural or managed ecosystem boundaries, to sustain plant and animal productivity, maintain or enhance water and air quality, and support human health and habitation".

The concept of health is also central to the applied definition proposed by Kibblewhite et al. (2008) which determines that "... healthy agricultural soil is capable of supporting the production of food and fibre to a level, and with a quality, sufficient to meet human requirements, and deliver ecosystem services essential to maintain environmental quality, quality of life for humans, animals, plants and conservation of biodiversity". However, Toth et al. (2007) defines soil quality in slightly different terms, being "... an account of

the soil's ability to provide ecosystem and social services through its capacities to perform its functions under changing conditions".

The ability to define those functions, and effectively measure the impact of management practices on the outcomes of those functions, is fundamental to sustainable soil management and, by implication, the impact this has on future food security and environmental integrity.

Soil health is imbued with transferable performance-enhancing characteristics that influence plant, animal and human health. Not just in terms of the nutritional bio-chemistry that supports healthy growth, development and the expression of genetic traits; but also functional metabolite-related, elicitor-induced and microbe-mediated disease resistance, abiotic stress factor mitigation, and associative adaption. Each individual attribute has specific physical, chemical and biological frames of reference.

Physical soil health

The relative content of sand, silt and clay, traditionally referred to as the fine earth fraction, defines the texture, or "feel", of a soil. However, it is the orientation, alignment and aggregation of these soil particles that define its structure, or function. Part of this definition relates to the size and distribution of pore space, which regulates:

- water movement, retention and availability
- infiltration and drainage
- air exchange and anaerobic-aerobic balance
- soluble nutrient retention
- root development and
- primary root-microbe interactions.

In essence, physical soil health defines the abiotic parameters, or hard landscape, of the rhizosphere and its associative microbial habitat.

Health vs Structure

As physical soil health declines, structural integrity declines. As pore space distribution shifts from macro (large)

to meso (small) dominated, the volume of soil occupied by hygroscopic water (which is inaccessible to most plant roots and soil microbes) increases. Such water tends to extend the plasticine limits of soil consistency, elevating the risk of erosion, compaction, impaired drainage, localised saturation and run-off.

This can result in the formation of anaerobic zones within the soil profile that influence carbon-nitrogen transformation and associated nitrous oxide emissions.

Changes in soil microbial population dynamics can also be induced, not just within the soil around the roots, but throughout the soil profile, often detected by changes in the relative ratios of protozoa and the balance between total and active, or live, biomass of indicator microbes.

Agriculturally, this can lead to:

- significant changes in the ability of beneficial microbes to suppress pathogens
- performance limitations related to water and nutrient availability and
- reductions in the activity of rhizosphere microbes that both feed and protect plants.

Delays in seed germination and plant emergence can occur, leading to reduced expression of genetic yield potential and impaired tolerance to abiotic stresses, particularly drought, temperature and photo-oxidative stress. This, in turn, can impact yield, quality and response to inputs. Declining physical soil health can also extend the dormancy, germination and population dynamics of grass weeds, affecting the efficacy and application of selective herbicides.

Sustainable improvements in physical soil health are most often associated with elevated activity in biological processes that transform carbon; mainly derived from the decomposition of complex plant residues, root exudates and microbial mucilage, which stabilise soil aggregates, maintain pore space, encourage root development and facilitate plant-microbe interactions.

Key performance indicators of this process, relative to particle size distribution, include:

- water infiltration, retention and drainage rates

- soil bulk density and shear strength
- carbon flux and carbon to clay ratio
- carbon respiration and
- nitrous oxide evolution.

Additional metrics are being generated by advances in electromagnetic and hyper-spectral scanning; remote sensing of moisture, temperature and aerobic-anaerobic balance through the soil profile; and digital image analysis of soil structure to determine aggregate and pore space distribution.

Penetrometer measurements to determine shear strength and structural limitations to root development are also providing useful in-field data, particularly in determining the requirements for, and working depth of, primary cultivation practices. Although shear strength often increases as a result of the improved carbon dynamics associated with bio-pore formation, this is usually offset by decreases in soil bulk density, delivering a net positive gain to physical soil health.

Chemical soil health

Although chemistry has been the focus of soil husbandry guidelines for

decades, much of the nutrient availability recognised as delivering agronomic benefit to the growing plant could not be achieved without appropriate physical and biological support. Traditionally, only soil pH and the “easily extractable”, or “readily available”, levels of phosphorous, potassium and magnesium have featured in the chemical soil health toolbox.

However, since the turn of the century, a steady increase in the complexity, cost and implied value of more detailed soil analysis has added depth and breadth to applied soil chemistry. The determination of soil particle size distribution and clay chemistry; the inclusion of anion-cation exchange and base saturation ratios; measurements for electro-conductivity, salinity, functional carbon dynamics and respiration-evolution rates; can all now be added to an array of major and micro-nutrient assessments.

Key nutrients

In that same time frame, focus has moved to two key nutrients, both of which have significant agronomic and environmental impact. The first of these is phosphorous; the nutrient that

essentially drives root development and plant-microbe interactions. Phosphorous is strongly anionic (negatively charged) and is readily adsorbed to the cationic (positive) charge associated with humic polymers, organic matter and dominant cations (calcium, magnesium). This gives it really low mobility and uptake characteristics. However, phosphorous associated with erodible or diffusible soil particulates can enter water courses, leading to eutrophication (nutrient enrichment) and oxygen depletion of aquatic eco-systems.

As chemical soil health declines, phosphorous movement from labile, organic and biological reservoirs within the rhizosphere can also decline. In response, plant root systems may be smaller, architecturally simpler and less adventurous. This can lead to decreased root exudate production and associated microbial activity. In addition there may be a decline in bio-pore formation and soil structural integrity and increased risk of erosion, compaction and aggregate destabilisation.

All of these can have a direct impact on photosynthetic efficiency, carbon



Robert Plumb

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partitioning, stress response and disease resistance. An extra interaction, specific only to legumes, is a reduction in biological nitrogen fixation; a process that is very phosphorous-dependent. An uplift in physical soil health can alleviate much of this.

The second nutrient to receive increased attention is nitrogen, which essentially drives protein production, plant growth and yield. The introduction of nitrogen fertiliser has generated an increase in global food production of around 45%. However, the manufacture and application of nitrogen fertiliser can account for up to 80% of the production emissions of arable crops. Routine application of nitrogen fertiliser also provides a selection pressure for soil microbial communities, which often shift population dynamics away from symbiotic and non-symbiotic nitrogen fixing organisms, placing greater reliance on fertiliser.

In addition, current nitrogen use efficiency is low, with significant levels of nitrogen entering the environment rather than being taken up by plants. Part of the issue relates to the rapid movement through the soil profile of nitrogen in the nitrate form. On its own, nitrate entering ground or surface water represents a significant threat to water quality. But once at depth in the soil, if it encounters anaerobic conditions, nitrate can be converted into the potent Greenhouse Gas nitrous oxide.

Selective ion sensor arrays, generating real-time data for nitrate movement, soil moisture deficit and carbon dioxide-oxygen levels; coupled with weather data and hyperspectral determination of both soil and plant nutrient status; are advancing predictive nitrogen modelling and decision support tools. The result is not only seen in performance uplifts and operational savings but also in reduced global warming potential and enhanced levels of environmental protection.

Plants often deploy positive feedback mechanisms in response to a decline in chemical soil health, adjusting root exudate composition in order to stimulate the activity of specific rhizobacteria, promote nutrient uptake, combat abiotic stress factors and prime disease resistance mechanisms.

Biological soil health

Although often viewed as a new and

emerging horizon in soil health, studies into the biological functionality of soil have a long history. However, unlike physical and chemical soil health metrics, the biological metrics currently under consideration have to contend with increased levels of spatial and temporal variability.

The introduction of a conceptual framework for the soil microbial food web and associated laboratory techniques for evaluating microbial population dynamics is providing a greater insight into biological soil health. Supported by more generic soil enzyme assays; functional carbon-nitrogen determinations; the detection and evaluation of pathogen-mediated elicitor and signature molecules; and the deployment of rapid gene sequencing techniques; the biological soil health toolbox is progressively expanding. However, the inherent variability of both the composition and distribution of soil microbial communities continues to exert practical limitations on sampling and analytical protocols.

Specific analytical focus has been applied to the biological processes of atmospheric nitrogen fixation by symbiotic microbes that occupy the rhizosphere or the intracellular space of plant leaf tissue. The biochemistry of converting nitrogen gas into microbial protein and plant-available ammonium is reliant on phosphorous, magnesium, manganese and iron. The process is energy-intense, time-consuming and often host-specific, but the commercialisation and application of nitrogen-fixing microbes would be transformative in terms of sustainability, food security and environmental impact. However, results to date clearly illustrate the importance of establishing physical, chemical and biological soil health prior to deploying this emerging technology.

One area of particular interest, outside the plant health sphere, is the role of biological soil health in carbon sequestration and transformation. Seen as instrumental to climate change mitigation, the ability for plants to move carbon from atmosphere to soil, and for soil processes to safeguard the storage of this carbon, has the potential to halt, and reverse, global warming. Realising this potential resides, at least in part, on our ability to evaluate, verify and monitor

soil carbon dynamics.

Summary. Soil health is a prerequisite for the health-related characteristics expressed by plants, animals, humans and ultimately, the planet. Monitoring soil health is fundamental to the effective management of this globally significant resource. The processes involved in regulating, maintaining and enhancing soil health are complex. As a result, no one single metric has, as yet, proven to be the definitive soil health metric.

Technological advances in the realms of physical, chemical and biological analytics, coupled with innovations in sensor design and geo-bio-chemical data acquisition; evaluation of microbial population dynamics and target metabolite functionality; observational data sets generated by in-field soil assessments; determination of carbon sequestration and transformation rates; all provide valuable insight into the effective measurement, monitoring and management of soil health.

Neil Douglas Fuller is Technical Director at Atlas Sustainable Soil Program. He grew up on a small farm in Lincolnshire and studied soil science at Newcastle University, graduating with a B.Sc. (Hons) in Agricultural and Environmental Sciences as his second degree. Post-graduate studies in crop ecology, nutritional biochemistry and soil microbiology prompted the establishment of a private consultancy company, delivering practical advice on soil management and applied biological farming systems, and his services have been engaged on a wide range of farming, food and nutrition projects around the world. Having spent a lifetime digging holes and talking to plants, he is currently the technical lead on a virtual agronomy platform, using special sensors to monitor soils, plants and animals from aircraft. For more information on the work Neil does in the area of Soil Health go to The Good Soil Guide



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INSURANCE- ANOTHER COST TO ATTACK UNDER REGENERATIVE FARMING

One of the many aspirations producers will have when moving to a regenerative farming system is to take a fresh look at both variable costs and fixed costs in connection with their whole farming system.

