

ISSUE 11 | OCTOBER 2020

DIRECT DRILLER

MAGAZINE

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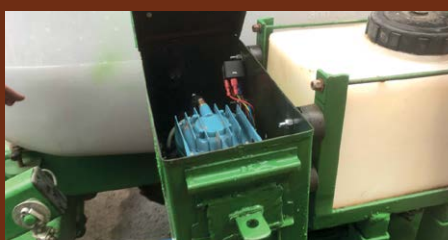
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MAGAZINE

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INTRODUCTION

MIKE DONOVAN, EDITOR

Welcome to another 100 pages of Direct Driller magazine. Pages that tell farmers so much about the mysteries of soil and the ways ingenious engineers and scientists have devised to handle it. This story has only recently become news.

In recent years the world of media, politics and education have begun to grasp the story, but often in a negative way. The headlines are about the final harvest being just 60, or is it 100, years from now. Farm chemicals polluting waterways; insecticides wiping out whole species of insects... we're all too familiar with the stories.

In a recent BBC broadcast Tony Juniper, chair of Natural England, echoed Sir David Attenborough's evidence of unfolding global catastrophe, and agriculture was at the top of his list of ills which are reducing the population of the natural world of insects, plants, birds and animals. The world, quite rightly, nods in agreement but does little more, continuing to buy fresh peas from Zimbabwe when the same crop was growing here in the UK.

I wrote to him (no reply, naturally) saying that it was wrong to tar the industry with

one brush. I reminded him that agriculture is highly diverse, ranging from the total sterility of poly tunnels to the improving habitat from cover cropping and No-till. I explained that farming is making giant strides in accommodating the natural world into their production systems, not to appease the campaigners but because it actually makes long term economic sense. The world of microbes is being harnessed to help, and crop protection is changing out of all recognition as farmers learn to love the insects they had been brainwashed to hate. The inveterate old codger Dan Archer - "it's all in the soil" - might have been onto something all those years ago, but his message was villified by all involved in modern agriculture. Is his message being told on farms in Africa and other developing parts of the world? Certainly no evidence when I visited Zambia, where centre pivot irrigation, ploughs and cultivators is the modern way of farming.

What a shame it is that people with real influence can only think negatively. Imagine the results if the converse were true. Sir David telling his global audience

how farming techniques are not set in stone, and modern farmers can and are working with rather than against nature. How the techniques of creating soil biomass are getting amazing results. Where all that green waste which the world now takes to the recycling centre (dump) ends up. Stories that are positive for both the natural world and farming itself. Publicity which converts into funds for research, for knowledge exchange, globally.

It's a real honour to edit a magazine which does just this. I know that readers will be fascinated by the contents of this issue. The mixture of science, engineering, ethics and, of-course, the invaluable Farmer Focus articles. Reading how farmers have coped with the savage season that was 2020, and what changes they have planned as a consequence are always interesting.

Finally, a quick reminder that I am available to take on speaking engagements over the upcoming winter season.



THE PROBLEM WITH INFORMATION

As farmers, information is becoming very important to us. However, the ability to move information from one place to another is never easy. Thus, every platform we use requires us to add the information all over again. It's something I point out to companies a lot, "that's a great idea, but asking the farmer to enter that information all over again manually won't be popular". The big question is why can't information transfer be standardised? The simple answer is of course, it can. At the moment we don't have an ISOBUS standard for information - but it would be really useful and I do think it will happen. Afterall, it is your information, so you should be able to export it from any system and import it into another.

We are just as guilty of this as every other company, it is something we have

recognised and are trying to fix. Our latest development project is called Farm Compare. It will allow farmers to share anonymised and rounded prices for crop protection products for free. It's a great example of how to share information to gain business intelligence. Answers are immediate and the more farmers that use it, the more powerful it will be. You will be able to compare one buying group against another and even in the future compare whether serviced or supply would be best for your business. However, you will do all this using your anonymous The Farming Forum username. No need to create another account to access another service. We are also talking to the crop management software companies to

allow you to export the prices out of their systems and into Farm Compare.

We have also recognised that it isn't easy to manage your Direct Driller subscription. The plan over the next few months to incorporate your subscription preferences in with your TFF membership. So that you can update your own address and whether you would like to receive the magazine in print or digitally. At this point, one username and password will give access to Direct Driller subscription, The Farming Forum and Farm Compare. A very small step forward in trying to make all your lives a little easier.

Written by Chris Fellows



Farm Compare



Groundswell

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FEATURED FARMER

MARTIN LINES

AGRICOLOGY
SUSTAINABLE PRACTICAL FARMING



PAPLEY GROVE FARM, ST NEOTS, CAMBRIDGESHIRE

Farm Facts

MANPOWER: 2 full time plus part time in office
FARM TYPE: Arable
OTHER TENURE INFORMATION: Owner, tenant, share farmer, contractor
REGION: South East England
RAINFALL: 559 mm
ALTITUDE: 65 m
SOIL: Chalky boulder clay
APPROACH: Regenerative agriculture
KEY FARMING PRACTICES:
No Till
Soil monitoring
Minimum Tillage
Undersowing
Biological control
Cover crops
Direct drilling
Diversified rotation
Habitat creation
Integrated Pest Management
Intercropping

I am a third-generation farmer and contractor and grow mainly arable crops on the family farm and rented land. The farm is just over 400 acres. Our rented land and contract farm agreements bring the farm area up to 1334 acres.

We mainly do combinable cropping growing commodity crops of winter wheat, winter and spring barley, winter beans and oil seed rape (OSR). We always try and find a human food home for the products or, as with beans, they go to an animal feed home to replace imported feed.

I am Chair of the Nature Friendly Farming Network (NFFN) and have a particular interest in farm conservation management. I am currently running an ELS and HLS agreement on the home farm and Countryside Stewardship schemes on land I rent. For over 10 years our farm was in the old Countryside Stewardship Scheme to try to improve the natural habitat for wildlife on the farm. We replaced many hedges around the fields which had been removed, improved the few that were remaining and planted new ones. We also established grass strips alongside hedges and ditches and on our field boundaries. Over this time, we saw a significant increase in both flora and fauna on the farm. RSPB volunteers undertook several surveys which identified a wide range of species, including birds of high conservation concern such as turtle doves, yellow wagtails and corn buntings.

In the last 8 years we have been in both an ELS and an HLS scheme, planting areas of wild bird seed mixes and creating wildflower areas (see the two videos below) and flower

enhanced boundary strips, as well as leaving an area of fallow land as a food and nesting source.



We have over 40 skylark plots distributed throughout our fields (see video footage below) and continue to sympathetically manage our old ridge and furrow meadows.



I hope to continue and extend our conservation work and link up wildlife habitats on neighbouring farms. We have made many wildlife corridors across the farm to help the wildlife move about.

Other nature friendly farming practices we carry out on the farm are following an integrated pest management (IPM) approach, using chicken manure to help improve soil and replace artificial fertiliser, and cover cropping and direct drilling. We have started to bring in sheep to graze cover crops in the winter and are trying to use a crimper to kill cover crops.

Talking to other like-minded farmers as part of the NFFN has given the opportunity to share best practice and understand that the best way we can farm is farming with our environment

around us. Watch the video below to hear me describe what I have done on the farm to attract wildlife and my message to farmers who may be interested in joining the NFFN.



Sustainability in Practice:

Direct drilling, cover cropping and crimping

I moved from a plough-based system to using a machine that moved the soil I wanted to a depth I wanted, allowing us to treat fields with compaction or soil health problems differently. I now try and work with our soils with the understanding that doing less is better. My soil is my asset - it's where I get my production from.

I grow cover crop mixes including buckwheat, phacelia, sunflower, vetch, linseed, fodder radish and crimson clover, to benefit the soil health, produce and grow nutrients, harvest the sunlight and turn it into organic material to help increase our soil organic content.

I have started using a drill with a crimp roller on the front - which allows us to grow big cover crops and be able to manage them. We are looking at establishing which cover crops work for us and different lengths of growing season. The crimp roller lays the crops down, creating a mat which suppresses weeds (see the video footage below).



The machine I have been using also allows us to use different seed mixes according to the area, so in compacted zones we can put in a different crop mix and target those areas. We can also intercrop rows. In addition to improving our soil health and reducing compaction, the low soil disturbance due to cover crops and direct drilling has led to more insect life in the fields - predators are building up and managing most of our pest problems, allowing us to reduce our operation and input costs. This video explains the machinery I've been using and benefits I've noticed in a bit more detail:



Nature based IPM

About 7 years ago I decided to do what I could to control pests without insecticides and monitor the impacts on my yields and profit margins. There is no blueprint to IPM - it has to be a whole farm and landscape approach, it is not as easy as conventional farming with pesticides. Many measures I have adopted in the transition to regenerative agriculture have multiple benefits.

I have broadened the range of crops I grow; moving from a system of 2 wheats, OSR, 1 or 2 wheats, and beans, all winter-sown, and a ratio of crops in the ground of roughly 70% wheat, 20% OSR, 10% beans, to now having winter and spring barley and no fixed rotation, and tailoring the cropping in each field to help with weed pressure and soil health. If I have a black-grass problem I will not go with a second wheat, even though this may give a better return than a spring or break crop. Crops in the ground now are about 40% wheat, 30% barley, 20% beans and 10% OSR. This would seem like a less profitable rotation, but I have slashed my cost of production (which has made up for any reduction of yields and crop values) and my net profits have increased.

I use pest resistant varieties where possible and have moved back to traditional recommended cropping intervals - with 5-6 years between OSR crops. I drill cereals after mid-October if weather allows, rather than September to reduce black-grass and autumn aphid pressure. I avoid over-feeding crops with

nitrogen fertiliser in one application to prevent rapid growth, making the crop more prone to pest and disease pressure.

Creating habitats to enable beneficial insects and spiders to thrive is key. In addition to flower-rich margins around the outside of the fields (see the video footage below), I've been adding flower-rich strips every fourth tramline (120m) to improve natural pest control and insect pollination.

I see the benefits of in-field strips on the yield maps of my OSR and beans; yields are 5-20% greater next to the strip and tail off further into the field. This also reflects my observation of the number of bumblebees I see across the fields. The yield response is probably a combination of the effects of increased insect pollination and increased natural pest control.

Improved soil health, crop health and better rotations have also enabled me to cut down on my use of herbicides, fungicides and molluscicides. I monitor slug levels, but if I see lots of beetles in the field, I see if they can do the job first and only treat areas that seem to be struggling.



I have been trying a few ideas this last year to further benefit from the IPM approach - I've sown a mix of wheat varieties in my wheat field to avoid pest and disease risks that can arise from a single variety monoculture, have undersown beans with clovers, and tried intercropping oilseed rape with phacelia and clovers to see if these measures will disguise the crop from pests and boost beneficial numbers further.

Overall, crop yields are a little lower, but this is more than made up for by the reduction in costs of production and the net margins are up, despite reducing the areas of wheat, our most profitable crop. There are visibly more beneficial insects and spiders and more wildlife overall, especially birds. The incidence of pest levels exceeding economic thresholds has declined to zero.

You can find this information in the Farm Wildlife case study on AgricoLOGY, which also gives more detail on what led me to transition towards not using insecticides and the environmental and cost impacts of that and of reducing herbicides, fungicides and molluscicides and applying the other regenerative agriculture techniques I describe.

Motivations:

I joined the NFFN because I believe that safeguarding the future of our countryside and the wildlife that resides in it is imperative and the way that we produce food in the UK and the rest of the world needs to radically change.

Healthy soil and a healthy environment are essential to long-term food production. If we do not deliver a healthy environment, the next generation will not have reliable food

production. Unless we join up environmental improvements, climate mitigation and biodiversity delivery alongside production of food in the landscape, we cannot guarantee the long-term availability of food. A national shift to nature friendly farming is one of the only ways we can guarantee long-term food production.

The diversity of the British countryside is an asset that is vital to wildlife and of great value to the general public. The right support is crucial to the continuation of work done by many farmers and landowners to improve the habitats for wildlife. I believe that by working together, we can enhance and improve our countryside for all to benefit, but we need the right policies and support in place to help us fulfil the potential that farmland has for conservation.

Read more about my thoughts on the value of the NFFN and what it offers to the industry on the NFFN website..

Listen to Martin talking about his farm and the story behind the NFFN in this 'Meet the Farmers' podcast published in January 2019:



FARMER TIPS

- Have an open mind to change.
- When spraying if possible try leaving a small area untreated to see if the treatments was really necessary.
- Plan the changes you want to do over a 5 to 10-year process giving you time to adjust the business and purchase any new equipment needed. This will give time for your soil and environment to change with you.
- If you are doing a process now to deal with a problem in your system how can you work with nature to make it better in the future?

The video footage below is an example of trying to safeguard the future of some of our wildlife - using herbicides to selectively target weeds and protect lapwing nesting in a field of winter beans.



All photos courtesy of Martin Lines. All Rights Reserved

Visit www.agricology.co.uk to view this profile in full. 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. In response to social distancing we are hosting a series of online virtual field days on a range of agroecological practices in collaboration with our partners. 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

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GLOBAL STUDY REVEALS **TIME RUNNING OUT FOR MANY SOILS** - BUT CONSERVATION MEASURES CAN HELP

Written by Lancaster University, UK

A major new international study has provided a first worldwide insight into how soil erosion may be affecting the longevity of our soils.



The study, led by Lancaster University in collaboration with researchers from Chang'an University in China, and KU Leuven in Belgium, brought together soil erosion data from around the globe, spanning 255 locations across 38 countries on six continents.

This data was used to calculate how long it would take for the top 30 cm of soil to erode at each location - the soil lifespan. The top layer of soil is often rich in nutrients and organic matter, making it important for growing food, fibres, feed and fuel. Soil erosion is a serious threat to global sustainability, endangering food security, driving desertification and biodiversity loss, and degrading ecosystems

The study included soils that are conventionally farmed, as well as those managed using soil conservation techniques, to find out how changes to land use and management practices can extend the lifespans of soils.

Researchers found more than 90 per cent of the conventionally farmed soils in the study were thinning, and 16 per cent had lifespans of less than a century. These rapidly thinning soils were found all over the world, including countries

such as Australia, China, the UK, and the USA.

"Our soils are critically important and we rely on them in many ways, not least to grow our food", says lead author Dr Dan Evans of Lancaster University. "There have been many headlines in recent years suggesting that the world's topsoil could be gone in 60 years, but these claims have not been supported with evidence. This study provides the first evidence-backed, globally relevant estimates of soil lifespans.

"Our study shows that soil erosion is a critical threat to global soil sustainability, and we need urgent action to prevent further rapid loss of soils and their delivery of vital ecosystem services."

However, there are causes for optimism. In the data, soils managed with conservation strategies tended to have longer lifespans, and in some cases these practices promoted soil thickening. Only seven per cent of soil under conservation management had

lifespans shorter than a century, and nearly half exceeded 5,000 years.

Co-author, Professor Jess Davies, also of Lancaster University, said: "Whilst 16 per cent of soils with lifespans shorter than 100 years is a more optimistic estimate than '60 harvests left', soil is a precious resource and we can't afford to lose that much over a human lifetime.

"But importantly what our study also shows is that we have the tools and practices to make a difference - employing the appropriate conservation methods in the right place can really help protect and enhance our soil resource and the future of food and farming."

Converting arable land to forest was found to be the best way to lengthen soil lifespans. However, other approaches that allow farming to continue, such as cover cropping, where plants are grown between cropping seasons to protect the soil, were also shown to be highly effective. The ploughing of land along contours rather than down slope, and hillslope terracing were similarly suggested as beneficial for lengthening soil lifespans.

Professor John Quinton, of Lancaster University and co-author of the study,

said: "It is clear that we have a conservation toolbox that can slow erosion and even grow soil. Action is needed to promote the adoption of these measures so that we can protect and enhance our soil resource for future generations."

The study is detailed in the paper 'Soil lifespans and how they can be extended by land use and management change', published in the journal *Environmental Research Letters*.

The paper's authors are Dr. Daniel Evans, Professor John Quinton, and Professor Jessica Davies of Lancaster University, Dr. Jianlin Zhao of Chang'an University in China, and Professor Gerard Govers of KU Leuven in Belgium.



Abstract - Soil lifespans and how they can be extended by land use and management change

D L Evans¹, J N Quinton¹, J A C Davies¹, J Zhao² and G Govers³

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Human-induced soil erosion is a serious threat to global sustainability, endangering global food security, driving desertification and biodiversity loss, and degrading other vital ecosystem services. To help assess this threat, we amassed a global inventory of soil erosion rates consisting of 10030 plot years of data from 255 sites under conventional agriculture and soil conservation management. We combined these with existing soil formation data to estimate soil sustainability expressed as a lifespan, here defined as the time taken for a topsoil of 30 cm to be eroded. We show that just under a third of conventionally managed soils in the dataset exhibit lifespans of <200 years, with 16% <100 years. Conservation measures substantially extend lifespan estimates, and in many cases promote soil thickening, with 39% of soils under conservation measures exhibiting lifespans exceeding 10000 years. However, the efficacy of conservation measures is influenced by site- and region-specific variables such as climate, slope and soil texture. Finally, we show that short soil lifespans of <100 years are widespread globally, including some of the wealthiest nations. These findings highlight the pervasiveness, magnitude, and in some cases, the immediacy of the threat posed by soil erosion to near-term soil sustainability. Yet, this work also demonstrates that we have a toolbox of conservation methods that have potential to ameliorate this issue, and their implementation can help ensure that the world's soils continue to provide for us for generations to come.

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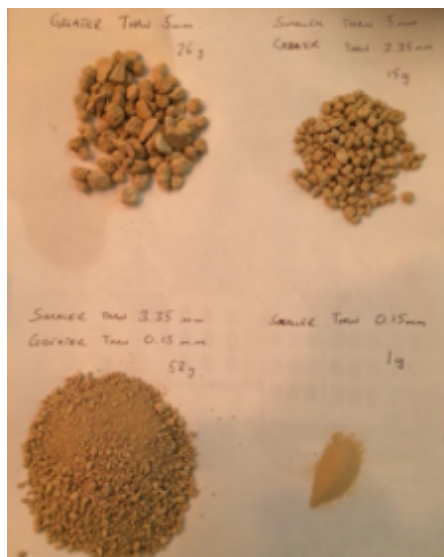
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AGRICULTURAL LIME – CALCIUM CARBONATE

Written by James Warne from Soil First Farming

"I don't care what colour it is, what it looks like or it's consistency, it's lime, get it spread" were words quoted to me recently by an agronomist who clearly didn't understand the basics of some simple chemistry. The above quote was part of a conversation about the quality of liming material and in particular the particle size of lime delivered to farms in the UK. I was being accused of over-complicating liming by requesting that 'Ground limestone' should be specified and should be tested to make sure the product meets the specification. My point being any lime particle larger than 0.6mm (600 microns) is not going to effectively neutralise an acid pH. This little nugget of useful information is clearly stated on the Agricultural Lime Association website (www.aglime.org.uk). For greater clarity and understanding 0.6mm is about the same size as the full stop at the end of this sentence. Not all lime is equal, and certainly our experience is that there is a lot of mis-selling going on in the ag-lime supply trade. A few years ago we were so dismayed by the quality of some of the bulk lime products being delivered to farms that we invested in a set of laboratory quality certified sieves to test our theory. To date we have tested many samples of lime and have yet to meet one which meets the statutory requirements of the Fertiliser Regulations 1991.



Below is one of the worst samples we found to date. To the many reading this I suspect this looks like the lime you are regularly sold, but in reality it's total rubbish. Read on to find out why.

In case you can't read the handwritten notes in the photo, they are as follows;

Top left; larger than 5mm 26% (should be zero %)

Top right; smaller than 5mm, larger than 3.35mm 15% (should be maximum 5%)

Bottom left; smaller than 3.35mm, larger than 150 microns 58% (should be ~5%)

Name of material	Meaning	Declarations	Limit of variation (percentage by weight)
Ground limestone	Sedimentary rock consisting largely of calcium carbonate and containing not more than 15% of magnesium expressed as MgO and of which 100% will pass through a sieve of 5 mm, not less than 95% will pass through a sieve of 3.35 mm and not less than 40% will pass through a 150 micron sieve.	Neutralising value Amount of material as a percentage by weight that will pass through a 150 micron sieve	5.0% of amount
Screened limestone dust	Sedimentary rock consisting largely of calcium carbonate and containing not more than 15% of magnesium expressed as MgO and of which 100% will pass through a sieve of 5 mm, not less than 95% will pass through a sieve of 3.35 mm and not less than 20% will pass through a 150 micron sieve.	Neutralising value Amount of material as a percentage by weight that will pass through a 150 micron sieve	5.0% of amount stated

Bottom right; smaller than 150 microns 1% (should be minimum 40%)

All ag-lime sold in the UK must meet the requirements of the Fertiliser Regulations 1991 to be sold as lime, for the purposes of this article I will look at limestone only, but these regulations also apply to dolomitic limestone, chalk and many other types of lime. The table below is taken from the Fertiliser Regulations.

Using the detail in the table above we

can see that the lime in the photo above fails on the following;

- Only 74% has passed the 5 mm sieve, where it should be 100%.
- Only 59% has passed a 3.35 mm sieve, where it should be at least 95%
- Only 1 % has passed the 150 micron sieve, where it should be at least 40% if declared 'Ground'

Why does this matter, after all if 'it looks like lime and smells like lime' it must be okay surely?! My agronomist or lime supplier can't be wrong, can they?

Sadly, yes they can and this seems to be going on around the country as far as we can tell.

Why is this important? Getting soil pH and soil calcium levels at the desired levels is fundamental to all cropping, whether arable or grassland, vegetable, fruit, flower or viticulture production.

Once the levels start to decline the effectiveness of inputs also starts to decline and the return on investment declines alongside. The health of the crop suffers which results in an increase

in inputs which are already under pressure. You can see this becomes an ever-decreasing circle of increased cost and decreasing output.



Focus on the detail of the basics and the output and profitability will follow. In order to substantiate the claims above please read on to discover the fundamentals of why and how lime works to ensure you are spending your hard-earned cash wisely.

Neutralising value

NV is a figure given to the potential of a lime to neutralise the free hydrogen within the soil. The figure is based upon pure Calcium carbonate equivalence. A high-quality limestone will have an NV of 55. As stated above this is the potential of the product to neutralise the hydrogen ions in the soil solution which cause acidity. To give this some perspective consider the photograph below. This is oolitic Cotswold limestone as found in my garden and sold from many local quarries as a liming material. Both the lump of rock and the 'crushed' pile are derived from the same piece of rock. I simply smashed a larger piece of rock with a hammer a few times to achieve the 'crushed' sample. Both of these samples, the lump of rock and hammer produced 'crushed' sample will have an identical NV. If lab tested I suspect it would have an NV of ~50. So which one is going to be more effective at neutralising acid pH soil? If the only information given to you by the lime supplier is NV, you could receive lime like that on the left, or on the right. NV is only part of the story.

So, taking the example above the 'crushed' sample on the right will work faster at reducing the soil pH because it has a much larger surface area and is therefore more reactive. The piece of rock on the left will do very little, if any, neutralising in a time scale that matters to you. The timescale for good

neutralising is weeks to months if the lime is correctly ground, or years to decades, if larger than 0.6 mm.

Grind size

As mentioned above we now know that grind size is as important as neutralising value in determining whether the lime will actually do as intended. This is where the fertiliser Regulations 1991 become relevant because they set out the standards for lime quality as a fertiliser. If we consider these regulations for a moment it is clear that both the neutralising value and the specific material name must be given, in addition the percentage by weight passing through a 150 micron sieve must also be declared (the grind size). A limit of variation (tolerance) of 5% is allowed.

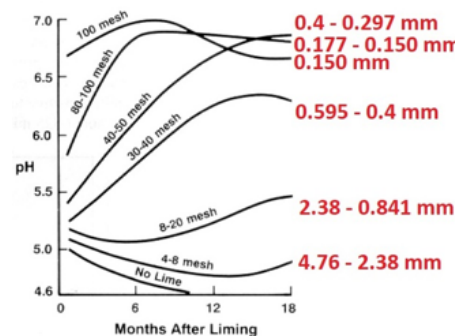
By grinding the rock finer we are increasing the surface area of the product. It is this increase in surface area which allows the lime to react faster and bring about quick reductions in soil acidity. If we calculate the degree of grinding and surface area we can see from the table below that ground

	Prilled Lime	Ground Limestone	Screened Limestone
Sieve size			
5 mm	100	100	100
3.35 mm	100	95	95
0.15 mm	100	40	20
Surface area (m ²) per metric tonne	44776	19476	11528

limestone has a surface area nearly twice that of screened limestone, while prilled lime products can be four times the surface area of screened limestone. This increase will give greater reaction and therefore faster pH reduction.

So how fine does the rock need to be ground to be effective? The aglime website states that "coarser material requires a heavier application" and that "There is a considerable reduction in the effectiveness of liming materials containing particles above 600 microns (0.60mm, 60 mesh) unless the material is easily broken down".

This is supported by work taken from



North Carolina University in the US shown top right;

This graph clearly demonstrates that lime in the range of 0.177 – 0.150mm (177-150 micron or 80-100 mesh) gave the quickest pH rise and most sustained pH rise. The larger particle size 0.841mm and above gave a very limited pH increase and took 18 months to achieve it.

Another response I have had is "I have been using the same products for years and never found a problem". There are two responses to this proposition;

1, you have been using a good quality product all along;

or

2, soil pH testing generally occurs every 4-5 yrs in line with regular soil analysis. Suppose that your soil testing shows a pH of 5.9 and you decide to apply lime in accordance with the recommendations, this will be around 8 tonnes/ha for a medium soil (RB209). But the product you use is of low quality and does not meet the specification. This will have little effect in raising the soil pH but you don't go back to test again for another 4 yrs. This time around the soil test is registering around pH 5.8. You are almost expecting this as we are programmed to expect the pH to be low after 4 yrs of no lime so you go through

the same routine again and again. But if you had used good quality ground limestone you may find that the pH has not dropped so far and therefore less is needed. You may also find that output

point difference in pH the hydrogen ion concentration changes ten-fold as shown in the table below. Therefore the number of hydrogen ions that need to be neutralised by the lime increases

	pH	H+ Activity		OH- Activity
Acid	0	1.E+00	1	0.000000000000001
	1	1.E-01	0.1	0.000000000000001
	2	1.E-02	0.01	0.000000000000001
	3	1.E-03	0.001	0.000000000000001
	4	1.E-04	0.0001	0.000000000000001
Neutral	5	1.E-05	0.00001	0.000000000000001
	6	1.E-06	0.000001	0.000000001
	7	1.E-07	0.0000001	0.00000001
	8	1.E-08	0.00000001	0.0000001
	9	1.E-09	0.000000001	0.000001
Base	10	1.E-10	0.0000000001	0.0001
	11	1.E-11	0.00000000001	0.001
	12	1.E-12	0.000000000001	0.01
	13	1.E-13	0.0000000000001	0.1
	14	1.E-14	0.00000000000001	1

increases while your inputs decrease as crop health improves. But why doesn't the pH drop lower 4 years after an application of low-quality lime? pH is a logarithmic scale which mean that each

ten-fold for each unit drop in pH.

Cost comparison

If a routine application of granulated limestone extended to 200kg/ha/yr

of product. Product cost is £125.00 tonne, the product cost is £25.00/ha plus a farmers spreading cost of £7.00/ha. Total cost £32.00/ha

To get an equivalent amount of useful lime from the sample shown at the beginning of this article assuming 10% fits through a 0.6mm sieve would require 2 tonnes/ha of aglime. Assuming a cost of £25.00/tonne delivered and spread. The total cost would be £50.00/ha.

The way forward

I am not saying don't use lime, quite the contrary, lime is essential where required, but pay special attention to the quality if buying ground limestone. There is a downside to using good quality ground limestone and that is watching your neighbours benefit from your investment if your lime spreader turns up on a windy day. For the most cost-effective lime applications I suggest regular (annual or bi-annual) small applications of a granulated lime. You can apply it yourself with your own machinery, it's 95% finely ground lime, and best of all, every penny that you spend on it will work for you.

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FARMER FOCUS

SIMON COWELL



I have always found that pioneering a different system of farming is a lonely task, there is lot of contradicting advice out there but ultimately you have to make the decisions yourself.

I have read stacks of books on soil biology and regenerative agriculture and follow all the latest ideas from around the world, but I have increasingly found that a lot of information is not evidence based and relies on wishful thinking. Additionally, I receive advice on what I should be doing and what other farmers are doing from a conventional agronomist who is tied to a chemical distribution company, but this seems to be working on the same principal as paying life insurance premiums just in case the crop is going to die next week.

Being exposed to vast amounts of diverging concepts and ideas makes decision making challenging. For example, whether or not to use a fungicide on my wheat this year has been a difficult decision that had to be made several times during the growing season. The agronomist began by finding the first signs of yellow rust on several leaves - conventionally, a hefty fungicide would be used to kill off the disease and protect the rest of the crop. However, I had to balance this option with a wealth of unsubstantiated ideas that I have picked up over the years - fungicides damage soil life and interfere with photosynthesis, thus reducing plant sap sugar levels and increasing susceptibility to disease later on.

