

ISSUE 3 | SEPTEMBER 2018

DIRECT DRILLER

MAGAZINE

THE FUTURE OF YOUR SOILS

Do you know your WORMS?

ALSO IN THIS ISSUE

Nutrient Stratification
Page 34

Grazing Cropped Land
Page 49



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Choosing Between
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How to become a
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Farmer Focus: Tom Sewell.
Life is full of Compromises

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INTRODUCTIONS

MIKE DONOVAN

THE CHALLENGES OF NO-TILL

No-till remains the most exciting, and challenging, development in global farming today. My six years of continuous and enthusiastic journalism on the subject has come at a time of an ever-increasing flow of information. For no-tillers and those contemplating it, knowledge is essential. However there's another challenge: getting information into the world of farm supplies and also farm education. Making the most of the new techniques; having knowledge

and sharing the experience to predict and avoid pitfalls, all involve effective research and development. No-till has already had an impact on machinery, but crop rotation, fertiliser use, seed rates, timeliness are topics that present equal challenges to both the no-till farmer and advisor, and all are comparatively new. Farm suppliers have an obvious need for genuine knowledge and experience which they can hand on to customers. Education is front-line and key to success.

This third issue of Direct Driller shares a great deal of information that is of direct relevance to all those involved

in the technique. Behind these pages is a huge wealth of knowledge, and the intention of this publication is to bring people together for the benefit of everyone involved.



SUPPORT FOR DIRECT DRILLER MAGAZINE FROM GEORGE EUSTICE MP

In February, just before the first Issue of Direct Driller was launched, we were invited to speak to Michael Gove's Defra team about what constitutes systems of reduced cultivation and how they can be monitored in the future.

After Issue two we again contacted the Defra team to see what they and the government in general thought about the focus of Direct Driller Magazine on improving our soils and reducing cost of establishment in the UK.

In response, Farming Minister George Eustice said:

"The work that farmers do to replenish our soils, cleanse our seas and rivers and cut greenhouse gas

emissions is vitally important.

"Leaving the European Union provides an opportunity to design a new system – public money for public goods – that delivers for British farmers and rewards them for the invaluable work they do to improve the environment.

"In our 25-year Environment Plan, we have set how we will improve our soils, including investing in soil health metrics so that we can deliver

the connected benefits for water quality and the wider environment."

Which reads to us like those farmers who are running a conservation agriculture based system, with high levels of focus on soil health are going to be those farmers who benefit most from public money in the future. What no one knows, is exactly how Defra will implement this, but we certainly have interesting times ahead!

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SOIL ORGANIC MATTER AND ITS ROLE IN CLIMATE CHANGE MITIGATION

Written by Mark Measures BSc. (Hons.), IOTA (Accredited), ARAGS, Churchill Fellow 2017 of the Organic Research Centre, first Published July 2018

Soil organic matter (SOM) is the focus of much attention in both organic farming and conventional circles; conventional arable farmers have finally woken up to the fact that SOM is important and that poor rotations and lack of organic matter inputs might be something to do with their poor soil structure and static or declining yields. Organic farmers have always believed that SOM is important, not just for soil structure but also for mineralisation, which results in nitrogen release, needed for crop growth and they have in the back of their minds the idea that SOM has something to do with pest and disease control. More recently it has been realised that SOM plays an important part in overall soil biological activity and nutrient release. The potential for carbon sequestration and for the soil to function as a carbon sink has led some to think that SOM can play an important and major role in reducing green house gases and addressing climate change.

Many organic farming practices will contribute organic matter to the soil; grass clover leys, use of farmyard manure, compost, green waste, cover

crops and green manures will all contribute to SOM. The extent to which these inputs will result in a net sequestration of carbon is dependant on how they are processed in the soil, the level of nitrogen input and C:N ratio, on the initial SOM levels, on cultivations, soil type and climate. The evidence for long-term on-going carbon sequestration from organic farming is not clear-cut and categorical statements that organic farming will have a significant impact on green house gasses and climate change should be treated with caution.

The fate of organic matter, or carbon, added to the soil is particularly dependant on its form; fresh manure and slurry will contribute little to the build-up of SOM, but it will supply readily decomposable material that will provide nutrients to the plants. Compost, on the other hand will provide a more stable form of organic matter, which will contribute to SOM build up. Mineralisation is the oxidation of the chemical compounds in organic matter by the soil microorganisms, in the process releasing nutrients, particularly

nitrogen, phosphorus and sulphur in a form available for plant uptake, together with the release of carbon dioxide. This process of mineralisation is brought about by cultivations and aeration and is absolutely central and fundamental to providing the nutrients for organic crop production.

Humus is an important component of SOM and of compost. Humus is relatively stable and is primarily the result of fungal decomposition of lignin and has many roles in the soil including water holding, soil structure and nutrient retention.

Farms that use well-made composted manure or green waste will tend to build SOM, while fresh or once turned FYM and green manures will not result in the same build up of SOM. They will of course be tremendously important for providing nutrients in a plant available form, either directly or indirectly as a result of biological breakdown. Multiple cultivations, whether that is ploughing or repeated use of cultivators will tend to deplete organic matter as it encourages mineralisation.

Soil type will have a major impact on SOM accumulation potential; dry, light sandy soils will tend to be difficult to build SOM and such soil in an arable rotation will often have naturally low levels of 1.5 – 2.5%, unless they have evolved under acidic conditions in which case levels of 6 – 10% may be found. Clay loam soils in the UK will typically have SOM in the range of 3 – 4.5%. Clay soils will tend to have higher SOM than other soil types.

Finally we need to recognise that the SOM accumulation reaches some equilibrium. Depending on the soil type, management practices, organic inputs, rotation and the cultivations used the accumulation of SOM will

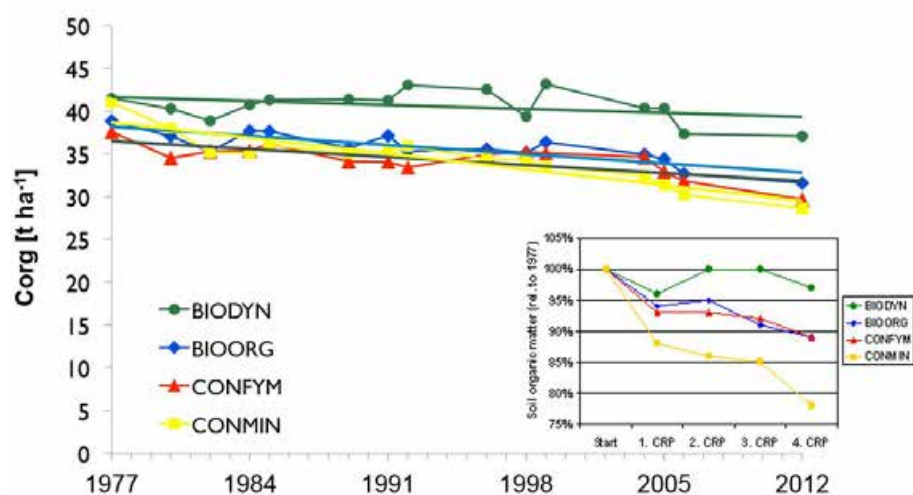


Table 1. DOK-trial soil carbon

tail off at some point; it is not realistic to expect to be able to increase SOM from say 4% to 10% under normal farming practices, an equilibrium will be reached before that.

Does organic farming increase SOM?

The evidence from farm experience in the UK is limited because there has been very little thorough and reliable monitoring; inconsistent sampling methods and field locations, changes in analytical methods and infrequent sampling are all a problem. Experience from the arable organic farms that I have worked with is that sometimes, but not always, SOM levels initially increase following conversion to organic farming from continuous non-

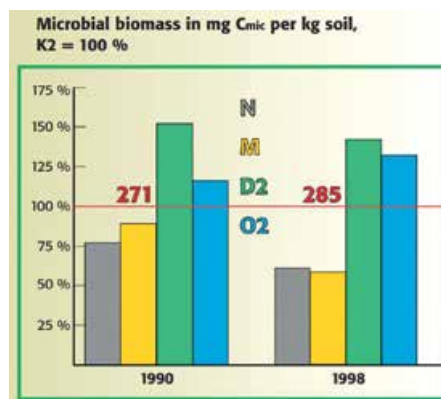


Table 2. FiBL DOK-trial Microbial Biomass

The total mass of microorganisms in the organic systems of the DOK-trial was 20-40% higher than in the conventional system with manure and 60-85% than in a conventional system without manure. This result was also stated in 1990. Microbial biomass and enzyme activities were closely related to soil acidity and soil organic matter content

organic arable cropping; an example from Holme Lacy College shows an increase from 2.7 to 3.1% over 10 years, and average of 0.04% SOM per year. Experience elsewhere is that subsequently increases are small.

Replicated research over long periods of time is a more reliable indication. The 40-year-old DOK trial at FiBL (Switzerland) compares conventional, organic and biodynamic systems.

The results after 35 years, Table 1. show that SOM levels have declined slightly in all four treatments. The conventional and the organic treatments are not significantly different, however it would be

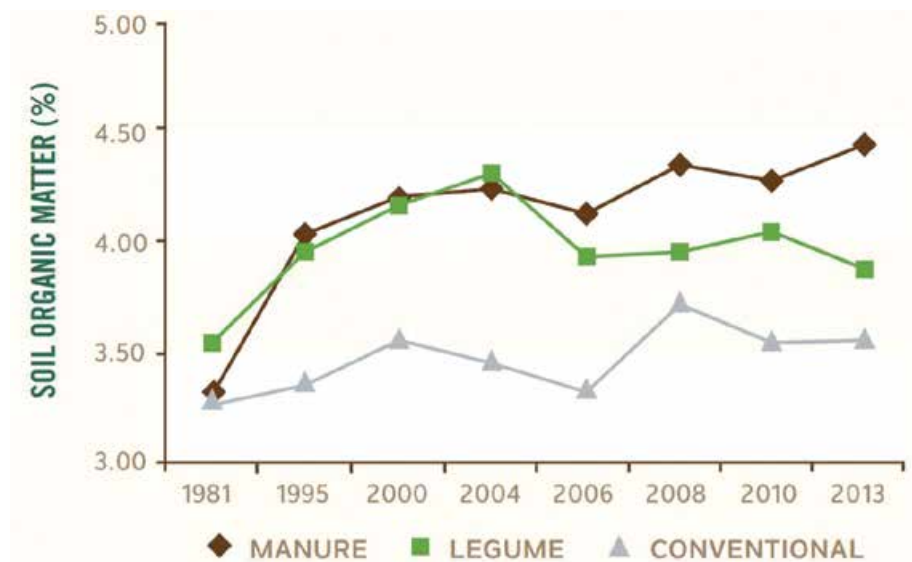


Table 3. Rodale SOM levels

expected that if the conventional had followed a continuous cropping rotation that this would have resulted in a greater decline and that the difference between the organic and the conventional would be expected to be greater. The biodynamic treatment resulted in a small but significantly higher level of SOM than the conventional or the organic; this may be a result of the use of well-composted manure rather than the fresh manure in the organic.

Interestingly there is a significant difference in the soil microbial biomass between some treatments, Table 2., Showing that Organic (O2) and Biodynamic (D2) has greater biomass than Conventional both with manure (M) and without manure (N).

The Aarhus University (Denmark) farming systems trial was set up in

1997 on 3 sites, the one at Foulum continues to run. A replicated trial compares organic using both green manure and manure with a continuous cropping non-organic rotation. While there are significantly higher levels of carbon inputs to the soil under organic management and there is indication that a one-year green manure with residues returned does increase SOM, overall the conclusion is “not able to detect consistent differences in measured Soil Organic Carbon between systems”.