Written by Nigel Wellings, Director ,Acres Insurance Brokers

I will base my thoughts for this article on combinable cropping farms

For many producers significant cost savings are achieved in terms of variable costs.(seed, fert and sprays) From my own farming experience it was always difficult to get variable costs below the £500/ha mark. Yet I have a number of regenerative farming clients regularly achieving variable costs in the £380-£420/ha range without any significant fall in output.

From a fixed costs point of view labour and machinery are the 2 most significant items and again there is a huge scope for savings here. Gary Markham from Land & Family business quoted fixed costs of £350/ha against £449/ha for conventional farms in his benchmarking survey for No Till Farms in 2019. He concluded that one of the main drivers of profit is machinery costs. Lowering machinery costs especially in terms of self propelled items (tractors, sprayer, combine etc) will have a direct effect on insurance costs. As a general rule something like 50%-66% of Insurance Costs on a conventional farming business will



be for the vehicles insured on the farm. Therefore the less horsepower used per hectare generally the lower insurance costs will be.

Benchmarking Insurance costs is fraught with difficulty because included in the majority of farm insurance bills are items such as private cars, houses and house contents and other personal items that do not really relate to the business. There will also be major differences in insurance costs between an owner occupier having to insure all houses and farm buildings and a tenant

who does not have to. Insurance Costs will range between £10/ha and £20/ha on a larger combinable cropping business. The marginal costs of adding further contract/share farmed land to this will tend to be very low-often around the £1/ha mark.

As an example I have looked at the Insurance costs for 1 combinable cropping farm on 1000ha, both whilst using conventional tillage and since moving to a NO till regime. Under a conventional system the prime movers consisted of an Agco Challenger Crawler at a value of £220 000, Bateman Self Propelled Sprayer at £180 000, Claas Lexion 770 Combine at £230 000 and 3 John Deere tractors at £40 000, £90 000 and £120 000. Total value tied up in self propelled kit is £880 000 (£880/ha). For Comprehensive insurance on all these items plus implements and trailers the client was paying approx. £7500 per annum (£7.50/ha)

Since moving to No Till the machinery fleet has been drastically altered, Out has gone the Challenger Crawler along with Sumo Trio and Vaderstadt drill, No longer using a self propelled sprayer this has been replaced by a



large trailed unit (with no insurance cost because it is automatically insured as an implement). Combine remains as before. Of the 3 John Deere tractors the one at £40,000 remains as a secondary machine and the 2 frontline ones- 250hp and 310 HP have been upgraded so are now insured at £125,000 and £150,000 respectively. Total value tied up in prime movers is now down to £545,000 and from an Insurance costs point of view the premium came down to £4500 in 2020 (£4.50/ha). Overall the total Insurance bill on this farm has moved from £16,500 to around £12,500 (£12.5/ha) since the move to No Till. Other Insurance costs on this farm include 3 cars, 2 pick ups, telehandler, 2 extensive ranges of farm buildings, 4 houses and contents, crop insurance Public Liability, Employers Liability etc.

The particular farm that this example comes from is located in the East Midlands on medium-heavy soils and had already achieved a 20% premium saving when they moved across to Acres Insurance in 2019, having previously been Insured with a major Insurer for decades. The Insurance covers had not been subject to any independent scrutiny in the past and this was reflected in the fact that the farm buildings and 2 of the houses were vastly under-insured prior to moving Insurers. The cost of correcting this was relatively low.

Another common problem that we encounter is that many Insurers and their Farm Insurance Advisors do not understand the difference between a Whole Farm Contractor/



Contract Farmer and an Agricultural Contractor. It is important that this is fully explained and understood by the Insurer. The Contract Farmer carries out all operations from stubble to stubble on the same land year on year, he often also has an interest in the crop. The Agric Contractor does individual operation work, often on a fire brigade basis over a wide geographical area. Insurers claims records will show that claims made by Agric Contractors are generally more regular and more expensive. Hence the fact that premiums for businesses doing more than 50% individual operation work will be around double that of the Contract Farmer/ Own Farmer. We consistently come across farm businesses paying 20-40% more than they should because they have wrongly been bracketed by Insurers as Agric Contractors. Ensure this does not happen to you.

Insurance is an input just like any other therefore it deserves the same

scrutiny that you apply to purchasing fertiliser, chemicals etc. There are a number of Independent Brokers throughout the UK specialising in Farm Insurance and capable of delivering good independent advice. When choosing a Broker make sure they are prepared to take the time to fully understand your farming business, its aims and aspirations and that they will look to conduct an annual on farm review with you. Price is important and their can be scope for saving but quality independent advice is just as important.

Savings in Insurance costs are obviously no where near as large as those being achieved in terms of labour and machinery costs with No Till Farming, but they help make another contribution to improving bottom line profit whilst at the same time ensuring you have the optimum Insurance in place is important to protect the business against major liabilities and losses.

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TYRES FOR ZERO TILL FARM



A Norfolk farmer has moved to a zero-tillage system and invested in new tyre technology to protect his soil. It has taken James Goodley four years to change his farming methods, and he believes by fitting his machines with the latest VF tyres he can protect his investment and use his machinery more responsibly.

James farms in Norfolk, where he grows wheat, oil seed rape, peas, and forage rye. In addition, 175 acres have been given over to a stewardship scheme and he is growing AB15, a two-year sown legume fallow mixture. "We don't have a fixed rotation. I judge each field based on its performance and decide what to drill the following season," he says. "Nothing is left brown here. As well as peas, I use a cover crop mix which includes phacelia, radish, and oats," he adds.

James has worked closely with his agronomist, Stephen Keach, to reduce chemical use and improve soil health by moving to no till farming. "We are lucky that we don't suffer with black grass. Over the last four years I have seen my herbicide cost go down significantly because we are not cultivating the land like we used to. Now we just pull a very fine harrow behind the combine at 20 millimetres depth to chit the weeds," he says. Following this the field is sprayed with glyphosate before drilling. "I think this is as sustainable a model for farming as there is," he adds.

To spray, he has invested in a SAM Horizon 4000 self-propelled sprayer. "I have a really good relationship with SAM and their after service has been second to none. This is my third SAM and every machine I have owned has the same first-class British build quality," he says. However, this latest sprayer has been specified with an unusual tyre option. "I attended a course to learn about tyres three years ago, and ever since I have been extremely conscious of the impact that tyre pressures can have on soil compaction," he says.

James chose to specify the SAM with Continental VF TractorMaster 600/60R30 162D/159E tyres. "I met Richard Hutchins on the Continental stand at LAMMA, and he explained the investments that the brand had made to develop new tyres that could reduce soil compaction. I was encouraged to hear that so much was being spent on research and development and curious that in 2020 there would be VF tyres with pressure monitors that could be used on sprayers as well as tractors," he says.

Continental returned to the agricultural market with new tyres in 2017. A new facility in Lousado, Portugal has a dedicated research and development facility and is also producing tyres with new technology. "VF tyres are the future for farming. Our tyres feature a more flexible side wall with patented N.Flex technology. On the road this enables the vehicle to carry forty percent more load than a standard tyre at the same pressure. Alternatively, in the field, the pressure of VF tyres can be lowered by forty percent compared to standard tyres, even when carrying the same load. This spreads the weight of the vehicle over a larger surface area and reduces soil compaction," explains Richard Hutchins, Continental agricultural tyre specialist.

James is a firm believer in the saying, 'you get what you pay for'.

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Having experience of SAM machines, he believed that changing the tyres would help reduce soil compaction and enable his operator, Steven Day, to work more considerably in difficult conditions. "Manufacturers naturally put a cost-effective tyre on new machines. There is nothing wrong with this, but I wanted to do better. Considering the cost of a new sprayer, it seemed logical to invest a few hundred pounds in better tyres. There is a huge range of tyres on the market, but for me it had to be VF and I chose Continental to make use of the new tyre pressure monitoring sensors and system," he says.

ContiPressureCheck™ is a new system that monitors the pressure and temperature of tyres to provide the operator with the information to adjust the tyres to a task. "I want the sprayer tyre pressures as low as possible to maximise the footprint and minimise compaction. My concern has always been to not run them too low, and that is where the tyre monitor comes in because it can tell the operator if the pressure is correct," says James. The SAM benefits from an onboard air supply, so can adapt the pressure of the tyres to suit the land. "It's the perfect combination, intelligent tyres and a sprayer that can make the most of them," he adds.

With a 4000-litre capacity and increase in boom width from 24 to 30 metres the SAM helps to increase daily output. "We have a sufficiently high spray capacity to get out when we need to and pick our windows. This means we can avoid times when the ground is too wet. I work with my agronomist to minimise the impact to the land and I also refer to our weather station," he explains. A Pessl weather station helps the farm to plan by

using a modelling algorithm which shows the likely conditions for common crop diseases such as Septoria and Rust. "It's about having the data to make the decision and then, if we have to go out, I want to make sure that we are causing as little damage to soil as possible," he says.

The SAM is being used to spray liquid nitrogen, fungicides and pesticides. However, James is quick to illustrate that this is kept to a minimum. To reduce interference with the soil and the crop our oil seed rape is drilled in July to reduce the risk of flea beetle. "We drill early and then let the sheep graze the fields. It's more ecological and pesticides are expensive, so I try to avoid using them as much as possible," he says.

James trades in his sprayers every five to six years. In doing so, he believes he realises the best resale value. The sprayer is unlikely to wear the tyres out during this time so he also believes that they will be an asset to him in the future. "The resale value will be higher if the tyres are in good condition, so making this investment now will also pay off down the line. If the tyres are showing little sign of wear then I could also choose to fit them to my new machine, which will also be a cost saving," he concludes.

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GLYPHOSATE SUBSTITUTION

Written by Thomas Preuße, Chief Editor "DLG-Mitteilungen" and DLG-Agrifuture Magazine

Forgoing glyphosate will increase the demands made on the cultivation system as a whole. It is vital to minimise the pressure caused by weeds overall. Replacing glyphosate with one single alternative measure is therefore barely conceivable, especially in systems that do not involve the use of ploughs. Wherever ploughing is not possible or desirable, greater importance will also (have to) be given to crop rotation and/or intercrops because of this.

Are Iron and Electricity the Answer

If the curtain really does come down on using glyphosate at the end of 2023 in the EU we do not yet know if the UK will follow. However, it does not mean either the end of the world or necessarily a forced return to ploughing. But it will certainly make life more difficult for regenerative farmers. They will have to think more extensively in terms of 'the system' than 'the measure'. In the future, arable farming will not be led by the technology; instead, the technology will follow the arable farming objective.