Furthermore, after years of biological farming, I consider my soil to be somewhat “disease suppressive”, meaning that the crops ought to be capable of fighting off disease themselves.

My crops came out of the winter in poor condition from standing in water for five months and with the onset of drought, I was expecting lower than normal yields, meaning costs had to be saved wherever possible. All these variables meant that deciding what to do with my wheat relied upon gut feeling and guess work; being a risk-taker and optimist, I applied very few fungicides this year and the yellow rust disappeared. I can only assume that the plants' natural defences may have protected the wheat from yellow rust. Therefore, despite the benefit of hindsight, I am still unsure if these chemicals would have paid for themselves in a low yielding year or not.

The decision of whether or not to apply nitrogen this year was also tricky. The first two splits of three went on as usual, but then drought set in and it became obvious that the last application would never get washed in and become available to the crop. Tissue tests showed that there was plenty

of nitrogen in the plants, so I was presented with another opportunity to save money on what was obviously going to be a lower yielding crop. Typically, when I can't resolve a dilemma, I experiment and hope to learn for the future; so with my gut feeling saying that it would be a waste of time and money to apply the last nitrogen, I put the last dose nitrogen on only one field and left the rest. Unfortunately, this did not teach me anything because although yields were quite variable, there was no correlation with nitrogen rates at all. In fact, in one trial, a strip with no nitrogen out yielded the half rate strip, and the rest of the field which had the full rate of nitrogen. My only conclusion is that the wet winter and spring drought had an overriding effect on yields, and there was nothing that could change them, whatever was applied.

It is generally recognised that building a natural soil structure by increasing organic matter and not cultivating will enhance the soil's capacity for holding water.

High levels of mycorrhizae are supposed to improve water scavenging and roots should go deeper when not encountering cultivation layers. Unfortunately, I have yet to see any difference between my farm and any others around the area. There is a possibility that it works on light land, but on clay I have not found this to be the case. It seems to me that as clay shrinks through the course of drying, it allows more air into the soil which dries it out further. This drying puts the soil biology into hibernation, a real problem when you are hoping that this biology is going to do the work of fertilisers and chemicals. I think that the more we rely on natural systems, the more vulnerable we are to weather extremes, sort of the opposite to hydroponic farming where everything is controlled so that the outcome is guaranteed. Conventional high input farming would be somewhere in between, still vulnerable to the weather but the nutrition being taken care of to a large extent by mineralisation from cultivations. There is also the fact that building soil organic matter levels requires nutrients, it is a biological process in direct competition with the growing crop. Unfortunately the bugs eat first, so there is very little left for plants when natural availability is limited by very dry conditions.

Like many farmers in the UK, I have not had a very good harvest. Winter crops were disappointing; however, some spring crops have done reasonably well considering the conditions they endured. With cost savings in so many areas of my business there is little stress on me when growing conditions are less than ideal. All farming has its ups and downs, but if we are able to step back and look for answers, progress will continue to be made.

AGRICULTURAL ETHICS: CHARTING THE PATH TO A SUSTAINABLE FUTURE

By Ralph Early (ralph@theethicalfoodie.co.uk)

Part one of this two-part article on agricultural ethics set out a thesis which argued that the development of farming as an industrial activity during the 20th century, aided particularly by dynamic and commercially advantageous sciences and technologies, has brought us to a point where agriculture itself now presents a substantial threat to the natural world. This is indisputable.

The UK's State of Nature partnership's 2016 report cites, for instance, that farmland birds have declined by 54% since 1970, while butterflies as an indicator of the wider countryside have declined by 41% since 1976. Sadly, many species of wild plants and animals indigenous to the UK have been subject to extirpation as a consequence of various farming and land management practices over the last century, while some of the country's most iconic wildlife is threatened by extinction. People, like wildlife, need the land. The health of the land as a resource for human food production, and the linked capacity for wildlife to flourish, depends on an abundance of biodiversity: the biomass necessary for nature's ecological processes to function properly in maintaining the vigour of the land and nature itself. Isabella Tree comments in her book, *Wilding*, saying that Britain is "among the most nature-depleted countries in the world". It seems that Britain is on a path which risks possible ecological collapse, threatening the very food systems that support both people and wildlife. It is clear that if we do not rethink farming – and, it has to be said, urban planning which is increasingly defined by avaricious motives and corrupt Westminster politics – we may reach a tipping point where, for example, seemingly inexorable environmental decline and the loss of keystone species brings down the increasingly fragile house of cards that is our country, our wildlife heritage and our home. It is, after all, our choice.

Farmers are members of the moral community. They are moral agents. They have the capacity to understand moral concepts and to distinguish what is morally right from what is morally wrong. Indeed, by reference to objective moral



If hen harriers have a right to life, do pigs, sheep and cattle not have the same right? Pic credit: The Times

values, which ideally calibrate their own moral compasses, farmers employ moral agency every day. They make decisions which are ethical in construction and which can be framed within the discipline of agricultural ethics. Such decisions may involve, for example, the management of farm staff, the welfare of farmed animals, the protection and preservation of the farmed and wider environment, the safeguarding of biodiversity dependent on farmland for survival, and interactions with those employed more widely in agriculture as well as others in the rural community, etc. Indeed, there are farmers who, in the Greek philosopher, Aristotle's conception, are incontestably virtuous persons. We can think of them as virtuous farmers who, by their character and intellect, are distinctive within the farming community. They cause good through their ideas and associated actions, serving as role models for farmers generally and for wider society. Many who read this article will know such individuals as exemplars of moral conduct within agriculture. They will be recognised as the people most likely to take the lead in rethinking farming to deliver the widespread ecological balances necessary to preserving the planet and achieving genuine environmental sustainability.

Farmers contend with many issues which embody moral dimensions. One of the most thorny is that of protecting and preserving the soil as the land, and the land as the countryside. Soil is essential to food production. Much of the quality of the soil we enjoy today was created by large herbivores grazing the land over the millennia, since the end of the European ice-age some 14,000 years ago. As a natural resource, soil is finite in terms of the amount available and its quality. In temperate climates, e.g. Britain, it takes about 4 lifetimes to produce 1 cm of soil, with around 10 lifetimes to achieve adequate levels of fertility. We know that the nutrition quality of crops, e.g. cereals, fruit and vegetables, has declined over the last 50 years as soil quality has declined due to industrial farming and increased use of fertilisers, pesticides and irrigation. We also know that increased mechanisation and pesticide use have chased native flora, insects, birds and small mammals from the fields, while artificial fertilisers can trigger the eutrophication of water courses. British farmland soil is dying before our eyes and its capacity to produce food may not extend beyond another century. Yet supermarket strategies and the ambitions of governments place farmers under constant pressure to cut costs in order to produce cheap food. By utilitarian calculus, the production of cheap food may appear to deliver the greatest good for the greatest number. However, given the intensive methods which farmers are often forced to use just to keep up, to what extent does cheap food policy diminish the soil and the land as our key food production resource? While farmers strive to feed people, an ethical lens reveals their undeniable moral obligation to preserve the soil, not just for use today,



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but as a resource upon which future generations will be dependent. The soil itself, and the land, are legacies of good which must pass from one generation to another and, morally, they should be preserved.

The protection of the environment and certain species can be achieved to a certain extent through legislation which frames legal rights. This may also reinforce moral rights. For instance, the hen harrier, with a UK breeding population of less than 1,000, is an endangered species protected by law. Hen harriers, individually and as a species, have a legal right not to be made extinct. The moral right of these birds to enjoy life and to flourish as a species is, though, not grounded in law. It is grounded in the fact that as moral agents we are able to know that hen harriers have the right not to be killed for sporting or commercial benefit and, consequently, to be forced into extinction. To do so would be an evil act. If we recognise the moral right of hen harriers to survive as a species, as rationally we ought because abundant biodiversity benefits humanity, ethically we and particularly land owners and farmers bear the correlative moral duty to ensure their protection.

Asserting moral rights for the protection of hen harriers constitutes an appeal to deontological ethics: an ethical domain concerned with notions of duty, rights and justice. The deontological philosopher, Immanuel Kant (1724-1804), stated that we ought to treat people as ends in themselves, not merely as the means to our ends: a value which is not necessarily restricted to the good of human beings. Normatively, when an animal species is facing extirpation or extinction we ought to respect the species as an end in itself and work to ensure its protection. It is the morally right thing to do and stems from the principle that abundant biodiversity is naturally good for nature and instrumentally good for human beings. Land owners and farmers



ought then to protect hen harriers, simply because it is morally right to do so. Such a notion of rightness by appeal to Kantian ethics can, however, also be applied to the protection of the soil and, hence, the countryside. Those who consider themselves as stewards of the land, take unto themselves particular moral duties or obligations. The claim of stewardship asserts an ethic of duty correlated with an ethic of care. To be a steward of the land, rationally and irrefutably implies a duty to care for the soil which constitutes the land. It follows that this imposes a duty to care for nature which co-exists with healthy and productive soils, as the land. In ethical terms, the soil ought to be regarded as an end in itself and not merely the means to the end of e.g. agricultural profitability. This then compels an intellectual shift which places priority on the soil for the common good of both people and wildlife, establishing, conceptually, the moral right of the soil to be preserved and enhanced.

Assigning value to the moral dimensions of agriculture by means of an ethical lens in order to support practical, on-farm decision making is not necessarily a simple and trouble-free activity. For instance, though we may assert the moral right of hen harriers as an endangered species not to be killed for commercial benefit, e.g. to protect grouse, how does this square with the fact that farmed animals are killed for food? Arguing from a hard animal rights position we may posit the philosopher, Tom Regan's (1938-2017) view, that animals are subjects of a life and have inherent value: meaning, essentially, that their interest in living and enjoying life is fundamentally the same as that of human

beings. Such a position demands, for instance, that animals have the right not to be eaten by human beings (although they may be eaten by other animals). Meat eating is, however, a cultural norm in many societies and for many millions of often poor people, it can be an essential and not easily replaceable source of nutrition. There is not the space here to analyse the moral arguments for and against the human consumption of meat, but we should recognise that while the justification for granting hen harriers moral rights is based in the rarity of the species, commonly used domesticated food animals are abundant. Indeed, in evolutionary terms, we might consider their success is linked to the fact that they are food for human beings.

If animals are to be farmed, a fundamental moral principle which ought to govern methods of production concerns the ethical principle of non-maleficence, meaning that whatever one does one should cause no harm. The utilitarian philosopher, Jeremy Bentham (1748-1832) expressed his concern for the well-being of animals, stating: "The question is not, Can they reason? nor, Can they talk? but, Can they suffer?". Bentham was unconcerned about the use of animals to feed human beings. He believed though, that if they are so used, then as sentient beings capable of experiencing pain and suffering they ought to be kept in ways which prevent unnecessary suffering. Such a position coordinates with the Farm Animal Welfare Committee's 'Five Freedoms', established in 1979, which express normative moral standards for ensuring the welfare of farmed animals: (1) Freedom from thirst and hunger; (2) Freedom from



Pic credit: National Trust

discomfort; (3) Freedom from pain injury and disease; (4) Freedom to express normal behaviour; (5) Freedom from fear and distress.

Agricultural ethics is a large and complex subject which, considered in detailed philosophical terms, can easily fill many text books. Consequently, some topics must be excised from consideration here. However, we cannot leave this review without considering examples of ethical issues which may affect farming in the future: particularly in light of Brexit and the British government's apparent desire to replace EU policies and standards by integration with America's corporate agri-food sector. The EU has long presented a barrier to certain patented US agricultural technologies, including, for example, GM (genetically modified) herbicide tolerant crops and genetically engineered recombinant bovine growth hormone (rBGH) (known as recombinant bovine somatotropin (rBST) in Europe). In ethical terms, new agricultural technologies, which may present benefits and harms, ought to be weighed for approval on a case-by-case basis, objectively and independently of political lobbying and commercial pressures for approval. The

EU employs the Precautionary Principle in such evaluations. It emphasises caution in advance and places the burden of proof of absence of unacceptable harms on vested interests seeking approval. However, some British MPs argue that Brexit will permit agricultural and environmental deregulation and they seek adoption of the Innovation Principle, which, in essence, means try it and if things go wrong, try to work out how to repair the damage. This is a morally dubious position.

The evaluation of new agricultural technologies should, of course, centre on scientific evidence, but it should also elicit appeal to different ethical theories. The moral right of people, animals and the environment not to be harmed solely as the means to the end of corporate profit can, for instance, be framed by deontological ethics. To give a few simplified examples, GM technology raises questions about the integrity of species and the right not to be altered by transferring alien genes. The use of routine rBGH injections with dairy cows to increase milk yields raises questions about a variety of consequential harms to cattle as well as the right of consumers

not to drink milk containing increased levels of IGF-1 (insulin-like growth factor 1: a hormone associated with cancer in people)

The value of agricultural ethics to the evaluation of new agricultural technologies cannot be understated. It is an intellectual discipline which can provide clarity in problem solving through different ways of thinking. Importantly, it can cause difficult and often uncomfortable questions to be asked, but they are questions that should be asked. In this respect, agricultural ethics is a discipline which ought to be employed routinely by governments in decision-making affecting farming and food. Crucially, if agriculture itself is to continue to serve humanity long into the future, farming will need to adopt a continually reflective disposition which, assisted by ethical analysis, learns from the past in order to chart its path to a sustainable future. Fundamentally, if we as humanity are to survive – an outcome which is not obligatory – we must find ways to produce food which respect and benefit people, biodiversity and the environment. In this, agricultural ethics can play an unparalleled part.



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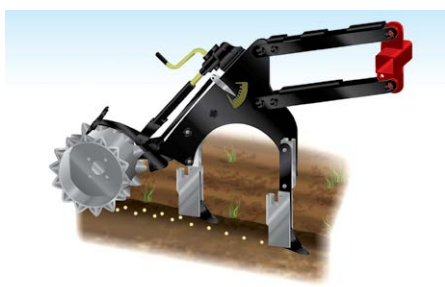
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WHY BUY A DALE DRILL

By James Dale

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20-30hp/m).

Many users view this feature as a key benefit to the drill as they can pull a wider working width machine (often significantly wider when considering HP requirements for drills with cultivation elements) with the same size tractor, boosting their output without having to invest in more horsepower. What is more the wider working width reduces the amount of trafficked soil in a field (for example a 3m drill on a tractor fitted with 650 tyres will traffic over 43% of the field, the same tractor on a 6m drill will reduce that number to 21.6%, whilst a 9m drill brings it down to 14.4%). One new customer has switched from a 3m Strip Till drill to a 9m Eco XL, and is able to use the same drilling tractor. Tripling output whilst reducing trafficked soil by around 30% is a real no brainer.

As farm margins are squeezed, reducing costs and diversifying into new revenue streams is more important than ever. Our Eco range of drills not only allow users to reduce cultivations by moving towards a No-Till establishment system, but also allow you to increase drilling output by going wider, meaning the retiring farm hand may not need to be replaced, and

there will be more time to devote to the other businesses on the farm.

One Pass, More Applied

We have been offering drills capable of drilling two different products for nearly 20 years. Most commonly used to apply fertiliser alongside the seed, improving establishment, whilst reducing the risk of volatilisation of the fertiliser and increasing the efficacy of the nutrients. The Eco drilling assembly is fitted with two tines whose position can be adjusted quickly to alter the row width from 12.5cm to 25cm. When in the 25cm position the two tines are effectively lined up, allowing fertiliser to be placed by the first tine and seed to be positioned next to the fertiliser. More recently we have added options to allow customers to be able to place both seed and fertiliser at 12.5cm spacings, ideal for crops that prefer tighter row widths.

We have seen a significant increase in the number of customers wanting drills fitted with additional applicators over the past few years. The ability to apply a dose of pellets, or control blackgrass with a dose of Avadex at the same time as drilling improves farm efficiency, saving time and money. Our drills utilise RDS Topcon's Isocan Artemis system, which allows up to 4 channels to be controlled through the drills control box, meaning up to 4 different products can be applied at the same time, their application all automated by the drill. Furthermore, the Isocan system is Isobus compatible so can be run through the tractors screen, de-cluttering the cab and saving setup time.

Accurate Depth Control

Many new customers opt for an Eco drill due to its ability to establish and maintain an accurate drilling depth. Drills with coulters mounted rigidly to the frame suffer from not being able to follow contours across their width meaning seed can end up too deep or too shallow. The Eco drilling assemblies parallel linkage and depth setting press wheel ensure that



contours are followed accurately, allowing operators to determine the depth they want to drill to and ensuring seed is positioned correctly.

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Despite offering a huge amount of versatility, our drills are really quite simple. We've made significant efforts to reduce the maintenance required on our drills to a minimum, from using oil filled bearings on our press wheels to self-lubricating nylon bushes in our pivot points. Less maintenance means less downtime during the drilling period, helping to boost output and increase farm efficiency.



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The tungsten carbide tipped, boron steel tines and openers are designed to last, typically achieving over 500ac/m of drill (a 6m drill will average 3000ac on a

set of points). This puts wearing metal at under £1/ac, and the long life means less time and money spent on changing tines.

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ARE NITROGEN STABILIZERS WORTH USING?

3 FACTORS TO CONSIDER

Written By Laura Barrera and first published in AGFuse.com

When it comes to fertility in crop production, nitrogen is one of the most critical nutrients involved. "Nitrogen plays an important part in many essential functions and compounds necessary for life," says the University of Missouri Extension and can be found in various parts of plants.

Unfortunately, nitrogen fertilizer is susceptible to leaving the soil before it can be used up by the plant. According to Cornell University Cooperative Extension, nitrogen loss can occur in three ways:

- Denitrification: Nitrate converts into gaseous forms of nitrogen which are lost to the atmosphere
- Volatilization: Ammonium (NH_4) converts to ammonia (NH_3) gas which is released to the atmosphere
- Leaching: Nitrate, which is negatively charged like soil particles and not well retained by the soil, is washed downward by excess soil water beyond the root zone of crops.

One way to reduce the loss of nitrogen is by using nitrogen stabilizers. Penn State Extension explains there are two broad categories of nitrogen stabilizer products: urease inhibitors and nitrification inhibitors.

Urease inhibitors prevent urease from converting into ammonium, while nitrification inhibitors are actually a pesticide that kills a specific group of nitrifying bacteria that are responsible for the conversion of ammonium into nitrate.

While these products can help protect your nitrogen from loss, are they worth using on your farm? More importantly, will they pay off?

Consider Soil Texture

University of Nebraska Extension Soil and Nutrient Management Specialist Charles Wortmann says that like most practices in agriculture, you can't expect universal benefits from use of nitrogen stabilizers, but it can be very beneficial if it's well targeted to certain situations.

The University conducted a near three-decade study on N-Serve, a nitrification inhibitor, that was applied

along with anhydrous ammonia in the spring on an irrigated, continuous corn field with silt loam soil near Clay Center, Neb. Researchers found use of nitrapyrin produced a positive yield response 36% of the time, which only occurred when weather in the 6 weeks following a nitrogen application included moderate-volume, well-distributed rainfall, or higher-volume rainfall coupled with higher temperatures.

The inhibitor didn't affect yield in 46% of the years, while there was a negative yield effect 18% of the time.

Wortmann thinks the results were highly affected by soil texture.

"If it was a sandy loam, loamy sand or sand, we would have expected it to be more beneficial," he says, explaining that there's a greater risk of excess water moving through the soil, especially in May and June. Those two months have the highest leaching potential because there's more rainfall and the crop isn't using as much nitrogen at that point.

"With a sandier soil, it just holds less water, more water passes through carrying nitrate."

He says the results from the study tell us that we shouldn't expect many benefits from the nitrification inhibitor with spring-applied nitrogen for a silty loam soil, silty clay loam soil, or any soil that's finer textured. The one exception, he adds, would be where there's a moderate or high due to waterlogging.

"In low lands that are occasionally flooded and waterlogged, a nitrification inhibitor could help prevent loss of nitrogen due to denitrification," Wortmann says.

Weather a Primary Factor

Soil type isn't the only influence on the effectiveness of nitrogen stabilizers.

Because the weather is often one of the driving forces behind lost nitrogen — whether it's high rainfall that can lead to leaching, or dry weather that can cause volatilization — paying attention to the forecast can play a big role in whether a stabilizer pays off.

The University of Nebraska has also looked at urease inhibitors used with surface-applied urea ammonium nitrate (UAN) for corn in central Nebraska for 3 years. They found the urease inhibitor only had a positive effect in one year when there was little rain for 2 weeks after surface application of urea ammonium nitrate. "In this year, the urease inhibitor delayed urea conversion to ammonium," Wortmann says. "Ammonium easily converts to ammonia which is easily lost to volatilization."

Studies conducted by Beck's Hybrids' Practical Farm Research in 2014 also saw positive results from nitrogen stabilizers during adverse weather conditions.

The company tested three products — Instinct, Agrotain Plus, and Nutrisphere-N — on its central Illinois, central Indiana, Kentucky and Ohio sites. The products were surface-applied before corn emergence with 180 pounds of liquid UAN.

They found that across the four sites, the products all provided yield increases and positive returns on investment. Instinct, which delays nitrification but not volatilization, was the top-performing product of the three. Beck's Hybrids researchers believe this was due to frequent rain events all of the sites experienced throughout the 2014 season.

Results of Beck's Hybrids 2014 PFR multi-location study on nitrogen stabilizers. Table pulled from 2014 Report.

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What About Slow-Release Nitrogen?

In addition to nitrogen stabilizers, another product option are slow-release fertilizers, which help reduce nitrogen loss by limiting how much nitrogen is exposed over time.

The University of Nebraska conducted a 3-year study on ESN, a polymer-coated urea, on an irrigated corn field with loamy sand soil in south-central Nebraska.

Researchers saw positive results from using ESN over UAN with and without stabilizer at various rates. Averaged across the different rates, corn yield with ESN was 49% greater over unstabilized UAN. In one year there was a very small rain shortly after UAN application sufficient to activate urease, but then it didn't rain again for another two weeks, resulting in much ammonia volatilization. The polymer coating of ESN prevented urease access to the urea.

A lab study simulating field conditions found that ESN compared with unstabilized UAN reduced ammonia loss by 15% with dry soil conditions and leaching of nitrate by 60%.

However, Wortmann warns that while the study was good in testing the effectiveness of slow-release products, it's not the type of nitrogen management farmers should be following for an irrigated sandy loam. Less nitrogen should be applied early, he says, with most applied in-season, such as through fertigation.

Does Tillage Make a Difference?

With the nitrogen in these studies being surface-applied, does it make a difference what tillage practices a farmer uses? It can.

In the 28-year Clay Center study, the site had both no-till and disk tillage. Researchers found no difference in the effects of nitrpyrin due to tillage.

Wortmann says that when they sampled for accumulated nitrates in the vadose zone to about a 30-foot depth, there were less nitrates under no-till, but researchers couldn't find a good explanation for that. He suggests it's possible that with a better water infiltration under no-till conditions, the nitrogen could have leached deeper than 30 feet under no-till, or it may have been lost through denitrification. Either way, the yield was not any greater.

However, no-till systems often have more surface residue, which Wortmann says increases urease activity, resulting in more rapid conversion of urea to ammonium.

"High residue conditions, high soil pH, and delayed rainfall following surface application of urea are expected to contribute to more benefit from urease inhibitors," he says.

Which is why Wortmann recommends if you're no-tilling and you're going to surface-apply urea or UAN, you consider using urease inhibitors, including for corn after soybean.

"Unless the weather forecast gives them a strong indication of rain or they're planning to irrigate," he adds. "For in-season, whether it's applied with a land applicator or through the irrigated system, then I do not see a significant advantage to using the inhibitor."

Deciding When to Use Nitrogen Stabilizers

Unfortunately, because weather is often the biggest factor in whether a nitrogen stabilizer pays off in a season, it's hard to predict when it's wise to use them, and when they'll be a waste of money.

"A lot of it is targeting," Wortmann says. "You have to think about your situation, both your field and your anticipated weather, and decide from there."

In situations where you're surface-applying urea or UAN, especially in no-till fields where there's crop residue, then the economics might be favorable, he says. "We don't have enough data to see how frequently we get these losses."

Conversion of ammonium to ammonia is also more rapid on soils that have a high pH or are calcareous.

"Urea application to wheat in spring, I would say that would be a good time to use it. If it's a rain-fed area, in case the rain comes," he says.

Wortmann adds that if the forecast indicates no rain for 10 days, then he would recommend a urease inhibitor to inhibit volatilization loss.

In very sandy soils, even at relatively small amounts, if it's applied pre-plant in the spring then he suggests inhibitors be routinely used.

"With fall application, it may do some good but very often the effect of the inhibitors is gone by the time we have our highest leaching potential, which is again in March, and probably through May and June," Wortmann says. "It should be very much discouraged anyway of nitrogen to sandy soil in the fall. But spring application, even if you're putting on less than 50% of your total nitrogen, you might as well protect that."

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ECOLOGICAL PRINCIPLES FOR WEED MANAGEMENT - STEPS TO GET YOU ON THE ROAD TO MAKING PEACE WITH WEEDS

Written by Chloe MacLaren As based on information found on AgricoLOGY (www.agricology.co.uk)

Chloe MacLaren is an ecologist at Rothamsted Research exploring how we can design resilient, sustainable cropping systems. Her PhD focused specifically on weed management, but now she works more generally on how different crops and management practices can be combined to maximise both productivity and environmental benefits. Chloe splits her time between the UK and sub-Saharan Africa.



For a long time, the pursuit of effective agricultural weed management tools and strategies was framed as 'the war on weeds.' We developed increasingly merciless mechanical and chemical weapons to rid our fields of unwanted greenery, striving toward a vision of pure crops from horizon to horizon.

These days, we're slowly realising that war is not a helpful perspective on weed management. Sure, no one wants a field full of weeds, but not all weeds are bad, and sometimes the actions we take to get rid of them do more harm than good. That's harm to both our farms and to our surrounding environment. Furthermore, weeds are proving to be irrepressible opponents; if they don't like what is thrown at them, they quickly adapt, or a more tolerant species subs in from the sidelines. Making peace with the weeds will cost us less in the long run than trying to eradicate weeds from the fields.

The benefits of learning to live with weeds are illustrated by some recent studies showing that crop yield loss declines as weed diversity increases, and that retaining some weed cover

can support beneficial insects as well as farmland birds. Perhaps most interesting is a study from France showing that some groups of weeds - typically diverse, and typically composed of small, low-growing species - have no detectable effect on crop yield at all, even when no weed management actions are taken.¹ This, rather than weed-free fields, should be our goal.

How do we get there?

Managing weeds for net benefits rather than costs requires an understanding of why different numbers and types of weeds occur in different places, and what can be done to influence that. What, for example, led to the diverse, low-growing weeds occurring in the French study, and how can farmers obtain similar weeds in their own fields?

Current weed science is beginning to answer this question through exploring the ecological relationships between weeds and their environment (disturbance and nutrients) and other organisms (crops, livestock, and wildlife). In this blog, I would like to share some simple principles arising from the

study of weed ecology that farmers can look to implement on their farms. These principles should help to reduce the likelihood of problematic weed outbreaks, whilst promoting beneficial weed diversity.

Implementing each principle of ecological weed management should be done with the strategies and tools most suitable to everyone's own farming system. They can fit conventional, organic or no-till systems, arable or perennial crops or livestock - although how you do it may be very different in each system. I have also shared a few practical ideas of how these principles can be put into practice, although the suggestions are by no means comprehensive (weed scientists have more work to do here, and many farmers may have better ideas about it than we do!).

A key point about following these principles is that they should not be extra work done simply for the sake of weeds. All could also be recommended for managing pathogens and insect pests, contributing to soil health, increasing resource use efficiency and improving yield stability.

Think of weeds as a reminder to manage the farm in a resilient, sustainable manner. Weeds keep us in check as we keep them in check; the more monocultures we farm, the more fertilisers we apply, the more we disturb the soil, and the more chemical tricks we use, the more weeds get out of hand in the long run. If we keep these things to the absolute minimum that we need to support crop or animal growth, then weeds will slowly become more manageable, and possibly even beneficial.

Increase diversity in all its forms

Crop rotation, crop mosaics, crop mixes, intercrops, forage mixes, integrated crop-livestock systems, organic matter sources, nutrient sources, hedgerows, margins, trees, wildlife, microbes. All these are avenues for farm diversification that help to limit weed numbers and to promote weed diversity, by varying conditions in space and time across the farm and landscape, and promoting the natural enemies of weeds. Diversification ensures that no weed species encounters uninterrupted favourable conditions that would allow its population to continuously grow. It also helps to sustain weed diversity, by reducing the chances that some species encounter consistently unfavourable conditions and are lost (think of cornflowers).

Diversification in farm practices can also reduce selection for weeds that behave like crops. The best way for a weed to survive a rigorous management regime is to mimic the crop: germinate with the crop to avoid tillage, tolerate the same herbicide regime as the crop, utilise the fertilisers applied to the crop. This means that the most competitive weeds - the ones that want the same resources at the same time as the crop - are most likely to survive intensive control. If the same crop is grown consistently, its weed mimics will thrive (think of blackgrass in winter wheat).