The Rodale Farming Systems Trial (USA) has been running since 1981, it is a replicated trial comparing an organic manure system with an organic legume system with a conventional continuous arable cropping system. Table 3. The SOM levels in both the organic systems increased from 3.5%

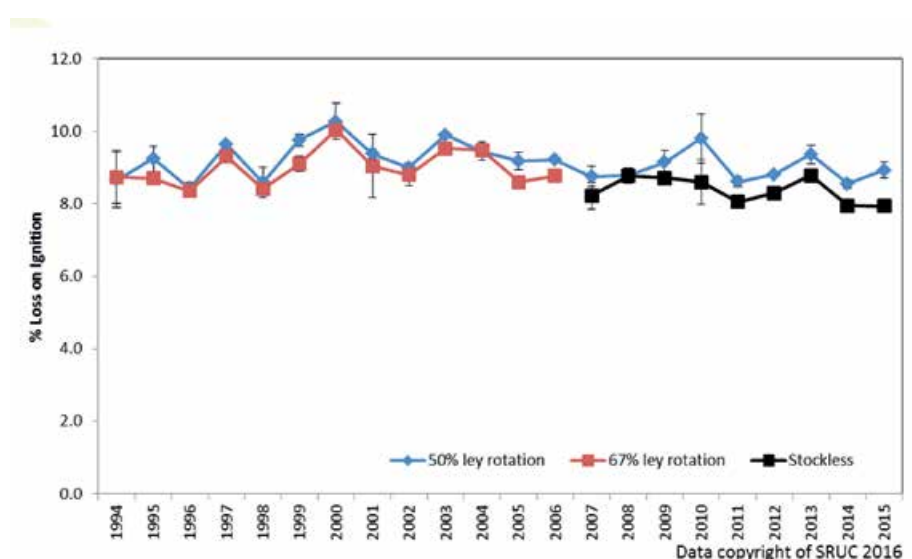


Table 4. Tulloch rotational trial, SRUC Aberdeen Soil Organic Matter

to approximately 4.25% in the first 20 years (0.37%/year) thereafter stabilising or in the case of the organic legume system subsequently declining to approximately 3.9%. The conventional has shown some recent decline to approximately 3.3%. In the absence of trial data and peer-reviewed papers it is not possible to know the statistical significance of these results.

The Scotland Rural College (SRUC) organic systems trial was set up in 1991 following a period of conventional ley arable farming. The results, Table 4, show over a period of 20 years that organic ley-arable under a rotation of 50% ley, 50% arable maintains SOM, but that under the prevailing conditions SOM did not increase, even during the conversion period. This reflects the previous cropping regime and the fact that these are inherently high SOM soils, in the order of 8%. The stockless organic rotation introduced 8 years ago indicates a slight decline in SOM, but which may not be significant.

The conclusion of the review of available evidence undertaken by Organic Research Centre in 2011 is that:

Organic cropping systems have considerable potential for increasing soil carbon, through the incorporation of fertility building grass-clover leys and use of livestock manures within diverse crop rotations, when compared with specialist (e.g.: monoculture) cropping systems;

The exact amount of carbon that can be sequestered through organic management of cropping systems is still uncertain, due to the disparity in assessment methods, and farming/land-use systems;

The difference between the wide range of organic and conventional farm types is not yet clear, partly because of the current difficulty in defining these systems and their individual characteristics;

Organic management of grassland is unlikely to increase soil carbon levels over those from conventional management, but the reliance on legumes and biological instead of industrial nitrogen fixation will still have a positive impact on climate change mitigation through reduced

fossil energy use and related carbon dioxide and nitrous oxide emissions

The ratio of Clay to SOM is considered important by some of authorities (Agroscope and Aarhus University) and it may be a more important measure of the need and potential to increase SOM levels than SOM% per se.

Claims that the practice of Mob Grazing results in substantial increase in organic in the order of a change from 3 to 5% over 3 or 4 years have not been substantiated under UK conditions.

The use of very high levels e.g. 50 tonnes/ha/year of imported manure, compost or green waste will undoubtedly result in SOM increase over time, up to a point, but that is not typical of organic farming.

The studies that I have seen have focused on arable systems, the situation with permanent pastures is very different, and soils under permanent pasture generally have higher SOM and will have developed an equilibrium. This higher level may be due to both the lack of cultivations and the use of manures and fertilisers as well as forage residues. In my experience there is very little difference in SOM levels between conventional and organic management of permanent pastures.

Conclusions

Based on the evidence of the three farming systems trials that I visited under the Winston Churchill Fellowship in 2017/18, the results of the SRUC trials, my personal experience and the review of research by Organic Research Centre I draw the following conclusions.

SOM is important for soil physical, biological and nutrient reasons and mineralisation of SOM is particularly important in organic farming.

The following practises will all tend to increase SOM: Grass clover leys, farmyard manure, compost rather than fresh manure, green waste, over-winter cover crops and annual green manures.

The following will tend to decrease SOM: cultivations, continuous cropping, nitrogen supply.

Given that organic arable farming

involves many of the beneficial practises identified above, there is likely to be some advantage to organic farming during conversion from conventional, continuous cropping conventional farming, particularly where longer leys are involved.

There is no evidence that organic arable farming offers potential for on-going, long term sequestration of carbon in the soil. The indications are that increased SOM levels of between 0 and 0.4% per year may be possible during the first 10 – 20 years of organic conversion, but that this depends on the initial SOM levels, soil type and management practices. Thereafter increases are unlikely.

SOM is likely to be higher under some established organic arable rotations than under conventional rotations, but this is not necessarily so and will depend on various management practices, particularly the length of the ley and use of compost.

65% of organic farms in the UK are permanent pasture, not in an arable rotation. These farms are unlikely to show a significant difference between conventional farms.

Organic arable farming has higher levels of soil microbial biomass compared to conventional. Organic farmers wanting to improve crop productivity should focus on improving the quality and biological activity of their soils rather than merely focusing on total SOM.

Given the wide range of results from arable system comparisons and the fact that the majority of organic farming in the UK is permanent grassland claims that organic farming will contribute significantly to climate change mitigation through carbon sinks should be avoided.

Climate change mitigation is one the principle challenges of our time and needs to be addressed by a radical change in the food and farming system as a whole, including food distribution and with a particular focus on drastic reduction in use of fossil fuels. Organic food and farming systems offer the best agricultural system to do that. Soil carbon sinks play a supporting role.

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Farming 160ha of combinable crops on light "boys" land over chalk between Cambridge and Newmarket, I've just had my third direct drilled harvest. I'm 100% combinable having been a sugar beet grower since the days of hand hoeing as well as offering a drilling and harvesting service with a 6 row tanker in the past, I have since stopped growing beet when I wanted to start direct drilling. All crops types are grown for premium markets and are stored in Camgrain central storage which makes having a rotation of 6 or 7 crops and different varieties very easy.

Rumours of my retirement are very much exaggerated

There comes a time in life where the pressure of being either at work or on duty (ie on stand-by in case the wind should drop to allow some spraying to be completed or it being dry enough to drill or harvest a crop) most days of the week for most of the year becomes tiresome.

An opportunity arose to reduce my contracting workload, the distance I travelled and the area I farm. The need to be "on duty" so often came along, so I took it thinking this would be staged or semi-retirement, something farmers are very bad at! This coincided with an interest in a different type of farming being stimulated through discussion on Twitter and The Farming Forum, (I won't name the culprits as where there is blame there is a claim!) which also requires less "intensity" in many forms. I also have other business interests which bring diversity to my business life through selling Trimble GPS correction signals for precision farming www.rtkfarming.co.uk and the other being Vice Chairman of Camgrain Stores, both of which make farming a less solitary profession and life very much more interesting.

So, back to this different type of farming. Some of the local walkers that use the footpaths through Hawk Mill



clearly had heard mention, probably down the pub, of "retirement" and noticing that my fields appear to be growing what are in their eyes weeds thought I had thrown in the towel as the farm looked as if it had gone to pot. "Farming Ugly" as the Americans call it is something that takes some adjusting to as traditionally the best farms have been the smart tidy farms, but I quickly realised that beauty is in fact soil deep.

The journey to a new way of farming.

Conservation Farming, it's like going back to school and questioning and un-learning most of what I thought essential to be a successful arable farmer, but am now largely not bothered about.

- Inversion of "trash" to stop disease carryover; trash is good

- Deep loosening, especially tramlines so crops can root well; none done
- Annual dressings of P and K to maintain fertility; very little now purchased
- Short stubble for easier management; long is better
- Fine seed beds achieved through intensive mechanical soil manipulation; none done
- Multiple seed dressings to stop disease or early insect attack; not used
- No green bridge to prevent disease and insect carryover
- Wide tramlines so no green grains at harvest; no coulters blocked off as green living tramlines stay drier
- Pre-em herbicides and active stacking essential; use now reduced
- Autumn insecticides essential; reduced through later drilling and companion cropping



Two views of companion s beans in rape September 30th and January 9th

A farming career born of ploughing, subsoiling one year in four to 18" deep, discing, harrowing, rolling, harrowing again, rolling again all went out of the window the minute I got my head around the fact that roots and worms do all that for you 24 hrs/day for very little effort and expense. Instead of increasing the size of tractors purchased each change in the traditional way of the agri rat-race I find the smallest on

the farm is more than enough for most jobs.

Instead of a tine and disc machine, a plough, a press, another press, a disc-roller and a harrow for every soil condition I now have two drills and some infrequently used rolls doing all the establishment.

Homework consisted of reading catalogues of seeds of plants that I'd mostly not heard of, never mind grown before such as Phacelia, Vetch, Black Oats, Buckwheat, Crimson Clover, Forage Rye, Tillage and Oil Radish, White Mustard and Sunflower. What type of root system do they have, how do they influence soil biology?

So the result of the changes has been to reduce the fixed costs of running a farm through requiring smaller tractors, less machinery, lower labour and tractor hours, reduced consumption of fuel and wearing parts but with the requirement of increased level of management skills and understanding of how nature works. Trying to work with it not work against or change what naturally happens is a new mindset you have to want to buy into to make Conservation Farming work.

Machinery inventory, listed by importance

- Polaris Ranger (used daily)
- Spade x 2 Fork x 1 (kinder on worms)
- Fendt 716 and 415 with Trimble RTK Auto-Steer
- S/H Horsch CO4 with Dutch openers and Bullock Tillage small seed hopper (soon to be 2)
- John Deere 3mt 750a bought new with Techneat small seed hopper
- Bateman RB25 24mt with full Trimble control
- JCB Loadall 530-70
- 6 of 1.25t Tote bins (extremely useful)
- KRM Bogballe spreader
- Grain and seed trailers
- 9mt Cousins rolls
- Note, Combining done on contract by a neighbour

Three years in how's it been?

Fascinating, the farm is now a more interesting place, it supports more wildlife and with a more diverse rotation relies less on artificial inputs and feels much more sustainable.



Modified disc and tine drills both very low disturbance

Whilst yields of spring beans and oats can't be compared BCF (before Conservation Farming) as they weren't grown. The yields of winter wheat and spring barley have been maintained but are still influenced by occasional partial flooding in a wet spring or over 30-degree temperatures in June. Not much we can do about that, and oil seed rape now grown again has increased.

Reduced cultivation and direct drilling have quickly changed the look, feel and structure of my soils which I'm hoping will make this light land yield potential be more resilient in a dry year with a more reliable margin through reduced costs. There is no question that the soil is now better able to resist compaction from machine trafficking due to higher organic matter levels, like driving on a spring mattress. Tramlines despite being perinatally placed with RTK are level not rutted and the ground carries harvest equipment very well.

Fertilizer indices have remained stable at 2/2+ despite not having an annual dressing of P and K. The top 3" of soil have changed colour and are more friable leading to easier slot closure with a disc drill if using it in the right conditions, something we all get excited about in the early years of direct drilling.

Eureka moments

Visiting Agrii Stow Longa site and seeing a difference in soil comparing a cultivation plot and a cover crop plot 50 yards away that was like moving to a different county!

Seeing pictures on Twitter and The Farming Forum of the variety of cover and companion crops in flower being grown in the UK!

A social media contributor saying that if this field has just grown a 10t/ha wheat crop and I don't do anything to change it (mechanical interference) why



won't it do it again!

Attending a BASE UK arranged talk arranged by Frederic Thomas @FthomasTcs and subsequent visit to his and other farms in France which highlighted the value of a flexible rotation and companion cropping with rape.

An Irish direct drilling farmer in America describing how the "fines" get washed down in cultivated soil upsetting the natural structure.

Buying a spade and starting to open my eyes to what goes on underground.