For a while, the situation surrounding the most controversial crop protection active substance of all time had settled down a little, but the date has been set. Glyphosate is only approved throughout the EU until the end of 2022, and that is next year. Even if the active substance were to be registered again at EU level and approved nationally, its use will either be restricted in terms of quantity and/or will only be possible in special cases: the product has long since had its heyday. At times, it accounted for 70% of the crop protection agent volumes used in Germany. Another reason why

glyphosate is so popular is that it can also be used to control volunteers such as grass weeds and rapeseed and not just rhizomatous weeds.

Farmers may say 'If I can't use glyphosate, I'll just have to start ploughing again.' And many of them will do exactly that or are already doing so today. After all of their positive experiences, others don't want to see a plough on their land again at any price. Amongst others, Detlev Dölger and Wiebke Lenge of Hanse Agro, a private consulting company headquartered in Schleswig-Holstein, believe that both groups should rethink their stances. The standard for the technology must be the arable farming objective – and only this, not the existing technology. To determine this objective and therefore make the right decision, it is necessary to ask oneself several questions, whereby the question concerning grass weeds is at the very bottom of the list.

- What are the demands of the subsequent crop; what time remains until sowing?
- Does the soil have to be loosened?
- What about the volume of straw and chop quality?

- How deep down is the germination moisture? Where is it (too) dry or (too) moist?
- What must/can I do to control rhizomatous weeds, grasses, slugs, mice or cutworms?

Winter rapeseed after winter cereal, for instance, is a classic case in which forgoing glyphosate may pose a problem. The time between harvesting and sowing is very short, and it is very tempting to use a plough before sowing. It couldn't be easier: the straw is ploughed under, grass weeds are buried and the soil is sufficiently loosened. No wonder that plough sales have picked up again, although some people had already consigned this implement to the 'scrap heap of history'. Boundary ploughing to control the influx of grasses is a widespread standard. But is it really necessary? If the location is dry, the straw can be easily worked in and sufficient time is available, there is nothing to suggest that tillage and cultivation cannot be undertaken without the use of a plough. Here, Hanse Agro recommends shallow cultivating (4 – 6 cm and 6 – 8 cm) twice to distribute and mix in the straw, then deep cultivating once and



Tools that work at very shallow depths are suitable as an alternative to glyphosate, particularly where black grass is concerned. Photo: Väderstad

perhaps shallow cultivating once more as 'false seedbed' just before sowing. If grasses and volunteer rapeseed are involved, however, the objective is to leave their seeds as close to the surface as possible, encourage them to emerge and then control them mechanically. This is when very shallow tillage to a depth of 2 cm comes into play. Implements for this have been increasingly launched onto the market in recent years. A special share may possibly be required for loosening. Hanse Agro is going one step further in trials for problematic locations: precision sowing of rapeseed in wide rows enables subsequent hoeing to control grass weeds and/or volunteer rapeseed.

If sowing winter wheat after winter rapeseed is involved, compact disc harrows are often the solution and problem at the same time. Working in too early and too deeply prevents the volunteer rapeseed from emerging. Again, the consultants recommend flat tillage several times using harrows, rollers or even mulchers in this case. The latter solution is expensive but very good for arable farming purposes because it encourages the rapeseed to germinate without it being buried.

In dry locations, the yield is often determined by forgoing ploughing due to water conservation. Trials conducted by the Federal State Institute for Agriculture and Horticulture in Bernburg (LLG) of Saxony-Anhalt confirm this in a sugar beet - spring barley - winter wheat - winter barley crop rotation. Real conflicts of interest occur here: glyphosate was not required with ploughing or deep mulch seeding but led to poorer cost effectiveness (higher effort and/or lower yield). Shallow mulch seeding, strip tillage and direct sowing were not possible at

this location in Saxony-Anhalt without this active substance, especially with high pressure from volunteer plants in tight crop rotations. Extending the crop rotation (in this case with lucerne) along with consistent harrowing and mulching subsequently kept the pressure caused by weeds to a manageable level in this trial. Together with glyphosate, however, we may also have to bid farewell to pure direct sowing forever. The conclusion drawn by Dr Joachim Bischoff (LLG) is that action recommendations as a patent solution are impossible. Instead, weed control should be regarded far more as a holistic system of diverse arable farming and crop production measures adapted to the specific location.

Before row crops. A second 'domain' of glyphosate is its application prior to maize or sugar beet sown using mulch seeding in the spring. The 'opponents' are old weeds as well as catch crops that have not or not sufficiently been killed off during the winter. The objective is to achieve the best possible catch crop stock in order to suppress weeds. Of course, this is very difficult to establish in dry years such as 2018. The catch crop can be mechanically removed prior to vegetation. However, the prerequisite is that the soil can be driven on.

A spring-toothed harrow with uniformly shallow-cutting double-disc coulters particularly stood out in trials conducted at Bingen University of Applied Sciences with sugar beet. While the disc harrow enabled the intercrop to be regulated well, it was unable to control weeds and grass weeds. Pelargonic acid is occasionally claimed to be a substitute for glyphosate, but it proved ineffective in these trials. Straw mulch seeding is only considered to have a slight likelihood


of success.

Glyphosate is not needed for maize mulch seeding, as shown by trials in southern and eastern Germany and reported on by Klaus Gehring of the Bavarian State Research Center for Agriculture. Weed control using selective herbicides functioned equally well, unlike direct sowing or strip-till systems which are reliant on pre-treatment.

Electrophysical method. Compared to glyphosate, the use of electricity as a herbicide substitute appears to be a niche solution, but without the total herbicide, even implements such as the 'Elektroherb' are attracting attention. A generator driven by the PTO produces electricity that reaches the plants, where it is distributed, via skids in the tractor's front-mounted implement. In trials conducted so far, it has proved effective in controlling stubborn rhizomatous weeds and also in killing intercrops. Apparently, organisms in the soil are barely harmed. A further developed version of this system wets the plants with an electrolyte solution before the electricity is applied. This enables the necessary voltage to be significantly reduced and increases the system's comparatively low efficiency.


Conclusion: don't just deal with the symptoms. As has already been mentioned, forgoing glyphosate will increase the demands made on the cultivation system as a whole. It is vital to minimise the pressure caused by weeds overall. Replacing glyphosate with one single alternative measure is therefore barely conceivable, especially in systems that do not involve the use of ploughs. Wherever ploughing is not possible or desirable, greater importance will also (have to) be given to crop rotation and/or intercrops because of this.

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DRILL MANUFACTURERS IN FOCUS...

mzuri LET'S TALK OILSEED RAPE.

Mzuri Trial Farm Manager and Knowledge Exchange Officer, Ben Knight talks about how Oilseed Rape still offers growers excellent opportunities.

"Once the much-loved favourite of the British grower, the humble Oilseed Rape crop has fallen out of favour in recent years for its inconsistent establishment and relentless pressure from pests. However despite this, the crop should not be discounted as it is still one of the best break crops in our tool kit and with the right system behind it there is no reason why it cannot continue to deliver profitable returns."

"Like all crop's establishment is key, but for OSR good establishment is particularly important for achieving (and maintaining) a healthy crop through to harvest. The single biggest factor is to get plants up and away as quickly and as evenly as possible. Struggling crops are an easy target for pests, who can quickly take hold and decimate a crop during the vulnerable early stages."

"On our own trial farm and from feedback from other growers, we find that the Mzuri strip tillage system suits oilseed rape and can offer a consistent and reliable method of establishment that promotes early vigour."

"The Pro-Til consistently produces the ideal nursery seedbed for quick germination by creating tilth and placing fertiliser with the leading leg, removing air pockets with the central reconsolidation wheels and seeding at an accurate



Oilseed Rape on our trial farm is drilled between rows of stubble for best results and provides protection to the soil over winter.



The staggered design of the Pro-Til gives it excellent clearance for easy drilling into straw and cover crop residues.

depth across the width of the drill. This combination proves ideal for oilseed rape and by giving the crop the best start, it promotes quick even, establishment across the field."

"To make the most of the system and to preserve soil moisture reserves, we encourage our customers to leave as much of the previous crop residue on the fields surface as possible. For us at Springfield Farm this involves chopping wheat straw behind the combine and drilling directly into the mulch between the stubble rows."



Drilled in rows spaced 66cm apart we ensure good light interception throughout the crop right through to harvest.

"The young oilseed rape plants thrive in this environment and the standing straw between the rows discourages pigeon activity. Often visitors to our farm are surprised by the volume of straw that we plant our oilseed rape into, but it does not hamper the crop and instead provides nutrients and increases organic matter whilst protecting soils over winter."

"Not only does strong early growth mitigate against pigeon damage, but it

also gives the crop the best chance against flea beetle. Excellent establishment combined with a variety renowned for its early vigour can bolster the crops ability to grow through the vulnerable early stages and maintain a good plant stand."



By promoting even germination across the whole field we can achieve even crops throughout the season.

"Oilseed rape can also be a good economic choice, delivering sound returns as well as providing valuable variety in the rotation. Since switching to strip tillage on our trial farm, our oilseed rape is consistently yielding over 4.5t/ha if not closer to 5t/ha - which is a much healthier sight than struggling to bring in 3!"

"This ability to get the crop drilled into moisture with an abundance of surface residue and have it up and away in no time was the turning point for our oilseed rape. It can be a rewarding crop if given the right conditions and I can honestly say that it has been one of our best crops since we took the plunge to stop over cultivating and underperforming. And don't our fields of gold agree!"

BIOLOGICAL PATHWAYS TO CARBON RICH SOILS

Webinar with Dr Christine Jones

Dr Christine Jones will be well known to anyone that has been studying soil health or regenerative farming as her reputation spreads far and wide. I first saw her speak at Groundswell in 2017 and have spent many hours watching YouTube videos ever since. Christine is renowned for speaking about the Liquid Carbon Pathway which explains how carbon is a dynamic product in the soil.

Carbon is a hot topic in agriculture across the world at the moment, mainly as a commodity that could be sold to buyers that need to offset their corporate carbon footprint. I believe that this is missing a fundamental piece of the jigsaw which is that Carbon is the basic currency in the soil. It is traded for nutrients and other essential resources by plants and microbes, so the loss of carbon in our soils means that they simply don't function as well as they should. By paying attention to carbon management we can improve function, reduce inputs, produce food that is better for consumers and crucially be more profitable. In addition it is clear that carbon plays a key role in providing wider Ecosystem Services, including climate resilience.

Dr Jones explained how photosynthesis was the real foundation for all life, as it uses free resources to drive energy into the system. Green plants use light, CO₂ and water to create carbohydrates that are exuded into



Root exudates cradled by fungal hyphae mag x 150 (14 July 20)

the soil through plant roots. Here the microbes in the rhizosphere exchange the carbon for other products that the plant needs, which in turn facilitates

more photosynthesis and the cycle continues. In a monoculture, the variety of microbes in the rhizosphere is quite limited, but in a multi-species situation there is an increase in both number and diversity of the microbial population. This diversity can be increased by the improved photosynthetic efficiency of a diverse sward, as the variety of leaf architecture means that more sunlight is intercepted. More light interception delivers greater photosynthetic capacity, driving more exudates into the soil that feed higher populations of microbes.