'Little hammers' not 'sledgehammers'

The phrase 'many little hammers' has long been used to encourage diverse weed management practices, and it is increasingly apparent that those hammers must indeed be 'many' and 'little.' Really big hammers, such as using every herbicide and tillage tool you

can get your hands on all in the same season, get rid of most weed species but can select for specific strategies that a few weeds use to avoid all of these. For this reason, variable germination times, fast growth rates and herbicide cross-resistance underpin many of the most problematic weeds worldwide. Instead try to rotate tactics between years rather than using everything at once.*

'Little hammers' can also be used to shift weeds to more desirable types, by disadvantaging the weeds you don't want. For example, taller weeds tend to be more competitive, so tactics that kill tall weeds but allow short weeds to survive can promote a less competitive weed community - mowing, topping or weed wipers might be appropriate, depending on the farm type.

*NB: to delay or avoid resistance to herbicides, the evidence so far suggests that using mixes of herbicides each year is better than rotating single herbicides between years, but rotating different mixes of different herbicides is better, and using non-chemical tools in rotation with herbicide mixes is best.

Reduce resource availability

Weeds will grow wherever there is enough nutrients, light and moisture, so try to reduce these opportunities. Competitive crops are a good way to capture resources and keep them away from weeds - choose competitive cultivars, sow as densely as appropriate, and consider intercrops or crop mixes. Combinations of crops with different growing times and growth forms can more effectively utilise available resources than single crops.

Minimise fertiliser applications, and where possible, use slow-release fertilisers (green manures and composted animal manures are a good example). This avoids a big flush of nutrients being available to weeds before the crops can make use of the nutrients. High resource availability also promotes types of weeds that grow quickly - their life strategy is to grab as many resources as fast as possible before anything else (like the crop) does, and this makes them more competitive. In contrast, low resource levels select for weeds that grow more conservatively and impose less intense competition.

Take advantage of the positive effects of weeds

Weeds help to support natural enemies such as lacewings, ladybirds and beetles that eat aphids and other pests. Some weeds also taste better to pests than crops, and help to distract the herbivores. Weed flowers and seeds, as well as the bees, the birds and the butterflies they support are all needed for wider ecosystem health. Weeds can help to shelter the soil from the weather, while leguminous weeds can provide free nitrogen and the long taproots of weeds like dock can bring nutrients up to the surface that will be available when the plant decomposes. Managing for a diverse weed community is the best way to maximise benefits while minimising competition with crops.

Of course weed control will always be necessary to some extent, but in some situations, the cost of the weed control (in terms of money spent, fuel used, soil disturbed and ecosystem function lost) may be greater than the cost of the weeds. The more we learn about weeds, the better we will be able to judge this, improving our capacity to maximise farm productivity and profitability whilst sustaining a healthy environment.

¹Adeux G, Vieren E, Carlesi S, et al (2019) Mitigating crop yield losses through weed diversity. *Nat Sustain* 2:1018-1026.

Header image © Rothamsted Research

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TIM PARTON

Tim Parton looks to the future in farming and sees microbes taking a leading part in crop and animal production

To quote Rudyard Kipling,

"If you can keep your head when all about you
Are losing theirs...."

– seems quite appropriate at the moment. Something, as farmers, we are good at living with, is uncertainty: weather conditions – out of our control; corn prices – out of our control; government legislation out of our control; DEFRA subsidies out of our control. I could rattle on about the suffering and anxiety surrounding the weather, the harvest and re-drilling. Instead, I chose to focus on what I am doing to "keep my head"; concentrating on the things I have control over: Buying my staff breakfast, or an evening drink on those long days of harvest: Thanking Pontesbury Tractors for coming out of hours to repair machinery, so I can get on harvesting in the dry weather before the next downfall of rain: Turning around the disappointment that crop yields are down (remember wet winter and baking Spring?), trusting my gut feeling wheat prices will rise, thus leading to an increased return for my low yield crops.



Challenges faced head on can reveal new ways of working with nature, seeing how nature survives through



extenuating circumstances can be an awakening for the human caretaker.

On the farm here I have been modifying the 750a (yet again!) with the addition of an air pump on the drill liquid system. This is for two reasons; the first being to keep the biological brew aerated, the second to keep the mix agitated to stop any settling out in the bottom of the tank. This has been done with the help of Trevor Tappin (TT Engineering) and has so far worked well.

Another new move for me has been the introduction of the Johnson Su static bio reactor, with thanks to Andrew Jackson for the introduction to the regenerating soil diversity system. This is to make a richer microbial compost over the next 12 months in order to apply as a drench at drilling, through the peristaltic pumps: in addition to making compost teas. The real magic of the system is that you only really need two kilogrammes per hectare which will reintroduce a varied biology back into the soil, which mimics the process that would occur on land had it been grazed with livestock. Thus, resulting in improved soil fertility.

As Dr David Johnson, molecular biologist and research scientist says "... microbes are the backbone of every





organism and eco system on the planet....". Dr Johnson goes on to say that they are involved in human brain development and have a part to play in mental health issues such as anxiety, depression, autism, arthritis to name but a few; being responsible for a large portion (80%) of our immune system. I foresee a future of microbes replacing antibiotics to fight infections, as diseases continue to show resistances to the overuse of antibiotics in medicine.

Doing a similar job on the plants' immune system you can see why I am keen to put the new system into practice. Dr Johnson has seen 2750 different species of bacteria within compost, with counts of 83 million bacteria and 10 million fungal spores in samples used per square foot, leading to more nutrients becoming available. This in turn leading to an increase of carbon being sequestered into the soil due to healthier, larger plants.

The reactors are filled as shown in the picture. I am trying different recipes which I will evaluate with a microscope to try and assess fungal to bacteria ratios. The pipes are added to allow air into the bacteria as the compost does not want to be more than twelve inches away from air. Water is added to the compost to keep the correct moisture content. The pipes are removed after 24 hours once the compost has bound together leaving an air filled column.



This year once again I have tried to continue to use biology for disease control. This has worked yet again fantastically well on fusarium and brown rust. Yellow rust has presented more of a problem, resulting in the use (much to my disappointment) of some epoxiconazole. On the positive side it allowed me to learn a lot more about the disease and by doing a lot of leaf tissue tests, Nick Woodyatt (Aiva Fertilisers) and I have a plan for the coming year to once again move still further away from fungicides. Once the nutrition of the plant is right it will not be susceptible to



disease. A healthy plant can fight off fungal attacks. In this situation foliar applications of nutritional elements come into their own.

As in a dry Spring such as the one we have just experienced, biology in soil does not function as well, resulting in nutritional deficiencies within the plant. Thus, in my opinion, we will always need to step in and keep the plant nutritionally balanced. This does not really concern me as foliar applications are seven times more efficient than soil applied nutrients. This is far less polluting to the environment in which we live.

Another move for me is to start and monitor the Eh of the plant using a redox monitor, which is a measurement of available electrons in the plant, as well as continuing to measure pH – (availability of protons in the plant). The two complement each other. As I become more familiar with the test it will aid my making decisions on nitrogen requirement and other nutrition, in order for me to keep a healthy plant that will be able to resist disease and fight off pest attack. I believe this will further reduce the need for any fungicide requirements.

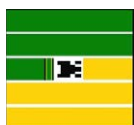
Another successful trial has been carried out in a Spring barley field following a rye, vetch and bean cover crop. The following Spring barley crop has only received 40 kilos of applied nitrogen, the remainder being made up of amino acids. No fungicides have been applied to the crop, just biology and the correct nutrition. The combine yield monitor has revealed no difference compared to the more conventional grown barley. However, the real difference has been the fact that the crop had no small grains (as we grade all our grain) and was a much bolder sample. Sample results will reveal a true comparison, but I already feel that the trial barley show what can be achieved from healthy soil, with the correct nutrition. It is all about working with Nature, not against her.

One thing is certain, through these uncertain times, soil will continue to live and evolve, and we must too: and if we do

“.... you'll be a Man, my son!”

I wish everybody a successful autumn and growing year.

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Simtech T-Sem tine drills are probably the most versatile of all the direct drills on offer today. Their heritage is from the inverted T-slot coulters, initially developed in New Zealand for establishing new seed into living grass, which is probably one of the most difficult of direct drilling challenges. From Simtech importing these drills, the European T-Sem was born and has progressed from a simple 3m machine to the range of drills we see today.

The unique T-Slot coulters create the perfect environment for seed to germinate and develop. At only 10mm wide at its leading edge it is designed to cause as little surface disturbance as possible. Preceded by a vertical cutting disc, that creates a path through surface trash, the inverted T-slot coulters ensure that the seed is always placed on a firm base, with the vibrating tine creating the tilth to cover it. In soil held together with a large amount of root material the T-slot coulters create a void in the soil, which is like a mini greenhouse, generating humidity to enhance the speed of germination, but at the same

time allowing sunlight to penetrate through the partially open slot. This scientifically proven feature allows small seeds to be placed deeper than would normally be viable into an environment which is much less likely to result in poor germination or seedlings drying out.

The T-Sem is the ideal drill for a farmer in the early stages of converting to direct drilling. Versatile enough to cope with all the other drilling tasks such as min-till or ploughed surfaces, but none the less a dedicated and powerful direct drill, able to handle large amounts of surface trash and hard or wet ground conditions. The heavy duty 30mm square double coil tines are strong enough to direct drill crops such as beans to a depth of up to 10cm (4") in most soils, once again ensuring that the seed is always placed in the correct environment for its development, not at a depth limited by the drills capability.

The T-Sem is also uniquely placed for the establishment of cover crops, which is enabled by its ability to work in high levels of crop residue, without

"hairpinning" and at a time of year when the soil can be quite hard to penetrate. The subsequent drilling of the cash crop into the cover crop is also a job that requires the T-Sem's ability to work in large amounts living vegetation, once again placing the seed in the best environment for its rapid development.

The base arable model T-Sem 3 metre is available with pneumatic or gravity metering. Further models from 3.5 metres up to a new, shortly to be released 8 metre trailed model, are all pneumatic seed delivery, with electronically driven seed metering and computer control. Speed sensing is via a GPS unit and variable rate seeding is possible when connected to a suitable controller.

An additional micro hopper, with independent control is available for all models, which in the case of the pneumatic machines, injects the product into the air flow with the seed. This can be used for starter fertiliser, seed or slug pellets. A further option allows the second product to be metered separately to the individual rows. Liquid fertiliser is also available for all models, with front mounted tanks up to 1800 litres.

All T-Sem drills are capable of drilling into pasture, but where this type of work adds up to a reasonable proportion of your overall workload we recommend choosing our closer spacing models, which can either be the T-Sem 300 with either gravity or pneumatic metering. Or there is a 2 model T-Sem Grass range, which are designed primarily for livestock farmers and contractors. These drills also have the capability to work in quite extreme ground conditions, where large rocks and stones may be present.

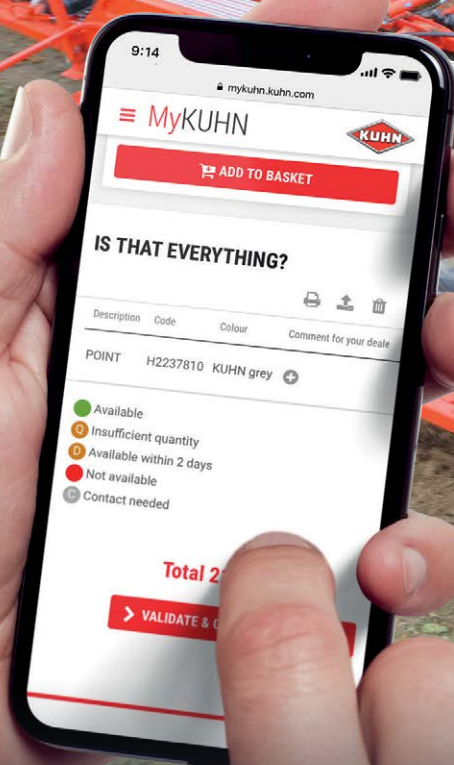
In the United Kingdom all sales are direct to the customer and Simtech's sales and technical team have a wealth of experience, not only in their products, but also of the techniques employed with conversion into no-till.



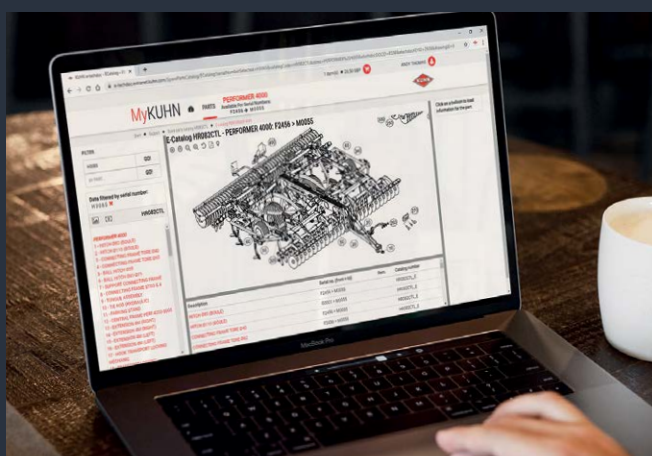
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DOCTORAL CANDIDATE RECEIVES ENDOWMENT TO HELP FUND ORGANIC FIELD PEA RESEARCH

Written by Denise Attaway, Clemson University, South Carolina USA

Phosphorous is one of six essential nutrients for plants and a Clemson University doctoral candidate wants to show farmers how organically growing cereal and pulse crops can improve nutrition while lowering production costs.

Sarah Powers is a doctoral candidate in the Clemson Plant and Environmental Sciences Department. Her research focuses on understanding phosphorus-use efficiency in field pea. To help fund her studies, Powers has received a Columbus Hamond Townsend Student Assistant Endowment for the second consecutive year.

"I want to determine if it is possible to select cultivars that can sustain growth and yield under phosphorus-limited conditions," said Powers.

According to the United States Department of Agriculture (USDA), organic farming is a production system that incorporates practices, such as cover cropping and crop rotation, to improve soil quality and build organic soil matter.

Phosphorous is a naturally-occurring element found in the soil. All living organisms require phosphorus. Plants use phosphorous for photosynthesis, storage and transfer of energy, and respiration among various other functions.

While phosphorus is very important to agriculture, it is a non-renewable resource and cannot be naturally replaced quickly enough to keep up with consumption.

"This can be particularly limiting for organic growers," Powers said. "Phosphorous-use efficiency will become a greater concern as phosphorous fertilizers become more expensive and difficult to obtain."

Organic agriculture could benefit from phosphorous-use efficient field pea cultivars by increasing yields and soil nutrition. Greater yields of field pea could benefit health food markets as these peas are highly nutritious and have superior protein quality, Powers



Sarah Powers, a Clemson doctoral candidate in Plant and Environmental Sciences, is studying phosphorus-use efficiency in field pea. Image Credit: Clemson University

said.

Powers' research is part of a study that involves developing pulse and cereal grain crops that can be grown organically in South Carolina. The study is funded by a nearly \$1 million grant from the USDA and is led by Clemson professors Dil Thavarajah, Rick Boyles, and Stephen Kresovich. The USDA is using cooperative research on pulse crops, such as dry beans, dry peas, lentils, and chickpeas; to provide solutions to the critical health and sustainability challenges facing people living in the United States and across the globe.

"Current organic grain production depends on cultivars that have been bred for non-organic production, but these often are not suitable for organic

production," Thavarajah said. "We need varieties that can be organically grown."

By using organic farming practices, farmers don't need to buy expensive chemicals and fertilizers. Instead, they use farming practices, such as different tillage methods and cover-cropping for weed control, and biological methods for insect pest control. Organic farming is sometimes equated with lower yields and nutritional quality.

"This research will allow for the breeding of future biofortified field pea cultivars with increased economic returns," Powers said. "These traits will make field peas more desirable and popular in the organic market, as well as better able to resolve micronutrient deficiencies."

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THE FUTURE OF EFFICIENT CROP ESTABLISHMENT

THE QUESTION IS, 'WHY IS SYNTHETIC NITROGEN BURNING CARBON?'

Written by Nick Woodyatt

Time and time again the main topic of conversation is Nitrogen. Whether from the side of the regeneration farmer who wants to turn the tide from the toxic, expensive inputs, or from the conventional farmer who still believes in the phrase, 'Nitrogen builds yield'.

It is my belief that it is the excessive use of Nitrogen that has burnt the life out of our soils much more than any piece of machinery, and it is the farmers' 'addiction' that has allowed the chemical companies to have such a hold over the industry. The abuse of Nitrogen has led to the overuse of other chemicals which has in turn led to the rise of certain issues such as some of the monsters we struggle with today, Fusarium and Cabbage Stem Flea Beetle, along with others. Science gives us a lot to be thankful for, right up to the time that science was hijacked by large corporations; thankfully, many farmers and consumers alike are now starting to wake up.

The Dutch sum up Nitrogen use well in this poignant saying 'Nitrogen is good for the father but bad for the son'.

From a consumer's perspective with high Nitrogen under question, the problem is much worse than we realise as most of the salad crops that are bought are just bags of nitrate with little nutritional value, which puts the 5 a day regime into great doubt. It is now also not uncommon to come across issues in food quality such as oranges and black currants with zero vitamin C. University of California studies show that vegetables can lose 15 to 55 percent of vitamin C within a week.

A 2004 study evaluated Department of Agriculture data where the researchers found statistically reliable declines for six nutrients; protein, calcium, potassium, iron and vitamins B2 and C. It has to be concluded that the broad evidence of nutritional decline in our food from intensive

systems ran on high nitrogen and pesticides seems difficult to dismiss. What do we do about this?

This problem started in the middle of the last century when farmers were told there was a new, easier way of growing more. The system of cover crops and manures went out of the window with the core principles of soil and plant health garnered before the Nitrogen boom of the 1920s, and was replaced by lorry loads of synthetic Nitrogen because it was cheap, but only a limited few had worked out the damage it was going to cause. Since then, we have been confidently strolling down the road of burning off all of the good stuff out of the soil, which led to not only a decline in soil itself but also of course, resulted in lower field health and quality, and yet rising costs.

I can't argue that synthetic Nitrogen has helped feed the world, but at what cost?

From the outset, it has been assumed that synthetic Nitrogen would build organic carbon even though the truth was exactly the opposite, which is one reason for the global climate change that we are seeing. The thought was that the more Nitrogen you apply, the more growth you get, ergo the more carbon dioxide is pulled from the air. What is now being seen is that synthetic Nitrogen stimulates certain soil microbes which then feast on organic soil carbon, once that carbon is used up the bacteria alter their DNA to survive on ever increasing amounts of Nitrogen. As organic

matter is used up, the soils natural ability to store organic Nitrogen runs out. A large amount of Nitrogen then leaches away, fouling ground water in the form of nitrates, and entering the atmosphere as nitrous oxide (N₂O), a greenhouse gas with some 300 times the heat-trapping power of carbon dioxide. In turn, with its ability to store organic Nitrogen compromised, only one thing can help heavily fertilised farmland, keep cranking out monster yields: more additions of synthetic Nitrogen meaning onto the treadmill we go...

Almost from the start, farmers put far, far more Nitrogen onto the soil than the crops could utilise, meaning that we started very early on to pollute our water and seas, and tightening our soils pushing out the most important part of it, air. The trouble with synthetic Nitrogen is that it can complex with organic soil carbon, oxygen, and water. This leads to the soil tightening up pushing us to apply more and more, hence a favoured phrase of mine, 'the moron (more-on) approach.'

A recent researched study has suggested that for every 1kg of Nitrogen that is applied to the soil that isn't taken up by the plant, we lose 100kg of organic carbon. It is easy to see that intensive farming together with high doses of Nitrogen, with only around 50% efficiency, can already start to cause heavy damage to the environment and atmosphere, giving a large release of CO₂ from our soil into greenhouse gasses.

Obviously, the excess usage of Nitrogen has not just meant higher Nitrogen bills, as I touch on above, we see compaction, erosion, lack of water

holding capacity and a huge increase in the use of fertiliser. The reason we see so much growth following a Nitrogen application is that the plant sucks up loads of water leading to a massive drop in brix, which then leaves the plant open to pest and disease attack resulting in chemical applications to counteract these factors. Are you starting to see why some are so keen to hang onto this system? Universities and the World Health Organisation both agree that world agriculture, in the current system it is in, has only 60-100 harvests left, which should frighten anyone with children to death! Nitrogen use is the reason for this statement.

How about this statement?

'The use of artificial manure, particularly synthetic Nitrogen... does untold harm. The presence of additional combined Nitrogen in an easily assimilable form stimulates the growth of fungi and other organisms which, in the search for organic matter needed for energy and for building up microbial tissue, use up first the reserve of soil humus and then the more resistant organic matter which cements soil particles.'

This was by renowned soil biologist, Sir Albert Howard, in 1947, before we understood bacterial DNA and many of the other issues. Did we listen? Did we hell.

I now go onto farms where the soil is held together with a polymer glue... Many of these farms have cereals and

other crops growing in just the top 2-3cms soil, and a major Magnesium deficiency after just a few days of no rainfall. Good soil structure depends on a living soil and a living soil depends on not using excess amounts of Nitrogen. Water is becoming the new oil of the world and yet by using synthetic Nitrogen we are making the problem far worse than it needs to be, and yet the Nitrogen fixation goes on.

It is strange but many environmental organisations are fighting the damage that has been done to our oceans but ignoring where the problem came from in the first place. Take Chesapeake Bay for example. In 1970, Chesapeake Bay was found to contain one of the planet's first identified marine dead zones, where waters were so depleted of oxygen that they were unable to support life. Today the Bay's dead zones are estimated to kill 75,000 tons of bottom-dwelling clams and worms each year. Hypoxia, low oxygen conditions, results in part from large algal blooms, which are nourished by the runoff of farm waste (nutrient run off from the land). The runoff and pollution have many components that help contribute to the algal bloom, which is mainly fed by Phosphorus and Nitrogen. Run-off that we must not forget, has been paid for by the farmer.

The RB209 says that 40-60% of the applied Nitrogen goes into the plant which means it can also be read as 40-60% of applied Nitrogen does not, yet we continue to load our soils. Of course, we must remember that run off comes from organic applications as well, so let's ask why do we put on more than we need? We also must remember that much of the FYM and chicken muck contains copious amounts of synthetic Nitrogen.

I find it hard to accept, although resigned to it, that the synthetic Nitrogen that we use was first designed as an explosive when scientists found a way to convert inert N₂ into Ammonia (NH₃) which can be used to feed plants and blow things up. It is suggested that the manufacture of synthetic Nitrogen takes up 1% of the world's energy which is stunning. We look at limiting factors when growing crops and suddenly Nitrogen was not a limiting factor. Very quickly

we went to applying 10 million tons of synthetic Nitrogen to the soils in 1960, but the writing was on the wall. Every older farmer I talk to admits that they have to apply far more to get the same result as the soil dies out from under them. To back this up we used 100 million tonnes in 2005, an increase of 900%.

As we have seen this year (2020) yields are vital. So, the thought of reducing yield puts many farmers off which leads to them being stuck in the chemical trap. However, if we take small steps and are careful with how we move forward, this does not have to be the case.

A great example of this is Tim Parton, farm manager at Brewood Park Farm and a good client of mine. He is Sustainable Farmer of the Year; Arable Innovator of the Year and he also achieved Soil Farmer of the Year in 2017. This year, he is having as bad a year as everyone else following the wet winter and the dry spring, but it is as Tim says in that, 'when you have good yields in most years your business can carry a bad one.' This is how agriculture used to be before we lived on the financial edge. I have huge respect for Tim as he is passionate about soils but also passionate about getting viable yields in a sustainable way showing that it can be done, and now many other farmers are following this route.

We do have alternatives, some of which would be incorporating Humates, composts and balanced nutrition. We can invest into our own futures rather than a failed chemical experiment. Obviously, we (the regen boys) are depending on sensible governmental policies which take soil/water health into account as well as working with like minded people who have seen the light. If you are interested in keeping this conversation going, please get in touch: office@aivafertiliser.co.uk. Lets build a better future together, looking into system approaches and most importantly, regeneration.

For those who would like further science behind these statements, there is a wealth of information online as it is all there for those that **want** to understand and to continue to develop.

FARMER FOCUS

ANDY HOWARD



Clean Slate

Harvest has been and gone and was fairly straight forward here in Kent, all bar the Linseed came in dry. Harvest ended well with the Linseed and the Lentils performing well, previous to them it was a real mixed bag. Glad to be starting with a clean slate for harvest 2021.

I had my local wildlife officer ring me the other day asking whether I thought our Regenerative practices had given us more yield compared to others. It is a difficult question to answer but my reply was: "probably not, but it cost me less to get the yields we achieved, our soils are in good heart and so don't need a lot of expensive remediation. This is unlike others who planted in adverse conditions last autumn and have been left with compaction and ruts".

Any soil damage we have is near the surface and we currently have catch crops or cover crops growing to repair the damage. I managed to plant a mix of strong rooting plants on our bare patches on June 19 once we had moisture. You can be seen in the picture they have rooted to a good depth. One of the lessons I learnt from last autumn is that we need catch crops growing before and second wheats or winter beans at least. I kept hearing others say their best establishment of later crops were planted on volunteers or catch crops. As we don't have the labour to follow the combine with the drill I had to think of other options of getting catch crops established. After much searching and deliberation, I found a second-hand Autocast unit for our combine which was fitted just in time before harvest. (See picture) Autocasting needs



moisture which is something that was lacking at harvest and for a couple of weeks after. For a while I thought my new idea was going to fail. Luckily towards the end of August it rained and now we have a crop. It is current small at the time of writing but still has over a month to go. (See picture) This year I planted a 10-way mix and I will assess to see what grows and doesn't. First out the blocks have been Buckwheat and Linseed, quickly followed by Phacelia and Berseem Clover.



We did manage to get some catch crops drilled after Winter Barley and these are growing well. These are growing before another Winter Barley crop and the hope is that the catch crop will break disease cycle and add some diversity. (See picture)

All covers have been planted and are growing well, grass seed is just poking through so now we have a few weeks before we start planting more winter crops. A few quiet weeks will be appreciated as the last 12 months have seemed a bit relentless. I think we all need some time to relax and recuperate. Here's hoping 2021 is an improvement!

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WHAT WILL THE NEW SEASON HOLD IN STORE?

As part of his ongoing series chronicling events on E. T. Claydon & Sons' farm in West Suffolk, Jeff Claydon, who invented the Opti-Till® System of direct strip seeding, reflects on last season's challenges and outcomes, together with how he is approaching the season ahead. The article was written in mid-August.



Spring oats drilled on 24 March being harvested on 12 August.

Most farmers in the UK will be glad to see the back of the 2019/20 season, which was fraught with challenges caused by a triple weather-whammy.

Winter was the wettest since national records began in 1910 and on the Claydon farm we recorded only three rain-free days from October through to mid-March. The exceptionally dry spring which followed was, according to the Met Office, the sunniest on record and exceeded the previous UK-high of 555 hours in 1948 by 71 hours. Summer was one of the driest on record.

With all that going on there was never any chance of matching five-year yield averages, much less of breaking records and the Claydon farm was no different.



The Claydon family's 345hp John Deere 8345R is seen here working with a 15m Claydon Straw Harrow at 18 km/h on oilseed rape stubble to kick-start the process of germinating volunteers and weed seeds.

The difficulties of operating during the COVID-19 lockdown only added to the challenges of farming in an annus horribilis, to use the words of Queen Elizabeth II. Not being a Latin scholar, at times I resorted to more Anglo-Saxon terminology!

Rather than dwelling on problems, I like to take a positive view. When government restrictions prevented Claydon Drills from welcoming the hundreds of existing and potential customers who normally attend our open days in May we filmed a virtual event to highlight the progress of our crops and soils. That was a great success, and you can still view it on the website (claydondrill.com/news/article/virtual-open-day-overview)

Ironically, May was the sunniest in the UK since 1929 and the driest in England with 9.6mm of rain, 17% of the long-term average for that month. On the Claydon farm we had even less. Just 4.2mm of rain fell in May, so the 35.8mm in June really did save the day, but the 48mm in July arrived too late to contribute to yields.

Last season, despite the very wet autumn, all 280ha of winter wheat, beans and oilseed rape went in as planned. The winter wheat was established by 31 October, the last winter beans went in on 19 November and the remaining 46ha of spring crops were drilled directly into a perfect growing environment at the end of March.

The beans desperately needed more rain in May to produce stem and pod growth. The lack of it meant that the crop never grew more than 45cm high but produced a plethora of pods, many of them extremely close to the ground. Fortunately, almost two decades of direct strip seeding using the Opti-Till® System has left our fields very well structured, supportive and almost perfectly level. That was a huge benefit because it allowed the 12m header on our Claas Lexion 600 Terra-Trac to shave the beans off at ground



The 15m Claydon Straw Harrow has 120 pairs of 14 or 16 mm-diameter round steel tines which mix up and expose chopped crop residues. When operated at high forward speed they create a "boiling" action on the soil which takes out weeds and volunteers, destroys slugs/slug eggs and creates up to 30mm of tilth. The result of just one pass is shown below.

level and recover most of the pods. The task would have been impossible on farms where deep ruts were created by spraying and spreading machinery during the very wet winter, and significant potential yield would have been lost.