Farm trials past and Ongoing

Some companies are doing trials on direct drilling, cover and companion cropping and the like but there is nothing better than trying things at home. There is a lack of knowledge in many of the advisory and agronomy organisations so farm up knowledge exchange has been very important in forming views on the way forward on my farm.

My future aims are to keep trying new things and on-farm trials, as I thought when I started out drilling wheat with the JD 750a for the first time in four foot high mustard, if this doesn't work I can always plough it in and stick in some spring barley, truth is I'd now spray it off not plough but pushing the boundaries and making mistakes is the only way to learn.

I also want to reduce reliance on Glyphosate, reduce nitrogen rates and maintain yields and ultimately to become an insecticide free farm, only trying on one field at present that is my target.



CHOOSING BETWEEN DIRECT DRILLING OPENERS

Dr C John Baker, Feilding, NZ

If you want to start a pub debate amongst farmers, try telling them which direct drilling (no-tillage) opener is the best. Everyone has an opinion. Here are some of the problems that direct drilling openers have to cope with, plus summaries of what published science and field practice tells us about how close each generic opener type comes to fulfilling those functions.

This is an opportunity to sort fact from fiction.

Please note, this author uses the terms direct drilling and no-tillage synonymously.

It is helpful to firstly understand that the functions we have asked drill openers to do have changed over the approximately 60 years since the first attempts at direct drilling were reported in the 1950s.

- In the 1950s, the main purpose was to introduce new and improved pasture species into clover-dominant pastures in New Zealand's Central Plateau without tilling the soil.

- In the 1960s and 1970s, the main aim changed to reducing wind and water erosion in North America and reducing on-farm costs and historical soil compaction in arable soils in the UK.

- By the 1990s and early 2000s, although the original soil erosion and cost objectives remained, emphasis shifted to making food production sustainable.

- Now the objectives have morphed further into reducing Green House Gas (GHG) emissions and regenerating soil health, plus all of the above.

Early direct drilling demanded disc openers because of their ability to handle residues. But most disc openers at that time produced patchy establishment and were expensive and difficult to use. So farmers gravitated to tined or shank-type openers over time. In the UK, the chemical company ICI Ltd (now part

of Syngenta) sparked a lot of the early developments. ICI had developed the herbicide paraquat but no European machinery company was prepared to design a special drill for untilled soils. ICI therefore designed its own triple disc openers. But these turned out to be so limited in their functions that everyone in Europe eventually gave up direct drilling altogether and reverted to minimum tillage, because it did not require a special drill - just shallower tillage tools. Fermentation of "hairpinned" straw, slot wall compaction, difficulty in closing the slot, stimulation of unwanted grass seed germination and an inability to band fertilizer separately from the seed, were just some of the shortcomings of triple disc openers.

Most USA drill designers simplified the design of triple disc openers to double disc openers and also introduced single angled disc designs. But these only partly overcame the shortcomings of the original triple disc design. On the other hand, Argentina and Brazil managed to live with triple (and double) disc openers, mainly because their soils and climates are so kind that it is difficult to fail with any opener design.

Australia and North America were the first arable countries to abandon disc openers in favour of simple shanks or tines. While these designs allowed fertilizer banding to be added to the list of desirable functions, tines

disturb a lot more soil than most discs and block with long residues. This, in turn, severely limited the opportunity to use crop residues as a mulch to smother weeds, reduce evaporation, control the slot micro-environment and re-stock the soil with photosynthesised carbon.

Tined openers made crop residues into a partial enemy of no-tillage systems rather than their greatest asset. Their limitations in this regard forced farmers to change their no-tillage cropping practises to minimise the amount of residues that tined openers had to cope with. Burning made a comeback and other practices included pushing the residues aside, chopping them into shorter lengths and even burying them in vertical trenches. Most of these actions either required an additions pass over the field with a separate machine or demanded additional power from combine harvesters when they were asked to chop the residues during harvesting.

Over time, tined no-tillage openers have become synonymous with strip tillage because many farmers take comfort from seeing the seeds embedded in tilled strips of soil as they used to in fully tilled seedbeds.

But the science shows clearly that re-positioning residues (chopped or un-chopped) over the sown slots in otherwise undisturbed slots (in order that the mulch of residues forms the



Seedlings emerge without a problem



5 low-disturbance no-tillage openers have passed through this residue

top layer of the slot-covering medium with little soil visible) is one of the best things a no-tillage opener can do. It traps soil water vapour (humidity) in the seed slot itself, creates a barrier against the soil-discharge of CO₂ into the atmosphere, and sequesters new carbon into the soil for the first time since mankind began arable farming on a large scale.

These are scientifically proven facts that are very significant for several reasons:

- a) The world's arable soils have already lost approximately 75% of their organic matter from oxidation caused by repeat tillage and other soil disturbance.
- b) The residues left after harvesting arable crops are rich in carbon that has been re-captured from the atmosphere by photosynthesis. If left to decompose on the surface of undisturbed soils, this carbon is taken back into the soil by earthworms and other soil fauna.
- c) All undisturbed soils contain 100% relative humidity in the pore spaces between individual soil particles, even when very dry.
- d) Most seeds can germinate in 90-100% relative humidity, even in the absence of liquid water.
- e) All soil disturbance (including strip tillage) allows this pore space humidity to escape.
- f) Because we have tilled soil for centuries (and thereby eliminating the role of pore space humidity) we have come to believe that seeds only germinate in contact with soil.
- g) But it is no accident that the world's network of seed testing stations germinate their seeds on blotting paper where there is no soil present at all.
- h) In the field, untilled soils therefore have two moisture resources for germinating seeds, vapour and liquid water. Tilled soils have only one, liquid.
- i) Strip and minimum tillage simply eliminate one of those germination resources altogether and therefore defeat one of the main objectives of no-tillage in the first place.
- j) Not only does strip tillage allow water vapour to escape it

introduces excessive oxygen to the soil, which re-oxidises soil carbon into CO₂, that escapes at the same time.

Mankind has therefore inadvertently moved backwards in its otherwise understandable preference for high-disturbance no-tillage openers. We must now move back towards low-disturbance no-tillage

Against this background of conflicting problems and solutions, this author spent 30 years identifying and mitigating the issues that had been hampering direct drillers from the outset. Some 30 graduate students and numerous fellow scientists at New Zealand's Massey Universities published a multitude of research reports in the international scientific literature that explain the many hitherto unstudied interactions between machines, soils, seeds, seedlings, fertilizer, growing plants, weeds, and pests.

For those practicing no-tillage, the following list of issues might be familiar:

1. My drill or planter only works well if some prior surface tillage has taken place.
2. I only get reliable establishment if I cause maximum slot disturbance with the openers.
3. Most of the time I get lower crop yields that when I practiced tillage.
4. Although I get reasonable germination when the soil is crumbly, I get only patchy results when the soil is wet or even sometimes just damp.
5. I find that although crumbly soil is preferable, it is also drier and this sometimes creates germination problems if I don't get rain or can't irrigate immediately after seeding.
6. Where irrigation is available, I nearly always irrigate after no-tillage seeding.



An array of graduate no-tillage research theses produced at Massey University.

7. In damp soils, although I can usually get adequate seed cover, I am often left with poor establishment when the soil dries after drilling causing slot shrinkage that exposes seeds.
8. I find that the timing of no-tillage drilling or planting is critical.
9. I find that my machine will direct drill some crop types well, but is limited with others.
10. I find I often have to make significant adjustments to the openers when going from one field to another, or even sometimes in the same field when conditions change.
11. I have had to modify the drill or planter openers significantly since purchasing the machine in order to make the machine work best in my soils.
12. I find that my machine works fine on flat land but is not very effective on hillsides.
13. I frequently have difficulty drilling into sod or dense pasture.
14. Stony soils cause numerous breakages and other problems with my machine.
15. My machine can cope with stones but in doing so brings many of them up onto the surface.
16. The soils on my farm have become more difficult to drill since I changed to no-tillage.
17. I seldom see 70% or greater residue-cover over the slots after drilling or planting.
18. I often find I have retained less than 50% of the residues that were there before drilling.
19. Getting good seed-to-soil contact is often an issue for one reason or another.
20. I try to avoid spring drilling if at all possible because establishment is problematical.
21. I restrict my no-tillage to low-value crops, cover-crops or pasture and seldom risk it with high-value crops.
22. My machine has difficulty handling heavy residues without blocking.
23. In addition to spraying, I nearly always need to pre-treat the residues or soil in some way

- before drilling or planting.
24. My machine handles chopped straw, sod or standing stubble OK but has difficulty with long un-chopped residue or straw, especially if it is damp.
 25. I never attempt to direct drill through long rank grass or weeds without at least a 6-month spray-fallow beforehand so the residues can decay somewhat.
 26. I frequently get residue blockages that are sufficiently severe to require stopping.
 27. My machine physically handles residues OK but has difficulty avoiding hairpinning (tucking) of uncut straw into the slot, which in turn affects germination.
 28. The way that my openers handle residues is to push them to one or both sides of the row.
 29. My machine cannot position seed and fertilizer in separate bands at seeding.
 30. I would like to drill in narrow rows but my machine can't band seed and fertilizer separately in narrow rows so I am forced to drill in wider rows than desirable or broadcast fertilizer.
 31. My machine can position seed and fertilizer in separate bands in some soils and at certain drilling speeds, but not in other soils or at other drilling speeds.

32. My machine can position seed and fertilizer in separate bands but uses two openers per row to achieve this, which increases soil disturbance.
33. My machine could not be described as a low-disturbance no-tillage drill or planter.
34. Seeding depth varies noticeably across the field, especially where the surface is not smooth.
35. My machine cannot seed consistently shallower than 1" (25 mm) without risk of the openers riding out of the ground altogether in some places.
36. I have difficulty getting enough downforce on the openers when the soil is hard or dry.
37. I cannot vary the downforce on my openers without leaving the tractor cab.
38. My machine is not capable of constantly and automatically increasing and decreasing the downforce applied to the openers on-the-move to match soil hardness.
39. I find I need to seed deeper than desirable in order to be sure of getting adequate covering.
40. The maximum speed I can seed at is seldom greater than 5 mph (8 km/hr).
41. My openers stimulate too much weed seed germination.
42. There are a large number of

- greasing points on each opener that need frequent attention.
43. I expect that the useful life of my current drill or planter will be less than 5 years.
 44. I experienced a reduction in crop yield during the first few years of direct drilling.
 45. Even after several years of direct drilling, my crop yields seldom beater tillage yields.
 46. I do not believe that no-tillage opener design can influence crop yield.
 47. Purchase price is more important to me than the machine's potential to influence crop yield.
 48. My dealer does not seem to know a lot about no-tillage as a farming practice.
 49. I find no-tillage to be altogether more risky than tillage.
 50. If it wasn't for the environmental issues, I would prefer to go back to conventional tillage.

Our research sought to mitigate as many of these issues as possible and the results can be seen in the Table below, which quantifies how well (or badly) 8 generic no-tillage opener types perform 29 identified functions. Five of these functions (shown in red) are considered to be vital to all no-tillage cropping.