So why are microbes important? I can remember being taught that it was the roots that took up the nutrients, but in fact it is the microbes that facilitate this. They are far more efficient and numerous, as long as we look after them properly. Microbes have a huge array of different functions and services that they can provide, so diversity of the population leads to a wider variety



Rhizosheaths on oats



Triticale in monoculture vs polyculture. Oyen, AB (24 July 15)

of services being provided. Dr Jones listed some of these – aggregate formation; Nitrogen Fixing; disease resistance; frost resistance; drought and flood tolerance.

In my own experience of using diverse cover crops, soil structure improvements are the most obvious and rapid visual changes (VESS Assessments). Dr Jones explained that aggregates make the soil particles far

more water stable, preventing erosion. However they also provide improved drainage in times of water excess and hold moisture inside them for use in times of drought. These can be huge benefits and as climatic conditions become increasingly challenging, surely they cannot be ignored.

The diverse mixes were also shown to deliver immediate benefits in a growing crop. An example was shown where a

monocrop of Triticale was grown in a field next to a mix of Triticale with Oats, Radish, Sunflower, Peas, Beans, Chick Peas and Millet. The history of the field was uniform, but the monocrop succumbed to drought quite badly. Incredibly, despite the increase of competition for available precipitation, the multi species crop showed no signs of moisture stress and grew really well. This can only be explained by the diverse microbiome of the multi species crop accessing moisture and nutrients that the monocrop could not reach. At Oakbank we have seen similar results when using Companion Crops in winter oilseed rape, with an improved nutritional profile in the leaf analysis compared to a monocrop with the same applied nutrition.

Improved nutrients within the plant are not just good news for the growing plant, as they also provide enhanced nutritional value for grazing animals. Dr Jones mentioned work carried out by Dr Fred Provenza that showed how a mixed sward containing grasses, legumes, tall and short herbs (or forbs) was able to deliver significant benefits to the animals. The diversity in this type of mix delivers a diet that is high in secondary plant compounds such as bioflavonoids, carotenoids, polyphenols and anthocyanins. Dr Provenza's work showed that these compounds delivered a number of benefits:

- Increased microbial biodiversity in the gut
- Increased ability to digest a wide variety of feeds
- Improved feed conversion efficiency
- Improved immune function

The question you could be asking yourself is could this translate to nutrient density and diversity in human food stuffs, which then leads onto the discussion about using food as medicine. I saw an excellent presentation on this given by Dr Daphne Miller at No Till on the Plains last year (available on YouTube) called "Our Soil, Ourselves", recommended viewing!

Possibly the most memorable part of Dr Jones presentation was when she showed the effect that high analysis fertilisers have on the rhizosphere. In simple terms it could be stated that products such as DAP almost sterilised



Triticale in polyculture, Oyen, AB (24 July 15)

the roots, leaving them white, with no rhizosheath and no microbial interactions. It was explained that if the main nutrients were provided in such high concentrations, that the plant put no effort into exudation. This can often give the impression that all is well in the early stages of crop growth, with rapid lush green plants coming through. However, these plants have none of the resilience to stress that can be provided by effective associations with the microbiome, so they succumb to pests, disease and drought far more quickly.

Dr Jones recommended looking at the work undertaken in the Jena Biodiversity Experiment and summarised the effect of plant diversity as follows:

- Restores Ttopsoil
- Replaces fertiliser
- Renders insecticides obsolete
- Makes fungicide redundant
- Supports beneficial insects
- Displaces weeds
- Improves landscape function

The thorny subject of testing for soil carbon was also discussed, with Dr Jones explaining how the sub-soil was very important for stable carbon sequestration. An analysis of 2700 soil profiles had shown that 42% of the carbon was stored in the 0-20cm horizon, but 58% was stored in the 20-100cm zone.

| Soil depth | Diverse Mix | Ryegrass Monoculture |
|------------|-------------|----------------------|
| 0-15cm | 7.7% | 6.5% |
| 15-30cm | 3.9% | 1.9% |
| 30-45cm | 1.8% | 1.0% |

My interpretation of those figures is that the subsoil is where it's all happening in regards to the sequestration of stable soil carbon. We need to concentrate our efforts on having deep rooted plants in order to capitalise on that potential. Most measurements are only taken on the 0-10cm or 0-15cm increment of the soil profile, hence they miss the bulk of the soil carbon.



Corn OSR Crop

On one farm in New Zealand, that Dr Jones calls "The Carbon Capture Farm", the difference between monoculture ryegrass swards and a diverse mix has been demonstrated at different soil depths. The soil on this farm is a pumice with little natural fertility, but the soil building that could be seen in just a few months was quite remarkable.

The figures shown are the Soil Carbon % and it can be seen that at the deeper zones, the diverse roots have sequestered approx. double the amount of carbon as the monoculture. These types of mix are effectively what is being facilitated by the current Countryside Stewardship options AB15 and GS4, so it would be worth paying careful attention to what is in your seed mix to extract the most value from this "fallow" period. Remember that carbon is the currency for many more benefits, so bank it while you can and it will pay back over time. Plant roots have been shown to build soil carbon between 5-30 times faster than the carbon derived from above ground biomass. This goes back to what Joel Williams discussed, saying Roots not Shoots are what you should be looking for.

So can farmers really get paid for soil carbon? Well in a number of countries

this is certainly true, but the first one was Australia where there is a Federal Government Climate Solutions Fund. Farmer Niels Olsen sold the world's first carbon credits under a government regulated scheme in March 2019. His soils were recorded as sequestering 11.2t CO₂e/ha in 2019 and in 2020 this figure went up to 13.7tCO₂e/ha, resulting in a total of 24.9 tCO₂e/ha sequestered in 2 years, using multi species swards. Researchers estimate that 2/3 of the carbon was derived from root exudates. If these figures seem very high, remember that to get the tonnes of carbon you need to multiply the CO₂e figure by 0.27, so 2019 was about 3 tC/ha and 2020 was another 3.7 tC/ha. The value of carbon credits are expected to rise significantly from their current position, so these numbers could become very attractive, whilst still farming the land remember!

Dr Jones overall message was that the 'secret' to sequestering soil carbon was to stimulate the soil microbiome, which requires greater plant diversity and less synthetic inputs. My suggestion is to start looking at this on your own farm on a small but meaningful scale, my clients that have done this rarely go back and feel very positive about the changes.

NIAB CSFB PROJECT

In recent years, NIAB have been conducting research to help growers manage their oilseed rape crops in the presence of Cabbage Stem Flea Beetle (CSFB). We are all aware of the fact that in most of England, the area of this crop has been decimated and UK wide, we are now growing half the area we were before the removal of neonicotinoid seed treatments.



The autumn survey run by NIAB in recent years has shown the geographical spread of the problem with the map showing results from autumn 2019 with the red dots being crop failures and the yellow significant damage.

In light of widespread pyrethroid resistance, control of CSFB now relies primarily on a range of non-chemical control methods that either allow crops to avoid the pest or mitigate against its damage. However, more work is needed on a farm scale to identify how reliable these methods are, the situations in which they work best, and the benefits that can be gained by using multiple methods in concert.

We accept that what we have to do is learn to live without insecticides and manage our crops in ways that allow us to get at least a profitable yield in relation to the whole rotation but possibly less as a stand-alone cash crop. As a break crop, oilseed rape has performed greatly over the last few decades and our team feels that it still has a place in arable rotations. With this in mind, we now need to explore whether what we

have learnt from small plot trial carries through into commercial crops.

With that aim, csfbSMART has recently been launched. csfbSMART – ‘Sharing Management and Agronomy Research Tools’ – is a new industry-wide monitoring and trials programme set-up to test management methods for use against cabbage stem flea beetle on UK farms.

The programme connects two research projects investigating CSFB control. The first, ‘Reducing the impact of CSFB on OSR in the UK’ aims to improve understanding of the pest’s biology and investigate alternative management methods, led by ADAS and Harper Adams University and funded by AHDB and a consortium of industry organisations. The second, ‘CSFB: evaluating management of oilseed rape on-farm for maximum margins’, led by NIAB and Rothamsted is funded by Defra.

The coming together of these two projects along with the backing of the trade allows us at last to look at a range of management techniques that have developed lots of anecdotal information which pulled together over time will provide proper evidence.

Growers and agronomists will be encouraged to sign up, but their level of involvement will be their choice, from providing cropping details to carrying out field scale trials. The team will provide advice as to what and how different management techniques can be carried out together with adult and larval monitoring techniques should growers wish to carry them out. Those carrying out field scale trials will be provided a point of contact who will stay in touch for the three-year duration of the project.

All of the team involved believe that csfbSMART is a unique, one-off, opportunity, drawing together everybody’s knowledge and experience in a coordinated and sustained effort. We aim to support farmers, to monitor, assess and share information, building

a national and seasonal picture of the pressures of CSFB larvae and adults within oilseed rape crops and the wider farming environment.

One of the big issues in recent years has been crop establishment. Making use of available soil moisture has been key to getting the crop established. The project will give us the opportunity to collate information from a range of regions, soil types, drilling dates and varieties. We will be encouraging growers to assess and record the behaviour of their crops through emergence and into the autumn so that even where growers are not carrying out field trials, we still aim to collect information and in many cases, we will be able to add larval counts through the winter and into spring.

One comment we do hear is “I am trying this but have no idea if it is making any difference”. With the help of researchers and a coordinated approach, we aim to answer these questions and compare results with similar techniques in different regions.

We will also be looking to create clusters of growers with a dedicated contact to help share information and assist those who wish to explore new management techniques.

Over the next few months, we will be rolling out information and kits to help with monitoring so that we can be ready to start in the summer. The project has had its first online meeting and we are excited that we have a range of growers looking to be involved.

We have a long list of questions including those below which with growers help and feedback, we aim to shed light on.

- How does seed bed preparation affect CSFB numbers?

- Do organic amendments make a difference to larval numbers?
- Do WOSR volunteers left to grow close by make a difference? Can I manage volunteer OSR to increase effects?
- Does stubble height/management of the previous cereal make a difference?
- Should I establish WOSR with a companion crop? If so what?
- Shall I graze or mow my well-established crop to reduce larval numbers?
- How do I use trap cropping most effectively?
- Which variety is least palatable to CSFB?
- Which varieties recover best after CSFB grazing?
- Which varieties recover best from CSFB larval damage in the stem?