The lack of moisture also took its toll on the oilseed rape, which reached a maximum height of 70cm, but it podded well and harvested easily during the last few days of July. All things considered, it turned in a reasonable yield, albeit slightly below our long-term average.

Harvest was incredibly early this year, a couple of weeks ahead of where we would be normally, and the wheats fared best. Yields were slightly less than I would have liked but given the extreme lack of rain and very warm weather that was always to be expected. On the plus side, quality was excellent and exceptional hectolitre weights meant no deductions.

After getting off to a flying start in April, our spring oats slowed due to the lack of moisture and were yet to be harvested at the time of writing.

All of us will be hoping for better things from the season ahead, but on a positive note, the exceptionally dry spring and summer created an immense amount of soil fissuring on our heavy land which partially offset the negative effects of the extremely wet winter on soil condition.



Jeff Claydon highlights where the Straw Harrow has been used and where it has not.

Hoping for a better season

After harvesting oilseed rape during the last week of July we immediately got to work with our 15m Claydon Straw Harrow to kick-start the process of germinating volunteers and weed seeds. This is a key part of the stubble management process and critical to growing clean, high-quality, high-yielding crops.

Exceptionally hot weather during mid-August made us cautious about using this very useful implement on fields situated close to local houses as working the bone-dry soils would have created a lot of dust and probably upset our neighbours. After a spell of heavy rain the Straw Harrow easily produced 20mm of tilth and a carpet of green growth emerged a few days later, so we carried out a second pass to thin the self-set oilseed rape and allow any grassweeds to be sprayed out. The volunteer oilseed rape which remains will act as an improvised cover crop, so it will be interesting to see if this will further benefit soil condition and health, which are already excellent. We will stop using the Straw Harrow three weeks before drilling and spray off any remaining material with Roundup® shortly before winter wheat is sown in early October. It will be interesting to see if this improvised cover crop will further benefit soil condition and health, which are already excellent.

Weather permitting, we will carry out another two or three passes with the Straw Harrow across the other stubbles during the next few weeks to take out as many slugs, slug eggs and volunteers as possible before drilling autumn sown crops. This season we will have just over 200ha of winter wheat, all feed varieties as there are several good homes for those locally. The balance of our 326ha will be 46ha of oilseed rape, 25ha of winter beans and 55ha of spring oats.

Oilseed rape went into wheat stubbles on 8 and 9 August, somewhat earlier than

normal because last season we found that drilling on 10 August compared with 10 days later produced an additional 0.25t/ha. After drilling the oilseed rape, we had five consecutive days of 30°C-plus temperatures which peaked at 36°C and had me worried, but after 25mm of rain the following week the crop got off to a flying start. It looks good, as does the oilseed rape which we drilled for a contract customer who was so pleased with the 150ha that we established for him last year with our 6m Claydon Hybrid because it yielded 4.5t/ha that he asked us to do more this season.



Jeff Claydon in an area where Hutchinsons MaxiCover had been drilled just days earlier using the standard Claydon Opti-Till® set-up and was just beginning to emerge.

Will cover crops be of benefit?

This season we are experimenting with a cover crop on some of the 55ha destined for spring oats and have drilled Hutchinsons MaxiCover, a general-purpose over-winter mix containing linseed, buckwheat, phacelia, daikon radish, fodder radish, brown mustard, hairy vetch and crimson clover. It will be interesting to see if it has a positive effect in terms of controlling grassweeds and further improving soil condition.

We drilled it at 12.5kg/ha on 9 August using three approaches. In one area we used the standard Claydon Opti-Till® set-up, comprising a patented leading tine which relieves compaction and aerates the soil followed by a seeding tine fitted with a 20cm A-share. In another area we used the leading tine followed by our new lower-disturbance 'LD' twin-tine kit and finally the twin-tine kit preceded by double front cutting discs which reduce power requirement by up to 50% and minimise soil disturbance.

Changing from the standard seeding tine to the twin tine is as simple as undoing three bolts and takes minutes. With a few simple, quick modifications any new or existing Hybrid drill can now 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 them a much more versatile and cost-effective solution compared with purchasing a strip till drill and specialist low-disturbance drill.

The two 44mm x 12mm hardened steel tines in the twin-tine unit are four times stronger than normal 30mm x 10mm tines. Fitted with 15mm points, they incorporate unique double-leaf helper springs which maintain a consistent seeding depth even in very dry, hard, heavy soil conditions, yet permit enough lateral movement to displace surface trash and prevent blockages.

This approach provides a more traditional finish than band seeding and the seeded rows from the twin tine set-up are normally spaced 150mm apart. The brackets which hold the tines in place can be moved in by 50mm and this allows the width of the seeded band to be reduced to 100mm, providing more space for a Claydon TerraBlade inter-row hoe to take out weeds growing between the rows. This can be done in the autumn once the crops are sufficiently well established, right through until late spring before the TerraBlade would damage the growing crop. The TerraBlade is an excellent mechanical method of enhancing chemical control.

For ultra-low-disturbance drilling of soils in excellent condition the Hybrid drill's standard leading tines can be replaced with twin 330mm-diameter front cutting discs. These can be either the plain design or new fluted 'Spiradisk' which does an excellent job of cutting through trash without 'hairpinning' material into the slot and creates a slightly wider channel and just the right amount of tilth to provide perfect growing conditions.

It will be interesting to see how these establishment methods compare, so I will go into more detail about them and our cover crop trials in the winter issue of Direct Driller magazine. In the meantime, you can find out more about the Claydon Opti-Till® System by contacting your local Claydon dealer, calling the Claydon office on 01440 820327 or visiting the website: claydondrill.com. Videos of the new LD options in action can be viewed at claydondrill.com/lower-disturbance.

UNLOCKING GYPSUM'S SOIL HEALTH BENEFITS

Applying gypsum in liquid form could prove particularly beneficial in relieving soil compaction ahead of the autumn sowing programme.

It's been a tough season for soils. Many fields were drilled in less-than-ideal conditions, often after abandoned earlier attempts at cultivation that left soils prone to slumping, while others were left bare fallow which has done little to improve their structure.

"A good number of fields will need remedial action if growers are to get the best out of next season's crops," says Agrovista's head of soil Chris Martin.



Agrovista's head of soil Chris Martin.

"Carefully targeted loosening will be a priority, but on clay and high magnesium soils, I'll also be recommending a liquid conditioner to aid aggregation, improving workability, drainage and root exploration to optimise crop establishment."

Liquid Gypsum provides calcium which is needed to flocculate clays, binding smaller particles together along with clusters of sand and silt.

This aggregation is one of the most important keys to a healthy soil, providing a favourable structure that promotes air and water movement, biology and increased root development, says Mr Martin.

"Gypsum has been used to good effect in agriculture for more than 250 years, but applying it in liquid form truly unlocks its many benefits," he adds.

"Liquid Gypsum is highly soluble and weight for weight is around 2000 times more effective than insoluble granular gypsum. It starts working immediately, acting when and where needed to flocculate the soil throughout much more of the rhizosphere than traditional forms of gypsum."

Soils treated with gypsum require less energy for subsequent cultivations. The product is applied with a conventional sprayer using traditional water volumes, ensuring fast and accurate application.

Annual treatment is recommended, before or during the cultivation programme, at 5 litres/ha. Liquid Gypsum can be tank-mixed with glyphosate so can be applied during routine stubble-cleaning operations.

The improved soil aggregation and permeability that Liquid Gypsum brings also provides an excellent starting point for no-till management systems, says Mr Martin. In this case, a primary application at 10-20 litres/ha should be used.

"Soil health is a key component of the new Agriculture Bill, so reduced tillage will be a key factor in improving and maintaining it.

"The use of gypsum to help improve structure and functionality is likely to increase significantly across the UK, as farmers are encouraged to move less soil mechanically."

Traditional gypsum sources still have a place, aimed at long-term multi-year effects as only a tiny fraction of these sources will be soluble when applied to the soil, says Mr Martin.

"If you want to get flocculation happening close to the rhizosphere and working on the crop you are growing now, the only option is Liquid Gypsum."

Liquid Gypsum benefits

- Reduces compaction
- Improves soil porosity
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- Improves high magnesium soils
- Improves soil biology
- Supports crop establishment

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WHY AGRICULTURE IS A PRACTICE AND NOT AN INDUSTRY?

Jon Williams provides a fascinating insight into the development of chemical farming, the super-importance of calcium and magnesium, and the limitations of using PH as a guide to fertilising. He ends with a useful soil sampling suggestion

At the end of the second World War there was rationing in the UK and the Government edict to agriculture was to expand food production and farmers quite rightly responded to that call as they always do and particularly in times of crisis. This has been recently highlighted with the Covid Virus raging the country and the shut-down of most industries but agriculture remained resolute and carried on producing food for the nation.

However there is a major difference between agriculture and other industries and food production from our soils needs to be re-classified as "The Practice of Agriculture".

Why is this so?

Firstly it is important to understand that companies such as ICI were very powerful at the end of the war as they had produced all the raw materials used for bomb making such as TNT (Nitrogen) and Potassium from their mined resource at Cleveland.

The call for increased food production resulted in these bomb making ingredients being used for food production. The drive for more and cheaper food is the ethos we have followed ever since and has resulted in a more industrial approach to agriculture involving inputs and outputs and the margin of cost between these two regarded as success or failure of the farming methodology principals followed.

This approach to agriculture has resulted in ever tighter margins of production as the costs of the inputs have risen, and the yields have stagnated. This has been made worse as the hidden cost of the depletion of the natural assets of the soil such as Organic matter have not been accounted for.

The result of this is soils used for cropping only, being depleted of organic matter to the extent that 70% of all arable land in the UK has now less than 3% organic matter remaining. This situation obviously cannot continue and

if the UK was taken as one large farm it is out of balance with the intensive livestock areas having too much organic matter averaging 9.5% (the results of over 900 soil samples in Wales).

For good soil structure, nutrient holding capacity and good water retention the ideal levels need to be between 5 % and 7% and farmers are increasingly becoming aware that they need to rebuild this organic matter with the introduction of cover crops and re-introducing grassland as part of a rotation with livestock, as well as reduced tillage.

This rebuilding of soil organic matter levels includes the sequestration of carbon as it contains 55% Carbon and moisture retention levels improve, up-to 170,000 of extra water per hectare being held within the soil per 1% increase.

With the emphasis on public good along with food production this can be termed as "Regenerative agriculture" as we develop systems to rebuild soil as well as produce food it is likely farmers who have this intention will receive financial benefits alongside building a more resilient business.

The increasing supply of fertiliser was encouraged by ICI when they set up a company still operating today to carry-out basic soil analysis which was a guide for farmers as to which fertiliser to purchase and a PH reading for liming requirements to ensure a better response to that chosen applied fertiliser. Today it is important to understand that this was a tool to be used to purchase fertiliser only and it is now time to consider a more detailed look into soil analysis for building resilience in the food production process.

With the increasing awareness of impending climate change with rising temperatures and more unpredictable weather patterns it is imperative that we transform our agricultural practices quickly.

To achieve this transition as quickly as possible we need to follow the Albrecht Philosophy of soil analysis which is the result of 36 years of research into soil chemistry and along with soil texture can be used to amend the soil to improve soil structure and the aerobic nature of soil. This method of soil analysis results in a picture being formed of the effect of past management on the soil and can be used as a management tool to take the farm forward for improved crop performance and at the same time sequester carbon.

Having carried out nearly a 1000 of these tests there are several issues which are being highlighted and the first and possibly most important is the realisation that every field can be different according to its past cropping policy and this is why we need to consider agriculture as a practice and not an industry.

The realisation that the soil sampling method is holding back the development of this approach to food production is key to building a more resilient business and that the two nutrients required in greatest volume in soil - Calcium and Magnesium - need to be raised up to 80% on the clay colloid with the balance between the two dependent on soil texture. This incidentally raises the PH and so it is not PH that is the key indicator for successful crop performance but the level of these two major nutrients that governs the response of other elements and enhances crop performance

pH can be at optimum for ever!

The choice of liming material can be done when a detailed soil sample is carried out and I suggest that all purchases of lime from a quarry need to come with a full analysis as the soil amendment needed may be for Calcium limestone or

Dolomitic limestone depending on the existing levels with no more than two tonne being applied at any one time. For major shifts in the levels of Calcium and Magnesium the liming always need to be done in volume, however for small adjustments the liming can be achieved using the granular products now available such as Calci-fert or Mag-fert. The introduction of these relatively new products means that we need never allow the PH of soils to drop below the optimum for ever and the potential for improved crop performance is ensured.

Calcium is "KING" in the soil as it can be considered the trucker that takes most other elements into the plant and the other major nutrient Magnesium has a key role to play in "Nitrogen Use Efficiency" within the plant and so correcting both these nutrients and raising the levels to near to 80% on the clay colloid is a priority and not PH as such, which is essentially a measure of Hydrogen Ions.

More nutrient dense quality food

The adoption of this method of assessing soil quality is key to future proofing the resilience of the practice of agriculture and switches the emphasis away from the industrialisation of farming towards a more holistic approach to food production with the added benefit of producing more nutrient dense quality food. This is highlighted by the fact that 50% of the UK population is short of Magnesium and we ignore this method of analysis to the detriment of our soils, our crop performance and the health of the people we supply with our produce.

Maintaining these two major nutrients ensures that the locked-up Phosphorus in the soil and applied soluble fertiliser Phosphorus is made more available to the plant. The positively charged Calcium will attract the negatively charged Phosphorus reducing the potential for run-off and severe lock up when more Aluminium is present as a result of low Calcium levels.


Farmers need to be rewarded when they produce such quality food and ensuring a fair price is essential for the shift towards the practice of agriculture and away from the more industrialised approach.

Monitoring soil with detailed soil analysis as a management tool.

I suggest farms are split into four areas for the purpose of soil analysis with a quarter of the farm being analysed every year and in year five the process is repeated. This needs to be the base from which to go forward before digital nutrient mapping and variable fertiliser rates can be employed successfully.

Min-Til

To ensure Min-Till is successful a good open structured soil needs to be established via this soil analysis method which when used to balance the major nutrients will produce and maintain a crumbly soil structure which is ideal for slotting in new seeds. So the need for traditional cultivation methods is eliminated and The Rodale Institute of America has been developing systems and machinery to introduce these methods for successful crop establishment on a wide scale including in organic agriculture systems. (therodaleinstitute.org)



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DEEPTILL RADISH

THE LIVING "SOIL DRILL"

Written by Christoph Felgentreu, Deutsche Saatveredlung AG · Bückwitz

Deeptill Radish (*Raphanus sativus*), also known as "melioration radish" is a plant breeding innovation. The focus was on a strong rooting performance to combat soil compaction during the crucifera selection process.

The aim of the breeding was to select a strong, aggressively downwards growing root. It should have properties similar to those of lupin roots: downwards vertical soil penetration, if possible even through compacted areas, such as tillage pans. This breeding goal has been achieved to a large extent (Figure 1). Today, Deeptill (DT) is also known to offer many other benefits such as a later generative phase, lower winter hardness compared with common oil radish varieties and faster soil warming in spring. The considerably cover crop programme "TerraLife", as its name suggests, places emphasis specifically on good rooting in the soil.

Warming the soil faster

Another advantage of Deeptill radish is its ability to break up soil compaction and open up the soil, allowing the soil to warm up faster in the spring. Experiments by the U.S. Department of Agriculture (USDA) (Graph 2), were able to demonstrate the advantage of faster soil warming by Deeptill radish in spring. It allows the farmer for instance to sow maize earlier without deep cultivation.

Deeptill radish will die quicker than other varieties of radishes (Fig. 3). Very shallow tilling or mulching in autumn can help to secure winter kill, particularly in a mild winter.

TerraLife DT

For the new cover crop season, DSV is offering mixes including Deeptill radish. These are marked with the abbreviation "DT". These mixes are particularly well suited to limy sites, where lupins don't grow well or possibly not at all, and combining the advantages of the other components in the mix with those of the radish.



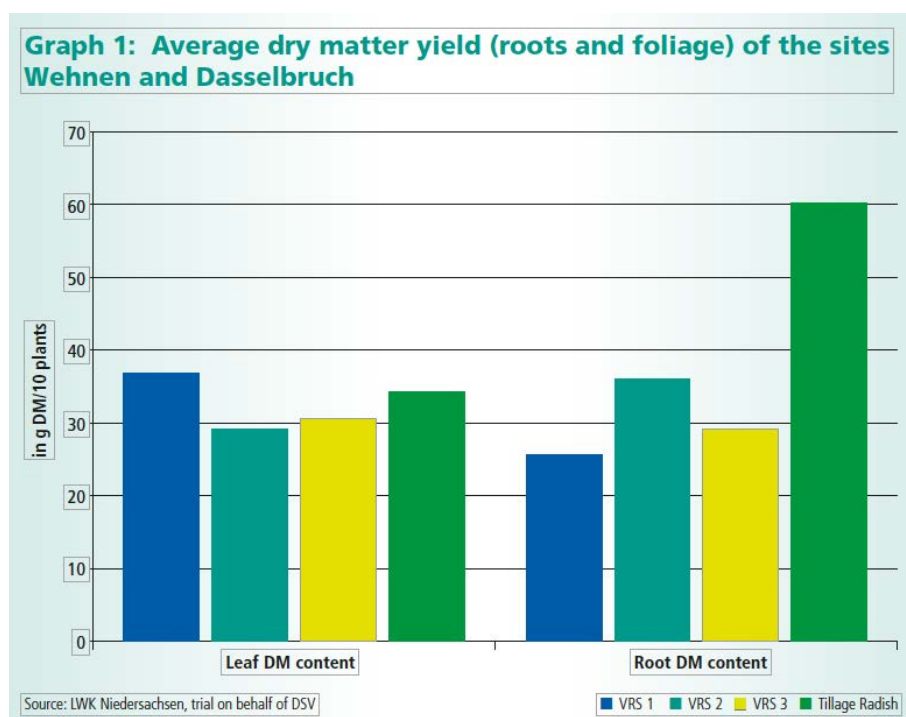
Figure 1: Root of Deeptill radish perforates the tillage pan



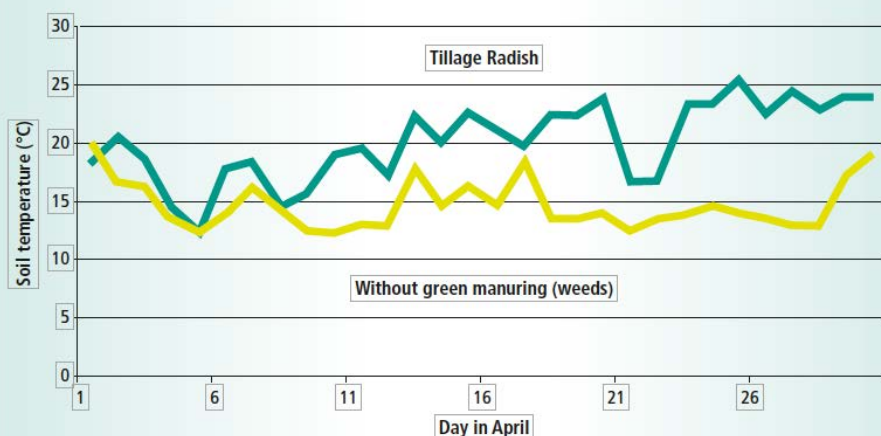
Figure 2: Deeptill Radish (left), oil radish "Reset" (centre), oil radish "Black Jack" (right)

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Graph 2: Soil warming in a depth of 5 cm with and without tillage radish, USDA, Beltsville 2006



Source: Beltsville 2006



Figure 3: Deeptill Radish freezes off well

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TerraLife from DSV

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DRILL MANUFACTURERS IN FOCUS...



SOIL HEALTH BONUS FROM COST CUTTING SOLUTION

Cutting the cost of cultivations was the key driver for arable farmer Chris Marchment when he parked his plough for the final time 12 years ago.

Farming 80ha near Andover in Hampshire, just to the south of the North Wessex Downs, he faces the challenge working with clay-capped soils with flints. Under a conventional cultivation regime, the cost of wearing metal and excessive diesel use had become unsustainable, so he turned to a non-inversion minimum tillage system.



Kuhn's Cultimer L is used as the primary cultivator in Chris Marchment's minimum tillage approach to crop establishment and copes well with his increasing use of cover crops.

Initially building his own three metre machine, he then progressed to a four metre system where a single pass with a trailed shallow tine and disc cultivator precedes a min till drill. A decade or so on from his initial tentative steps, Chris is not only operating with substantially lower operating costs but is seeing a continual improvement in soil health.

"We've now reduced the cost of wearing metal down to around £5/ha and our diesel use for cultivations is in the region of £5 - £7/ha," he says. "These cost reductions are vital, but it's been just as beneficial to see the improvement in the overall workability of the land."

One of his biggest hurdles when converting to min till was finding the right cultivator for his system. This wasn't due to any shortage of choice, but more to do with a lack of responsiveness from most machinery suppliers.



Chris Marchment has seen significant improvement in the workability of his soils over the past decade, since converting to a minimum tillage approach.

"It was difficult finding anyone willing to demonstrate a machine without some kind of guarantee of purchase or payment for delivery," recalls Chris. "In the end, I saw the Kuhn Cultimer working at a tillage event and it seemed to offer most of what I was looking for. Within a week of seeing the machine in action Kuhn had arranged a demonstration on the farm and we then had a machine supplied by T.H Whites of Marlborough.

"I'm not aiming to move a lot of soil, so wanted a machine that would create a good tilth within the top four inches. I also wanted a trailed machine, to minimise the amount of weight on the tractor. The Cultimer is relatively light, being as much as two tonnes less than equivalent four metre machines, and yet it is still very strong and well built.

"Run behind a 170hp tractor, we're able to operate with low tyre pressures of

around 12psi, which - along with flotation tyres on other machinery - means we're reducing the risks of compaction.

"Most important of all is the quality of the seedbed that's created. When one of my neighbours saw the job the Cultimer was doing he immediately ordered his own six metre machine, it was that good."

The Cultimer has three rows of staggered tines, a row of levelling discs and a rear roller. It's a versatile machine, offering a range of cultivation depths down to 35cm, but Chris opted for a specification with front depth control wheels and with wings on the tines, so the machine works within the top 10cm of the soil. With his flinty soils front of mind, he also specified tungsten tipped points on the tines and has certainly seen the benefits, as he has from the double spring loaded non-stop



Chris specified his Cultimer with front depth control wheels and aims to work within the top 10cm of the soil.



Flints are a constant challenge for Chris, so tungsten tipped points have proven to be a wise investment. The original set of points has now worked over 1,000ha without the need to change.

mechanical break-back system.

"It's certainly been worthwhile investing the extra in tungsten tipped points because after close to 1,000ha of work we're still on the original set," says Chris. "The spring back safety system really protects the machine and is a particular advantage in our conditions. The system operates with 600kg of pressure at the points, so ground penetration is very good, but when there is an obstruction the leg retracts a good distance and springs back into work immediately. I can cultivate up to 30ha in a day and that's certainly helped by the efficiency of the spring back system."

The typical rotation at Foxcotte Farm is a first wheat (yielding close to 10 tonnes/ha) followed by spring barley, grown for



Mustard is grown as a cover crop as it offers deep rooting characteristics but is soft stemmed and can be worked over relatively easily by the Cultimer.

malting, with either winter or spring beans as a break crop. These are now all established with a minimum tillage drill, usually after one pass with the Cultimer, but a second pass is used where a cover crop has been grown.

Cover crops, along with the practice of incorporating all the straw, are another important factor in improving the soils.

"We've not baled any straw for ten years," adds Chris, "and we've started

growing mustard as a cover crop more recently, avoiding where possible any bare soil over winter. The mustard is soft stemmed, and we only allow it to grow to about one foot high, so the Cultimer copes with this perfectly well and allows the drill to follow without any problems.

"It's all part of building fertility and improving the workability of the soil, and that's helping to keep the cost of establishment down."



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THE EVOLUTION OF THE £8000 ZEROTILL DRILL

Back in issue one of direct driller Mike Donovan of Practical Farm Ideas wrote about our budget no-till drill in his article "How to start drilling for 8k". The drill had been bought and modified at the time to run along our John Deere 750a, partly to increase capacity to cope with a seemingly ever expanding workload in constantly tightening weather windows and also to provide a low disturbance tine option, complementing the disc coulters of the John Deere machine,

by Clive Bailie - twitter.com/TWBFarms

The question of tine vs disc on no-till drills has been frequently debated amongst farmers. The disc can cope with extraordinary amounts of trash that would turn a tined drill into little more than a rake yet in some situations the disc can push straw residue into the slot, a process commonly referred to as "hair pinning" with undesirable agronomic consequences for the plant, whilst the tine avoids this by sweeping the seed zone clear of trash.

Coulter designs like the Cross Slot and Novag drills combine the trash handling ability of a disc drill with the slot clearing characteristics of a tine equipped machine but come at a cost both financially and in terms of power requirement, for the direct driller looking for a single drill this design of coulter possibly best provides that solution.

Some disc drills are fitted with row cleaners that clear the

trash ahead of the coulter, as our farmed area grew and we needed to use both the 750a and converted CO6 in situations with hair pinning potential we did ultimately end up with a set of Aricks row cleaners imported from Australia fitted to our 750a, which although a good solution, not a cheap option or always one available to UK farms.

The initial modifications carried out to the CO6 are covered back in issue 1 but other than a good service, fitting a 2nd small seed / slug pellet / avadex applicator and conversion to a low disturbance point it was still mostly as it had left the Horsch factory. Since then we have covered many acres with this machine and the modifications have evolved to become what I now think it's the perfect tine drill solution.

Drawbar

We opted to buy a European spec Co as the seed carts ran a far superior single floatation tyre than the small double



The original conversion



Drawbar and K80 hitch

castored wheel more commonly specified in the UK. As well as the obvious ground pressure advantage this design was much more stable on the road, the drawback however was a lack of machine following on the road making traffic islands and access to tighter gateways off narrow lanes somewhat of a challenge. The solution was to add an articulation between seed cart and toolbar creating a drawbar with K80 style ball hitch, doing this also created the ability to disconnect the toolbar from the seed cart completely if required and use it in the front hopper configuration described later in this article.

Conversion points

The drill was originally converted to low disturbance using Metcalfe points, these 12mm points provided a very low disturbance solution, however on our higher stone content soils they often lost the tungsten tip leading to premature wear, the seed tube was too narrow to flow large seed like peas and beans without blockage so needed upgrade to their larger tube diameter which was prone to rapid wear. To try and address these issues we set about making our own version, slightly wider at 15mm and using Ferobide wear tiles rather than the tungsten of the Metcalfe, the logic being that the Ferobide could be replaced if it broke off using farm workshop Mig welder rather than specialist induction welding that is required to reattached tungsten. We also added a slide plate to these farm designed points to protect the seed tube all of which gave a significant improvement to reliability and wear but at the cost of much more soil disturbance.

The other commonly used conversions for these drills

are the Dutch Industries coulter and the Bourgault VOS (Versatile opener system) both offer a similar cast point with seed (and in some versions fertiliser) delivery run internally through the casting. Having run a test of both brands the Bourgault seem the better option, not only did it seem to wear better on our soil types but it offered more options for both solid and liquid fertiliser placement and a range of seed banding widths.



19mm Bourgault VOS opener



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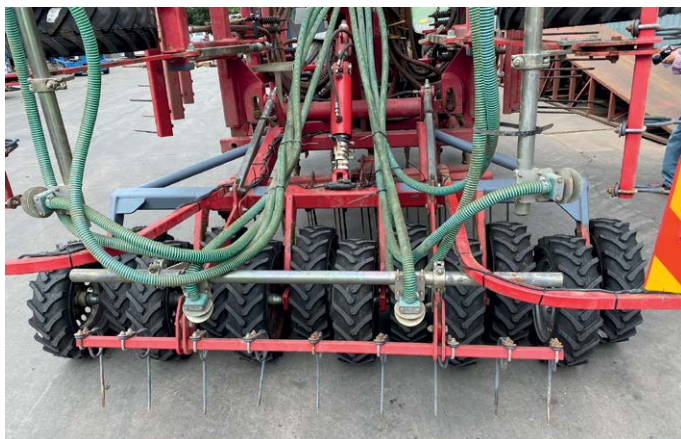
Possibilities with this coulter seem endless and open opportunity for companion cropping, seed and fertiliser banding and biological liquid placement separately or in the same slots. We started off using the 75mm twin band point which was very successful but in the terrible wet conditions and late drilling of autumn 2019 we moved to the single row 19mm point. I doubt we would have had half the area planted if we hadn't used it. This point seems to be the sweet spot for us and I like the 250mm row widths which are the same as our Avatar disc drill. For farms with more challenging grassweed issues than we have I can see the wider twin row versions of this point would be an excellent solution. As well as the performance the wear rates seem low so I do not think we will look any further in the future than the VOS opener

Packers

Our CO6 had clearly been loved by its previous Polish owner who had made several upgrades. Not only had they converted the rear packer to the later, more reliable sprinter style bearings but they had fitted a front packer to the toolbar. Such a front packer would have been ideal when the drill was used on cultivated land providing some consolidation ahead of the seeding. But in a none disturbed no tillage situation it was somewhat redundant. However when the drawbar conversion was done it served a new role in providing depth control at the front of the machine so was retained. The tyres were a small diameter which in wet conditions could struggle to keep turning, they were also quite worn, punctures and a few tyres with damaged sidewalls ultimately made it more economic to replace its



Front depth wheels



Rear packer with self-cleaning tyres fitted



Relocated packer add stability on the road



Safety locking bar for road transport

depth control role with 4 larger diameter wheels, we used the same size wheel and tyre as fitted to our 12.25 Horsch Avatar giving us a universal fitting spare.