COMPARISONS OF 8 GENERIC NO-TILLAGE OPENERS BY FUNCTION

	GENERIC OPENER TYPES							
	Narrow hoe	Winged narrow Hoe	Wide hoe	Sweep	Single disc	Double (or triple) disc	Slanted disc	Combo disc & winged side blades
MOST COMMON SLOT SHAPE (see illustrations below)	U	Inverted T	U	Inverted T	U	V	V	Inverted T
FUNCTION OR FACTOR (5 key functions are in red)								
Ability to handle heavy residues without blocking Leaves min 70+% of the original residues in place after seeding	1	1	1	1	4	4	4	5
Minimizes in-slot soil disturbance	4	4	2	1	4	5	3	5
Traps moisture vapour in the slot in dry soils using residues as cover	3	5	2	2	2	1	4	5
Avoids placing seeds in hairpins	5	5	5	5	2	1	2	5
Ability to maximise in-slot aeration in wet soils	3	4	4	3	3	1	3	5

	Narrow hoe	Winged narrow Hoe	Wide hoe	Sweep	Single disc	Double (or triple) disc	Slanted disc	Combo disc & winged side blades
Avoids in-slot soil compaction or smearing in damp soils	1	4	1	3	5	1	5	5
Maximises soil-seed contact, even in greasy ("plastic") soil conditions	4	4	3	4	3	3	4	5
Self-closes the slots	2	3	1	3	3	2	4	5
Mitigates slot shrinkage when soils dry after drilling	2	2	5	5	2	1	4	5
Ability of individual openers to faithfully follow surface contour	2	4	1	3	4	2	2	5
Extended range of vertical travel of individual openers	2	3	1	1	2	2	1	5
Consistency of downforce throughout this range	3	3	1	1	3	2	3	5
Ability of openers to seed accurately at shallow depths	2	3	1	1	2	2	1	5
Ability of opener-downforce to auto-adjust to changing soil hardness	1	1	1	1	4	1	1	5
Simultaneously bands fertilizer with (but separate from) seed	1	1	5	5	2	1	3	5
Ensure fertilizer banding is effective with high-analysis fertilizers	1	1	5	5	1	1	2	5
Ability to handle sticky soils	5	5	5	4	3	1	3	2
Ability to handle stony soils	3	3	3	1	4	4	2	4
Avoids bringing stones to the surface	1	1	1	1	5	5	3	5
Functions are unaffected by hillsides	5	5	5	4	2	5	1	5
Minimal adjustments required between different conditions	3	3	3	3	1	4	1	5
Ability to maintain most critical functions at high speeds	3	3	1	1	3	4	3	5
Wear components are self-adjusting	5	4	5	5	2	3	2	5
Design life of whole machine matches the tractors that pull it	4	4	4	4	2	2	2	5
Low wear rate of soil-engaging components	5	5	4	4	3	2	3	3
Wear components (including bearings) are cheap and easily replaced	5	5	5	4	2	2	2	4
Requires minimal draft from tractor	4	4	3	2	4	5	3	3
Proven positive impact on crop yield	3	3	2	2	3	1	4	5
29 FUNCTION RATINGS (possible 145)	85	95	82	81	84	73	79	136
% Possible	59%	66%	57%	56%	58%	50%	54%	94
SUMMARY 5 KEY FUNCTIONS (possible 25)	14	16	15	14	14	12	16	25
% Possible	56%	64%	60%	56%	56%	48%	64%	100%

CONCLUSION:

- 5 of the 8 generic no-tillage opener types (63%) performed little more than 50% of the 29 desirable functions listed.
- 3 of the 8 (38%) performed about 2/3 of the 5 vital functions listed.
- Only 1 of the 8 (12%) performed all of the vital functions and 90% of the desirable functions.

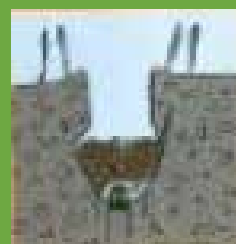
OVERALL CONCLUSION:

Most people are little more than

The three basic slot shapes produced by most no-tillage openers



V-shaped



U-shaped



Inverted-T-shaped

half way towards mastering true no-tillage or direct drilling – but at least they are that far. And half way means progress in the right direction. Keep learning!

ALTERNATIVE WEED CONTROL - A WORLD WITHOUT GLYPHOSATE BUT WHAT ARE THE ALTERNATIVES?

Written by Maxime Barbier. First Published in TCS Magazine N°97 in March 2018

With the list of agrochemicals that is available to agriculture constantly shrinking and a threat hanging over the use of glyphosate, there is a growing interest more and more in alternative weeding solutions. All over the world many alternatives are being investigated; electricity, microwaves, thermal foam, water jet and bio herbicides. However a cheap and reliable alternative systemic weed killer at the same unbeatable price as glyphosate is not available currently. But who knows, from the emergence of all these innovations there will perhaps come new tools to help control the most challenging weeds growers and farmers face. Will these alternatives consolidate or even improve our systems in both Conventional and Conservation Agriculture systems?

The first problems appeared with the beginning of agriculture. Without the domestication of animals and crop raising we would probably have had to stay as hunter- gatherers, feeding on berries, acorns and wild meat. So busy finding food we wouldn't be able to write this article! We evolved from largely a dense forest canopy of oak and beech to a succession of annual plants which has led to an incessant energy expenditure against Mother Nature who only wishes one thing; to return to a balance of perennials. A struggle,

helped in recent decades through the development of synthetic herbicides, has allowed us to maintain a perpetual crop of annuals. Now the list of usable agrochemical products as well as their efficiencies is decreasing, the situation is more and more urgent to find replacement techniques. Encouragingly, solutions exist already and interest is much revived and accelerated with the regulatory and consumer pressure on the use of glyphosate.

A complete herbicide through using an electrical current

The use of electricity as weed control technology was invented in the early 20th century but little interest was shown in the technique and had been largely forgotten due to the growth of synthetic herbicides after the Second World War. The first patents were issued in 1913, however it wasn't until 1990 that the researcher Nippo-Bresilien Satoru Narita, restarted the research on this method of weeding, with the help of private funds from a large owner of a forest that wanted to manage his weed problems which including herbicide resistance in some areas of the plantations he owned. A project 10-year research was set up with the University of Brazil and in partnership with a Brazilian private

sector company Sayyou, the first prototypes were launched in 2012.

Large-scale trials of electrical current have been conducted in forestry and horticulture and also on wheat, soya, and citrus plantations. One major benefit is that the systemic action killing the whole plant. The current destroys both parts of the plant. The foliage and its root, preventing the plant from being able to regenerate.

"In the tests, the level of weed regrowth after 3 or 6 months is comparable to treated plots using glyphosate" says Benjamin Ergas, director of the company Zasso Group AG, from which Sayyou (now Zasso Brazil) is now part. Indeed, the machine, called the Electroherb, is distinguished by a destructive effect that kills foliage of the target plant to the root system. This mode of action is possible because the machine runs on a closed circuit. The PTO generator transfers the electricity to a row of "plant" applicators located on the front linkage made up of metal spatulas spaced every (10- 20 cm). Working widths are available from 1 to 10 meters.

These applicators are interchangeable with a cultivator. As the spatulas touch the plants, the current flows through the tissues returning through a second row of spatulas which act as an earth closing the circuit. By getting into the



weeding innovations that are emerging will not replace short-term synthetic herbicides. However they offer the potential at least reduce chemical use as a first step and have the potential to be incorporated into existing systems.



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The electric current of the Electroherb destroys both the aerial part and the reproductive biomass of weeds. More efficient on young dicots than on perennials, essays to complete the evaluations and demonstrations are planned in France in 2018.

vegetative parts of the plant, electricity has the action of breaking the vessels and damaging cells. The machine delivers a high alternating current frequency (3-30 kHz), with a voltage (5,000-15,000 V), the charges usually don't exceed 6000V. The dose of voltage is determined by field conditions and type of plants encountered.

"The system self regulates according to many parameters: height and density of foliage and weed roots, soil moisture and density, topography, tractor speed and lastly width of Applicators. There are several patents that revolve around this problem, the main challenge being to provide a continuous and stable feed of current" explains the director. The energy needed varies from 100 to a 1,000 joules, enough to dry out foliage without burning or cooking it. The destructive effect is better in full sun, although the manufacturer indicates that the machine can operate under most conditions, except heavy rain. There are less favorable conditions at dawn, because of the dew, and also when the plants to be destroyed are very close to the ground. In this case, the current may tend to dissipate more easily, the loss of effectiveness can then be order of 10% "

comments the specialist. The machine seems to have a useful action on dicotyledons, identified as having non-parallel leaf veins, tap roots and seedlings with two cotyledons.

"The lower the dry matter of the plants, the more they are sensitive to the electrical current. This is equally the case for their root structure also. Weeds

with rhizomes like wild buckwheat are harder to destroy than grasses, which have a network of roots more which are more concentrated."

explains Matthias Eberius, technician at Zasso.

New evaluations in 2018 were carried out in France. "We tried the prototype on organic plots of soybeans sown direct in the stubble of the previous crop. The technology is very interesting in organic systems as it may be possible to evolve towards a direct seeding approach. The operation was used just after sowing because we have a window of 5 days before crop emergence. The tool has controlled annual weeds, which measured between 5 and 25 cm above ground. Control was less effective on some perennial plants, especially those well-established root systems, where it took two or three passages to achieve a kill. In our conditions, we must also be careful that the soil is not too wet so as to cause compaction because of the weight of the machine. In terms of diesel consumption, we've seen numbers between 10lt and 12 ltr / ha ", says Marcio Chaliol, from the Swiss company Gebana who supervises a group of organic producers "ABC" in southern Brazil. Since, the manufacturer worked on the machine weight, they have sold 15 machines in Brazil weighing on average 800 kg (200 kg for applicators and 600 kg for the generator). The aim is nevertheless for a significant weight reduction for future agricultural equipment.

The current working speed of Electroherb is around 3 to 5 km / h,

although it is possible to go up to 10 km / h. The biggest constraint remains the contact time between the electrodes and the plant: it must be between 0.1 and 1 second dependant on the height of weeds present. With a current width of 2.5 m to 3 m wide, the machine has a work rate of 1 ha/hour.

In terms of risks to soil fauna, worm tests of earth and springtails are in final stage of testing. At the moment, the final report is not available but according to the manufacturer, the impact is limited. "The results of tests carried out in 2017 under normal conditions and typical dose rates, did not show any significantly negative effects on earth worms, soil mites and microorganisms. However tests carried out in non-targeted areas under normal use of equipment, such as wet permanent pasture, have revealed a sensitivity at very high doses, says the director. The scheduled tests for 2018 will seek to evaluate the dosage optimal for ensuring complete destruction of weeds while having minimal impact on non-target organisms.

Is the magnetic field potentially harmful for the user? "Intensity of these fields was measured and the main source of radiation comes from the generator, which is shielded. The applicator's radiation field that is produced is well below critical values for man and the environment" concluded Mr. Eberius. The price of the machine has yet to be announced by the manufacturer. They hope to launch the machine on the market in 2019. By then, Arvalis and the French Institute

of vine and wine will have finished conducting assessments on the safety of the machine. The current version will be available for demonstration in France in second half of the year.

Microwaves for “Cooking” weeds.

Another technology that has the advantage of not touching the soil is weeding by microwaves. Created initially in order to warm up frozen dishes, his interest in destroying unwanted plants has been studied since 1920. From pizzas to weeds, there is only one step. Graham Brodie, of the University of Melbourne in Australia, in 2006 used a kitchen microwave with a power of 600 watts to study its weeding potential. “Microwaves make the water molecules contained within the food stuff or plant to oscillate very fast. Plant moisture is transformed into steam that generates a strong pressure that will degrade the cellular structure. It's also very impressive to hear the vegetation cracking as the machine moves across the field”, says Graham Brodie. Since 2008, he has been developing an experimental version with a power of 8 kW. It consists of four independent generators of 2 kW each. The output antennas are 11 cm wide which allows the wave to be directed between rows where cultivation has taken place. “The tool is used at a speed of 1 km / h, which generates a temperature 60 ° C on the floor, enough to eliminate weeds at a young stage. With a power of 18 kW, it would be possible to work between 6 and 10 km / h, and there are already generators of nearly 100 kW”, he says. The machine is also used to treat the soil in order to reduce the weed seed bank and will also destroy some organisms, pathogens such as nematodes, bacteria and fungi various fusarium and sclerotium).

This operation however requires much more energy and operates at a much slower forward speed: 40-50 m / hour. The effect on weed development, on the other hand lasts for much longer. Of the tests carried out before sowing cereals (rice, wheat) it was showed that under certain conditions a weed pressure reduction up to 85% over to the untreated cultivated land. The tests have also shown gains in yields



The machine working five days after a direct sowing of organic soya, controlling well annual weeds that were between 5 and 25 cm tall. Control was less effective on some perennial plants, where it took two or three passages. The technology remains interesting for organic systems in direct drilling situations says Marcio Chaliol, technician in southern Brazil.

that varied between + 35% and + 92%. “Microwaves will only penetrate to 5 cm, but that is enough to kill some of the bacteria present. Which is the same as a tillage operation but without the soil movement. This destruction also causes a mineralization effect and the release of nitrogen is where the yield increase comes from. Populations of bacteria regenerate

very quickly and after a few weeks, there are more bacteria than before the passage of the machine. It was noted that this effect on the soil treatments performance persists even during the next three seasons”, added Graham Brodie.