For several years, NIAB has been monitoring CSFB adults and we are looking to continue this whilst getting more growers involved so that they can begin to use better local knowledge to help them make their own decisions.

This will also include training and help with using the Syngenta water bath method for assessing larval numbers in the winter and spring.

We will also be looking at novel techniques such as funnel trapping which has been tried on long term trial sites at Morley as another way



of monitoring larval levels later in the year. The use of funnel traps (pictured below) within trials in 2018 and 2019 successfully captured falling larvae as they left the plants in the spring; on average 14 larvae per trap. If scaled up this is approximately 5.5 million larvae leaving the OSR plants per hectare over the 24 day period, providing context to the scale of the issue growers are facing. This data also shows the potential of funnel traps as a low cost, relatively low input method of capturing larvae data in crops in order to be used for comparing methods of Integrated Pest Management in OSR. However, it is recommended they are used in combination with either one of or a combination of foliage and stem damage scores, yellow water traps and plant dissection so data from the novel method can be linked to pressures on crop and treatment effects.

We hope over time that this project will grow in size and that we can help growers to understand the best establishment and management techniques to help them manage their crops in the presence of this pest.

Dynamic Range

C- Coulter
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DRILL MANUFACTURERS IN FOCUS...



WEAVING DEBUTS NEW BRITISH-MADE GD3001T 3M TRAIL DISC DRILL

We at Weaving Machinery always listen to what our farmers need, so we can continue offering innovative machinery at affordable prices.

This approach has resulted in the launch of our new GD3001T to meet demands from farmers for a scaled-down version of larger trail models. The 3m trailed disc drill packs exceptional power into a compact design for handling grain and fertiliser. Dual cropping is also an option – the drill's front row can be used for small seeds and the back row coulters for large seeds, making cover cropping straightforward and simple. Alternatively, both tanks can be used for grain. Whether you have a mixed farm or want excellent performance at a smaller scale, this is a powerful new drill that offers consistently high-level operation.

Following customer requests, we are also proud to release our new Front Tank. Up until now, these have been built purely for our Combi Drills. As more and more farmers seek better weight distribution, we saw a way to upgrade our offering. The new tank is fitted with a sleek stainless steel double metering unit, higher output capabilities, a two-ton capacity, and extra "quality of life" features like front row lights and built-in cameras to aid pulling out at junctions.

We are also pleased to announce our new Shortdisc, which makes ease of use a priority along with better performance for chopping up trash at shallower depths, thanks to the new wavy disc design.



Weaving Trailed GD drill

The new cast V ring rollers can handle wet or dry conditions without blockage, and each of the 3 sections can be easily replaced in the unlikely event this is necessary. Additionally, the Shortdisc can be used alongside our multi-purpose Magnum Seeder for drilling cover crops while going over stubble. Constructed entirely in the UK, the new Shortdisc is available in working widths of 3, 4, or 5m.

Amongst our new offerings is the Fenix Grass Drill. After two wet winters in a row, a lot of farms are hoping to reseed their winter grass but are cautious about ploughing. This new drill which will be brought to market from April 2021 is built with this in mind, able to stitch grass in a narrow 3-inch row using its serrated disc, with a full width press roller at the back and an option to block off alternating coulters for wheat, barley or oats. With its 3 metre working width, 80-100 HP requirement and electric metering, this compact machine is designed to be small but mighty, ideal for smaller farms.

The requirements of successful farming

are always changing. At Weaving, we never stop developing new equipment that meet the real needs of our farmers. In just the last couple of years we've had incredible feedback for our newest Sabre Tine Drill, which gives the user freedom to move towards either minimal cultivation or conventional cropping, all while handling damp conditions and needing very little horsepower. A new 8m width will be available in Autumn 2022.

We have also received an excellent response to our recent interrow Mounted IR Drill, which lets farmers drill two or three rows of grass between maize in all weather conditions resulting in significantly less soil erosion and compaction whilst providing a crop of grass for livestock during winter if necessary, or available for silage in early spring.

It's been a difficult year for everyone but farming hasn't slowed down. Neither have we. Weaving is dedicated to fitting the needs of our farmers, whatever they may be. Our popularity is due to our straightforward nature. What you see is what you get, the price you see is the price you pay, and we are always on hand to help set up and provide assistance as required. Following two difficult autumns, we would like all UK farmers to know that we're geared up to deliver exceptional machinery and are here to help.

To see these machines in action, join us at Groundswell on 23rd-24th June. We hope to see you there.



Weaving Trailed GD drill



The new Weaving front tank



Weaving Shortdisc



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WHY TAKE THE REGENERATION ROAD?

Herefordshire farmer John Joseph writes: In the January edition of Direct Driller, I was impressed by the article 'Regenerative Agriculture... Fad or system' (William Waterfield) because it showed how useful this system is becoming and it took me back to my youth, (which is a challenge) when what we refer to as Conventional agriculture was at its height and still growing. On numerous occasions we watched as new ideas, normally based on organic farming, came to the fore and were then carefully laughed out of existence. Time and time again I heard the phrase, 'this is it this time', just to watch it dwindle away in the smoke of exhaust fumes from the chemical delivery lorry. I too have to admit that back in the day when I had a proper job actually growing plants that a non chemical system didn't register at all, in fact if modern me turned up to see me back in the seventies and eighties I would be told to sling my hook (or something similar to that anyway).

Written by Nick Woodyatt from Aiva Fertiliser

Now this started me thinking, what was it that finally turned us, (well some of us), from chemical junkies towards a more sustainable system that our children will not look back on in despair and anger which is how I view my own growing past. My reason for this is not just being nostalgic but perhaps those who are just thinking about coming into the light might like to hear this from me and a few others who I have asked this question.

For me it started in 1995 just after I had stopped growing and entered the shady world of sales (yes it is, I was there). To be honest my old boss and I never really believed what we were told; consequently, I did all my own trials the results of which are so valuable to me now, so I didn't get caught on the con but as soon as I went into the office scene it really was quite frightening. My own epiphany came when a chemical called Fongarid disappeared which had been the go-to chemical to kill Phytophthora, Fusarium, and Downy Mildew. As there was no replacement the industry was doing its normal, 'oh woe is me' routine so I decided to have a go with Bacillus Subtilis which was so much better than the chemical had ever been. Since then, nearly all my trials have shown that this is a way forward but unfortunately, we will have to wait to see the fruits of this work as most of the powers that be are joined at the hip with the chemical companies. Over the past two years with my overseas contacts, I have rid soils of Leatherjackets and Wireworm with Beauveria Bassiana, Frit Fly larvae with Bt and no end of diseases with a batch of bacteria. The thing we will have to note when we can do this is that they work better in groups with a food source rather than as lone wolves.

So this, along with my experience with chemical companies when I was a National

Sales Manager (I had to move to New Zealand to escape), was what prompted me to look at a more sustainable way forward. By the time I returned from New Zealand the terms Regenerative Farming and Carbon Capture Farming were the terms being used to soften the blow and move away from the frightening organic word. The question is, 'What was it that moved others?' They cannot all be cynics like me, surely.

John Joseph is a farmer in Herefordshire and started his journey back in the nineties which explains why his soils are so much darker than his neighbours. John says that he had felt like he was on the hamster wheel just adding more and more products and spending more time working for his suppliers and needed an alternative. Added to these, two wet years had done an enormous amount of damage to the top soils as there was nothing holding them together explaining why no root structure was visible. This threw up many questions but the main one was simply economic as there was no future following this system. My question to John was that for smaller farms is it not easier to follow a conventional system with its list of fertilisers and chemicals rather than the hard thinking that is necessary for regen systems. John replied that the work is worth it in the end. He had started regen farming almost by accident as he started using cover crops in the early nineties; 'People thought we were trying to pinch their pheasants', John says. 'I was drowning in a sea of cultivation and poor crops, so I needed a change and direct drilling gave me the time I needed.' The cover crop work that John did meant that the change from ploughing to direct drilling was fairly simple, but it is this change that can define the successful regen farmers from the ones who are trying to get from A to

Z far too quickly. Now John is starting to enjoy farming again, reporting that he can see more root on a grass lay in 3 months than I did in a year before. The strip till arrived in 2013 which is a marvellous first step, in my opinion, as it keeps air in the soil at a maximum. This last winter an Avatar drill has arrived and has a place of honour in the shed and John reports it as fantastic. John also agrees with me that a liquid applicator on the drill is an excellent investment and allows so many options from fertilisation and microbial inoculation.

Farm owners can make the decision to jump to regen farming as they only have themselves to please but looking at change from a manager's point of view can be whole different ballgame. In my working lifetime I have always had a respect for managers as they have to balance the needs of the crop with the expectations of the owner or the board. In fact, I think I can make the statement that any manager has to have a like-minded owner to even contemplate going down this route.