The rear packer ran the standard CO car pattern tyres that were again getting quite worn and were less than ideal in wet conditions so these have now also been replaced with a similar size BTK tyre with a self-cleaning tread pattern again helping with wet condition performance

Safety and stability

With the addition of the drawbar the stability of the machine when folded was reduced, the high centre of gravity less anchored by a fixed linkage. The solution was to remove the first packer axle from each of the vertical wings and reattach it to the centre section, giving a wider, more stable wheelbase but still within the 2.95m road legal transport widths. Another small addition has been the addition of a fixed top link locking bar to hold everything securely on the road and not rely on hydraulics or straps.

Front Hopper

The move to having drawbar connection between seed cart and toolbar offered the possibilities of running the drill with a front hopper rather than the large seed cart. This offered the advantage of a much-simplified machine with far better visibility of the toolbar for the operator along with enhanced weight distribution and 2 less tyres on the ground. This created a drill that's wet weather performance is truly exceptional and was able to complete 100% of our 2019/2020 workload through record wet conditions. The combination of undisturbed soil, optimal weight distribution over as few weight carrying tyres as possible and the low disturbance coulter allowing the rear packer to run clean without soil contact. All worked together to establish crops successfully through a very difficult season.

The hopper we chose was the Horsch Partner, this fully ISO hopper uses the same control software as our Avatar and incorporates the same blockage monitoring system so is familiar to operators. Like the Avatar it's a very simple one man operation to calibrate and has metering and fan capacity to cope with a 12 m toolbar giving us options to use it with the Avatar (giving ability to drill up to 6 products, meaning less pre missing of cover crops) or with other 12m wide seeders in the future fitting in with the 12/36m control traffic farming system we operate. The hopper can be split into 2 products giving seed / fert or companion cropping options which with the versatility of the Boulgault openers creates a new word of possibilities!

Costs and Conclusions

Of course, over the years of development the cost has now moved on from the original £8000 spent buying and converting the drill, approximately an additional £6000 was spent on drawbar, opener, and packer conversion. The seed cart has been sold offsetting some of the cost of the front hopper the cost of which can be anything from £1000 for a well-used Accord unit at a farm sale to £20,000 plus for a fully specified ISO 2 product unit with blockage monitors

It's taken us 4 seasons to fully develop this machine to where it is today, even after the additional spend it offers a relatively cheap and versatile no till tine drill that



The Horsch Partner front hopper



The drill working in the wet winter of 2019

agronomically complements our Avatar disc drill, gives us additional capacity and offers a degree of insurance against wet conditions. It shows you don't always need to spend huge amount on a new machine to direct drill. All it needs now (this winter's project) is a sandblasting and a coat of shiny paint to smarten up all than "development mule" primer !

See more details of the drill
here via this link



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FEELING TIRED?



If you are serious about reducing soil movement to reduce costs in fuel and labour without reducing yield through compaction what are your options, and how do you 'dip your toe' without financial commitment? "Just looking thanks" is the phrase while on a manufacturers show stand whilst trying to form your own opinion. How do you do a bit of non-bias research on system change on your farm? AHDB's Monitor Farm meetings are one way, either on-line or in the future back to face to face meetings. But again how do you build a system for your farm, based on your soil type, your area to be covered and time available to you?

To gain an idea of the size and width of a direct drill whatever design you choose you can look up the AHDB Machinery Calculator and mess with the width, forward speed and field efficiency (time spent actually drilling rather than turning and filling) and come up with a drill width to suit you. If the numbers don't stack up, up the speed or more hours per day, eventually you will come up with a consensus of what you need.

But as the power needed increases so does the weight of tractor need to pull the drill. Can you assess the level of compaction going in below where your chosen drill is working? Based on the weight on the tyres, soil type and soil moisture, yes you can.

Terranimo is a website where you can select the tractor/implement combination or crop sprayer, combine harvester, beet harvester, Potato harvester, forage harvester for that matter. Select the tyres, calculate the weight on each tyre, select the soil type and soil moisture and calculate the depth of compaction based on the data you have entered. Hey presto you can generate a detailed report on your chosen set up. And, like the machinery calculator, if you don't like what you see, change the numbers and try again. Nothing ventured and all that.

For the lucky living in Scotland the soils data is already entered, just pick your county and the soil data at 10cm steps to 150cm depth is available. Choose between dry, moist, and wet for your soil water content and choose if you plough and cultivator or not. For those not living in Scotland work is on going to bring England into the fold, but for now your soil type can be entered manually.

Of course, those reading these pages will be keen to remind of

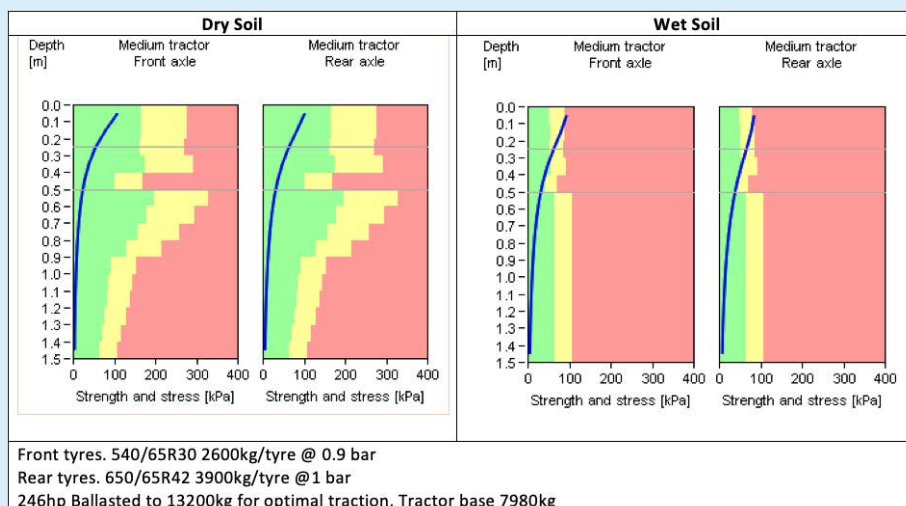


Fig. 1

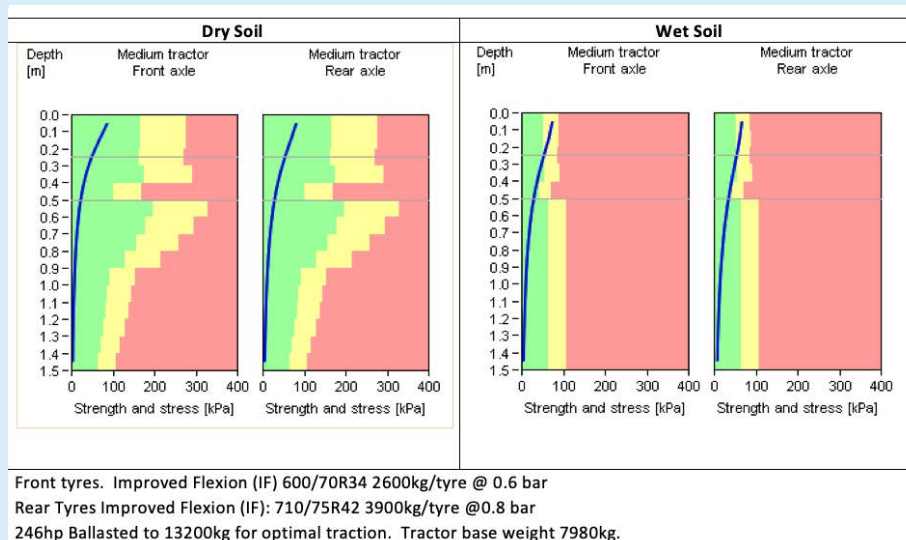
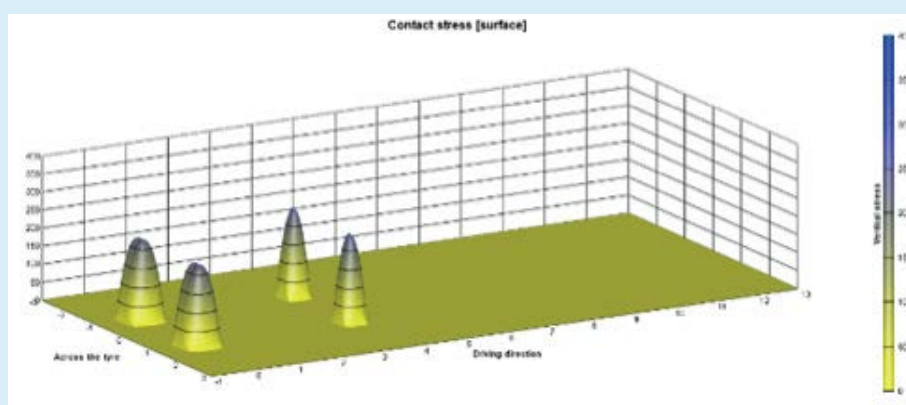


Fig. 2



Above; Front tyres. 800/70R32 with 7250kg/tyre

Rear tyres. 540/85R26 with 5000kg/tyre



Fig. 2

increased soil organic matter and higher magnesium content in clay soils would help too. But for now, let's keep it simple.

In choosing tyres there are over 800 tyre sizes, brands and designs to go at. Twin track and four track tractors are in there too. But I'm not pretending every brand and

combination is achievable and the very latest tyre on the market may not be present.

The website is the work of Aarhus University in Denmark and the AHDB have been funding its availability in the UK.

So, looking at a typical 246hp drill

tractor (Fig.1), if it is ballasted to achieve full traction then the graphs below represent the soils ability to carry the weight of the tractor on the tyres selected.

The blue line represents the tractors front and rear axles and the boundary between green and yellow corresponds to 75% of the calculated soil strength, and the boundary between yellow and red shows 125% the soil strength. In the wet soil condition graph both front and rear axles reach 125% to a depth of 10cm and compaction is still 'going in' at 50cm. In the dry condition graph, the soil is able to support the tractor without undue compaction.

If the same tractor is fitted with wider IF (Increased Flexion) tyres, (Fig.2), then things improve. But it must be stressed that the tractor is fully ballasted for full traction, so its unlikely in the real world to need this level of ballast for drilling.

Looking at a 125hp tractor fitted with the optional wider tyres (Fig.

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Here's a big thank-you to those who have contributed to Practical Farm Ideas and a warm welcome to all who want to join them.

Mike Donovan editor@farmideas.co.uk www.farmideas.co.uk

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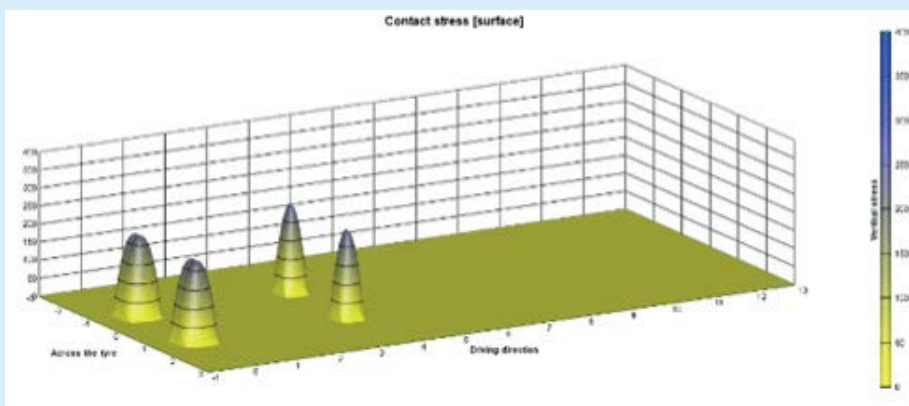
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Above; Track system with 8000kg/track

Rear tyres 750/65R26 with 5000kg/tyre



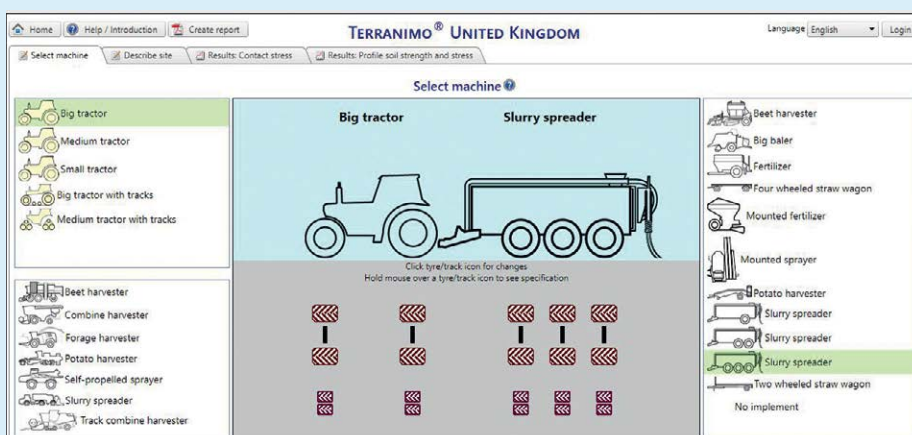
Getting the right balance between tractor weight and tyres will make more of the tractor and your soil.

Choosing whether to go with tracks or a wheeled machine for your next combine? The Contact Stress function can point out the peak pressures from wheeled or tracked combines. Below is a typical large wheeled combine with 9-metre header fitted. With both grain tank and fuel tank full the front axle comes to 14500kg with 10000kg on the rear axle. Note the rear axle in this case is exerting more stress on the soil the front axle.

The same combine with the track option fitted show a marked improvement in soil stress, the front and rear rollers with two centre idlers exerting the peak pressures. This combine is also fitted with much larger rear tyres but still exert more stress than the track unit.

Both combine calculations here used Dry Soil. But of course, this is not always available. Just as an illustration we have sent our fully leaden wheeled combine into wet, clay soil conditions. As you can see below the front axle did not find soil able to support its weight until at 50cm depth and the rear axle is little better. Yes, the combine is stuck. And if this were real, que the social media fest.

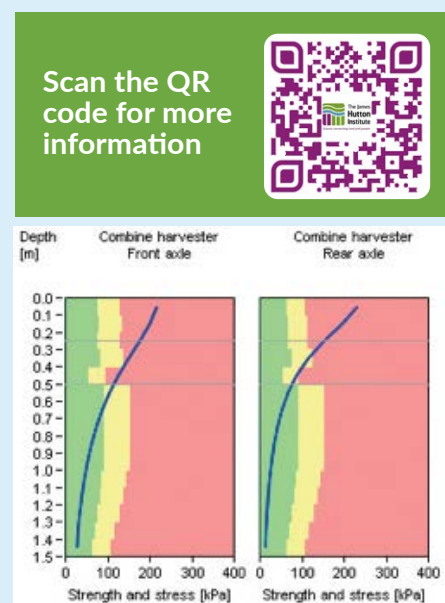
Obviously, the examples I have shown here, while real, are not likely to be what you need. So, get the kettle on, forget Strictly goes Dancing and have a go at calculating the right tyres, power, indeed farming system for your future.



A comprehensive calculation with a myriad of combinations will bring you the best solution for you capacity and location.

3) shows similar characteristics to the 246hp tractor on IF tyres and of course this is fully ballasted, worst

case scenario. Removing the ballast, sheds almost 30% off the tractors weight.



WILL IT WORK FOR US?



Andrew and Sam Melton, new to the AHDB Monitor Farm programme this year, are looking at how to make cover cropping and direct drilling work on their soils at Wisbech, Cambridgeshire.

Farming silty clay loam soils and with a keen interest in farming sustainably, whilst improving yields and productivity, Andrew and Sam Melton have kept a keen eye on the developments in cover cropping and direct drilling over the last few years.

Seeing how other farms have made the successful transition to using cover crops and shallow tillage, Andrew and Sam, the father and son team, invested in a new direct drill (John Deere 750A) last season and are now interested in how to get optimum output from the drill, soil and the crop itself for their business.

The Melton's farm 1,400 hectares of silty clay loam soils near Wisbech, Cambridgeshire. Their rotation includes wheat, barley, winter linseed, beans and sugar beet. The farm currently operates shallow tillage and full inversion cultivation systems, but have been looking at reducing soil tillage.

Joining the Monitor Farm programme in June 2020, one of the areas that Andrew and Sam are keen to focus on is incorporating cover cropping and reduced tillage into the rotation. To start on this journey, this autumn, the Melton's are doing a try-out and testing three different cultivation methods:

1. Plough with a 7F Gregoire Besson
2. Shallow tillage using a Vaderstad Carrier with cross-cutter discs
3. Direct drilling with the John Deere 750A

The three systems have all been trialled alongside each other in a field, which was winter wheat last season. Following the combine, a catch crop (buckwheat, millet and sorghum) was established on some of the tramline plots but not where ploughed.

In addition, the shallow tillage area has a section with and without straw. Andrew is interested to test which of the systems works better for managing straw residue, something that he is keen to get right for optimum establishment.



Try out

In this way, one part has been chopped and the second section baled and removed.

Measurements will be taken across the try-out areas through the season, including a look at soil (soil analysis, resistance, infiltration and structure), residue (levels left on the surface after drilling) and plant measurements (emergence, canopy cover, plant, tiller and ear counts, NDVI and yield).

The farm business also actively uses technology throughout all operations



Catch crop

and to effectively manage fields and areas. As part of this try-out, fuel use and machinery telematics will be analysed to look at the impact of the different cultivation methods, alongside an analysis of the costs of using the different establishment systems.

Building on previous farmer experiences, existing industry research on cover crops and now having the opportunity to try this on-farm, it is hoped that this will start to build a picture of how the Melton's can best employ this system effectively for their business in the future.

Results will be shared in a future issue.

For more information about the Wisbech Monitor Farm, please scan the QR code.



George Crane (left) Jason Pole (right)

Monitor Farm Winter Meeting Programme

This winter, Monitor Farm meetings will be taking place online as a webinar once a week on a Monday evening at 7pm – Monitor Farm Mondays. These will run from 2 November to 8 March with topical subjects and feature monitor farmers from around the country with an industry speaker. You will be able to join in the discussion with 'live' question and answer sessions.

To look at the detail of these and other events coming up, please scan the QR code.



ARBUSCULAR MYCORRHIZAE ALL GREEK TO ME!



In this article, Jason Pole explores the crop-friendly fungi focus of one of our crop PhD studentship projects, funded by AHDB Cereals & Oilseeds.

If your crop roots are in good nick, there's a decent chance they've cuddled up with some potentially powerful soil allies: arbuscular mycorrhizal fungi (AMF).

The word 'mycorrhiza' stems from two Greek words: mykos and rhiza, which mean 'fungus' and 'root', respectively. Unlike fungal pathogens, which infect and damage plants, AMF form symbiotic relationships with roots – in a healthy game of give and take.

AHDB PhD student George Crane has developed a fascination for AMF, which are ubiquitous in nature. AMF colonise root cells, undergo intense branching and form 'arbuscules' – sites for fungus-plant metabolite exchange and nutrient accumulation.

Based at NIAB, George leads on a series of field-scale trials and glasshouse experiments that aim to tap into the potential of AMF for crop production. As part of a UK soil assessment programme, the effect of common farm practices on AMF

diversity and abundance has already been examined. For example, deep cultivations influenced AMF species composition, with disrupted soils potentially hosting fewer beneficial species.

Cover crops, which deliver various benefits to farming systems, can also promote AMF. This aspect is under investigation in two fully replicated trials in Norfolk (Bawburgh and Morley). Various cover crop species are being tested – sometimes with a helping hand in the form of commercially produced AMF inoculum (five species).

The study has also linked with Innovative Farmers (IF) too, to apply these findings at the farm scale. The research is providing a steer for on-farm trials at six sites that use cover crops and anaerobic digestate (AD) to influence AMF. So far, all trials have delivered mixed results. However, long-term use of cover crops is most likely to deliver a positive effect on AMF communities.

The work has also refined the use of targeted primers that amplify specific AMF DNA. Such molecular approaches can help detect the presence of fungal species in soil samples. For example, George's work has confirmed the presence of 87



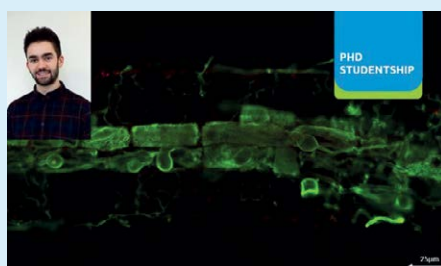
AMF taxa in the UK soil assessment samples, which will now be further investigated.

With UK farming under increasing pressure to demonstrate its sustainability, AMF provides another great opportunity to harness and work with nature. The PhD, which receives part funding through the AgriFood Charities Partnership (AFCP), is due to conclude next year.

For more information:



George Crane (left) Jason Pole (right)



Scan the QR code for project details and annual reports.



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DRILL MANUFACTURERS IN FOCUS...



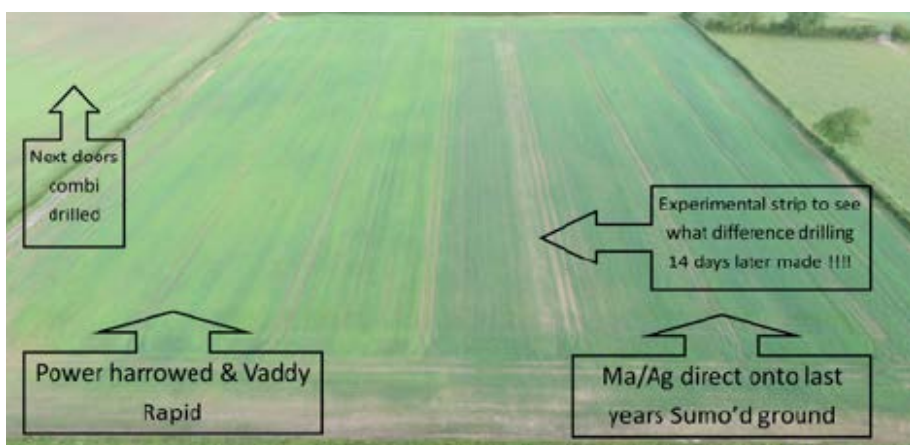
ESTABLISHMENT COSTS V RETURN



Harvest is nearly done, and the results are in!

For once weather conditions were similar around the country, poor conditions in the backend of 2019 leading to a lot of ground remaining undrilled or those that had been, failing due to water logging. A late start in spring thanks to prolonged rain on heavy land delayed drilling until well into April, then it stopped and didn't start again until most crops looked as though they had just about expired. The plants then decided that with a bonanza of water they would "wake up" and put their new found energy to great effect and a late surge of secondary growth led to crops looking much improved but meaning a late harvest and very uneven ripening.

Interestingly we had a trial field of





Spring Oat, drilling 5 acres with the farms conventional system of power harrow followed by a Vaddy, to the other 5 acres drilled direct onto last backend sumoed ground which had been successfully treated with roundup. All drilled the same day, unfortunately due to operator error a 4.8 metre strip was missed the length of the field in the direct drilled plot (more on this later). The two crops emerged at the same time, thanks to the Vaddys narrow row spacing and even colour of the freshly cultivated soil the crop appeared to have a much better coverage/emergence than the direct drilled crop. But as the crop grew in the dry conditions whilst the direct drilled crop remained a healthy dark green

virtually until the rains finally came, the cultivated crop look thoroughly sick, yellow and with every wheeling of the previous operations evident.

Certainly next doors conventionally worked and drilled field (inset) doesn't look any different to Ma/Ag direct drilled the same day with double the horsepower per metre!!!

We just now need a bit of warmth to get things moving

In order to widen the appeal of the Ma/Ag drill and offer a much more price competitive units for smaller farmers and contactors wishing to start down the direct route, we have launched ready

for Spring (when it arrives !!!) a 3 metre mounted version of the Ma/Ag drill. Utilising the same fully floating coulter unit with its twin disc design, including scalloped straight disc and angled plain disc with a rear rubber press wheel.

If you want to carry tools, fuel or perhaps some cover crop seed, maybe you should treat yourselves to a WorkBox ideal for anyone who needs to have a workshop in the field?

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More details on drills or Workboxes contact Ryetec on 01944 728186



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No-till compared with conventional plough-based system::

- Capital value of machinery - £186/ha less
- Capital value of machinery - £13/tonne of wheat less
- Variable costs - £74/ha less
- Working capital - £260/ha less (for example £130,000 less on 500ha farm)

*Source:
Groundswell &
LFB
Benchmarking
2018/19

For more info visit: www.groundswellag.com/agronomy



TYRES IN FOCUS...

COMPLETE TYRE PRESSURE SOLUTIONS

Written by Chris Dolman from Michelin UK

Michelin is introducing its latest agricultural tyre technology into the UK with the launch of Zen@Terra for high-powered tractors – enabling farmers to easily adjust tyre pressures for heavy road and field work.

Designed specifically for fitment in combination with a central tyre inflation system (CTIS) and Michelin's Ultraflex tyre range – although it can be used with any Michelin agricultural tyre – Zen@Terra connects directly into the tractor's ISOBUS system. Once installed, it allows farmers to switch between low pressures, for maximum soil protection, and higher pressures, to maximise performance on the road. The process takes a matter of minutes and can be operated via an easy-to-use, integrated in-cab touch-screen display.

Pre-programmed settings allow the user to tailor pressures depending on the implement attached and vehicle usage. Pressures can be adjusted for empty, half or full loads, as well as slope work. A 'boost' function sets extreme low pressure for three minutes, when extra grip is needed.

Compatible with most modern tractors, it is the result of years of research and development by Michelin's team



of expert engineers and, following successful trials across Europe, Zen@Terra is now being rolled out to farmers and contractors across the UK.

Mark White, Michelin's National Sales Manager – Agriculture & Construction, says: "Michelin is determined to keep helping farmers get the absolute maximum performance from their machinery.

"Zen@Terra is a complete solution, managing all aspects of tyres and their interaction with the ground, both in the field and on the road.

"Using an in-built CTIS and our Ultraflex technology tyres, the customer can quickly change tyre pressures to best suit the ground they are working on. This helps to optimise the performance of their vehicles, increases tyre life, improves productivity and yields, while reducing fuel costs and protecting the soil – all of which supports Michelin's core value of sustainable mobility."

The system has been developed following direct feedback from farmers and contractors, with Michelin focused on developing a solution offering maximum quality and reliability.

The in-built CTIS was designed in conjunction with PTG – industry leaders in tyre pressure control systems – which Michelin acquired in 2017.

Zen@Terra can be used with any Michelin Ultraflex agricultural tyres; including Michelin's AxioBib, AxioBib 2, EvoBib and XeoBib fitments.

It will be fitted exclusively in the UK by approved supplier TractAir – a family-owned company which designs, manufactures, supplies and fits air brake systems, air compressors and tyre inflation systems for agricultural applications.



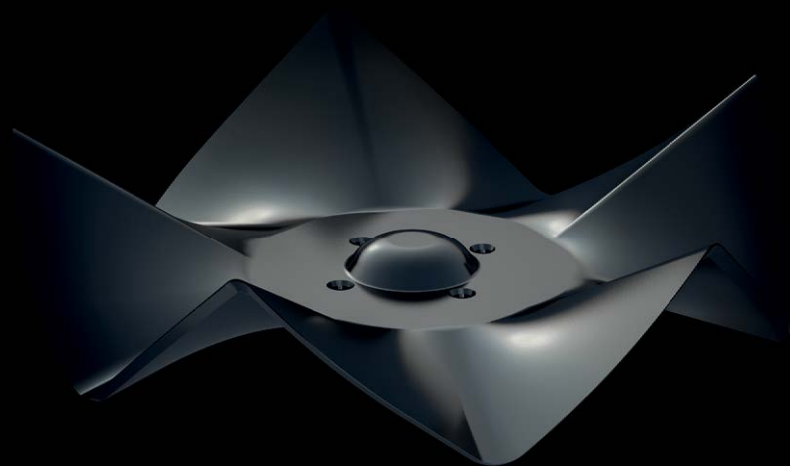


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DRILL MANUFACTURERS IN FOCUS...

HORIZON AGRICULTURE A NEW BRAND OF SLY AGRI LTD

This year has been an incredibly busy year for us. We sent our first DSX seeder to our customer in February 2020 and have now manufactured over 20 which has been a huge effort from our team.

We now have DSX seed drills in the UK, Tasmania, New Zealand, Germany, Denmark and France. We also build planter frames, planters and soon strip-till units. We have faced a global pandemic that has not been seen before in recent history. Supply issues have been there to be dealt with – and that has not been helped by one of the wettest autumns on record which led to earlier demand for sold seeders.

We are a UK company based near Spalding in Lincolnshire. We firmly believe in employing local people and as such we are a significant employer in our local area.