Microwaves also have a positive effect on slugs.

In addition to weeds, the technology helps to control slugs and snails. Tests show, the energy required to kill them was ten times less than those needed to destroy the plants present (see table). The flip side of these kill rates also relates to their effect on earth worms and all other useful macro fauna that can be found on the soil surface.



The Australian Dr. Graham Brodie's microwave weeder has a power of 8 kW. It destroys weeds in a single pass at 1 km / h. “With 18 kW generators, it would be possible to work between 6 and 10 km / h”, describes the scientist.

“At this point we don't know the effect of this on this macro fauna. Microwaves will probably kill earth worms very close to the surface just as a tillage pass would. Those at depth are protected because the effect is not going below 5 cm”.

The other major drawback of this technology is energy consumption. The 8kW machine needs two electricity generators of 7 kW. There is therefore a loss of energy inherent in the process of running the machine that emerges as heat lost to the atmosphere and which is not recovered. “The efficiency of a household microwave is less than 50% whereas in the agricultural system current is around 75-80%. But industrial generators in closed systems ensure efficiencies of 90%, concludes Graham Brodie.

Further green chemistry

In addition to these mechanical technologies, another solution to consider is bio herbicides. These are obtained from natural active molecules found in living organisms: bacteria, fungi, and plants. A quick overview of



Output antennas are 11 cm wide which allows to direct the flow of microwaves between the rows of a previous cultivation.

Microwaves and Slugs

Low level of energy required to kill slugs

Species	LD50(J/cm ²)	LD90(J/cm ²)
Annual Ryegrass	180	240
Barley	100	190
Soft Bromine	170	330
Erigeron	125	170
Snails and Slugs	6	14
Oats	100	180

Microwave energy in joule / cm² needed to destroy 50% of species tested (LD 50, lethal dose 50) or 90% of species tested (LD 90, lethal dose 90). Snails or slugs are destroyed with a relatively low compared to that needed to kill weeds.



Despite its cost (300 € / ha plus the cost of grinding the vines stems verses a hundred euros with a classical chemical strategy), Beloukha presents some efficiency for potato lifting (testing in Normandy on Caesar variety at 16lt / ha at a 10% senescence rate, at 11 o'clock on a sunny day compared to grinding the vines beforehand at a height of 15 cm).

available solutions brings one particular product to the top of the search. Marketed by the company Jade, this is a product which has gained approval for field crops in France. Belukha is non-selective herbicide consisting of pelargonic acids (nonanoic acid), an acid



Like all bio herbicides based on fatty acids, it is advisable to Pine Oil apply during the spring or summer, on young unwanted weeds that are in full growth (ideally when plants have less than 10 to 15 cm height).

fat obtained after during the extraction process for rapeseed oil. These molecules act by contact dehydrating the cells of the plant, causing it to dry out.

Belukha is a non-systemic product. In 2018 it was approved for use on vines, fruit trees and for desiccation of soil beneath the apple trees. Like all products of this type, it is advisable to apply in the spring or summer, on weeds in full growth. Its efficiency for certain weeds is known if used in good conditions and must be accompanied by crimping. "In our tests, when crimping and defoliating have been made in sunny weather it has increased the efficiency by 20% when used at the recommended dose (16 l / ha). The main problem to this approach is the cost per hectare. A price that is, hopefully, likely to decrease over time.

A Bio herbicide with potential - But at a Price

Another solution is pine oil extract.

Marketed in New Zealand and Australia for several years, it is produced in Quebec by AEF Global. Efficiency has been increased by raising the purity of the refined oil. The product has been shown to achieve up to 100% control on some broadleaf weeds and also on some annual grasses. Used at a dilution rate of 10% (on plants at the cotyledon stage) at 20% (on plants over 5 leaves) without addition of adjuvant. Here again the problem lies in the cost which is around 600 € / ha. The product can however find its place in agriculture when used for spot treatment with a jet directed in the row of maize combined with hoeing inter row hoeing.

"It can be used in cereals from the five leaf stage of the crop" says Claude Dubois, director of the company, which will launch the product in 2019 in the Canadian market. In the United States there is another bio herbicide based on fatty acid which interests the organic market. Marketed by the company Westbridge under the name of Suppress, it's a mixture of caprylic acid and the acid caprique, two fatty acids that it is possible to extract from Goat cheese! On sale for four years it's been used on several thousand hectares and claimed to be effective on dicotyledons and also on grasses, even in cold conditions. Applied at a dilution rate that varies from 3 to 9% (on average 6% for an application rate of 230lt/ha of water) depending on level of the plants development. The product is used mainly on fruit trees and vines, taking care not to touch the foliage of crops with a cost of 250 € / ha.

It also has some use in cereals as a pre-harvest biological desiccant but remains a very expensive approach. It is also used on soybeans as an inter-row herbicide, with directed applicators which protect the soya foliage. In Argentina it is used in soybean oil production by organic farmers who are trying direct drilling. The key to the products effectiveness is the lecithin contained within the legume that causes a drying effect. Lecithins are complex molecules, phospholipids, consisting in part of fatty acids. "It's necessary to choose varieties rich in lecithin, while the dilution rate for this is 5%". Attempts have been made to use it when direct drilling soya into a crimped crop of cereal rye. A first



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application is made during the first pass when rolling the rye to create a mulch. While the second application is made after drilling.

The product has a residual effect which lasts for ten days allowing the soya time to establish. The oil is not easy to use because it's hard to mix in

might have a use for permanent cover crop situations, is a product is called Organo-ground. It consists of a lactic acid bacteria mixture of the Lactobacillus family, which comes from the fermentation of dairy products which produce citric acid and lactic. This product provides partial control of

limited selectivity and its cost it never been marketed widely " says Claude Dubois, from the company AEF global. He concluded it must be made clear that the development of products based on microorganisms is much easier outside the EU due to the less restrictive regulations. In France, INRA

Bio herbicides were first marketed for domestic gardening, horticulture and used around perennial plants. They were recommended to be applied using large volumes of water. However attention has now turned to evaluate if they can be used at lower water volumes on broad acre cereals. The aim is to develop products which can be used at much lower dose rates while improving the efficiency reducing the overall costs significantly.

the tank of the sprayer and requires constant agitation. Levels of control are in the order of 66% on young seedlings at the 1 to 2 leaf stage, which is very useful for organic farmers. According to producers, sunflower oil could also be used, provided that the varieties are lecithin-rich.

Further products in the pipeline

Finally, another bio herbicide who

some legumes like white clover or bird's-foot. Authorized by the Canadian Government, it is currently only available for domestic use under the name of Bioprotec herbicide and the cost is still too high for use on broad acre crops.

"The substance is attractive enough for use in amenity situations but because of the regulatory context in place, this is also limiting its use as a conventional herbicide. Due to its

work a lot with the development and potential long term impact of this type product as the effects can take many years to become apparent. Because of this they will take longer to bring to market and therefore be more expensive. This is just a taste of some of the current developments in the bio herbicides arena one thing is certain is that they are likely to be less effective than current synthetic weed killers.

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DRILL MANUFACTURERS IN FOCUS...

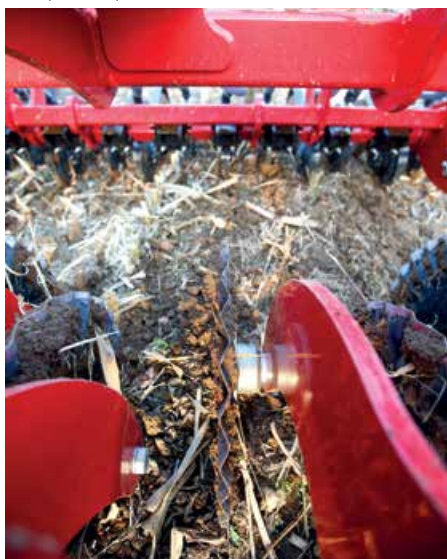


HORSCH PRONTO NT EXPANDS SEED DRILL FAMILY

Available in 6m, 8m and 9m working widths, the Horsch Pronto NT features the well-proven TurboDisc double-disc coulters at 20cm row spacing in combination with a compact, leading wavy disc, making it ideal for low disturbance drilling and direct seeding.

Operational speeds up to 20kph allow for a high area output even at smaller working widths. Horsepower requirement is very low as the wavy discs cut through organic material and cultivate the soil only in the seed rows, creating a fine earth in the seed horizon. The necessary weight for operation of the wavy discs and seed coulters is transferred via the sophisticated hydraulic system of the machine. In very hard conditions, additional weight up to 1400 kg can be mounted on the frame.

A large 4,000-litre seed hopper guarantees low idle times while a 5,000-litre double hopper allows seed and fertiliser to be applied at the same time. A micro-granular unit can be combined with double hopper as well as with the single hopper version allowing seed, fertiliser and micro-granular compounds to be metered in only one pass.



DRILL MANUFACTURERS IN FOCUS...



A PERFECT YEAR FOR EFFECTIVE STUBBLE MANAGEMENT

Stubble management is an essential part of any efficient, sustainable, profitable crop production system and conditions this season have been perfect to maximise the benefits. Jeff Claydon, who farms in Suffolk and designed the Claydon Opti-Till® System, explains why.

Stubble management is an essential part of any efficient, sustainable, profitable crop production system and conditions this season have been perfect to maximise the benefits. Jeff Claydon, who farms in Suffolk and designed the Claydon Opti-Till® System, explains why.

I guess that many who enter the world of no-till crop establishment think that all you need to do with such a system is to spray the stubbles with glyphosate and then direct seed. In a utopian world where Mother Nature is always kind, the farm is very clean and slug free you might be able to get away with that, but it's not like that for most of us.

Back in 2002 when we were in the early stages of developing what is now the Claydon Opti-Till System we used to think that way too. Sometimes that approach produced fantastic crops, but others would be poor or even an outright disaster, so we spent many years trying countless different ideas, techniques and equipment to overcome this variability and achieve consistently good results.

Initially, we genuinely thought that if we did not disturb the soil surface the weed seeds would degenerate, the chemical we applied would be closer to them and more effective, so our weed problems would quickly vanish. As it turned out we had more problems and to overcome them increased our use of



Jeff Claydon carries out a first pass with the 15m Straw Harrow, working at 30° angle to the harvester. This performs four main functions: trash and residue management, slug control, encouraging weeds and volunteers to germinate and levelling fields in preparation for drilling.

expensive chemicals, thereby negating some of the savings in establishment costs that we were making. After years of continuous research, we have subsequently developed the knowledge and machinery to achieve the very best results, in all crops, soils and conditions.

Every season is different and the conditions it presents require careful assessment, regardless of which system you use, so we have learned to address the challenges that Mother Nature sets us. The last two years, for example, have provided perfectly contrasting conditions. In 2017 when we were harvesting in August the soil was wet and gummy, but this year it was dry and crumbly with plenty of natural cracking which went down much deeper than any subsoiler. When we finished harvest in July the soil was bone dry.

As I write, on 28 August, over 80mm of rain has fallen in the month since harvest and we are seeing real benefits in terms of managing stubbles, which is a critical because otherwise slugs can pose a major risk. The adults rise to the surface, lay thousands of eggs under

crop residue and quickly populate the area, making it hard to establish the following crop.

Where the combine stops there is a tendency to leave 'Skylark' patches due to the extra straw left in that area and the following crop growing on them will lack vigour, allowing weeds to develop while any seed in the straw, and sometimes on the surface, will lay dormant only to reappear in the next crop. We overcame those issues, and others, by developing the Claydon Straw Harrow.

In 2007 we tried using a straw harrow on the Claydon farms, but quickly dismissed it because it appeared to do very little. How wrong we were, because where it had been used the crops were much better and more even, with far fewer slug and weed issues. After that, we further developed the straw harrow into the implement it is today, getting the weight and balance exactly right to achieve the best results.