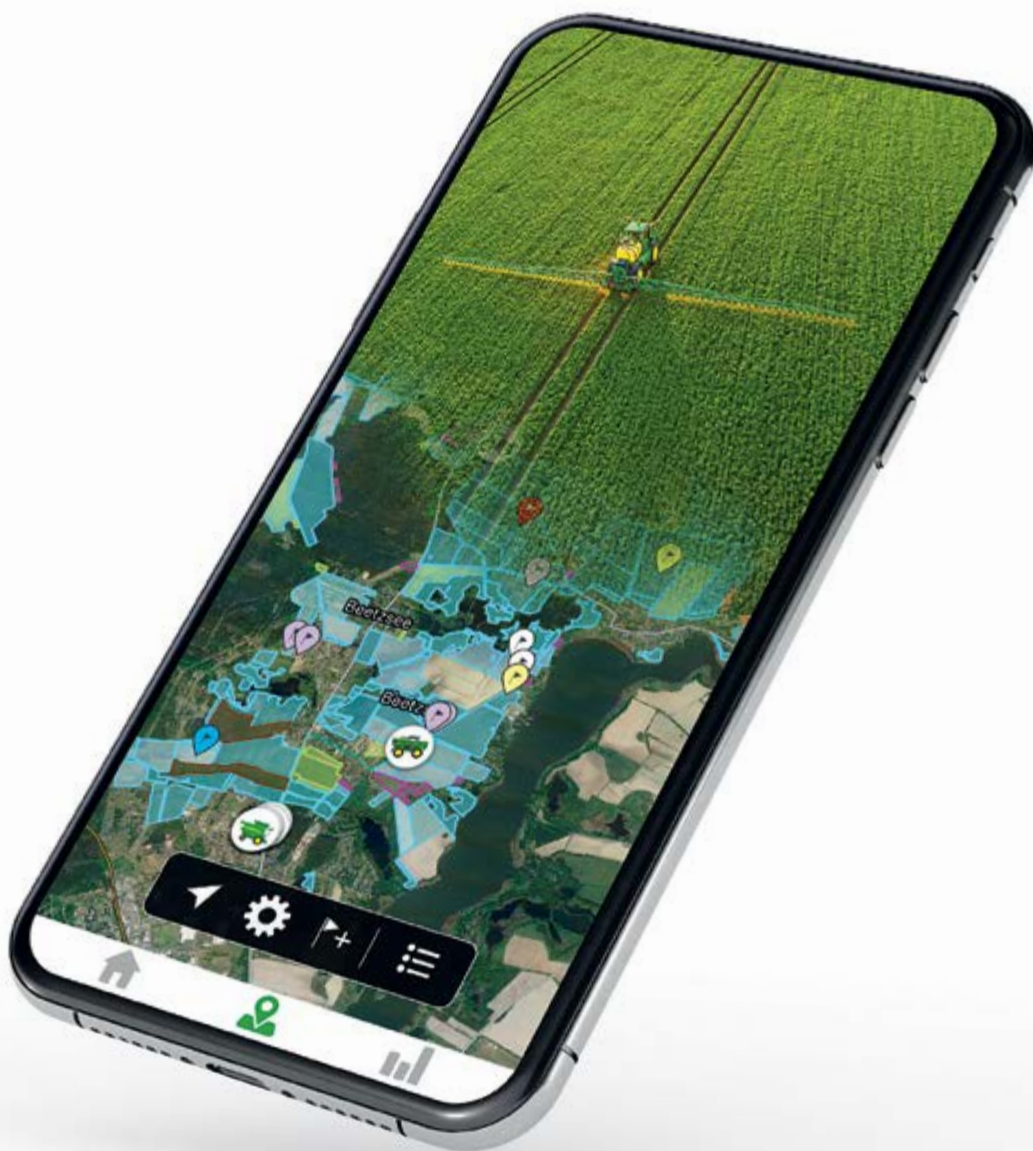
In the case of Jake Freestone at Overbury Enterprises he was brought onto the farm by a family who felt the responsibility of the past and the future and needed someone to take the soils forward. Jake was a Nuffield Scholar who had studied regenerative farming and had the necessary knowledge to put the right



Jake Freestone

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JOHN DEERE

NOTHING RUNS LIKE A DEERE



Tim Parton

team together and to work out a system that trialled products and systems so that they could be fully incorporated if they gave the required results. As well as getting the desired yields Jake says that his overriding mission was to increase the value of the land for future generations. Jake introduced trials of cover crops and direct drilling onto the farm but still managed to balance yields and soil improvement and anybody who has had the pleasure of visiting Overbury knows that it has been done to a superb level.

One point that Jake made was that he felt it essential to have an independent agronomist who works with the farm looking at the pros and cons of everything that is done. It is having this truly independent advice that is so difficult in Agriculture and yet so important regardless of the system that you are in. Having agronomy and sales so closely linked has done the worldwide industry and soils unmentionable damage, but that is only my opinion. I find it a fact

of incredible regret that most advice given on the farm from companies and organisations is fuelled by the chemical companies which is why I shout that I am a salesman every time I do any talks or presentations. If any farmer is looking for the takeaway advice from this, then that is read, listen to everything and then, make up your own mind.

When I asked if he thinks Regeneration Farming is here to stay Jake answered, 'It has to be based on all we do from profitability, environmental issue and Biodiversity; you should see the wild birds on the farm'.

Isn't it a shame that farmers such as Jake and so many more are not being given the credit they deserve by the BBC and their environmental programmes that make farmers out to be the enemy of the world and wildlife?

At Brewood Farm North of Wolverhampton, Tim Parton has also seen a huge increase in birds around the farm following his involvement with local bird

groups. This sort of thing takes time and effort, but Tim adores watching the birds and gets satisfaction from once again enjoying farming following his conversion to Regeneration Farming in 2009. Tim who has just won yet another award, this time 'Innovation Farmer of the Year' from the Farmers Weekly, is certainly one of the biggest advocates of regen farming there is, and his knowledge base of the system is quite frankly stunning.

'I had to change because the farm soils were simply collapsing and needed regeneration,' says Tim, 'and we did this for the sake of the soil and not for saving money although that came later.' Tim followed what is now thought of as a great way in to regen farming which is to dump the plough and go to a strip till system along with putting 50% of the farm to spring crops. Tim agrees with me that there is no need to see a dip in yield if you follow a step-by-step approach.

'It took around 3 years to see a huge difference in the soil when massive numbers of worms started to appear and now roots grow down rather than out.' Biology is a huge part of what Tim does and he has replaced his Nitrogen addiction that all farmers had with a brewing addiction.

'We have to replace some of the microbes that we destroyed before the soil can truly be classed as balanced,' Tim suggests. Microbes are applied with a liquid applicator which is very similar to Jakes at drilling and regularly over the crop to keep them happy so that fungicides are not needed. Whether applying microbes



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Alistair McGregor

or feeding up the ones that are there it is vital to make sure that the carbon levels in the soil are kept elevated as the carbon is the lifeblood of everything that lives.

An important note here is not to rush things. A farmer saw what Tim was doing and thought ... I want a bit of that but was not willing to do the work so just went for broke and bought a 750a direct drill. Of course, the soil wasn't in the proper shape to accept direct drilling so everything failed and then of course it was the drills fault which is a shame for the drill and the farmer.

Just outside Leamington Spa Alistair McGregor is just starting the regeneration journey as it is called although cover crops and reduced tillage has been on the farm for quite some time. Alistair sees Regen

farming as a way of further improving his soils and getting a more sustainable system. As a farmer with a young family having a system that leaves the farm in better condition than he found it is as important as looking at profitability. When asked if he can find the information Alistair says, 'There are lots of experts out there, but they often don't agree with each other which works to stimulate debate'.

As always it is a case of finding what works for your farm and the most economic price. Alistair does like to have a local farm group in which to discuss things and can see the importance of wider groups such as BASE where like-minded people can share views or have a damn good argument, after all they are farmers.

As ELMS continues in discussion it is obvious that this is the way forward and Alistair can really see the value of Carbon Credits that will soon be a major source of income into the farm.

Although I totally believe in regen farming and having an environmental part to what we do I think we have to be careful. I have spent a lot of time in units in Africa where giant farms are growing food for this country where many cannot afford

enough food to survive. To then return to this country and see that farmers are being paid to turn the countryside into a park does stick in the craw a bit. I would love a few politicians and the BBC to go to Africa and explain to those starving people why we are taking their food. That could just be me though.

So, there we have it. More and more farmers are looking at moving to a regen system and it is just for me to say that the information that you need is there ready for you to read and disseminate. Not everything works for everyone, but it never has plus we are still at the mercy of the weather. Try a field and move forward and things will soon start to improve and with the environment becoming the most important policy there is the time is right.

My last point is that there are some farmers who are simply nowhere near ready for this system yet and if you are one of them there is no shame in that but please try to think it through. I went to see an old friend some time ago and his last remark was,

'This is interesting, but can you tell my [company] Agronomist as he makes the decisions here'; Good Grief.

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REGENERATION IS RESTORATION

Written by David Boulton of Indigro

Born out of an industrial and intensive era, 'regenerative' and 'regeneration' are the newest buzzwords to describe a forward movement in agriculture.

By definition, regeneration is the process of restoration – to develop and improve something, making it as good or successful as it previously was. In an agricultural context, it is a holistic approach to improving farmland, by enhancing natural ecosystems and working with nature. At its core is the protection and restoration of the soil, the quality of which is the foundation for agricultural productivity and environmental resilience.

Following the agricultural revolution in the early post-world war period, land-use changes and the intensification of soil cultivations and synthetic product use has led to the provision of plentiful and cheap food, to meet the needs of an expanding population – but at what environmental cost? Agricultural efficiency has increased, with generally larger and more specialised enterprises. However, permanent pasture has been converted into continuously cultivated arable regimes and the use of pesticide and synthetic fertiliser has increased.

This current system faces many challenges, including widespread pest resistance, agrochemical and nitrate contamination of water, increasingly stringent plant protection product



A summer multi-species cover crop providing soil and environmental benefits where oilseed rape had failed

regulations, soil erosion and declining farm biodiversity, to name a few. We have reached an economic and environmental tipping point and require a more positive direction of travel.

The principles of regenerative farming

There is no single regenerative blueprint that will work on every farm and soil type, and each site will have its own unique challenges and opportunities. For example, poorly drained heavy clay soil will not be conducive to delayed winter cereal sowing or planting a spring crop after grazing a cover crop with livestock in marginal conditions. There are, however, several underlying principles.

Soil cover must be maintained, by returning crop residue and establishing catch and cover crops between cash crops. Miniature (small leaved) white clover can be very successful in providing a permanent, nitrogen fixing understory, that can be grazed by sheep when not in a crop.

Maintain a wide and diverse rotation

(including the use of different cover crop species) to control weeds, pest and disease, utilising winter and spring crops. Use companion crops where possible, especially in oilseed rape, to provide diversity of root architecture and to capture nutrients.

Utilise organic manures and amendments, such as compost, digestate, biosolids and farmyard manure. These are not just excellent sources of crop available nutrients but also improve soil structure and build soil organic matter.

Having livestock enterprises can help add another income to the business and are an excellent way of destroying cover crops. In conjunction, aim to cut down manufactured nitrogen use, because this will help to significantly reduce the carbon footprint of the farm, and will also make crops less dependable on other inputs such as fungicides and growth regulators.

Crop establishment should revolve around minimal soil disturbance. Since regenerative farming is not a prescribed approach, farmers and land managers



Trialling cover crop destruction using a crimper



A miniature white clover understory in winter wheat

have the ability to decipher and select which technique will suit their system the best. Either a low disturbance tine or disc drill may be appropriate, based on soil type, blackgrass pressure and cover crop destruction approach.

A further aspect is following the principles of integrated pest management (IPM) and using this process when making any agronomic decision on a crop.

Current constraints

A key question hangs over the dependency of the regenerative system on glyphosate. This broad-spectrum herbicide plays a crucial role in the destruction of problem annual and perennial weeds, such as blackgrass and couch grass and is also a dependable means of terminating cover crops and grass and clover leys.

Alternative chemical molecules and weed control strategies are being considered and will most definitely be

required. The destruction of cover crops can be successfully achieved using crimper rollers, livestock, toppers, and with some assistance from consecutive hard frosts. However, selecting the right species in the cover crop and timing of destruction is vital.

There are also challenges with making the system work on poorly drained, heavy soil types, which incur low yields, inefficient resource use and nitrous oxide emissions. The yield-drop in the transition period, dealing with compaction and managing the decomposition phase of the nutrient cycle when cover crops are destroyed are key aspects that require further understanding.