We invested over £500,000 in a semi-automatic blast and paint line, we did this to ensure a high end premium finish that the major OEM's are using. This preparation and paint process forms part of our whole business model, to produce premium, long lasting machines that are upgradeable over time. We believe this is the future in machine manufacture to allow the entire agricultural industry to become more sustainable and to counter the ever-increasing operation costs.

Our assembly hall works on a bay principle. We aim to have all the parts arriving in the bay for each machine just as the assembly team want to assemble them onto the seeder. This requires a lot of coordination with our



purchasing department as the only thing that is the same about every seeder we build is that each customer has a different specification.

Once the machine is assembled, we then spend a day inspecting it. The machine is connected to a hydraulic test rig and every function is checked to ensure leak free operation. The machines controller is programmed ready for delivery – with all electronic functions also being checked.

We are passionate about the entire manufacturing process from design to PDI and although it has not been easy to setup so quickly, we have a great team and are proud to be where we are today. There is a great ambition I feel pre and post Brexit for the UK manufacturing industry to thrive and it has been great to see British farmers choosing British made products.

The DSX has been designed to be modular. This means that should your needs change you can add or remove parts to the machine. It could be that you need to go up a size and make your 4m machine a 6m machine. We can sell you the parts accordingly so that you do not need to purchase a new seeder. Same goes for liquid, row cleaners and automatic downforce. When we did this we realized that we would need to make the seeder long lasting and robust. It's been designed with high quality bearings, bushes and parts as possible to ensure a good longevity.

We back all of our machines with a two year manufacturer's warranty. We carry a good inventory of stock ensuring that most crucial parts can be supplied on a next day basis. We have invested heavily in our people and have a dedicated service and parts team.





It is very important to prove and demonstrate the agronomic advantages of our opener and options. We have to give the user a return on their investment and as time goes on we will run studies and detail results on our website which will be independently verified. We also hope to welcome people back to our farm for open days when restrictions lift. We wish everyone the best for this autumn drilling campaign!

If you would like any further information about our products please get in touch with us. Our contact details are as follows:

Sales + technical advice:

Tom Carnell (UK)
Tom.carnell@horizonagriculture.com
 Mobile: 07487 387265

Service:

Jon Gray
Jon.Gray@horizonagriculture.com
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METHANE AND MICROBES

Written by Sally Morgan who edits Organic Farming magazine smorgan@soilassociation.org

With ruminants getting bad press at the moment over their methane-filled belches, Sally Morgan looks at the science and the critical role of methane-eating microbes

Are ruminants really to blame for the rapid increase in methane levels over the last decade?

There is no denying methane is a significant contributor to climate change. Its global warming potential is said to be as much as 28 times that of carbon dioxide, but it has a much shorter life of around 12 years.

The concern about methane is the sudden surge in levels since 2008. It came out of nowhere and scientists are still unsure of the cause. Current levels are just under 1,900 parts per billion, contributing an estimated 20 per cent of total atmospheric warming to date.

Commentators have been quick to put the blame on ruminants, a blame game that started back in 2006 when the UN Food and Agriculture Organisation published a study entitled *Livestock's Long Shadow*. The study claimed that livestock production was responsible for 18 per cent of all greenhouse gas emissions (a figure which has since been revised down considerably). Since then, many organisations have called for a reduction in meat consumption and a switch away from extensive systems to intensive ones, in which animals are raised quickly on grain and soya-based diets that generate less methane. However, it's becoming increasingly

apparent that the methane story is far from clear cut.

Methane sources

There are various sources of methane, both natural and anthropogenic, with the latter being responsible for about 60 per cent of global methane emissions. Methane is released by microbes called methanogens during microbial decomposition of organic matter, especially that which takes place under water in anaerobic conditions as found in wetlands and paddy fields.

It's also released by microbes living in the gut, in particular, the rumen of ruminant mammals and the gut of insects, such as termites.

Methane is released during the decomposition of natural gas, the so-called geological methane, which is stored in underground reservoirs and reaches the surface via seepage, geothermal and hydrothermal activity etc, along with climate-active ethane and propane. Other sources include fossil fuel extraction, fracking, mining, landfill, waste management and the manufacture of nitrogen fertiliser (see *Organic Farming* 131, Summer 2019).

Interestingly, atmospheric methane levels did not rise between 1999 and 2006 despite a 70 per cent increase in livestock numbers and looking



The Pantanal in Brazil, is the world's largest tropical wetland

further back to times when vast herds of ruminants were grazing grasslands across the world, methane levels ranged between 350 and 750 ppb. So what's caused the dramatic rise over the last 12 years? There's much finger-pointing. Some put the blame on leaks from gas fields, while recent research from Cornell University puts the blame on the boom in the US shale gas and oil industry. Discovering that the chemical fingerprint of methane from fracking differs from that released by traditional fossil fuels and livestock, researchers were able to track the source. They claim that as much as a third of recent methane emissions may come from shale gas development. However, others suggest that tropical wetlands are the only source large enough to explain the sudden rise.

Methanotrophs

It's not just methane sources that are important; we need to know how much methane is oxidised to carbon oxide and water. This happens naturally in the lower atmosphere but there's another methane sink of interest, a group of microorganisms called methanotrophs.

These are single-celled organisms, such as bacteria, that consume methane as their source of carbon. They can be aerobic or anaerobic and are usually obligate, which means that methane is their only carbon source, so they are particularly common in places where methane is produced. Without them levels of methane would be much higher. In fact, half the methane released by wetlands may be taken up by methanotrophs and oxidised (Dunfield, 2007).

Boosting methanotrophs

Little is known about the soil-living methanotrophs. We know they are found in a range of soils and survive on low levels of methane and that soil management affects their numbers. In conventionally managed soil, the continued application of inorganic nitrogen fertiliser reduces the capacity of soil to oxidise methane and this is linked to reduced numbers of methanotrophs, whereas organic sources of nitrogen, such as manure, enhance the ability of soil to oxidise methane (Brady, 2002). Tillage and other soil disturbance will also adversely affect their populations,

reducing numbers by as much as 80 per cent (Evershed, 2012). So, to boost methane oxidation, soils must be well aerated, and tillage and the use of inorganic nitrogen sources avoided. Also, research on alpine meadow soil found one group of methanotrophs to be strongly boosted by the grazing of cattle (Abell et al, 2015).

Livestock emissions

Ruminant emissions vary, even within species. Cattle, for example, produce between 164 and 345 mg of methane per day, with cattle on high-fibre feed producing more methane than those on a grain-based diet. But, as always, the whole picture has to be considered. Grain-fed beef animals may emit less methane, but overall, the energy required to finish these animals is twice that of pasture-fed, because of the use of fossil fuels in growing, harvesting and transporting grain, with additional greenhouse gas emissions from the manufacture and transport of nitrogen fertilisers etc. So, when looking at the lifecycle, it's important to offset any methane production with sequestering



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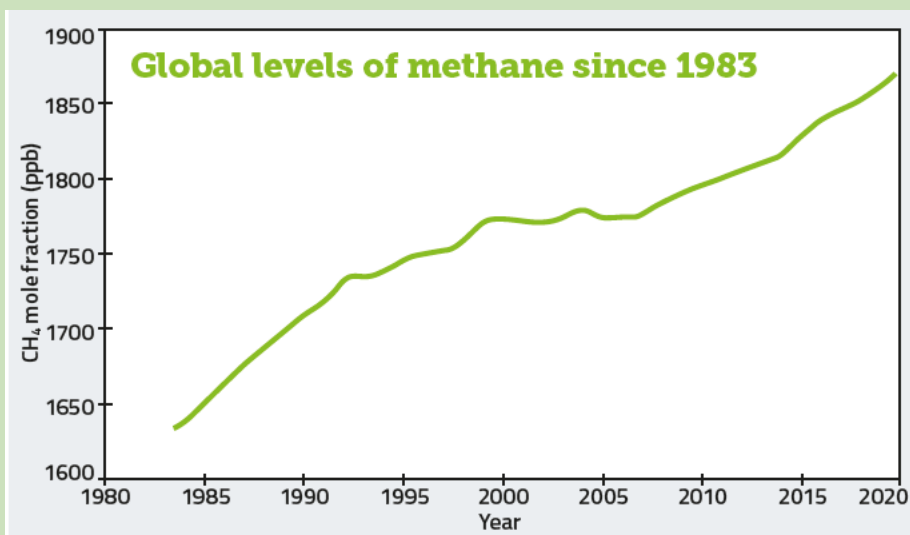


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gains; a well-managed, rotationally grazed permanent pasture will sequester carbon, so helping to offset methane production by the animals.

Plenty of lab-based studies have measured methane in a cow's burp, but this takes no account of its lifestyle. When they are on pasture, head down and grazing, a burp of methane soon gets mopped up by methantrophs living in the soil. If you have a well-managed pasture with a soil rich in microorganisms, methane is not so much of a problem. But place them in unnatural situations, such as vast feedlot in the US or on a poorly managed pasture in the UK that is regularly fertilised, you disrupt the system and the soil will be less able to deal with methane.

Simply tweaking the diet can result in fewer methane emissions: for example, the feeding of sainfoin silage, adding more oil or seaweed. Biochar, too, may have potential. Research shows that biochar can increase the ratio of methanotrophs to methanogens in paddy fields and a similar process may occur in the rumen

Intensive systems

Many overlook the role of intensive livestock operations. Animal waste from intensively raised pigs and large dairy operations is typically stored in lagoons and slurry holding tanks, where the anaerobic decomposition of the organic material produces methane (as well as nitrous oxide which has almost 300 times the GWP of carbon dioxide). This can be avoided if the slurry is fed into an anaerobic digester and the methane captured, or the manure is

spread on to heathy soil where dung beetles, earthworms and other soil life can pull it into the soil to be worked on by decomposers and the carbon locked up. Under these systems there will be no significant methane production (FAO, 2002).

There is no easy answer to the livestock question. I don't think anybody wants a shift to highly intensive systems with all the welfare issues that would result, but without livestock, we'd need more plant crops and they require nitrogen. A lack of manures would mean more land under fertility-building leys or more inorganic nitrogen fertiliser which has a major role in the methane story. It's a complex situation, whatever food type is producer, there are methane implications.



Methanogenic bacteria in the hind gut of termites release methane

Methane - producing insects

Ruminants are not the largest producers of methane. Weight for weight that honour goes to insects, with 200 to 300 cockroaches generating as much methane as a cow. The most significant contributors to global methane are termites. They feed on plant materials and release methane from their hind gut, contributing up to three per cent of global methane. Recent innovative techniques measuring methane in a termite nest found the production of methane to be far higher than first thought, but more than half of the methane is oxidised before it is lost to the atmosphere by methanotrophic bacteria in the walls and beneath the mound.

Methane and CO₂ equivalence

Most research papers refer to the unit 'CO₂ equivalence' and Global Warming Potential over 100 years, but according to research by IPCC scientists led by Professor Miles Allen at Oxford University, a better metric is GWP*, which provides a more accurate indication of the impact of short-lived pollutants on global temperature. Basically, past increases in methane emissions caused warming when they occurred, but constant methane emissions cause little additional warming. For example, if there are increases in the UK cattle herd, the increase in methane will result in a warming effect, but if the herd size stays constant, then there will be no additional warming given the 12-year lifecycle of methane. Using this new metric, agricultural emissions under GWP* are estimated to be a fifth of their original value. In fact, the 25 per cent fall in the size of the UK herd since 1984 could be argued to be having a cooling effect. As researcher David Frame explains: "Under current policies, industries that produce methane are managed as though that methane has a permanently worsening effect on the climate. But this is not the case. Implementing a policy that better reflects the actual impact of different pollutants on global temperatures would give agriculture a fair and reasonable way to manage their emissions and reduce their impact on the environment." The research summary can be read here: <https://bit.ly/2Y8nRkS>



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DRILL MANUFACTURERS IN FOCUS...



JOHN DEERE

Farmers have to collect a large amount of data to manage their farm and for documentation requirements. With the ISOXML standard it's possible to transfer field data from machine displays of the most popular manufacturers to the John Deere Operations Centre. In this way, John Deere is able to support customers that work with mixed equipment fleets.

Data commonly recorded by farm machinery includes field borders, application rates and crop yields, with the information helping farmers to operate more efficiently, cost-effectively and sustainably. However, customers with mixed fleets have often failed to successfully transfer and merge such data into as few software solutions as possible in the office.

The John Deere Operations Centre enables farmers and contractors to exchange different data formats, and there are several ways to transfer data from the machine to the Operations Centre:

- John Deere machines are connected directly and wirelessly with the Operations Centre via JDLink Connect, without any additional costs. Depending on the application, the data can be viewed in the Operations Centre in almost real time and work progress can be measured. Alternatively, the operator

COLLECTING AND MANAGING DATA



can use a USB stick.

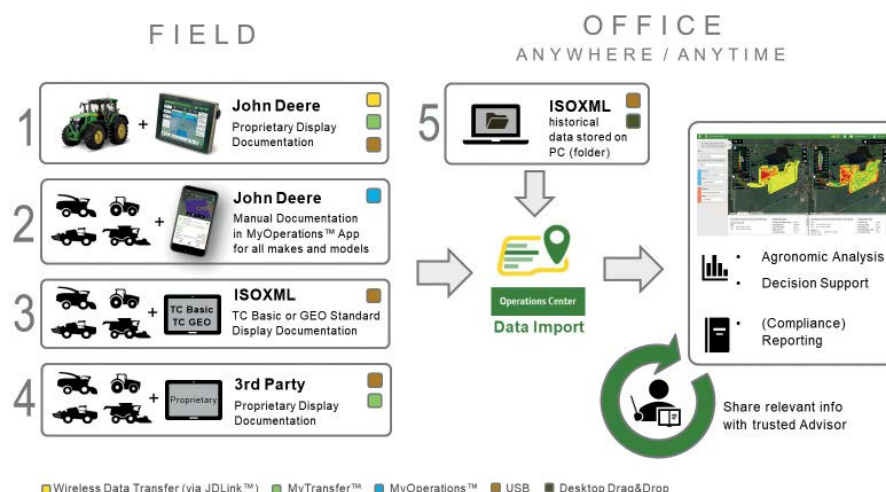
- Field data from machine displays that use the ISOXML format can be transferred to the Operations Centre from the beginning of August, but a USB stick is needed for the exchange. Historical machine data can also be included if still present, for example when stored on a computer.
- Proprietary data from other machine displays can be sent to the Operations Centre via a USB stick. In addition, data can be exchanged via a smartphone using a dedicated memory stick. The

data can be forwarded from the phone to the Operations Centre using the John Deere MyTransfer app.

- Manual documentation of field work is also possible. This helps for example when collecting information from machines without a documentation function, or if the driver has forgotten to start the documentation process. In this case, all data can be typed into the MyOperations app on the smartphone. Manual documentation via the app is currently available for soil preparation, drilling and crop care applications such as fertilising and spraying, with harvesting data to follow shortly.

In addition to seasonal machine documentation, the Operations Centre user receives a comprehensive digital field book. Customers can view and manage all data from any location using a computer browser or smartphone.

The John Deere Operations Centre and MyOperations smartphone app are free of charge. In addition, the exchange of data from various sources does not involve any fees for farmers or contractors. John Deere dealers can provide further information on compatible displays plus the various data formats and transmission options available.



MORE SUPPORT REQUIRED FOR AGROFORESTRY

Written by the Soil Association

A survey of 346 people interested in agroforestry reveals much greater support, information and payment certainty are needed for farmers and land managers to implement agroforestry in the UK. Planting trees on farms can boost farm productivity by 30%^[1] and bring a range of benefits including improved soil health, carbon capture, biodiversity and animal welfare. It would also support Government tree planting targets.

Respondents were asked to complete the survey after downloading the free Agroforestry Handbook, produced in collaboration with the Soil Association and the Farm Woodland Forum to help farmers decide which trees and systems are best for their farms. The handbook gave most farmers more confidence to implement agroforestry, with over 75% of respondents more likely to implement agroforestry on their farms after reading the guide. Respondents' most common motivations were increased biodiversity, landscape resilience, and farm resilience.



However, despite strong interest in the benefits of agroforestry for farms and the environment, the survey found significant barriers holding development back, including a lack of technical knowledge and uncertainty around support payments. Around 40% of respondents did not know where to go for further guidance on agroforestry, with many others finding that the information they need from government simply does not exist.

Ben Raskin, Head of Horticulture and Agroforestry at the Soil Association, said;

"The UK is amongst the least wooded countries in Europe – with only 13% of the UK under trees compared to 38% on average in Europe. Planting more trees on farms can be a win-win for climate,

nature and health and would support the huge ambition of the Government's National Tree Strategy. The UK is already well behind on our Government's own targets and there's been other issues, like the potential impacts on wildlife. It's critical for nature and climate that the right trees are grown in the right places.

It seems a no brainer for UK government to provide a supportive policy framework and more clarity on payments in order to increase the uptake of agroforestry. Tree planting can and must play a vital role in a green recovery – tapping into the strong appetite for agroforestry could support more resilient farming, and help restore nature, health and a safe climate."

The survey results revealed the need for:

- More financial modelling and case studies
- More information on UK specific benefits (environmental and otherwise)
- Greater knowledge exchange on systems design, species choice, and management
- Market development for the broad range of outputs from agroforestry systems
- Greater policy support and funding

Dr Tim Pagella, Lecturer in Forestry at Bangor University and co-author of the Agroforestry Handbook, said:

"Agroforestry is a new name for an ancient practice. Trees have potential to play a critical role as we move towards more sustainable and 'climate smart' food systems. Careful integration of the right trees onto our farms can improve soil and animal health, create diversification opportunities, enhance biodiversity,



reduce inputs and deliver public goods in our rural landscapes."

Survey respondent and Woodland Consultant, David Cracknell, said:

"One silver lining of Brexit should be that we can now shape our own domestic agricultural grants scheme so that we pay farmers to plant trees on their livestock farms – to improve soil, carbon storage, livestock well-being, productivity and the environment as a whole. With the right political will we could really lead on agroforestry in this country. We have the expertise."

The handbook also highlights opportunities for UK farmers to reduce farm inputs and replace imports with tree products such as fruit, nuts, fence post timber, animal bedding, fuel wood and mulches. Research by French think tank IDDRI has shown that in Europe a ten-year transition to agroecological farming practices – like agroforestry – would slash agricultural greenhouse gas emissions by 40%, help to restore biodiversity and protect natural resources – all while producing enough healthy food for Europe's growing population.



ROBOTS AS EVERYDAY TOOLS

Written by Chris Fellows based on information from Agrolntelli



After six years of intensive work, the new generation of Robotti, the autonomous implement carrier, celebrated its world premiere at Agritechnica last year amongst as lot of other robot technology. Built by Denmark's Agrolntelli, it's among the first autonomous implement carriers of its kind on the market and the way they have approached farming problems is certainly interesting.

The Robotti 150D is a versatile, autonomous implement carrier, with the power of a medium-sized tractor, but without a driver. Robotti is one of the first usable robots that can be used for harrowing, sowing, mechanical weeding, spraying and so on. Outputs of up to 3ha/hr are possible, depending on the task being carried out.

"With Robotti, we are at the start of a new agri-tech era in agriculture and horticulture where autonomous implement carriers become commercially sustainable and can be integrated

into daily operations," Agrolntelli sales director, Henrik Lynge Jacobsen, said.

"Timeliness, uniformity, time savings and sustainability are the major arguments for acquiring Robotti. For example, it is lighter and the soil can carry it as sooner, helping the farmer optimise sowing time."

Robotti is equipped as standard with a laser scanner, camera and RTK/GPS, which provides precision of +/-2cm.

Agrolntelli's Robotti 150D is an evolution of the unique, autonomous concept that the company has tested during the past year with good results. These results have now been incorporated into the new model for 2020. It is larger and more capable, with bigger wheels and 150hp. A version with 75hp, called Robotti 75S, will also be available.

Among others, Robotti has already been sold to Wageningen, Ghent and Aarhus universities, where it's part of experimental work within robot-technology.

The new large version is equipped with two 75hp Kubota diesel engines that provide plenty of power and good operating speed of up to 10km/hr. In addition, the hydraulics come with three double-acting outlets and one return outlet. It offers ample power to handle

a variety of implements via its standard three-point linkage. With a full height of 92cm, Robotti can also work during crops' later growth stages.

The centre mounting and the even distribution of weight on the four traction wheels helps balance the power and efficiency. Robotti is 35-50 per cent lighter than a similar conventional tractor, significantly reducing soil compaction.

Precision and safety are high priority

Precision and safety are based on digital technology and are a high priority for Agrolntelli. Robotti is equipped with a laser scanner, camera and RTK/GPS as standard. The security systems have built-in redundancy and function independently of each other.



Robotti is the start of a new era in agriculture and nurseries where robot implement carriers are integrated in day-to-day operations.

As an option, Robotti can be equipped with a number of powerful software packages, including plant counting and weed intensity measuring in the form of "weed maps".

Work plans for Robotti are managed online, where the user can use existing GPS field maps or create new ones. A computer calculates the most effective route plan to minimise fuel consumption, but also to minimise structural damage to the soil.

The log function also controls the machine history, with detailed maps stored and documented for each job. Likewise, images and recordings from



mounted cameras and sensors on the autonomous robot can be stored via the logging function.

During development, it was important for AgrolIntelli to let Robotti operate under realistic conditions. Therefore, it's equipped with standard Kubota engines and reliable hydraulics for low operating costs, and easy servicing and maintenance.

Robotti is being used profitably

Henrik Lynge Jacobsen said the company's calculations show that it pays to invest in a complete Robotti solution with tools for growing potatoes compared to a similar investment in a conventional tractor with implements.

"We have calculated the cultivation of 100ha of potatoes annually for a five-year period," he added. "With Robotti, the return on investment is 181 per cent versus 138 per cent for the conventional tractor solution. This is partly due to lower labour costs and higher dividends because of less structural damage in the field.

"The robots are ready, and now it's up to the agricultural industry to adopt the new technology."

How AgrolIntelli are approaching solutions



Ole Green: "Educating farmers and operators is essential to guarantee the success and endurance of robots and autonomous vehicles in farming." - Photo: AgrolIntelli

Ole Green, CEO of Danish robotics company AgrolIntelli, wants his solutions to be unique and not just replicate other ideas. Looking back at what has happened historically in farming helps his team do this, he even takes them to agricultural museums. He feels that modern day farmers have got detached

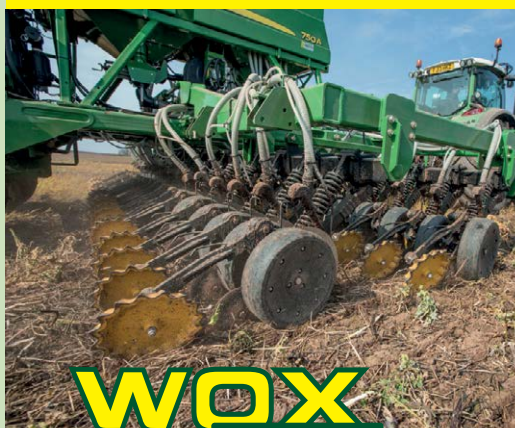
from the soil itself, spending more time in tractor cabins, with air conditioning far away from the soil. Farmers of previous generations would have spent far more time walking their land.

Therefore they have taken the approach with Robotti to work with implements that already exist. Thus the robotic elements add value to the current equipment as opposed to simply replacing it. This is a similar concept to what Continental did and was written about in Direct Driller Issue 9. However Robotti is in a much bigger scale. You can see the machinery in action via the QR Code.



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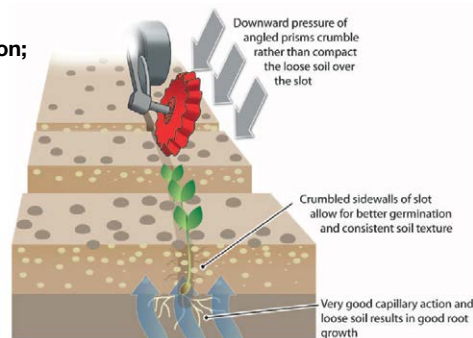


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FIELD ROBOTS MEET FARMERS' MECHANICAL WEEDING NEEDS DURING THE CORONA PANDEMIC

Written by Malene Conlong from the German Agricultural Society (DLG)

The DLG Digital robot webinar explored mechanical weeding as alternative to herbicide: Field requirements, monitoring, wear parts, solar power and remote service.



As farmers around the world face challenges in the use of herbicides in crop production, autonomous robot, capable of mechanical weeding on the field, offers farmers an attractive alternative. At the online robot webinar "Robots for mechanical weeding" organized by The German Agricultural Society on 16th June 2020, international experts in field robots from academia, research and industry

Mechanical weeding offers a solution to farmers in a number of ways. "Either the herbicide does not work as well or is not allowed anymore or, in some cases, societal pressure means some products, like glyphosate, cannot be used anymore. This is where autonomous mechanical weeding could provide a key solution," said Klaus Erdle, DLG Competence Center Agriculture, introducing the DLG

commercial robots with the dual feature of seeding and weeding from the Danish company FarmDroid are already working on several European farms, having covered more than 1000 hectares in the Spring of 2020. Using high-precision geo coordinates to seed and weed, the robots are solar powered with a back-up battery and operate with 8 mm accuracy within and between rows, which means manual weeding is significantly reduced and in some cases not necessary at all"

"As a fast response to the Covid-19 pandemic one customer even ordered a second robot", says René Jannick Jørgensen, CEO of FarmDroid, which shows that mechanical weeding robots are already considered to be reliable workers, also in a crisis.

The autonomous robot, which weighs some 700 kilos and has a working width of three metres, works both thoroughly and precisely at a steady pace of between 450 and 900 metres per hour. The FarmDroid can be



discussed what is practically possible for farmers today, including using field robots during the Covid-19 pandemic.

Digital webinar.

FarmDroid

Designed for fields of up to 20 hectares,



left in the field over the season and will carry out the work by itself through its connection with the RTK station.

Arno Ruckelshausen, Professor at the University of Applied Sciences Osnabrueck, Faculty of Engineering and Computer Science, Germany, noted that there are still legal and technical obstacles that need to be overcome

before field robots will overtake the herbicide solutions.



With 30 years' experience in mechanical weeding and field robot solutions for tractor-driven implements, including various sensor technologies, Germany company K.U.L.T. (Kress Umweltschonende Landtechnik GmbH) showed that autonomous mechanical weeding in the field is possible, but currently due to legal constraints still needs to be supervised by the driver.

In fact, farmers need to be actively involved when employing a field robot. "Farmers have to make a step towards the robot too, being open-minded for new developments, but also things like security systems to make them stop if there is a problem and, of course, they need to monitor the robot. A full control of the systems is important for the future set-up on farms," explained Christian Kirchhoff, CEO, K.U.L.T., to the 450 viewers.

Practical farming expert, Dr. Beat Vinzent, Bavarian State Research Center for Agriculture, Germany, agreed. "It is a bit like when dairy farmers first discovered milk robots. They needed some time to adjust to the fact they were no longer just dairy farmers, but needed to learn to handle the system. But in the end this turned out to be just a transition period."

"How successful the adoption of robots by farmers continues to be in the end will certainly depend on the reliability of the systems and on whether farmers own the robots or if they just buy the robot work as a service from a contractor," added Dr. Vinzent.

Field requirements, wear parts, remote service and security

"From our experience we know that farmers are ready to adopt the technology, even many small farmers," commented René Jørgensen, CEO of FarmDroid. "They recognize it still requires some effort. The wear parts need to be considered since minimal tillage can be hard on tools, so the farmer of course has to ensure that the parts are in good condition. Simply speaking, the same attention you give a tractor, you need to give a robot. We can track the robot any time, if required for security reasons, and we are also currently setting up a remote support centre that can identify any issue and deal with it before it become a problem in the field," added Jørgensen.

The requirements for some robots, like the one from FarmDroid, state that the field should not exceed 10 degrees slope which is determined by the power-to-weight ratio of the robot.

Return on investment within two years

Questions from online attendees covered investments and costs



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"How much do I have to invest?" "What is the return on investment?" "How high are the costs of maintenance?"

"Seven hectares and above gives a feasible business case, dependent of the crop type" explained Jørgensen. "Return on investment is less than two years in a typical scenario in which a farmer uses the robot for organic sugar beets for the spring season and then again for rapeseed, or any other similar crops, in the autumn. We have had creative farmers who have utilized it for many different crops and herbs, thus they themselves have managed to improve the business case beyond our calculations," added Jørgensen.



seeding and in-row weeding robot from FarmDroid is priced at 65,000 Euros.