Within a week of finishing harvest this year we ran our 15m straw harrow across the entire farm (see it in action

on www.claydondrill.com/video-gallery). Operating at 18kph, at an angle to the combine, the 15m straw harrow covers 25 hectares an hour and, using less than 2.5 litres of diesel per hectare, distributes the chopped straw while creating a fine, level, 2cm-deep tilth which encourages volunteers and weeds to grow. The key is to follow quickly behind the harvester before the soil bakes hard, because creating this fine tilth on the surface will halt the capillary action in the soil, preventing it from drying and baking out.



Two weeks later, on 15 August, we had liberated countless one-leaf volunteers and the first flush of weed seeds had germinated. We then went over all our 400-hectare farm with the straw harrow to remove them. Everything wants to grow in a healthy soil and after just a few days we had another flush, so on 25 August the straw harrow was used again to remove them, with the benefit of destroying any slugs that had emerged in the meantime.

In the days and weeks before drilling we will have the opportunity to take out additional flushes. The weather is currently ideal and with each shower more germinate. Ideally, we will stop straw harrowing two weeks before drilling and will apply full-strength glyphosate to clean up any remaining weeds before winter wheats are established quickly and efficiently with the unique Claydon Opti-Till® drill.

We use the straw harrow only when necessary, after we have assessed weed and pest issues. A pass of the harrow is fast, uses very little fuel and has a very low wearing parts requirement. Compared to a single pass of a deep cultivator, it is very inexpensive, and the cost is minimal in the overall scheme of things.



The Claydon Straw Harrow is used to take out weeds at the cotyledon stage when they are barely visible.

Our 15m Straw Harrow operates at 18kph and covers 25 hectares per hour, 400 hectares in 15 hours, which is the same output as our 24m sprayer. We use around 2.5 litres of fuel per hectare, so each time we straw harrow the farm we use around 900 litres. With red diesel at around 60p per litre it costs £540 to complete one pass with the Straw Harrow. With glyphosate costing around £3 per litre and applied at three litres per hectare the cost of chemical alone would be £3240, added to which you would still require nearly as much fuel to power the sprayer as to operate the Straw Harrow.

That means we can cover the farm

four times with the Straw Harrow for roughly the same cost as one application of glyphosate, which is considerably cheaper than any other single cultivation pass using traditional cultivation equipment. Having farmed in the days before glyphosate I would not wish to return to that situation, so we must do all we can to preserve this valuable chemistry. When, finally, we do apply glyphosate it is as a single, full-strength dose prior to drilling, which maximises its effectiveness and reduces the risk of resistance developing.

The Claydon Opti-Till system has been continuously developed over the last 16 years to enable crops to be established much more cost effectively and efficiently with reduced pressures from slugs and weeds. It also allows us to produce consistent high-yielding crops. Our long-term average wheat yield is 10t/ha, but even with just 23mm of rain falling between 1 May and harvest this year yields were just 10% below that at harvest. Grain quality was excellent, achieved the top specification and with 13.8% protein, 350 Hagberg and a specific weight of 78h/l at 12% moisture it sold at £192 per tonne. I am sure that many farmers would be happy with that, whatever system they operate.

To learn more about the Claydon Opti-Till System and techniques to improve your farm's performance contact your local Claydon dealer and arrange to visit our farm. You have nothing to lose and everything to gain.



Jeff Claydon inspecting the layer of mulch the straw harrow has created.

THIRD ANNUAL **GROUNDSWELL** SHOW ILLUSTRATES THE PARADIGM SHIFT TOWARDS MORE **CONSERVATION- MINDED FARMING PRACTICES**

The third annual Groundswell No-Till Show and Conference took place at Lannock Manor Farm on 27th and 28th June at Lannock Manor Farm attended by over 1,200 farmers, landowners and other delegates with a shared interest in soil health. The theme of the conference was health, the idea being that health is fundamental for soil, plants and the humans and animals that survive off the plants. The additional health argument lies in a healthy balance sheet and the take home message from Groundswell this year was the sense of achievability of this through a more conservation-minded approach to agriculture.

It was difficult to decide what to see at Groundswell with over 70 different sessions taking place with discussions ranging from no-till practicalities to small robots. The keynote speakers who had flown in from all corners of the world brought with them fresh ideas and ways of thinking that sometimes are hard to fathom for traditional UK farmers. Highlights included Dan Kittredge (Bionutrient Food Association, USA) questioning the assumptions when it comes to nutritional density of food. Packing out the Seminar Barns was Greg Judy (Green Pasture Farm, USA) who engaged both pasture and arable farmers. It was an inspiration to hear how mob grazing has transformed his farms soils and bottom line.

Ademir Calegari from Brazil was an entertaining and informative speaker, somewhat a Latin American no-till



Panel on Measuring Soil Health with Jake Freestone, Tony Allen, Joel Williams (Canada), Dan Kittredge (USA), Jacki Stroud and Gottlieb Basch (Portugal)

legend and a fountain of knowledge. The key message UK farmers took home was just how much improvement in soil quality can be made after a few decades of direct drilling and cover cropping. Ademir acknowledged that

the climate differences between South America and Europe are indeed tangible but the principles of soil health are universal.

Joel Williams gave a talk each day of Groundswell covering Diversity and

MISSED SOME OF THE TALKS AT GROUNDSWELL? YOU CAN WATCH THE SEMINARS FROM THE CONFERENCE ON THE GROUNDSWELL YOUTUBE CHANNEL

Watch "Groundswell The Film" by Fiona Cunningham-Reid
available on Vimeo <https://vimeo.com/246917162>

Groundswell 2019 Save the Dates 26th and 27th June for Groundswell 2019 which is staying at Lannock Manor Farm but evolving to incorporate a new demonstration field as well as more interactive demonstrations, workshops and practical advice for farmers embarking on direct drilling and Conservation Agriculture.

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Clive Bailye and Jake Freestone discuss how no-till works on their farms in the Agricology Breakout Tent

Carbon and Advanced Plant Nutrition which had the Conference Barn hanging on his every word. Delegates also had the opportunity of hearing Joel on the panel discussions on Measuring Soil Health which concluded, as we all know, that we are quite far from agreeing on a standard test to quantify this metric.

The results of the much-anticipated No-Till Benchmarking Group, the first of its kind in Europe were released to a packed-out Conference Barn by Gary Markham of Land Family Business. The independent group of 12 no-till farms revealed an average £10/t saving on wheat production and machinery costs averaging at £31/t, compared to £54/t with other establishment systems. Delegates also heard from Jake Freestone of Overbury Enterprises who claimed his establishment costs have fallen to just £52/ha on their 1,200ha Worcestershire estate.

Extreme conditions in the demonstration field really tested the 13 Direct Drill Manufacturers who illustrated the establishment, either by tine or disc into a waist high multi-species cover crop. Some crimper



A crowd forms around John Deere for their demonstration of the 750A direct drilling into cover crop

rollers attached onto the front provided a forward-thinking approach to helping terminate the crops and this is certainly an area for more investigation.

Amongst other highlights in the field; Cranfield University showcased their rainfall simulator showing a constant rainfall event on different soil conditions and how the water percolation and soil organic matter run-off is affected. In the AHDB Soil Pit Elizabeth Stockdale was keen to explain to farmers how significant it was that a root from the cover crop had followed a worm hole nearly 2m deep to find moisture and even in the drought conditions there were visible water drops forming at the bottom.

There were a significant number of campers at Groundswell this year and the weather was definitely on their side. As the sun started to set on the Wednesday evening, "The Earthworm Arms" Bar was packed out with thirsty minds sharing ideas over a pint or two of local ale and a grass-fed Argentinian asado. Adam Horovitz's words from his book "The Soil Never Sleeps" could not have been more appropriate!



BBC Look East filming Cranfield University's Rainfall Simulator in action

Groundswell Host Farmer writes..

It was good to see so many of you at Groundswell at the end of June. Like the best parties, the whole thing passed in a bit of a blur, leaving memories of snippets of talks and conversations and demonstrations, as well as regrets for all the things I missed.

I was worried that the ground would be a bit hard for the drills to make much impression on, but they all, in their own ways, scratched through the surface and planted their seed and each drill was followed by a mob of eager farmers looking for all the world like a flock of seagulls, studying their performance. I'll leave it to others to rate which was considered the most successful...

Of course, planting the seed is vital, but by no means the most important aspect of making no-till work on your farm. Keeping on top of weeds and disease, getting fertility right, planning what crops to grow and nurturing the soil are all crucial as well. All these subjects were covered in the various talks throughout the two days. For those who weren't there, as well as those who were but couldn't be in two places at once, we've now uploaded most of the talks from the two main halls onto our YouTube channel (type in Groundswell Agriculture on YouTube to find them). There's a lot of fascinating ideas and hard won knowledge in there.

One thing we've struggled to find on the farm here, is anything resembling a coherent rotation to adopt. Talking to other farmers, it seems we're not the only ones. Diversity of cropping is one of the cornerstones of Conservation Agriculture, but decent paying break crops are hard to find, peas and beans have been disappointing to say the least (although we tend to get a cracking wheat crop after them), rape is a nightmare with flea beetle, pigeons and constant expense from the moment you drill it until it leaves the farm and the various alternatives leave a lot to be desired.

So we'll be focussing on rotation, rotation, rotation next year, as well as companion cropping (aka getting all the diversity in at one go). Having ruminant animals on the farm gives us opportunities to grow summer covers for grazing, but not everyone has this option. We had the idea of having some form of speed-dating arrangement to pair arable farmers with graziers looking for out of season land to

feast on. If anyone has an idea of how we can make this work, please get in touch.

We are also planning on moving the demonstrations to another field on the same side of the road as the lecture barns, as we reckon it's about time we took a crop off the demo field before club root or some similar horror infects it. It'll also reduce the risk of losing delegates to a road traffic accident...

This is a show for farmers, by farmers, as we keep emphasising. So if any of you have thoughts or suggestions of what you would like to see covered next year, please get in touch. We know no-till works and we know it can work much better... there is not much enthusiasm from the



Horsch Avatar Direct Drill in action



Cousins Crimper Roller "terminating" the standing cover crop

mainstream advisory bodies for doing this, so it's up to all of us farmers to share our experiences and ideas to make it successful.

With this in mind, there will be more focus on adapting the lessons that our colleagues in the Americas and the Antipodes have learned, to European conditions. We're hoping to book more local speakers, remembering that local post-Brexit, still means European...

We've been quietly pleased with this years harvest, although everything suffered with the dry weather, nothing was a complete write-off and the barns are full enough and our costs this year have been very low, which means more money in the bank to add to more carbon in the soil. Life just gets better and better!

John Cherry

john@groundswellag.com

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DRILL MANUFACTURERS IN FOCUS...



Interesting things?

My experiences so far with the Ma/Ag direct drill, if you want to direct drill then some thought must be given to the system well before you even have a demo. Yes we can drill into almost anything from last year's crop aftermath to fully cultivated seedbeds. Direct drills, especially low disturbance machines can't work the ground and certainly don't level undulations, tramlines or carry out any remedial work so best not to do the damage in the first place. Tractors, trailers and implements with the right tyres, operators with the right instructions and also the knowledge and reasons of what is trying to be achieved. For example, on a recent demo a telehandler complete with bag of seed drove halfway down the headland to fill up the Ma/Ag drill, just adding to headland paddling, far better take the drill to the gateway surely?

Great experiences with cover crops, holding nutrients and moisture, tap roots driving through the pan, lots of organic matter back into the soil and far cheaper than using diesel and steel to do the same job !



Oil radish tap roots in recent cover crop, improving structure, think tillage radish is also worth a look?



And then drill, this is 2019 Oats gone in, should get a great start.



Also been sowing cover crops, not easy in the very dry conditions but there is still a bit of moisture, especially if the soil isn't allowed to dry out, here's a Buck wheat/Phacelia/Spring Oat mix starting to make it's mark



But not every soil, field or farm can always use the direct drill route and so the Ma/Ag drill is happy to work on cultivated ground, sterile seedbeds, or here straight onto rolled ploughing.

THE ALBRECHT METHOD

Written by Steve Townsend

Think you have your soil fertility mastered? Well-read on about possibly the most misunderstood soil scientist Dr William Albrecht, skip this article and you could be missing something.