Managing risk by farming for the environment

Farming regeneratively, is intrinsically, farming in a manner that supports the natural environment. Working together, the implementation of countryside stewardship can help to reduce the financial risk of the system, particularly where there is a yield decline in the first few years of transition and facilitate the improvement to soil quality.

Options such as legume and herb-rich swards, buffer strips and winter cover crops compliment the aims of a regenerative farming system and provide a fixed income, irrespective of turbulent weather and commodity market pressures. With the Environmental Land Management scheme on the horizon,

I would like to see greater flexibility with regards to the management and implementation of stewardship options, and further collaboration of neighbouring farmers to provide large scale environmental benefits.

The direction of travel towards carbon offsetting

The regenerative model places growers in a unique position to both lower the greenhouse gas emissions of one's own farming business and sequester the emissions from other industries and businesses. At present, there is no standardised accreditation for the process of carbon sequestration via land management in the UK, however, a 'soil carbon code' or similar scheme will facilitate the trading of carbon credits.

Potential incentives from government could be coupled with voluntary market initiatives, stacking the monetisation for land managers of regenerating their soils and farmed landscape. The challenge for the industry will be how best to measure and quantify successful outcomes for accreditation. Most likely, it will be a combination of satellite imagery and geospatial soil organic matter sampling.

A knowledge and collaboration driven approach

Being a holistic approach, the knowledge and level of understanding that is required to make the system work is greater than that of a traditional system. It is important that land managers and farmers seek advice from as many different sources as possible and learn from each other's experiences. Truly independent advice, that is not linked to the sale of inputs, whether that be conventional pesticides or biological products, is essential.

Whilst there are many names and guises for farming systems that emphasise improving the quality of soil and natural ecosystems, regenerative farming is an empowering and farmer driven approach that combines productivity with environmental sustainability and will greatly benefit future generations.



A miniature white clover understory established in spring barley

FARMER FOCUS

DAVID WHITE



"It's not about the machinery", except once you get into cover crops and producing larger ones it is about machinery because without a drill that can cope with big volumes of vegetation cash crop establishment is compromised. An interesting video worth seeking out in the YouTube Horsch Live series showing on Feb 24th <https://youtu.be/OoifwgXbEZ0> featured Julien Senez who talks of 4.5 ton biomass cover crops as being the target for adequate nutrition generation/recycling. Whether drilling green in the autumn or into early desiccated spring seedbeds this volume requires a cutting disc to avoid blockages. Another problem I have come across now I'm drilling second wheat is how you drill into big catch crops with an "understory" of wet chopped straw. Hair-pinning is always the worry and on soil that has been in Regen Ag for a few years with a residue build up in the top 50mm the soil is too soft to cut against. The question therefore arose is there a drill on the market (apart from a Cross Slot?) that would deal with big vegetation, much of which could be laying horizontal ie peas and vetch, and place seed cleanly through chopped straw.

To that end I had two drills on demo last autumn.

The first was in fact the first direct drill I ever tried, the SimTech T-Sem. Hands up, five years ago I was on the bottom step of understanding direct drilling and what conditions are needed to achieve even establishment. Certainly a wet undulating stubble that had been previously Discordon'd and Vaderstad drilled was a long way from the firm level conditions I now have on the farm. Establishment across the drill was uneven due to wheelings and my lack of foresight to at least work at an angle didn't help.

Lesson learnt, get your fields level in year one. Five years on this November the same drill has done a fabulous job with the slim feet causing minimal soil disturbance if used at a sensible speed with the tine vibration creating enough soil shatter to negate the need for harrowing or pressing over the rows. It did however struggle with an extreme amount of vegetation which may have been combated by pre rolling or it just being dryer! Score 8/10.

The second drill tried was the Virkar from Samagri. This is also a leading disc and tine drill which has many innovative features, and I'd urge you to check out the videos on Youtube. Used on the same high vegetation field as the T-Sem a few days earlier the pressure was on the guys doing the demo as I had invited a few other farmers to see the drill working. Again, we struggled with the high vegetation, soft soil surface and unwelcome shower and the finish could best be described as ugly, but the wheat now looks very well (see pics). Again, I'd give a score of 8/10 but as the progress of neither drill on the day could have



T-SEM Drill



The Virkar Drill



T-SEM Drilled Nov 15th



Virkar drilled Nov 18th

been described a “seamless” in these extreme conditions. I can’t say I’ve found a single drill to replace the need on this farm for a true disc and a pure tine drill.

A solution could be to modify the type of cover grown to only include upright species and those that produce less bulk. Sadly, this would be a compromise as knowledgeable farmers (ie Julien mentioned earlier) much further along the journey of Regen Ag promote big volumes of vegetation. I also clearly remember Frédéric Thomas saying when asked at a meeting “you can’t have too much vegetation”. So for me for now its stick with two drills to have maximum flexibility without any compromises.

Experience with light disc “Joker” type machine.



New Disc machine

The desire to be able to destroy covers by mechanical means without having to rely on frosts greater than -5 degrees led to me trialing a disc machine a few years ago. The principal worked well as ground conditions were reasonably dry that year in late November. Pluses for the technique were that the green matter was mixed into the top 50mm or so of topsoil to aid breakdown, feed the worms and importantly minimise the rate of glyphosate used. This proved to be successful as a single low rate was used to tidy up some small grass weeds predrilling.

So last summer I came across a very cheap new machine which was purchased and fitted with a small seed hopper to make its role flexible. Like a kid with a new toy I used it on several fields to establish catch crops pre winter wheat with the view to helping chit volunteer seed as well as establish the catch crop. It was operated at about 55mm deep and moved more soil than the Horsch CO that would have ordinarily been used. At the time I was satisfied with the job done however another wet autumn proved again less is more and right through until the end of Feb the moved ground walked wetter with the wheat crop looking less happy compared to where I’d left an unmoved control in the same field

Lesson learned, have faith and stick to the plan.



Trial destruction November 23rd 2018

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ARE YOU GETTING THE MOST **FROM YOUR SOIL?**

Recent interest in carbon trading and the Government's Net Zero by 2050 target has led to an increase in enquiries at NRM laboratories relating to Soil Carbon, Organic Matter and the link between them. Agriculture can play a significant role in carbon sequestration, with soil providing a huge carbon sink. Understanding the soil and what percentage is made up of carbon plays a key part in being able to effectively manage and increase the carbon stock percentage. The launch of the Environment Land Management Scheme (ELMS) is likely to create more reasons for landowners and farmers to understand their carbon stock. Although the details are not confirmed, it is expected that Soil Health and Carbon stocks will form part of the scheme.

In response to the increased interest, NRM laboratories have developed a comprehensive package which provides an accurate assessment of the carbon stored in soils, applicable to both grassland and arable systems. CarbonCheck provides not just an organic carbon stock figure but also a range of other useful parameters. It uses a combination of individually tested parameters and calculations to determine carbon figures and provides users with a report to enable action to be taken and comparisons to be made. It is recommended that sampling should be carried out regularly to monitor changes in soil carbon stock levels, ideally at the same time of year to reduce sampling variation.

The **Bulk Density** of a soil gives a good indication of how well plant roots can

grow and explore the soil for nutrients, and how easily air and water can move within the soil profile. The Bulk Density of the soil is used to calculate the Organic Carbon Stock.

This is carried out using the 'disturbed scoop' method. This is different to the undisturbed core method. The scoop method was chosen over alternative methods due to the positive supporting evidence regarding this method.

Sampling Depth and Stone Content details are provided by the sampler on the sample paperwork. This allows the laboratory to determine the soil coverage per square meter. Providing this background data ensures a more accurate assessment of the carbon stock in the soil.

Inorganic Carbon also known as Soil Inorganic Carbon (SIC) comprises of carbonates and bicarbonates which are abundant in chalky soils. The calcium carbonate content of the soil is determined from the SIC and means we can assess how calcareous the soil is.

Total Carbon % is determined using the combustion method, which is comparable with the Dumas method. Total carbon measures both inorganic and organic carbon forms in the soil.

Organic Carbon is then calculated by removing the Inorganic Carbon figure from the total Carbon figure. Also known as Soil Organic Carbon (SOC), it is the carbon component of soil organic matter. This diverse group of carbon-based compounds originates from the



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decomposition of plant material, animal residues, soil fauna and biota. The level of SOC is influenced by environmental factors and management practices. It is a key measurement in monitoring changes in the levels of carbon stocks. The report provides a visual representation of the SOC and SIC split.

Organic Matter % is a complex combination of all organic material found in the soil including living components (plant roots, microorganisms) and dead components (leaf litter, humic substances). Organic Matter increases the soil's water holding capacity and provides a slow-release source of energy for micro-organisms, increasing the cycling of nutrients within the soil. This report uses the Van Bemmelen factor of 0.58 to convert Soil Organic Carbon to Organic Matter.

Total Nitrogen % is determined using the combustion method. Nitrogen is the main driver of plant growth and is associated with soil organic matter. It is mobile in the environment and present

in many different compounds, some of which are available for uptake by plants. Total Nitrogen is the measure of all forms of nitrogen (organic and inorganic) in the dried sample.

C:N Ratio is calculated using the Total Nitrogen and Organic Carbon results. The proportion of organic carbon relative to nitrogen (C:N ratio) gives an indication of the right balance for soil microbes to support the release of nutrients. The optimal C:N ratio for nitrogen release in soil is between 10 and 12.

Organic Carbon Stock (t/ha) gives a total organic carbon value in tonnes of carbon per hectare of land to the specified sampling depth. This calculation factors in the measured soil organic carbon %, stone content, sampling depth and bulk density.

There is also the option of upgrading the package to CarbonCheck Plus which provides an additional measure – Active Carbon. This parameter is also available as a stand-alone test.

Active Carbon (mg/kg) or Labile Carbon is the portion of carbon which readily breaks down and provides an active source of nutrition to soil microbes. The effect of changes in soil management such as cultivation methods or the use of cover crops can be monitored with active carbon analysis as it is a precursor to the long term build-up of organic matter.

Understanding the Carbon Stock levels in the soil provides landowners with the opportunity to adjust land management practices to improve Organic Matter as well as providing future proofing against the imminent ELMS policy.

CarbonCheck is available direct from NRM Laboratories, or via your agronomist, advisor or soil sampling provider. You can get in touch with NRM for further information or to request your free sampling kit on **01344 886338**.



BASE UK

BASE-UK is a knowledge exchange organisation led by farmers for farmers and individuals passionate about the regenerative agricultural system increasing the sustainability and health of our soil, crops, livestock and therefore our industry.

If you read the December Direct Driller you will know that we have been holding weekly meetings for our members. These are proving extremely successful and our calendar is filled with a wide variety of speakers and more are planned for later in the year. All our meetings are recorded and protected for members to view at their leisure.