Future trends – Machine learning to distinguish between weed and crop; Swarms of robots will work as teams

"Over time, field robots will learn how to distinguish more accurately between weed and crop. This is achieved through analysis of literally thousands of images recorded by field robots that



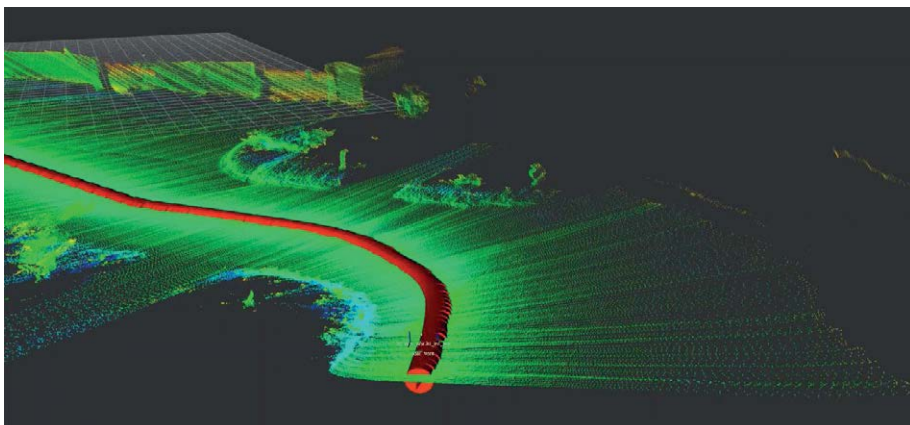
moisture of a plant and if it needed water, it could send a signal to another field robot, which would react and provide the required moisture. This is what has been termed 'swarming'. The field would be equipped with several small autonomous robots that would work as a team," concluded Prof. Ruckelshausen.

Crop residue and stone detection

A question was raised in the webinar chat about how well the robot can cope with crop residues and stones in the field. "It is only a matter of time until a robot will be able to cope reliably with crop residues," says Dr. Vincent, Bavarian State Research Center for Agriculture.

Klaus Erdle, moderating the online webinar concluded that it was interesting to note that two companies with such diverse backgrounds and approaches both agreed on the promising future of mechanical weeding.

"What is clear from this afternoon's session is that the farm has to make a first step in giving the technology a chance to adapt to the field. We cannot expect everything to work



"Machine learning will play an important role in the complex area of crop recognition," emphasized Prof. Ruckelshausen

"The FarmDroid robot can be easily transported to another field using a tractor to get an even better business case by covering more hectares," he added.

The prices of robots reflect their functions. The field robots from K.U.L.T., which uses a combination of GPS, lidar and camera sensing technologies, range from 25,000 Euros for small ones and 125,000 Euros for larger ones with in-row equipment. K.U.L.T. supplies robot systems to Naio robots, an Agritechnica innovation award-winner from France. The autonomous

enables the distinction between weeds and crop in the field. In other words, the field robot will be able to tell what kind of crop it sees and distinguish between harmless and critical weed. With this knowledge accumulated over time, the robots will be able to compare previous experiences, which will result not just in smarter robots, but also in smarter weeding," commented Prof. Ruckelshausen.

Other future trends noted by Prof Ruckelshausen include quality checks of the soil and plants. This could mean that field robots could specialize in tasks. One could be measuring the



perfectly. "Chemical spraying is still a top technology, but even the chemical spraying discipline went through a lot of learning steps. It is fair to say that robots will go through many phases still, perfecting their skills, but right now as we have seen today, field robots show a promising solution that will impact practical farming in the future quite quickly," concluded Erdle.

Field robot contest – a regular feature at DLG Feldtage exhibition

Field robots capable of "manual" weeding are under continual development by talented engineering students at universities throughout the world. A review of the many complex manoeuvres – weed recognition, weeding or headland turns - performed by field robots are shown in this science-fiction inspired video compiled by the DLG, the German Agricultural Society.

The students had planned to let their robots perform their advanced skills in the field at the international Field Robot

Event (FRE), held at the DLG Feldtage exhibition, now postponed until next year due to the Covid pandemic.

The Digital Webinar

The speaker panel consisted of:

- Christian Kirchhoff, CEO K.U.L.T. Kress Umweltschonende Landtechnik GmbH, Germany
- René Jørgensen (CEO) at FarmDroid ApS, Denmark
- Arno Ruckelshausen, Professor at

the University of Applied Sciences Osnabrueck, Faculty of Engineering and Computer Science, Germany

- Beat Vinzent, Bavarian State Research Center for Agriculture, Germany

Moderated by Klaus Erdle, DLG Competence Center Agriculture, Germany

The event can be watched back on YouTube:



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BREAKING THE CYCLE WITH GROUNDWELL AGRONOMY: THE FUTURE OF AGRONOMY REIMAGINED

By Richard Harding, ProCam - all views are my own

It was very refreshing to read Adam Driver's Farmer Focus article in issue 10 of Direct Driller. In this update, Adam echoed many of the thoughts I've held since I began my agricultural studies. It seemed then, as it does now, that our constant desire to externalise the problem and then purchase the solution - not by any means unique to farming - is a very flawed approach. We are all seduced by technology, me included, sometimes. Which leads to the assumption that nothing, but a man-made solution is able to provide the answer to agriculture's biggest challenges, whether they are perceived or real. This takes us back to Adam's article and his comment about the widely purported "feed the world" narrative, which is really about encouraging increased production at all costs, rather than recognising that the reality of hunger is more about politics, the unevenness of food distribution and fundamentally historic economics.

An illustration of our addiction to technology came just last week. At the end of a long day of soil sampling - stubbles to be precise - on a sunny September autumn afternoon, I suddenly felt that sinking feeling while

discussing soil sampling with a local farmer. We were comparing the very pretty variable spreading maps that had just been produced by a local liming company, with my just-completed more random soil sampling done by hand. To my surprise the farmer was more pragmatic, and wise enough to see that while this would be perceived as progress by many it was unlikely to produce a more reliable result than my random W sampling pattern across his fields. However, what I was doing couldn't be achieved by those specific maps. By this I mean: picking up the nuances of soil friability, compaction, getting a sense of biological activity through smell, and the general suitability of the soil for direct drilling of the next crop. Or, what the next crop should be, based on the soil's current state; for instance should we be sowing another cereal if there was enough friability, with or without a companion. Or should it be a large seed like a bean to restructure the slumped soil needing some restructuring with roots not iron? While I completely see the value that precision farming has, we occasionally need to ask the right questions of it and its interpretation. I agree with Victoria Sweet's question in her article

about Slow Medicine, that sometimes it could be a case of "Is inefficiency more efficient than efficiency?" (ref. Gods Hotel by Victoria Sweet, Riverhead Books. ISBN-13: 978-0399573316).

While looking round for some inspirational words I came across something I had seen a number of years ago in Brake the Cycle, a 2013 fundraising video for the Building Man Festival. To quote from that: "Given





we've had the cosmic shift, we are super apes, it's time to be evolution. Let us set our hopes high, have sky aspiring ambitions and reimagine our collective potential". While there's no denying this year farmers are feeling jaded by the extremely difficult season just gone, we need to keep pushing forward and resist the temptation to revert back to type and do what we've always done. The caveat to that statement is always to do so within the risk profile of the farm business as it stands today. The only question left is how exactly do we do that, and where should the enlightened advice for this come from now and in the future?

The enlightenment has come in the shape of a new agronomy service from the home of the Groundswell Show and Conference.

As many readers of Direct Driller will know, the Groundswell Show and Conference was born out of a strong desire by the Cherry family to spread awareness of Conservation and Regenerative Agriculture techniques. This involved creating a forum for learning and networking, not only for farmers but for all those who are involved in the food supply chain.

While discussing the farm's agronomy around the kitchen table at Weston Park Farm back in 2019 it seemed obvious, as there are a growing number of converts to farming in this way, that the natural next step was to provide a Groundswell agronomy and consultancy service. A service available to anyone interested in investigating or implementing anything from a complete system rethink to just one specific technique of Conservation or Regenerative Agriculture. Tailored to provide as much, or as little, ongoing support as is required.

A common request among farmers and attendees of the Groundswell Show and Conference is for advice on implementing ideas picked up at

Groundswell, on their farms. Farmers often talk of feeling isolated when surrounded by peers who may not be supportive of a change to the radically different system from the one they are used to. Groundswell Agronomy approved Consultants will be able to provide the advice needed to ensure the rural farm business is financially resilient and agronomically sustainable whatever the farming system - arable, mixed farming, horticulture or mainly livestock.

"The core underlying value of the Groundswell Agronomy Service is: independent advice and knowledge transfer through industry-wide collaboration"
–Richard Harding

The Groundswell Agronomy and Consultancy is made up of a national group of independent consultants offering a wide range of services which can be tailored to each unique situation and key features include:

1. Independent consultancy advice charged by the hour or day.
2. A traditional agronomy service charged by the acre with or without financial benchmarking which includes both confidential benchmarking provided by Land Family Business, charged on an area basis and membership of a regional Groundswell discussion group, which farmers are encouraged to join.
3. Trials and telephone agronomy service specific to Conservation Agriculture.
4. Practical support from experienced farmers practicing Conservation and Regenerative Agriculture.
5. Groundswell Farm - hosted individual technical events.
6. Livestock consultancy –specific to Conservation and Regenerative Agriculture.
7. Environmental Scheme planning and Direct Payment Scheme advice.

8. Facilitating Groundswell local meetings of farmers with reference to each specific regional need.

Just one example of existing industry collaboration is that of the first Groundswell Agronomy benchmarking and discussion group, facilitated by Gary Markham from Land Family business. While only in its third full year it is not only providing some reliable data on the profitability of farms practicing Conservation Agriculture it always combines discussions on the physical and financial performance of the group's farms, striving for continual improvement through knowledge transfer.

Below are some of the provisional findings from the group's results. We look forward to expanding the Benchmarking groups and if you're interested in joining a group in your area contact richard@groundswellag.com

No-till/ Conservation Agriculture compared with conventional plough-based system*:

- Capital value of machinery -£186/ha less
- Capital value of machinery -£13/tonne of wheat less
- Variable costs -£74/ha less
- Working capital -£260/ha less (for example £130,000 less on 500ha farm)

*Source: Groundswell & LFB Benchmarking 2018/19

One main advantage of a CA system particularly in a difficult season like 2020 has been the reduced capital required to run the farm business. Allowing the risk to be diversified over a range of non-farming activities much like a CA cropping rotation.

To be part of reimagining your collective potential with Groundswell Agronomy contact richard@groundswellag.com



EMBRACING THE NO-TILL 'GREENHOUSE' EFFECT

Written by John Dobberstein from No-Till Farmer USA and originally published in July 2018



PRECISION NO-TILL. West Union, Iowa, no-tiller Loran Steinlage has seen as much as a 15-bushel yield benefit in corn by interseeding it into cover crops with planters and drills he's built or modified. Ever in search of increased productivity, Steinlage is converting his 750-acre farm to relay or "companion" cropping to take advantage of synergies from raising several crops together.

From interseeding to relay cropping to 'engineering by inventory,' Loran Steinlage is building a profitable, divergent no-till operation

Several years ago, a trip with friends to look at greenhouses led Loran Steinlage to a Mennonite farm. It was there that he started looking at his farming practices a little differently.

The farm owner had a brand new, ice-block construction house and shop and three brand new Massey Ferguson tractors. "And if you understand the Mennonite faith, they don't borrow money, so he's making some serious money on 20 acres," he told attendees at the National No-Tillage Conference in January. "From that time on, I've really been trying to focus how we do things on our farm."

And Steinlage's farm doesn't look like most others in his state. Soil tests, crop yields and even infrared videos from his fields are proof enough that no-tilling, cover cropping and alternative planting systems are improving his farm's soils

and profitability.

On the Fringe

Steinlage's 750-acre farm sits in the northeast corner of Iowa in the Paleozoic plateau, on the edge of the glacial-till line. His area only sees 140

frost-free days, and he estimates his fields have at least two dozen soil types.

Steinlage used to raise continuous corn for many years, but rootworm resistance and weed issues started building up. He began working more closely with the NRCS in 2006 and since has brought soybeans and winter wheat back in the rotation.

This year he replaced Roundup Ready corn and soybeans with 100% non-GMO hybrids and varieties. He also raises barley, winter wheat, cereal rye and buckwheat for cash crops, and rye and wheat for seed.

Steinlage no-tills corn around April 17 at a rate of 21,000-38,000 seeds an acre, although he saw later planting dates this year with his non-GMO hybrid.

Because Steinlage variable-rates all his seed corn, using a DigiFarm RTK guidance, "we automatically get variable-rate cover crops because the covers thrive when you drop that plant population down to 21,000 to 24,000," he says. "Where do we need the covers to be better? On the gravel knolls. We're monitoring and seeing how fast we can gain soil organic matter on our hills."



NO-TILL HANDOFF. Non-GMO soybeans relayed near twin-row malting barley emerge in early June on Loran Steinlage's farm. He believes relay or "companion cropping" allows for long-forgotten synergies to take place with maturing plants, noting he's seen that on his farm with relayed soybeans and buckwheat.

Steinlage typically interseeds cover crops into corn when it's at the V2-V3 stage. He rarely runs the interseeding units any slower than 10 mph, usually shooting for 11-12 mph.

He shifts corn planting over 5 inches so no changes are needed for the seeders or his John Deere 8400T tracked tractor.

Over the last decade, he's tried various combinations of interseeded covers, including clover; annual ryegrass, red clover and radish; cereal rye, winter wheat, lentils and sweet clover; dwarf-Essex rapeseed, crimson and balansa clover and oats; phacelia, buckwheat, hairy vetch, flax and winter peas; faba beans and chickling vetch; and meadowfoam.

When growing corn on corn, he interseeds clover or vetch. As his rotation has changed, Steinlage often seeds winter wheat into soybean stubble going to corn and cereal rye into corn stubble going to soybeans.

A Big Shift

Although Steinlage has been known for his interseeding prowess, he's in the middle of shifting much of his operation to relay cropping, or what some refer to as companion cropping. It's the practice of planting different crops in proximity for pest control, pollination, providing habitat for beneficial creatures, maximizing use of space, and to otherwise increase crop productivity.



RISING UP. Corn no-tilled in 30-inch rows into twin-row winter wheat emerges in early June on Loran Steinlage's farm. The wheat was terminated about a week after planting. Steinlage likes to vary the populations on his corn, noting that lower seed counts allow cover crops to be more prominent where he's trying to improve soils, such as gravel knolls.

Many of the modern principles of companion planting were present many centuries ago in cottage gardens in England and forest gardens in Asia, as well as thousands of years ago in Mesoamerica.

"The biggest thing I see on companion cropping is productivity. I want my cover crops paying. When I committed

to cover crops, that's where I started and that's what I'm going to stay with," he says.

Steinlage is in his fourth year of relay cropping on a field scale. He began investigating synergies between different crops planted together several years ago, noting the productive 'Three Sisters' plantings by Native Americans of corn, soybeans and squash. Soybeans he planted in his own greenhouse in this manner that were supposed to be 12 feet tall grew 18 feet high.

This year, due to switching to non-



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GMO corn and soybeans and planting later, Steinlage interseeded about one third of his acres — mostly corn — with cowpeas and is relay-cropping the remaining acres with summer legumes. He typically sidedresses corn with N with his interseeder at V7-V8.

The DigiFarm RTK system in the tractor lets Steinlage shift rows over 5 inches to place seeds right next to the old plant into minimal residue.

He's found relay cropping can be very profitable compared to traditional no-tilling methods. A projection budget he shared this year showed 30-bushel cereal rye and 30-bushel soybeans, paying at \$10 a bushel each, and 400 pounds of buckwheat could make him \$660 an acre, which he feels compares favorably to 200-bushel-an-acre corn.

"The scary part is I know we can double those numbers," he says. "Do I have to farm the world? No, just got to farm smarter."

This year, Steinlage reduced his corn acres and focused on interseeding and relay seeding more warm-season legumes into his cash crops, taking some inspiration from his friend Chris Teachout, a veteran no-tiller and cover crop experimenter from Shenandoah, Iowa.

Teachout last year managed a warm-season legume interseeding test plot on his farm for Practical Farmers of Iowa where less than 40 units of nitrogen (N) was applied to corn. There were three replications of corn interseeded with cover crops, but in one area there was an early primer of cool-season covers that included brassicas ahead of corn.

Corn that followed the primer cover crops and was interseeded with treatments of fava bean, cowpea, corn/soybean/squash and sunnhemp all yielded 200-213 bushels an acre with just 40 pounds an acre of N applied, the study data shows. A test strip with the primer covers, but nothing interseeded,



IN THE SLOT. Loran Steinlage plants soybeans into cereal rye with a new seeder he fashioned from a 12-row Case IH Cyclo Air 900. Mostly used for relay crops, it can also be converted to interseed or handle conventional planting. The row units include Dawn row cleaners out front and the Case IH Early Riser setup on the back.

yielded 190 bushels.

Workshop Creations

Grand plans for interseeding or relay cropping don't become a reality until no-tillers have a planter or drill outfitted properly to deposit seed accurately and maximize emergence.

Steinlage got his start with interseeding systems several years ago when he used a small Agri-Fab spinner box pulled behind an ATV to seed cover crops into corn seedlings. Since then, he's gone through several different toolbars that he's modified for interseeding.

An early interseeder model used 7 years ago, while he was still strip-tilling, included a toolbar mounted with a Gandy air seeder. It was used to interseed up 80 acres of corn, but the machine proved to be too small to expand the practice.

He later revived an old 30-foot Hiniker drill that was adapted for twin-row seeding of cash crops and cover crops. It was later sold and he used the money toward his next machine.

In 2016, Steinlage worked with Dawn Equipment to build an interseeder comprised of a Dalton toolbar and the company's DuoSeed Cover Crop Inter-

Seeder row units from Underground Agriculture. Dawn also helped provide some modifications to allow for row-cleaner mounts for Dawn row cleaners, seed firmers and a Precision Planting 20/20 monitor.

Steinlage made further improvements, creating an in-row roller attachment for the DuoSeed units to roll down cover crops and interseed at the same time, saving time and fuel. Steinlage started using it to interseed annual ryegrass, cereal rye, clovers and other cover crop species into corn that's generally at the V4-V6 stage.

He runs the machine with a Hiniker box to drill soybeans, then switches the box out for a Montag to interseed covers and sidedress nitrogen. The interseeder also includes poly self-adjusting row cleaners.

"With the Montag tank I can dump four totes of seed in there and we go to work. We're drilling cover crop seed, we're interseeding with it and we're doing all our fertilizer application with it," he says. Adding this advice, "If you want to make a piece of equipment pay, build it with some versatility so you can use it."

"If you want to make a piece of equipment pay, build it with some versatility so you can use it..." — Loran Steinlage

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SINCE 1856



Never one to accept the status quo, Steinlage rolled out yet another seeding device in June, a 12-row Case IH Cyclo Air 900 that he modified to mainly handle relay cropping. But he can also interseed or do conventional planting with the machine. The row units include Dawn row cleaners out front and the Case IH Early Riser row-unit setup on the back.

A big key to the planter's setup is a Sukup Slide Guide that he modified to shift 15 inches in either direction, allowing the machine to do relay, interseeding or regular no-tilling.

Steinlage also owns a John Deere 1760 corn planter that he's modified with precision technology, parallel arms with bearings that he built himself and Shoup Mfg. Co. cast-iron row units.

Despite the changes in equipment and associated costs, Steinlage says the cover crops are paying their way. He reports an average 15-bushel increase in the current no-tilled corn crops when they're planted into cover crops.

'FLIR'ry of Data

Steinlage says he's gathered some interesting data on the impact his no-till system is having on his soils and popular assumptions made about cover crops by farmers and experts in his northern climate.

On one field he's been interseeding for several years, soil tests show the percentage of water-stable macroaggregates in the soil is at 70% on a 5-year basis, on par with restored prairie and up 30 percentage points from levels typically seen in fields with continuous corn. Pasture grasses and prairie remnants score in the 90% range.

Soil organic matter levels range from as low as 1.7% in gravel knolls to 6% in his better soils. He's found through soil biology tests that recovery of organic carbon on his farm has been slower than with recovery of soil aggregates, he says.

Soil Temperature Measurements

One of the myths often repeated about

no-till and cover crops in the Upper Midwest is that residue left in fields in the spring before planting makes soils colder and wetter, requiring tillage to warm soils up.

Wanting to find out for himself, in 2016 Steinlage bought a forward-looking infrared (FLIR) camera for his iPhone to take heat measurements in his fields, even doing side-by-side comparisons with his farm and a neighbor's.

Steinlage has infrared video from March 2016 of a field on his farm with cereal rye and soybean stubble next to a neighbor's tilled, ripped soybean stubble. The video shows soil temperatures as high as 47 F on Steinlage's field vs. temperatures as low as 37 F in his neighbor's field where the soil is more bare.

Another experiment where Steinlage raked residue away from a 10-by-10-foot plot in one field showed soil that was no-tilled and cover cropped were as high as 46-50 F, and as low as 36-42 F in the uncovered plot.

Steinlage says no-till residue and cover crops provide a beneficial insulating effect. Data from soil probes he inserted at a 4-inch depth has also shown soils were warmer in areas with covers in spring than uncovered soils, until equipment passes made temperatures spike cooler, he says. As warm weather arrived, the canopy kept soils cooler and the soil got warmer again after harvest.

"We make people scratch their heads pretty hard, with the results" he says.

Is Wider Better?

Steinlage is also looking for a way to get livestock back on his operation. But as you might expect it won't be the conventional way.

A couple of years ago he was invited to visit some farms in Ireland. While there he noticed the large amount of sheep used in grazing systems, with corn planted to 40-inch spacings so the animals could fit between the rows.

Hoping livestock will allow his daughters to help manage the farm when they return, Steinlage started working with consultant Bob Recker of Waterloo, Iowa-based Cedar Valley Innovation on experimenting with

different corn populations and row configurations that could lead to livestock grazing in living corn.

Recker is working with 14 growers in Iowa, Illinois, Wisconsin, Minnesota and Ohio on wide-row concept test plots for 60-inch rows. The wide-row system is defined as omitting one row to provide added sunlight to corn and interseeded cover crops. No-tillers turn off every other row on a traditional 30-inch row corn planter and double the per-row population in the other rows.

Plot work last year showed either a small or no yield penalty for 60-inch corn if populations were doubled in the 60-inch rows with the number of seeds per acre remaining the same. Where cover crops were used, the 60-inch rows significantly increased growth of the cover crops compared to 30-inch rows.

On his plot last year, Steinlage planted two rows of 30-inch corn at populations of about 34,000 seeds per acre, skipped a row and then planted two rows of 60-inch corn with populations over 50,000 seeds an acre.

His corn yields for 60-inch rows were 230 and 223 bushels an acre, but 213 bushels for 30-inch rows. Steinlage says those numbers compared favorably to 30-inch corn with or without cover crops on other farm plots Recker studied.

Recker also oversaw experiments with 60-inch monocrop corn and the resulting yields of 221 to 238 bushels an acre also exceeded expectations.

One goal of the wider rows is to allow access to the field any time of the year, which would be beneficial for high-clearance equipment, companion cropping or possibly grazing.

"If you can grow 60-inch corn and equal 30-inch corn and eventually have a grazing opportunity, isn't that something you'd look at?" he says.

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BASE UK

We had a busy start to 2020 with members visiting Agrovista's Project Lamport site on a cold and windy day in early February where Niall Atkinson and David Purdy talked about the results so far on soil management, soil structure and biology of the trials. Philip Wright added more detail on cultivations. They also visited a field of OSR where establishment plots with and without companion plants told a clear story on how adding diversity rather than mono-cropping can bring benefits.



This was followed by our annual conference and AGM on 11th and 12th February held in York. This was a great success attended by 150, with a wide variety of speakers discussing subjects as diverse as mob-grazing to how the mindset of farmers dictates how they cope with changing their systems from conventional to CA. A delicious dinner was followed by an intriguing quiz on seed types kindly provided by Ian Gould and we celebrated the 21st birthday of one of our newest members, Donald Christie.

Sadly, our next events were put on hold due to the Covid 19 situation and it has been really disappointing not to see one another at shows, farm walks and other events and visits which had been planned by the Committee. Once it became clear that the social distancing rules were not going to be lifted any time soon, the Committee took up the offer of setting up a BASE-UK Members Only Forum, hosted by The Direct

Driller which has proved to be quite successful.



The Committee also decided that to provide members with some interaction it would be great to hold some online meetings and these have proved a big hit so far. In July Kelly Jowett from Rothamsted Research provided a fascinating presentation on Carabid Beetles and in August James Warne from Soil First Farming discussed Cover Crop Strategy and The Path to Conservation Agriculture. These were loosely based upon his articles written for The Direct Driller magazine but also gave members an opportunity to open the discussions further. Whilst we planned for these to last an hour, the discussion went on for much longer.

As I write this we have just held another online meeting with Robert Brewster (who spoke at our AGM Conference and had planned to host a visit to his farm in Scotland) presented on how to Build Soil Health with Mob-grazing. This proved inspiring to those with and without livestock and we hope that our planned trip will take place sometime in the future.



SAVE THE DATES:

Going forward we have plans for more meetings for members including:

- 14th October – David Purdy and Mark Hemmant from Agrovista discussing Project Lamport results and what the future holds for this trial.
- November – date to be confirmed – members meeting with Adrian Newton from The Hutton Institute and Henry Creissen from SRUC presenting on IPM as a concept and practices under CA systems. More details will be sent to members in due course.
- We have invited Frederic Thomas from BASE France to present an online meeting (it is not likely he will be able to get to us from France any time soon!) – again the date is to be announced.
- 9th and 10th February 2021 – AGM Conference at The Park Inn by Radisson in York – Covid allowing!

BASE-UK, within its membership has unparalleled, impartial, practical expertise in the field of conservation agriculture which is not only openly and widely available to members embarking or contemplating initiating 'regenerative' practices on their own units but also caters for the more 'well-seasoned' practitioners.

Membership is for individuals and if you would like to know more about us please visit our website

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DRILL MANUFACTURERS IN FOCUS...

mzuri STRIP TILLAGE BEST PRACTICE

At Mzuri, we champion sustainable establishment, and we believe strip tillage answers the questions that many growers are now asking to improve their yields, promote healthier soils and reduce operational costs.

We pride ourselves on supporting our customers and so we've shared our top 'Best Practice' tips that help growers get the best out of the Mzuri strip tillage system:

- **Correct strip tillage technique starts with the combine.** "By failing to prepare, you are preparing to fail," an old maxim which is also true for strip tillage. Good practice starts with preparing the perfect "canvas" to drill into and this means ensuring the field is "striptill-ready" at harvesting. We recommend an optimum stubble height of 150-250mm to ensure it flows well through the Pro-Til. An even distribution of chopped straw and chaff is also desirable as uniform mulching around the field is paramount for ensuring good moisture retention and availability of material for earthworms to turn into nutrients.



- **To chit or not to chit?** Although the Pro-Til will happily drill directly into surface straw in a one pass operation awarding excellent residue clearance, some growers may prefer to create a stale seedbed prior to strip till drilling. This is particularly pertinent for farms with a blackgrass or slug problem or for users who wish to accelerate straw decomposition. In this situation, we

recommend the Rezult straw rake. It features five-rows of extra stiff tines with the option to fit a set of leading discs. The result is a nice, light tilth creating the perfect stale seedbed.

- **Get the light right.** Good light interception from early growth stages is key to strong plant structure and high yields. The stubble height of 150-250mm is ample enough to shield the crop from cold temperatures and winds yet short enough to ensure the plants get sufficient light, providing an optimum micro-climate.
- **Leave the surface straw...** on the surface. Leaving previous crop residue on the surface helps retain moisture, reduce erosion, and improves organic matter.
- **Give the seed the best start.** The secret to fast and successful seed germination is good seed to soil contact for instant availability of nutrients and moisture. Soil must be reconsolidated to eliminate the air pockets leaving friable, fertile tilth to give the seed the best start. This is what the Mzuri Pro-Til does



exceptionally well thanks to its combination of unique, patented features. The auto-reset tines produce the perfect tilth with the option of placing a band of fertiliser just where it is needed, followed by the reconsolidating wheel. The coulter tool bar works totally independently to the cultivation zone, ensuring easy adjustment and constant seed depth control. Each coulter hydraulically exerts pressure to each of the seed depth wheels to ensure accurate seed placement and excellent soil to seed contact. As a result, the crop can get away quickly and grow to achieve its full potential.

- **Understand your soil.** One size does not fit all and so we recommend you should look to tailor the equipment to best suit your specific conditions. We offer a range of front leg options to easily adapt to any type of soil, including a choice of front discs and leading leg configurations. The optional front discs cut through surface residue and help to create a tilth with minimum soil disturbance. The choice of the cultivation leg and wing tips control the tilling depth and profile. Wider wings are typically fitted when seeding with a wide band coulter whereas narrow wings are best suited for drilling with a narrow coulter in harder ground.
- **Select the correct seeding coulter.** Not only is there a whole host of options to tailor to the soil, we also offer a range of seeding coulters to suit the crop too. Wide band seeding is recommended for wheat and barley whereas narrow band seeding would be better suited for oilseed rape and beans.
- **The choice of wheels is also important to ensure the right amount of pressure is exerted.** The Pro-Til can be supplied with a wide or narrow wheel profile to match the coulter and soil type. Dry soil conditions need slightly more pressure to ensure better seed to soil contact whereas drilling in wetter soils requires a lighter approach in order not to cap the soil.
- **The final touch.** The Pro-Til is supplied with a harrow bar which produces the perfect smooth finish for better coverage of pre-emergence herbicides. Some users prefer to keep the tilth profile untouched in order to create a microclimate which can be up to 2-3°C warmer in the ridges – a practice which is particularly popular in colder climates with freezing winters. The slightly raised contours of the ground coupled with the surface straw each side of the crop row provides shelter from wind damage and sub-zero temperatures. This practice can ensure a viable crop where conventionally drilled crops would often fail in the same conditions.
- **Rotation, rotation, rotation.** At Mzuri, we promote a minimum 4-year rotation to increase crop health. The changing of crops in a sequence reduces their resistance to chemical, builds up plant resilience against disease and helps to combat persistent weeds. With the Pro-Til single pass system promoting better establishment, users can feel more confident to include spring crops into their rotations, whilst we actively encourage users to experiment with cover crops and companion species for greater diversity and soil health benefits.