I don't think there is anybody in agriculture more misunderstood or misquoted than Dr William Albrecht, who was emeritus professor of soils at the University of Missouri from 1919 – 1959. He began his work in medicine but soon switched to agriculture when he realised that medicine focused on symptoms and not the cause. He reasoned that most health issues were the result of poor nutrition and this could be best addressed by focusing on the soil. He coined the phrase 'healthy soil, healthy crop, healthy animals', and we could possibly add to that 'healthy humans'. Many critics dismiss his work entirely but I believe they are missing the point and that is that crop production is an expression of the soil.

The trouble started, as I see it, when Professor Albrecht allegedly said that the ideal ratio in the soil for calcium and magnesium was 68% and 12% respectively. The wider scientific community took umbrage at this as it threatened the status quo and what they had been preaching on soil fertility. This position still exists today with some scientists saying that Albrecht's work has been peer reviewed and so doesn't work or is not relevant. The scientists of this persuasion then set out to prove that this statement was wrong and they found soils could yield just as well without the calcium and

magnesium being in these proportions. This is the crux of the matter. I have read many of Professor Albrecht's works but not once have I found the alleged statement. He refers to it as the average ratio as you could expect across many different soil types. The ratio he did talk about was that the calcium and magnesium should add up to 80% of the base saturation, then a soil could be considered balanced. Balanced soils he believed gave the most consistent yield and quality, not necessarily the greatest yield at one time. Hopefully that has helped to clear up some confusion and that the Albrecht method of soil testing could have some value to your farm business.

Albrecht talked about the soil as a complete entity encompassing chemical, physical and biological attributes. He recognised that correcting some mineral balances took care of the chemical part of the soil which in turn allowed the physical structure to improve which then provides an environment for the correct biology to flourish. It is a self-sustaining cycle. Of course, like the minerals, the biology has to be there in the first place for it to flourish, it could well be argued that decades of intensive agriculture have depleted our soils to the brink of extinction and the biology may well need re-establishing. Conversely though what this also shows is that there will be little response to 'bugs in jugs' if the chemical and physical environment is not there to allow them to flourish.

Exploring Albrecht's research further, he suggested that there is an ideal ratio between the levels of calcium and magnesium in the soil, which should be related to the soils clay content. While Albrecht did not discover cation exchange he did link cation exchange to the colloidal clay particles within the soil. The clay colloids are negatively charged and have the ability to exchange calcium, magnesium and potassium (amongst many others) for hydrogen with the plant.

Albrecht research initially focused on

forage production, and he discovered that calcium was essential in increasing protein content within the forage. He then took this a step further and began trying to relate the calcium content of the soil to the forage and then onto the health of the animal. With this work he found that improved animal health was reflected by the improved forage. This led him on to his hypothesis of the ideal cation ratios in the soil.

For the soil he was working on he suggested that the calcium saturation percentage should be 65% and the magnesium should be 15%. But the important point to note here is that the calcium and magnesium percentage should total 80%. Further work by Albrecht and others then suggested that there was a range of ratios depending upon soil clay content. These ratios are where we are today with ideally calcium 60-70% and magnesium 10-20%. Albrecht ignored soil pH reasoning that if the cations are in these ratios the pH will look after itself at around pH6.3

So what does this mean to you?

Many consultants will measure the cation exchange and calculate the calcium and magnesium percentages. A typical result, from a calcareous soil, may look something like this; calcium 84% and magnesium 5% to which you would conclude that all is well. The excess calcium can't be giving me a problem, after all the calcium is the beneficial element isn't it and I have low magnesium? But if the calcium level is too high that generally means other cations have suffered as a result. Albrecht discovered that as calcium becomes excessive it 'masks' magnesium. In the example above the calcium and magnesium percentages totals 89%, which is beyond Albrecht's ideal of 80%. If you try to 'strip' out the calcium the magnesium level will rise by the corresponding amount. Thus if you lowered the calcium to 70% you would increase the magnesium by 14% to the more accurate figure of 19% which is now a soil with excessive magnesium!





revealed a calcium percentage of just 46%. That's just not possible is it? Well, yes it is, if magnesium and potassium have filled the cation exchange sites they will have a stronger basicity than calcium alone, and result in a high pH. A simple pH test would suggest that calcium is not necessary, in this situation, and would result in poor crop production (as was the experience in this case), through lack of calcium, poor drainage, low air content and low health soils. Making sure you have the correct calcium content in your soil therefore can't be achieved by pH alone! Why is this important you might ask? It's not just about calcium, but blackgrass hates correct calcium & magnesium levels and as mentioned before, producing a healthy soil is difficult without a good balance of these and other elements.

If soil health, conservation agriculture or reduced tillage establishment systems are your goal don't overlook the basics and assume your soil will cope without the right chemical balance. You may be spending money in the wrong areas when a simple soil test will put you on the right track or leave you fighting a chemical imbalance with the cards stacked against you, leading to poor future and present crop performance.

Magnesium in excess is a problematic element in the soil. Excessive magnesium causes clay aggregates to disperse. Clay dispersion reduces soil aggregation in turn reducing pore space (the soil has slumped) and consequently reducing water and air movement. Without air and water movement your soil will no longer have beneficial functioning biology which facilitates nutrient cycling, soil carbon building, and help with soil aggregation to produce the crumb structure and tilth that you need.

It has long been known that calcium

can ameliorate the effects of heavy soils and their tendency to slump and compact. If your soils slump and compact your crop production will suffer. Your soil will no longer have the pore space to facilitate air and water movement.

But simply adding limestone to correct soil pH using a rough formula based around soil type is imprecise. And what happens if the soil pH is at pH 6.5 or above and there is still a calcium deficiency? I will use the example of a client who had a pH of 7.8, but when the cation exchange was measured

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Sheep Mob-Grazing herbal leys at Honeydale Farm

PUT THE BIG 'G' - GRASS - BACK INTO YOUR FARMING SYSTEM

Article adapted from a presentation given by Cotswold Seeds MD Ian Wilkinson at this year's Groundswell event

In 2016, the NFU reported the biggest year-on-year fall in farm profitability since the millennium, as farmers deal with the impact of devastating cuts in the value of their products and the rising prices of nitrogen fertiliser.

There are two ways to increase profit: Intensify to produce more, or lower cost of production with self sufficiency. 'Farmers should have a low cost of production...be a seller not a buyer' said Roman statesman Cato back in 234 BC. But how to achieve this?

Free Fertilising

After the Second World War, Sir George Stapledon advocated the 'dual aspects' of ley farming. In his book 'The Plough Up Policy and Ley Farming' he wrote: 'Considered as an agent for the promotion of soil fertility, the grass sod must be regarded as perhaps the most valuable foundation upon which the farmer can build.' In his book, 'Thirty Years Farming on the Clifton Park System,' William Lamin recounts how he took over poor sandy land near

Burton-on-Trent and made it one of the most productive in the district, giving credit to Robert Elliott, of Clifton Park, who demonstrated how ley farming and rotational grasses helped to build fertility.

A clover rich ley will reliably produce the same amount of nitrogen that farmers typically apply in costly artificial fertilisers. Nitrogen accumulates in small nodules found on clover roots, with some of it being released as the clover plant matures. But after the ley is ploughed in, a large amount of nitrogen is released into the soil and is available over many months. Peak nitrogen availability is around four months after termination, making it available to the following crop which is often a cereal or brassica.

Humus Building

Present day farmer Rob Richmond, who farms light land near Cirencester, has shown how effective ley farming can be for humus building. Twelve years ago soil organic matter on his farm was 2-4%. In 2017 it had risen to 8-9%.

Soil Enriching

Data collected by McCance and Widdowson shows the mineral content



Ian Wilkinson



deep rooting plants in herbal leys: (left to right) Lucerne, Red Clover, Sweet Clover, Burnet, Chicory (sown Spring 2018).

decline in food over a 50 year period (1940-1991). Levels of sodium, potassium, magnesium, calcium, iron and copper have all significantly dropped in vegetables, milk and meat. Minerals come from the soil and deep rooting plants (ribgrass, chicory, sheep's parsley, yarrow, and burnet) extract them.

Drought Resisting

The extreme dry conditions this summer have demonstrated the need for drought resistance. Ryegrass has a fibrous shallow root structure and can't reach down to moisture, but plants in a deep rooting herbal ley can and many farmers have reported that the only crop that's remained growing on their land this summer is the herbal ley. The best drought resistant species in mixes this year were chicory, sainfoin and birdsfoot trefoil.

Pan Busting

Chicory, with its deep tap-root, also busts through pans to improve the structure of the soil and help water infiltration.

High Yielding

Charles Darwin first noted how different plants grown together yield 50% more than their average, due to their overlapping growth habits and patterns. With some species providing their yield early season and others maturing later, the grazing season is also extended.

Black-grass Suppressing

Long grass leys kill blackgrass. It's an annual, and doesn't survive the grass ley part of a crop rotation.

Carbon Capturing

Plants capture carbon from the atmosphere and transfer it to the soil where it's utilised by the soil biology to help unlock precious nutrients which would otherwise be unavailable to the growing plants. A small increase in soil carbon content can also have a huge impact on its ability to hold moisture, so vital in times of drought.

Amazing Grazing

A herbal ley (with 30-50% legume content) is more palatable as forage. Livestock eat 10-15% more and the live weight gain and milk production is improved. Some plants such as sainfoin and birdsfoot trefoil

contain condensed tannins in their leaves and stems, which can reduce worm burdens. Charles Hunter-Smart, who farms 2500 acres on the Bradwell Grove Estate, has not needed to worm ewes for two years and didn't worm any lambs in 2017.

Crop Rotating

The key to success with a herbal ley is shallow sowing and good seedbed consolidation. For the best results, herbal leys should be left in the ground for four years, giving optimum forage yield, root growth, nitrogen fixation and species diversity. Though they are traditionally grazed, herbal leys can also be tailored for cutting for silage (or AD plant) or they may be cut and mulched with a topper.

Put the Big G back into your farming system. Get back on the grass!



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NUTRIENT STRATIFICATION NOT A PROBLEM IN NO-TILL

Nutrient stratification is common concern for no-till farmers.

By Laura Barrera, first published on
www.Agfuse.com in August 2018



Without tillage to mix fertilizer into the soil, no-tillers may wonder whether the nutrients applied to the soil surface are reaching the crop roots.

According to University of Nebraska Extension engineer Paul Jasa and Ray Ward, plant scientist and founder of Ward Laboratories in Kearney, Neb., the resounding answer is: yes, they are.

Even though stratification — the non-uniform distribution of nutrients within a soil's depth, with higher concentrations of nutrients toward the soil surface — does occur in no-till, it should not be a concern. In fact, they say it's a natural phenomenon and as long as you're managing your no-till system properly, you shouldn't have a problem.

Stratification: A natural effect

When you fertilize your pasture, your rangeland or your lawn, how deep do you till it in?

That's the question Paul asks farmers who worry about nutrient stratification in their no-till systems. He asks, if you can put nutrients on top in a natural growing system, why can't they be placed on top in a cropland system?

Ray also points out in native prairies, nutrients work their way down into the soil naturally, just as it occurs in no-till systems. It's why he prefers to

call it nutrient distribution instead of stratification.

In fact, stratification even occurs in tillage systems.

"A lot of people who say there's stratification in no-till have never measured the stratification of their tilled systems," Paul says, explaining that in his research plots he saw just as much stratification in the disk and chisel systems as he did in no-till.

Even as tillage continued, there was actually more stratification in tillage than in no-till. The reason for this is a stronger soil structure under no-till.

"The nutrients can move downward with water through the earthworm channels and root channels that are there," he says. "In tillage, we destroyed those channels so they can't move downward."

Soil moisture key for fertilizer uptake

Another reason stratification is not a concern in no-till is because of higher soil moisture, thanks to undisturbed residue.

Paul says that when it comes to nutrient placement, there are three rules:

- You have to have nutrients in the soil, because that's where the roots are.

- You have to have roots where the nutrients are.
- You have to have water where the roots are, because the roots need water to uptake the nutrients.

Because tillage dries the soil, there aren't roots near the soil surface, which means placing nutrients on top of a tilled soil won't work because there won't be roots there. But in no-till, if residue is left on top of the soil, there will be moisture, and if there's moisture, there will be roots.