These meetings are creating some fantastic interest in the group and at the time of writing this, in the past 2 months we have enrolled over 90 new members. We find

this very encouraging as it means that more farmers are looking at regenerative agriculture and recognising us as a means to learn and share knowledge which in turn creates confidence.

Now that it looks like lockdown is being lifted, we look forward to encouraging members to hold farm walks again, obviously with safety always at the forefront! If this means we must restrict numbers, that can be arranged but it will just be great to get together for face-to-face discussion and seeing what is happening on the ground.

BASE-UK will have a stand at Cereals on 9th and 10th June with speakers in the Soil Hub Theatre opposite and at Groundswell on 23rd and 24th June. We hope to see you there!

SAVE THE DATES – BASE-UK MEMBER MEETING PROGRAMME:

- **7.00 pm – 4th March** – Nikki Yoxall – Implementing Agroforestry as a low input solution to livestock production in the UK.
- **7.00 pm – 11th March** – Chris Martin – Spray Applications.
- **7.00 pm – 18th March** – Tom Chapman – Reintroducing Livestock into the Arable System.
- **7.00 pm – 25th March** – Stephen Briggs – Building resilient farm productivity through farming systems and sales innovation.
- **7.00 pm – 1st April** – Becky Wilson – Farm Carbon Cutting Toolkit research results.
- **7.00 pm – 8th April** – Joel Williams
- **7.00 pm – 6th May** – Joel Williams
- **7.00 pm – 3rd June** – Joel Williams

If you would like to know more about how to join BASE-UK, please visit our website: www.base-uk.co.uk or email Rebecca@base-uk.co.uk



www.base-uk.co.uk

FARMER FOCUS

GEORGE SLY

I'm finally and Agroforester!

It has been 5 years in the making, but we have finally planted our first 16 hectare field of Agroforestry.



We decided to do most of the work ourselves and I am so pleased we did. Farming has become quite an isolated world of technology, screens, twitter and stress along with some good times too of course! But if someone were to ask me what I enjoy the most from farming, it's the time spent working with my close family doing manual work like planting our trees, not driving tractors. We spent the weekend chatting whilst planting, discussing the past, present and future, having laughs and enjoying the work. In the western world manual labour can be sometimes frowned upon, however it has such powerful effects on mental health and general wellbeing. My father (78), my son (2) and me (34) were all there to help with something that will shape our farms landscape for 50-100 years. Bloody saw after digging 300 holes and shovelling compost and topsoil.

I have a weird affiliation with trees, have always been interested in them, they make me feel calm and somehow give me peace in what is a stressful lifestyle. I have no idea



why, but my gut tells me that purely cropping annuals is not the right choice for my farm for the long term future. I maybe wrong and it's not for everyone.

Our agroforestry system was designed to overcome some key fears. We have planted it largely North/South to avoid the effects of shading.

Specs:

24m arable alleys, 4m tree strips, trees planted offset 1.5m from the east edge and 2.5m from the west edge. The offset is to allow harvest traffic on the west side (side where the sun sets which should be dryer).

We have started jetting drains, however I am not too concerned about the drainage as trees generally don't seek the drain unless its blocked. We also plan to install new drainage schemes down the arable alleys over the next 10 years. If I wasn't on heavy land in the fens, I am convinced from research I have read, that trees may in themselves replace the need for field drains. They help, not hinder.

Every tree has its purpose, and it has taken me about 50 books and 5 million hours on google to decide what to plant. We settled on two initial tree row types, the first field alternates these rows.

Row Type 1: Hazelnut – we chose a specific bunch of varieties which have never entered the UK before (a headache with Brexit), they are grown largely for Ferrero (who consume 1 in every 3 hazelnuts grown worldwide) they have a very specific bunch of characteristics which I liked. I was very cautious not just to plant "any tree" but to heavily research the commercial output of the crop, even if they are sold in our local town, they have to taste nice and be disease resistant etc. I was also careful to choose genetics that will suit our site in 10-15 years with climate predictions. Hazels have to blanch well and there is a "blanchability index" which is how well the skins come off during blanching. I don't personally enjoy eating them with the skin on so spent some time looking at this.



Row type 2: Walnut (cash crop) with nurse trees of Italian Alder, Silver Birch and Wild Cherry.



The walnuts are the only “paying” crop in this row, we have chosen specific fruiting varieties that should suit our site and should grow on to provide an income for me, my son and future generations. The harvesting equipment for hazel and walnuts will be the same. Walnuts nutritionally are near to nature's perfection, they are packed with protein (half the protein of chicken per gram), Omega 3, polyunsaturated fats as well as lowering the risk of heart disease, and whilst they grow they sequester carbon, produce oxygen, rebuild soil and provide super nutritional healthy food. Walnuts do contain Juglone (but less in the types I chose), which is alleopathic to crops such as sugar beet, maize and soya.

So why not just have tidy lines of walnuts? Because I am trying to completely shift the landscape to a diverse rich ecosystem. The Alder are great N fixing trees, they also grow just about anywhere, they are being planted in the field lows, and they are one of the best trees on the planet for restoring and regenerating soils. Silver Birch are equally hardy soil improvers, and they host over 300 species of insect, this is the main characteristic that swayed me, I want insects and I want to give them back a house on my farm and in my fields. The Cherry are mainly there for the flowers (aesthetics) and

pollen for bees and other insects and fruit for birds. For every walnut there is 2 nurse trees 2m apart. Eventually we will fell the nurse trees and replant and use the timber.

Nuts have been described as nature's perfect food. Before deciding to start with nuts I first started eating more of them, different types and varieties. They are nutritional powerhouses and they grow back every year... I have played in the kitchen and have some ideas as to what we will do with them before sale. We intend to crack and roast although some whole nuts for the Christmas market hopefully. There is no way, that we will be able to compete with a Turkish hazelnut or a Moldovan walnut, but that is not my aim. We want to put a face, brand and story behind a niche product. I also have to add that the nut shells are something we want to keep, combine with prunings/coppice and return to the land. We also plan to dry the nuts with the previous years shells using pyrolysis.

We plan to use the arable/pasture alleys to rotate livestock, crops, grass etc, we basically now have 13 fields in what was a square 16ha field. I have used the trencher to install some water pipe for livestock so each tree alley has a water supply should it be needed in the future. This was done very cheaply with blue water pipe and our drainage trencher.

Our next field involves some berries and fruit as well (which I plan purely for the dried fruit product market not fresh (fresh would be a bonus). This will include some native and foreign berries and fruits.

Overall, I have to say, that I expect the tree rows to equal or surpass the gross margin for the arable crops on a per hectare basis and I hope they will improve and increase the arable yields. In time crops on the east side of the walnuts will suffer a little, but at that point the walnut income should surpass the arable. It's all about having diverse income streams. The carbon payments from the trees will add further income.

Farmers are more than willing to visit our farm and field, I am passionate about agroforestry and am more than willing to share what I have learnt so far.

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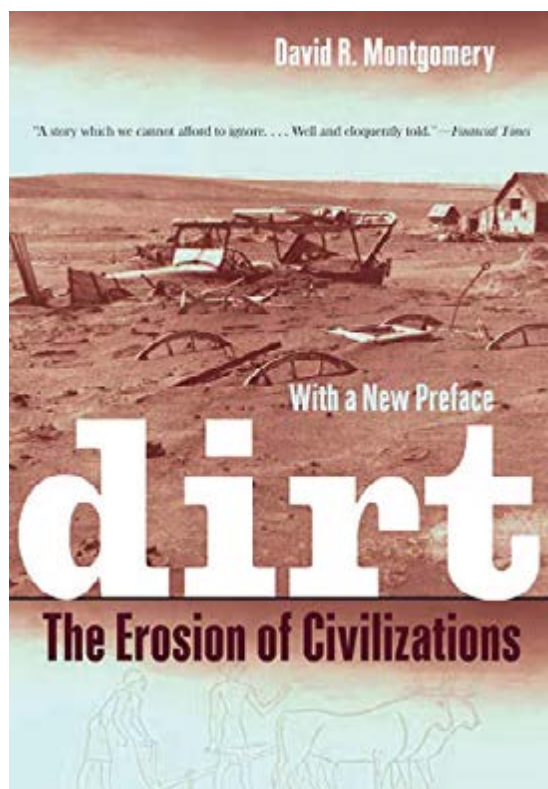
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WHAT DO YOU READ?

If you are like us, then you don't know where to start when it comes to other reading apart from farming magazines. However, there is so much information out there that can help us understand our businesses, farm better and understand the position of non-farmers.

We have listed a few more books you might find interesting, challenge the way you currently think and help you farm better.



Dirt: The Erosion of Civilizations

Dirt, soil, call it what you want - it's everywhere we go. It is the root of our existence, supporting our feet, our farms, and our cities. This fascinating yet disquieting book finds, however, that we are running out of dirt, and it's no laughing matter. An engaging natural and cultural history of soil that sweeps from ancient civilizations to modern times, "Dirt: The Erosion of Civilizations" explores the compelling idea that we are - and have long been - using up Earth's soil. Once bare of protective vegetation and exposed to wind and rain, cultivated soils erode bit by bit, slowly enough to be ignored in a single lifetime but fast enough over centuries to limit the lifespan of civilizations. A rich mix of history, archaeology and geology, "Dirt" traces the role of soil use and abuse in the history of Mesopotamia, Ancient Greece, the Roman Empire, China, European colonialism, Central America, and the American push westward. We see how soil has shaped us and we have shaped soil - as society after society has risen, prospered, and plowed through a natural endowment of fertile dirt. David R. Montgomery sees in the recent rise of organic and no-till farming the hope for a new agricultural revolution that might help us avoid the fate of previous civilizations.



Feeding Britain: Our Food Problems and How to Fix Them

How does Britain get its food?

Why is our current system at breaking point?

How can we fix it before it is too late?

British food has changed remarkably in the last half century. As we have become wealthier and more discerning, our food has Europeanized (pizza is children's favourite food) and internationalized (we eat the world's cuisines), yet our food culture remains fragmented, a mix of mass 'ultra-processed' substances alongside food as varied and good as anywhere else on the planet.

This book takes stock of the UK food system: where it comes from, what we eat, its impact, fragilities and strengths. It is a book on the politics of food. It argues that the Brexit vote will force us to review our food system. Such an opportunity is sorely needed. After a brief frenzy of concern following the financial shock of 2008, the UK government has slumped once more into a vague hope that the food system will keep going on as before. Food, they said, just required a burst of agri-technology and more exports to pay for our massive imports.

Feeding Britain argues that this and other approaches are short-sighted, against the public interest, and possibly even strategic folly. Setting a new course for UK food is no easy task but it is a process, this book urges, that needs to begin now.

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starts with
boots on your
ground

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