For more information on the Mzuri strip tillage system visit www.mzuri.eu or call **01905 841123**



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SOIL FARMER OF THE YEAR WINNERS ANNOUNCED

The Soil Farmer of the Year competition has been running now for the last five years and aims to find, promote and champion those farmers who are putting soil health at the centre of their farm business management. This year the competition has been slightly challenging to run due to the COVID pandemic and the inability to conduct judging in person. Our finalist farmers all did a magnificent job at creating videos detailing their individual farm journey to sustainable soil management as well as enduring a virtual grilling from the judging panel to decide the results.

The top accolade this year has been awarded jointly to two farmers, Jake Freestone from Overbury Farms and Alex Brewster from Rotmell Farm. Both farmers were doing amazing things around soil management in very different locations and settings. Our third place farmer this year was John Martin, an arable farmer from Dorset who has been working on soil management for over 20 years.

Normally by this time of year the farms walks have taken place and this article is a write up of the discussions that ensued, however this year things are a little different. The farm walks will be taking place in October, with some online and some in person with the required safety guidelines. All the information about the farm walks is available on the Farm Carbon Toolkit website (www.farmcarbontoolkit.org.uk). So its probably time to meet our winners for 2020!

Jake Freestone has been managing Overbury Farms since 2003. The farm sits within the wider estate on the Gloucestershire / Worcestershire border and is a mixed farm with 1600 ha of farmland, both permanent pasture and arable cropping, some land let out for vegetable production and a flock of 1000 ewes. The soils are incredibly varied on the farm from Cotswold Brash to an Evesham Clay series, and the farm has a diverse and wide rotation to help deal with the variety. The rotation includes wheat, spring barley, oilseed rape, peas, beans, linseed and quinoa. Jake started focussing on soil health and looking at adapting management following his Nuffield scholarship, working on a reduction in cultivation, improving organic matter and diversifying the rotation.

"Switching to no till has given us huge soil health benefits on the farm," Jake explains. "It's enabled us to grow bigger and better cover crops, that we can drill straight into which is reducing our costs, but also improve the soil structure and the organic matter. Especially on our stonier soils, we aren't having to move the stones as we were previously when we were cultivating conventionally, and the soil structure is also protected, helping with water infiltration which is key on this farm as we supply the nearby villages with drinking water. Other benefits come from a reduction in weed burdens and the ability for the farm to support enhanced biodiversity, so no till is really a crucial part of the jigsaw."

Cover cropping is integral to the farm system that Jake is running. A diverse mix of species is planted which effectively captures sunshine, help structure the soil and feeds the soil biology. The cover crops are also helping to reduce soil erosion by effectively capturing rainfall. Future plans include more integration of the livestock into the system to graze the cover crops and optimise the benefits that they bring in terms of soil health and biology.

Jake is seeing the benefits that these changes have made both in terms of improved soil health and structure but also



Alex Brewster



a reduction in costs. Benefits include the soil being easier to work with which has led to a faster work rate and a reduction in diesel costs. Water infiltration is enhanced and there is a large reduction in runoff and erosion, with any runoff that does happen being clean water. Jake is seeing more insect life and reduced pest issues alongside no insecticide use and has managed to reduce both nitrogen and phosphate fertiliser rates.

The journey hasn't reached an end though and there are more innovations and experiments planned including the use of a fertiliser tank on the front of the drill to apply biological inputs at the time of drilling. Other experiments include companion cropping and looking to optimise integrated pest management and a continuation of the reduction in Nitrogen fertiliser usage across the farm.

Jake explains, *"Ultimately we are trying to use all the tools that we have to improve soil organic matter, water infiltration and wider water management, soil structure and soil biology to achieve the long term goal of improving our resilience both for our crops, our business and our soil."*

Alex Brewster farms at Rotmell Farm in Perthshire. The farm is an upland beef and sheep farm with 200 breeding cows and a flock of 700 sheep. The farm occupies just under 1000 ha with 130 ha of that being improved pasture based on a sandy clay loam soil and the rest being rough hill ground with typical upland soils.

Alex has been working on building the biological capacity within the soil through the use of rotational and mob grazing systems. Starting out with a transition to a rotational grazing system, this has now adapted and is a hybrid mob system with a focus on improving the diversity of plants within the pasture. Other goals are to improve both soil organic matter and pH through the use of animals, and to build a deeper root depth and mass to allow the plants to access slightly warmer soils and moisture found deeper in the soil when temperatures drop in the winter. Soil temperature is the biggest limiting factor to grassland production, so by allowing the plants to root deeper and providing a cover on the soil through trampling some of the grass down, the soil can be protected from the weather and stay warmer for longer. This also transfers some of the carbon to the lower soil layers.

Alex is also focussing on improving the hill ground and explains, *"There is a huge capacity to improve the potential of the quality of some of our upland areas and the nutrition that*

this ground provides. We are working on sub dividing bigger blocks of land into hill paddocks, we are working on animal impact, building fairly tall grass covers, and then eating off 50% of the grass and trying to trample the rest back in to recycle the nutrient of the remaining 50% back into the top soil."

The increase in diversity is key to the whole system. By increasing the diversity of plants within the grass leys, there is an increase in leaf sizes, grass heights and densities which is more efficient at capturing sunlight which can then be turned into red meat. We want to create a system that optimises the feed value of this plant."

He is seeing the change on the farm especially over the last few of years. The rooting depth has been increased dramatically and the amount of friable soil is increasing to depth. Alex is seeing an improvement in water retention and improving worm numbers. This is all leading to an increasing resilience to extreme weather patterns. However as well as benefits from soil health, there is also a productive benefit arising with the grass remaining greener for longer and the farm being able to keep stock out for longer than in previous years, while at the same time carrying a higher number of stock.

Alex is looking at fields where there are issues with weeds and trying to use analysis and knowledge to understand where there might be an imbalance, and work to try and rebalance the system. One of the strategies that he is employing is the use of a diverse mix of plants in a bespoke forage mix which is used as a break crop that provides winter feed but also provide a diversity of plants which will then start to manage these soil imbalances. The theory is that if we can get the soils correct, then the weeds will drift away.

This rebalancing is also being seen in the forage, both in terms of improved grass yields but also mineralisation from forage analysis. Alex completed regular forage analysis and then targets the minerals for the cattle to address any imbalances found in the forage. He is seeing the benefits both in terms of animal performance but also in the pasture, with a larger rooting depth and root mass within the soil. The results are clear to see as Alex explains, *"we've doubled cow numbers in the last 5 years but we are actually using less bagged mineral than we were 5 years ago."*

There are more plans in the future to continue to evolve and hone the system to achieve Alex's aim of managing a beef and sheep farm which is totally carbon positive, promoting the benefits of animal impacts in land management and the relationship between rumen microbiology and soil microbiology.

Alex concludes *"The Future of farming is this absolute linkage between the total nutrient system. Its total nutrient of soils, total nutrient of pasture, and of red meat produced*



from these pastures and how these red meats then feed back into the food chain. It's a really strong story that's positive and beneficial for the future understanding what food production really should be."

The farmer that came in third place in this year's competition was John Martin. John farms 300 acres in Dorset on an all arable rotation with two thirds of the farm in spring cropping. The farm was a former dairy farm until 2000, and since then the overarching aim of the management has been to keep the soil status in good health. John's farm is situated in an area with a high degree of designations on it, being within a Class 1 Soil Protection Zone, an NVZ and the Poole Harbour Catchment, meaning that there has been a large focus on efficient nutrient use, especially on nitrogen.

A key strategy employed on the farm to boost soil health and also to help capture nutrients has been the use of cover cropping. All of the land that is in spring crops has a cover crop before it, and John has been experimenting with increasing the diversity of the mix. The mix now includes sunflowers, buckwheat, phacelia, linseed, and various clovers to ensure that the soil biology have a diverse diet. John explains *"its like taking a coach party of people to a fish and chip shop, some will want fish, some sausage and some pie and chips. All of the soil bugs bring something to the party and are all important, so we need to provide a diverse food supply for them so they can do their jobs."*

John is farming on chalk soils and enjoys the challenges that this soil type can bring. He first started looking at soils in the 80s, digging his first soil pit in 1985. This then prompted a move towards bigger, low ground pressure tyres and focussing on axle weights of machinery to minimise compaction. There is always a spade in the tractor allowing John to assess the structure of the soil at two key periods in the year; in winter when the soils are wet, to assess how the drainage is doing, and then after cultivation to see whether the machine has achieved its goal.

The chalk soils mean that John is keen to build resilience in his soils to aid water retention. A key strategy is focussing on returning organic matter to the soil to build humus. All of the crop residues are chopped and returned to the fields and 75% of the farm is cover cropped to ensure that there is something growing all year round. When John started his transition to enhanced soil management he took some baseline soil samples. He explains *"We tested fields for organic matter and they weren't bad, but we wanted to get another 1 – 1.5%. If we can get hold of that then we've got more resilient soils to do spring cropping. We can tell that we are moving in the right direction as the soils are much more springy. That elasticity is coming from the humus and the soils are developing the resilience to carry us through."*

John's focus on his soils is linked to his overarching aims for the farm which is to develop a more sustainable way of farming with consistent yields. He is involved in a range of applied research projects on the farm, including the ASSIST project, planting flowering strips through the middle of fields to aid in beneficial insect populations and an exciting project looking at reducing leaching from peas through using cover crops with Wessex Water.

Michael Kavanagh and Ian Waller were both awarded highly commended in this year's competition. Michael is farm manager near Wolverhampton and has been totally dedicated to improving soil management over the last five years with amazing results in terms of resilience, profitability, nutrient cycling leading to a reduction in plant protection and fertiliser use.

Ian Waller farms 450ha in Buckinghamshire on an arable rotation that has incorporated cover crops, and is using innovative drilling methods and hasn't applied insecticides for 5 years. He is a passionate advocate for soil management and its role in wider conservation and is constantly trying new things.

For more information on the farm walks please visit www.farmcarbontoolkit.org.uk



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SOIL CARBON SEQUESTRATION IS A NATURAL CONSEQUENCE OF DOING THINGS RIGHT

"This interview was originally published by Rodale Institute, and is part of a series of interviews to inform their new white paper, "Regenerative Agriculture and the Soil Carbon Solution," published September 25th at RodaleInstitute.org/Climate2020."

A conversation with microbiologist David Johnson, PhD about the role of soil health in carbon sequestration.

Rodale Institute's updated climate change white paper, "Regenerative Agriculture and the Soil Carbon Solution," will be published September 25th. To learn more, visit RodaleInstitute.org/Climate2020.

We're in the process of updating Rodale Institute's Regenerative Agriculture and the Soil Carbon Solution white paper and we wanted to learn more about the very promising results achieved with your BEAM system (Biologically Enhanced Agricultural Management). Can you explain what the BEAM system is?

BEAM is looking at agriculture from a different perspective: instead of chemical, looking at it from a biological perspective, to enhance the microbiological soil profile. The farming practices we've adopted over the past 150 years have been damaging to soil microbial communities. The first thing

they really wiped out was the fungal community, which does both logistics and communication in the soil system. If you wanted to start a war, what would be the first two things you'd take out? Communication and logistics; it would be crippling, and that's what we've done in agriculture. From there, the herbicides we've adopted are damaging to the structure of the bacterial community as well. We've hamstrung the soils we're working on, to where they're now living on life support.

When we bring the soil biological communities back, they have a phenomenal effect on productivity. Soil is a living organism, and you have to feed this organism. That means you have to have crops growing continually, either a commodity crop or a cover crop. Crops shuttle the energy from photosynthesis down to the soil system, as sugars, proteins and amino acids, which allow these organisms to survive.

The soil community is not that different from us. We depend on energy from the environment we live in. If we don't have much energy, we're basically caveman. If we start to add energy into the system, we get the ability to reproduce better; a little more energy into the system, we start to see the dynamics of diversity, start to develop different talents; a little more energy into the system and we start to see a synergy, where we're building up a complete community that has functions far above what any single organism

would have. Since we have stressed the soil so much, we've really reduced the photosynthetic capacity of the soils. When we bring the biology back into the system, that capacity rises—we see more carbon use efficiency because a lot of the energy that's flowing down into the soil is being turned into biological life. That biological life in turn harvests the elemental nutrients out of the soil parent material or fixes it from the atmosphere. We've observed that as you keep building this system up, it gets better year after year. I did an initial BEAM compost inoculation—not a lot of compost just a dusting—on a field and as long as we kept cover crops growing on it, the productivity improved year after year after year. We saw a five times increase in that field's productivity within just a year and a half.

That's a big increase in productivity. Was the difference between the treatment and control just the one compost inoculation? Or were the cover crop or other system components different too?

That's just from the compost inoculation alone, the five times increase from the year and a half mark. The system started to rebuild itself. Now, in that experiment we were putting everything back into the soil because I was trying to see, if there was a price on carbon and a farmer was going to dedicate himself to getting paid for the carbon sequestration, what could he do if he just put everything back into the soil? That's where I also observed a quarter percent increase in soil carbon per year.

In a different experiment, we are comparing conventional no-till corn production using 250 pounds of nitrogen per acre to a BEAM treatment, where we reduced that nitrogen by



Photo of David Johnson in a BEAM field, courtesy of the researcher.

85% down to about 38 pounds of nitrogen per acre and added two pounds of the compost per acre as an extract injected into the furrows as we planted corn. Through the microscope, we saw we were putting in about 80 million bacteria and 10 million fungal spores per square foot. At the end of the year, there was 218 bushels of corn produced on the conventional plot and the same amount on the BEAM using 85% less nitrogen. On the plot with BEAM only, no nitrogen, we saw a 6.6% reduction in productivity. This was with only one cover crop in the fall and then we came in with the corn planting. So, in the BEAM system there's 140 plus pounds of nitrogen that came from somewhere. As you bring the biology back, you can start to forego a lot of the amendments you were putting in.

It seems like the BEAM compost is effective with just a one-time application. Why do you think this is so different than an average compost in terms of its practical application and longevity? Especially for smallholder tropical agriculture, making and moving enough traditional compost around is not technically or economically feasible, but maybe BEAM compost is?

Nature doesn't go out and turn the compost pile, it's a static process. That's what we envisioned with the Johnson-Su Bioreactor compost. It's static, so it's never touched, never turned. We keep it at 70% moisture content, which is ideal for fungal growth, and we incorporate worms in it after the temperature gets down to 80 degrees Fahrenheit. It's allowed to mature over one year and it will turn into a clay-like consistency that can be applied as an extract when planting. At this point, we do recommend applying it every year until we know more. It can also be sprayed on as a seed coating and the seeds are fed normally into a hopper at planting.

We designed the Johnson-Su Bioreactor to make fungal-dominant compost, and we wanted it to be accessible all over the world. Now it's in India, Pakistan, Sri Lanka, Fiji, Africa, Chile, a lot of Europe, Russia, Siberia, Brazil and we're starting to get positive reports back. It's economical, and it kickstarts soil systems. We see a lot of happy farmers that have moved towards looking at soils differently, they're more profitable, they're more productive, it's showing benefits.

On those benefits, what have you seen in terms of BEAM's soil carbon sequestration's potential to mitigate climate change?

Soil carbon sequestration is just going to be a natural consequence of proper farm management and proper grazing management. The average dry biomass growth on farms is about 600 grams per square meter. In the most productive ecosystems, nature's doing 2200 grams dry biomass per square meter, without any amendments. In a desert soil, using the BEAM system we saw it go to 3200 grams per square meter. No farmers get that, but the possibility is there.

Bringing the soils back, having them be more productive and having them capture more carbon will take care of atmospheric carbon easily. We can take care of fossil fuel emissions and it's just a natural consequence of doing things right—getting the biology back and regenerating soil systems so they function properly.



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AGRICOLOGY

WHAT IS HEALTHY SOIL VIDEO

A healthy soil is vital to ensure both high yields and future high yields, as well as environmental protection - there are no negative consequences on the ecosystem from having a healthy soil! But what is a healthy soil?



Soil health can be defined as a soil's ability to function and sustain plants, animals and humans as part of the ecosystem.

However, due to the opacity of the soil and the fact that (most of the time) plants grow, the health of the soil is often over-looked. There are five main factors that impact the health of the soil and can have a large influence over its capability and resilience to function, they are:

1. Soil structure
2. Soil chemistry
3. Organic matter content
4. Soil biology
5. Water infiltration, retention and movement through the profile

A healthy soil will have a good combination of all these factors, whilst an unhealthy soil will have a problem with at least one of these. Whether there are structural problems - compaction, plough pans; or waterlogging; these issues will have a cascade effect until all the other factors are impacted. A healthy soil will provide a buffer to extremes in temperature and rainfall - reducing the impact of extreme weather events; it will also be able to maintain productivity and function within an agricultural system. A healthy soil has plenty of air spaces within it, maintaining aerobic conditions.

When a soil has limited air spaces,

anaerobic conditions dominate, leading to waterlogging and stagnation of roots and the proliferation of anaerobic microbes and denitrification (the loss of nitrogen from the system). A healthy soil will filter water slowly, retaining the nutrients and plant protection products (PPP) applied to the crop. If rainfall moves through the soil profile too quickly or if it is prevented from entering the soil through compaction or soil sealing, surface runoff increases, taking soil, nutrients and PPP with it, increasing the risk of flooding.

The potential of cover crops and no-till

At the Allerton Project we have been involved in investigating the sustainable intensification of agriculture through different experiments. Some researchers have investigated cover crops - which have been suggested to be the answer to everything; reducing soil erosion and leaching, whilst increasing water retention, soil organic matter and improving soil structure, as well as potentially suppressing weeds - although our results at this time do not confirm all of this. Other research has focused on moving away from conventional agricultural practice, with greater emphasis on no-till.

One of the fields at the Allerton

Project has not been ploughed for the last 14 years and the soil structure is visibly different compared to other soils on the farm. No-till systems can help improve soil fertility, create changes to the structure and properties of the soil due to the stability of the environment, and enhance soil biology. Over time the no-till field has had the highest yields compared to the conventional field equivalent on the farm. Soil compaction is easily created - one pass of farm machinery at the wrong time (when the soil is waterlogged) can create a compacted layer, which can take many years to remediate. Understanding the mechanisms of compaction and how to alleviate it is another experiment occurring at the Allerton Project this year.

Overall, crop choice, rotation, and management, as well as establishment practice and maintenance can all greatly affect the "health" of the soil.

Dr Felicity Crotty is the Game and Wildlife Trust Allerton Project's resident soil scientist. She writes:

"I have been researching soil biology and soil health for the last ten years. Firstly, I studied the soil food web during my PhD at Rothamsted Research (North Wyke) and subsequently as a post-doc at Aberystwyth University working on the PROSOIL project, which investigated maintaining healthy soil on livestock farms in Wales; and the SUREROT project, that studied the effects of festuloliums as a forage crop. I joined the Allerton Project in 2015. My research covers all aspects of soil science - biology, physics and chemistry; although my main areas of expertise are soil biology, earthworm, mesofauna and nematode identification. Understanding how different management strategies and cropping systems effects the environment is key to sustainable farming and through my work I investigate these changes over time. The main projects I have been working on have been the Sustainable Intensification Research Platform and the EU Horizon 2020 project SOILCARE."

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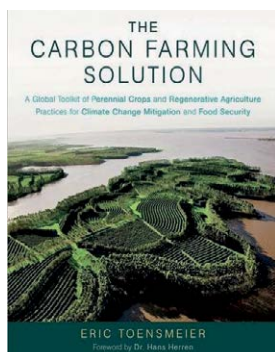
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WHAT DO YOU READ?

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.

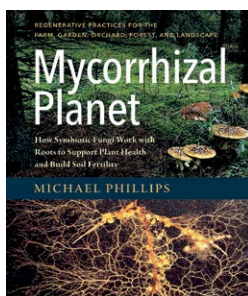
We have listed a few more books you might find interesting, challenge the way you currently think and help you farm better.



The Carbon Farming Solution

Agriculture is currently a major net producer of greenhouse gases, with little prospect

of improvement unless things change markedly. In *The Carbon Farming Solution*, Eric Toensmeier puts carbon sequestration at the forefront and shows how agriculture can be a net absorber of carbon. Improved forms of annual-based agriculture can help to a degree; however to maximize carbon sequestration, it is perennial crops we must look at, whether it be perennial grains, other perennial staples, or agroforestry systems incorporating trees and other crops. In this impressive book, backed up with numerous tables and references, the author has assembled a toolkit that will be of great use to anybody involved in agriculture whether in the tropics or colder northern regions. For me the highlights are the chapters covering perennial crop species organized by use staple crops, protein crops, oil crops, industrial crops, etc. with some seven hundred species described. There are crops here for all climate types, with good information on cultivation and yields, so that wherever you are, you will be able to find suitable recommended perennial crops. This is an excellent book that gives great hope without being naïve and makes a clear reasoned argument for a more perennial-based agriculture to both feed people and take carbon out of the air. Martin Crawford, director, The Agroforestry Research Trust; author of *Creating a Forest Garden* and *Trees for Gardens, Orchards, and Permaculture*



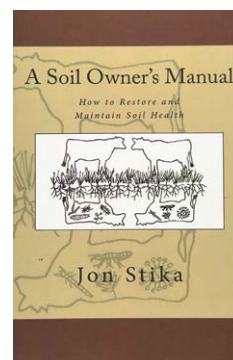
Mycorrhizal Planet: How Symbiotic Fungi Work with Roots to Support Plant Health and Build Soil

An Mycorrhizal fungi have been waiting a long time for people to recognize just how important they are to the making of dynamic soils. These microscopic organisms partner with the root systems of approximately 95 percent of the plants on Earth, and they sequester carbon in much more meaningful ways than human "carbon offsets" will ever achieve. Pick up a handful of old-growth forest soil and you are holding 26 miles of threadlike fungal mycelia, if it could be stretched it out in a straight line. Most of these soil fungi are mycorrhizal, supporting plant health in elegant and sophisticated ways. The boost to green immune function in plants and community-wide networking turns out to be the true basis of ecosystem resiliency. A profound intelligence exists in the underground nutrient exchange between fungi and plant roots, which in turn determines the nutrient density of the foods we grow and eat.

Exploring the science of symbiotic fungi in layman's terms, holistic farmer Michael Phillips (author of *The Holistic Orchard* and *The Apple Grower*) sets the stage for practical applications across the landscape. The real impetus behind no-till farming, gardening with mulches, cover cropping, digging with broadforks, shallow cultivation, forest-edge orcharding, and everything related to permaculture is to help the plants and fungi to prosper . . . which means we prosper as well.

Building soil structure and fertility that lasts for ages results only once we comprehend the nondisturbance principle. As the author says, "What a grower understands, a grower will

do." *Mycorrhizal Planet* abounds with insights into "fungal consciousness" and offers practical, regenerative techniques that are pertinent to gardeners, landscapers, orchardists, foresters, and farmers. Michael's fungal acumen will resonate with everyone who is fascinated with the unseen workings of nature and concerned about maintaining and restoring the health of our soils, our climate, and the quality of life on Earth for generations to come.



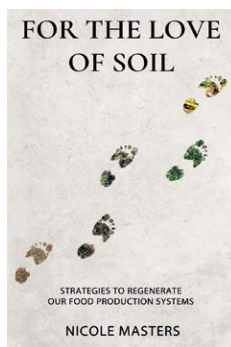
A Soil Owner's Manual: How to Restore and Maintain Soil Health

A Soil Owner's Manual: Restoring and Maintaining Soil Health, is about restoring the capacity of your soil to perform all the functions it was intended to perform. This book is not another fanciful guide on how to continuously manipulate and amend your soil to try and keep it productive. This book will change the way you think about and manage your soil. It may even change your life. If you are interested in solving the problem of dysfunctional soil and successfully addressing the symptoms of soil erosion, water runoff, nutrient deficiencies, compaction, soil crusting, weeds, insect pests, plant diseases, and water pollution, or simply wish to grow healthy vegetables in your family garden, then this book is for you. Soil health pioneer Jon Stika, describes in simple terms how you can bring your soil back to its full productive potential by understanding and applying the principles that built your soil in the first place. Understanding how the soil functions is critical to reducing the reliance on expensive inputs to maintain yields. Working with, instead of against, the processes that naturally govern the soil can increase profitability and restore the soil to health. Restoring

soil health can proactively solve natural resource issues before regulations are imposed that will merely address the symptoms. This book will lead you through the basic biology and guiding principles that will allow you to assess and restore your soil. It is part of a movement currently underway in agriculture that is working to restore what has been lost. A Soil Owner's Manual: Restoring and Maintaining Soil Health will give you the opportunity to be part of this movement. Restoring soil health is restoring hope in the future of agriculture, from large farm fields and pastures, down to your own vegetable or flower garden.

For the Love of Soil: Strategies to Regenerate Our Food Production Systems

Learn a roadmap to healthy soil and revitalised food systems for powerfully address these times of challenge. This book equips producers with knowledge, skills and insights to regenerate ecosystem health and



grow farm/ranch profits. Learn how to:- Triage soil health and act to fast-track soil and plant health-Build healthy resilient soil systems-Develop a deeper understanding of microbial and mineral synergies-Read what weeds and diseases are communicating about soil and plant health-Create healthy, productive and profitable landscapes. Globally recognised soil advocate and agroecologist Nicole Masters delivers the solution to rewind the clock on this increasingly critical soil crisis in her first book, For the Love of Soil. She argues we can no longer treat soil like dirt. Instead, we must take a soil-first approach to regenerate landscapes, restore natural cycles, and bring vitality back to ecosystems. This book translates the often complex and

technical know-how of soil into more digestible terms through case studies from regenerative farmers, growers, and ranchers in Australasia and North America. Along with sharing key soil health principles and restoration tools, For the Love of Soil provides land managers with an action plan to kickstart their soil resource's well-being, no matter the scale. "For years many of us involved in regenerative agriculture have been touting the soil health - plant health - animal health - human health connection but no one has tied them all together like Nicole does in "For the love of Soil"! " Gabe Brown, Browns Ranch, Nourished by Nature. "William Gibson once said that "the future is here - it is just not evenly distributed." "Nicole modestly claims that the information in the book is not new thinking, but her resynthesis of the lessons she has learned and refined in collaboration with regenerative land-managers is new, and it is powerful." Says Abe Collins, cofounder of LandStream and founder

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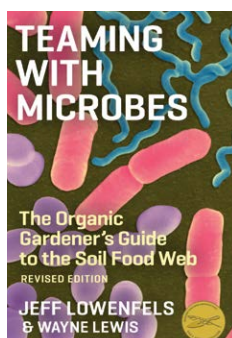
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of Collins Grazing. "She lucidly shares lessons learned from the deep-topsoil futures she and her farming and ranching partners manage for and achieve." The case studies, science and examples presented a compelling testament to the global, rapidly growing soil health movement. "These food producers are taking actions to imitate natural systems more closely," says Masters. "... they are rewarded with more efficient nutrient, carbon, and water cycles; improved plant and animal health, nutrient density, reduced stress, and ultimately, profitability." In spite of the challenges food producers face, Masters' book shows even incredibly degraded landscapes can be regenerated through mimicking natural systems and focusing on the soil first. "Our global agricultural production systems are frequently at war with ecosystem health and Mother Nature," notes Terry McCosker of Resource Consulting Services in Australia. "In this book, Nicole is declaring peace

with nature and provides us with the science and guidelines to join the regenerative agriculture movement while increasing profits." Buy this book today to take your farm or ranch to the next level!



Teaming with Microbes: The Organic Gardener's Guide to the Soil Food Web

Smart gardeners know that soil is anything but an inert substance.

Healthy soil is teeming with life not just earthworms and insects, but a staggering multitude of bacteria, fungi, and other microorganisms. When we use chemical fertilizers, we injure the microbial life that sustains healthy plants, and thus become increasingly dependent on an arsenal of artificial, often toxic, substances. But there is

an alternative to this vicious cycle. We can garden in a way that strengthens the soil food web the complex world of soil-dwelling organisms whose interactions create a nurturing environment for plants. "Teaming with Microbes" extols the benefits of cultivating the soil food web. First, it clearly explains the activities and organisms that make up the web. Next, it explains how gardeners can cultivate the life of the soil through the use of compost, mulches, and compost tea. The revised edition updates the original text and includes two completely new chapters on mycorrhizae (beneficial associations fungi form with green-leaved plants) and archaea (single-celled organisms once thought to be allied to bacteria). With Jeff Lowenfels' help, everyone from devotees of organic gardening techniques to weekend gardeners who simply want to grow healthy, vigorous plants without resorting to chemicals can create rich, nurturing, living soil.

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