In fact, studies have found that no-tilled crops tend to have greater uptake of surface-applied fertilizer than conventionally tilled crops.

According to a paper written by University of Kentucky soil scientist John Grove, Ward and University of Maryland soil scientist Ray Weil, research conducted in Kentucky from 1980-81 looked at corn's uptake of surface-applied potassium under moldboard ploughed and no-tilled plots that were established in 1970.

Despite the fact that potassium stratification was "substantial and more pronounced" in the no-till plot — 170 ppm for a 2-inch soil depth vs. 132 ppm in the moldboard plowed plot — potassium uptake of the no-tilled corn was 130% of the moldboard-plowed corn.

Table 1. Distribution of Soil K and Corn Uptake in Two Tillage Systems in Kentucky

Soil test K: Increment			Soil test K: Composite			Corn K Uptake	
Depth increment, inches	moldboard no-till (NT) ppm K	plow (MP) ppm K	Depth: composite, inches	moldboard no-till (NT) ppm K	plow (MP) ppm K	ratio NT/MP	
0 to 2	170	132	0 to 2	170	132	1.29	1980
2 to 6	104	113	0 to 6	126	119	1.06	1981
6 to 12	86	95	0 to 12	105	107	0.99	Avg.
							ratio NT/MP
							1.35
							1.25
							1.30

In this study, K stratification in long-term no-till actually enhanced corn uptake as compared to plow tillage. Plot tillage systems have been in place for 10 years at beginning of study. K soil test was by neutral ammonium acetate extraction. Source: R.L. Blevins, J.H. Grove & B.K. Kitur, 1986, Nutrient uptake of corn grown using moldboard plow or no-tillage soil management, Commun. Soil Sci. Plant Anal. 17: 401-417.

Table from "Nutrient Stratification in No-Till Soils" by John H. Grove, Raymond C. Ward, Ray R. Weil

When the study looked at the total or composite soil test potassium at a 12-inch depth, they found it was nearly identical between the two – 105 ppm for no-till, 107 ppm for the moldboard plough. Scientists concluded “this strongly suggests that the potassium nutrition of the two corn crops was improved by potassium stratification.”

Paul's research also supports that placing phosphorus higher in the soil for corn performs better than phosphorus placed deeper.

In 2004, he compared yields between corn that received:

- No phosphorus
- Phosphorus applied with an anhydrous applicator at 5 inches deep, 15 inches from the row
- Phosphorus applied 5 inches deep, 5 inches away on both sides of the row
- Phosphorus applied in-furrow

The corn that received the 5x5 and in-furrow placements both yielded around 10 bushels higher than the other two applications, and Paul notes that the 5x5 and in-furrow were statistically the same yield.

2004		
Phosphorus Placement		
Corn		Yield, bu/A
None		206.4
5"x15"		205.4
5"x5"	both	216.6
In-furrow		215.1

Table from Paul Jasa, University of Nebraska Extension

“If phosphorus stratification were a problem, putting it deeper should've given you a bigger yield,” he explains. “But it didn't. In the furrow was no problem.”

In 2005, Paul tried a few more placement options, including application through a strip-till bar (5x0 treatment), a grain drill to band phosphorus 2 inches deep on 7.5-inch spacing, and phosphorus dribbled on the surface on 7.5-inch spacing.

Noting that it was a dry year, Paul found the phosphorus that was banded and dribbled resulted in the highest corn yields.

2005	
Phosphorus Placement	
Corn	Yield, bu/A
5x0 strip	88.5
In-furrow	87.3
5x15 knife	91.5
5x5 Coulter	99.9
7.5 Bands	106.3
7.5 Dribble	107.5

Table from Paul Jasa, University of Nebraska Extension

“That's because the residue was not disturbed and the fertilizer was right there, so it ran down into the soil and the roots picked it up,” he says. “It just comes down to where are the roots, and is there moisture there for the roots to take the fertilizer up? If the residue is there, there should be moisture.”

Maintain at least 90% residue coverage

Because the roots need soil moisture to absorb fertilizer, leaving crop residue on the soil is key to maintaining that moisture.

Paul says he likes to see 100% residue coverage until the crop canopy takes over, but growers need at least 90% to reduce evaporation from the soil surface, according to irrigation engineer Norman Klocke.

Why do you need so much residue? Paul says that Klocke gave him the example of an energy-efficient house. If someone leaves the front door open, it doesn't matter how well-insulated the house is – the heat is going to escape.

Soil moisture works the same way. Too little residue and the water will find a way to escape from the soil surface.

For no-tillers whose soils are so biologically active they have a hard time maintaining residue, Paul isn't too worried about them losing some residue.

“Because that residue is being recycled, the nutrients in that residue are becoming available for the next crop,” he says. “So I'm not too concerned about that. Now, if

you need it for erosion control or for moisture conservation, that's where those carbon cover crops become vital.”

Cover crops bring added benefits

While there is some concern that cover crops can use up moisture, Paul says that it depends on your location. But if a grower selects the proper cover crops, he shouldn't be losing more moisture than is lost to evaporation. “Bare soil evaporation is much higher than people ever thought.”

Cover crops can also slow acidification that occurs from surface-applying fertilizer, says Ray. While the calcium-magnesium in corn stalks will help slow it, broadleaf covers contain a lot more calcium-magnesium than grasses, which can help slow it even more. He adds that growers using legumes as covers normally don't need to apply as much nitrogen to the following cash crop, which also helps slow acidification.

But even if soil moisture and acidification aren't concerns, no-tillers may still want to add cover crops into their systems for their soil health benefits, which in turn improves nutrient uptake.

Ray says that covers help soils get their mycorrhizae established, which does most of the nutrient feeding for the crop roots.

“Their threads and hyphae get out and pull those nutrients into the plant,” he explains. “The plant provides the food for the mycorrhizae, so the mycorrhizae can bring the nutrients to the plant. So if you've stopped doing any tillage, that mycorrhizae should be developing, and that would be helping nutrient uptake in that topsoil.”

He notes that soil health is critical in how plants uptake nutrients, so if a grower hasn't developed the soil health yet, then the plants may not be able to uptake those nutrients, regardless of how and where the fertilizer is applied.

One warning both Ray and Paul would like no-tillers to heed is the notion that they can heavily reduce or even eliminate fertilizer as their soil health improves.

Ray says that aside from nitrogen and some sulphur, which plants can



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acquire from the air, most nutrients that are removed from the soil will need to be replaced.

"When you take something off the land, you take nutrients off," he says. "So you need to either put that back with manure or compost, or you need to use fertilizer."

The paper by Grove, Ward and Weil recommends ensuring an adequate or slight surplus of nutrition using shallow subsurface placement or surface applications.

Location and crop exceptions

Paul does note that in drier climates, he prefers to place fertilizer in the soil when possible. But as long as there's adequate residue left, he's not too concerned, because the moisture should be there to carry the nutrients into the soil.

Ray also mentions that areas like the Palouse region in the Pacific Northwest can have dry topsoil from limited moisture, so growers usually put their fertilizer 4-5 inches deep in the soil where moisture is still available.

"Now we're doing no-till, so that's changed that dynamic some," he says.

Farmers growing crops that are sensitive to residue also may need to adjust their fertilizer strategies, Paul says. Canola in particular, he explains, is sensitive to too much residue because the canola seedlings are so small.

"Canola tries to get above the residue. It'll grow real fast, have a long stem there, and the frost can kill it."

His recommendation to farmers growing canola and other residue-sensitive crops is to put some fertilizer down in a starter application during planting.

"I'm a firm believer in starter fertilizer being placed down in the soil with the seed to get that crop started," he says. "Because in those early first couple weeks of growing, roots aren't out there in the row middles where the residue is protecting the soil or keeping the moisture there."

So if a no-tiller is running row cleaners on his planter to push the residue away, it'll provide a bare strip of soil that will warm up and dry out. "When it dries out, the nutrients better be in the soil itself there," Paul says.

Don't change your soil sampling strategy

Despite some suggestions that no-tillers should be soil sampling at shallower depths because of stratification, when it comes to taking soil tests for fertilizer recommendations, Ray does not recommend no-tillers do anything different.

The reason for this is due to how the soil tests are calibrated. While in Nebraska the tests are calibrated for an 8-inch depth, in most states it's a 6-inch depth. If a grower submits a sample that's at shallower depth, the calibration will be off, Ray explains. And because the nutrient concentration is higher at the top, he may get a lower fertilizer recommendation than what is needed and end up under-fertilizing his crop.

"The roots grow down 4 to 6 feet deep in the soil," Ray says. "So we're estimating from the top 6-8 inches of soil what that plant needs, when it's growing 4 to 6 feet. So if you start sampling different depths, you're going to get a different reading than if you were to sample 0 to 6 inches or 0 to 8."

"I don't encourage different sampling, if I'm trying to interpret fertilizer recommendations."

THE USE OF **BENEFICIAL MICRO-ORGANISMS** IN AGRICULTURE. A TAILORED METHOD FOR **IMPROVED PLANT PRODUCTIVITY**

Jamie Stotzka, Consultant Bioagronomist

Healthy soils contain billions of bacteria from thousands of species. A special group of these bacteria, collectively known as Plant Growth Promoting Rhizobacteria or PGPR are known to promote plant health, growth and productivity. PGPR are unlike the nodulating rhizobia only found associating with leguminous plants, as they are free-living in soils residing in the plant root zone whilst also having the ability to enter plant tissue. Nourished by plant exudates, these bacteria provide indispensable services to growing crops.

PGPR's plant growth promoting effects can be attributed to four main mechanisms: enhanced nutrient delivery, protection of plants from potential pathogens, improved root development and the bioremediation (cleaning) of soils.

Probably the most renowned trait

of these bacteria is their ability to fix atmospheric nitrogen. Over 78% of the atmosphere is gaseous N_2 , which is ordinarily unusable by plants. A unique set of enzymes allows PGPR convert this gas into plant useable NH_4^+ . Above each hectare of land, approximately 74,000 tonnes of N_2 are within reach to be converted by this process.

Another macro element phosphorus can be present in soils but is often-times 'locked up' – i.e. bound to metal elements. PGPR act to solubilise this element by producing organic acids and in concert with other soil microbes this community has the capability of increasing available soil P by up to 62%. Other essential nutrients are also chelated by PGPR. Working in tandem with other beneficial soil microbes, such as

arbuscular mycorrhizal fungi (AMF), these nutrients can be efficiently transported to crops in healthy soils.

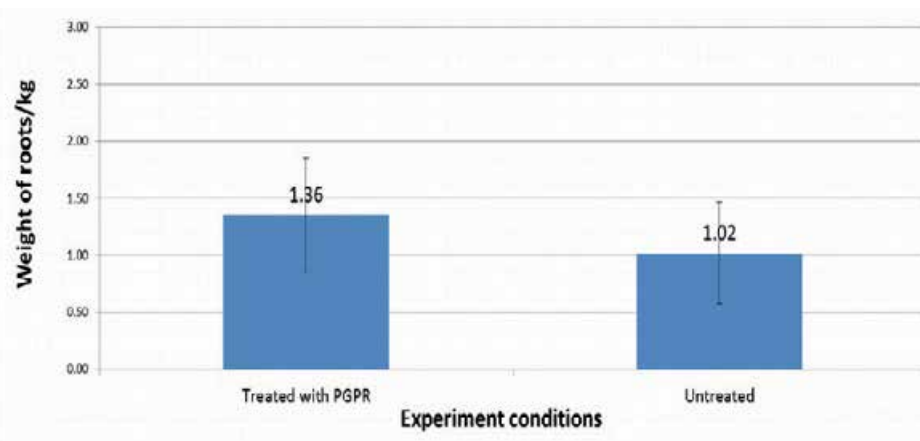
PGPR can further alter the root architecture and promote plant development via the production of phytohormones such as auxins, cytokinins and gibberellic acid. Plant protection is achieved by regulation of plant internal defences against drought and pathogens.

The positive effects of PGPR have in the past been assumed to be fairly generalist and to apply to a broad range of crops. Commercial inoculants have been available for a number of years to improve plant health and development in arable systems. Most of these products operate under a "more is better" policy and fail to discriminate between the particular effects of different bacterial species on



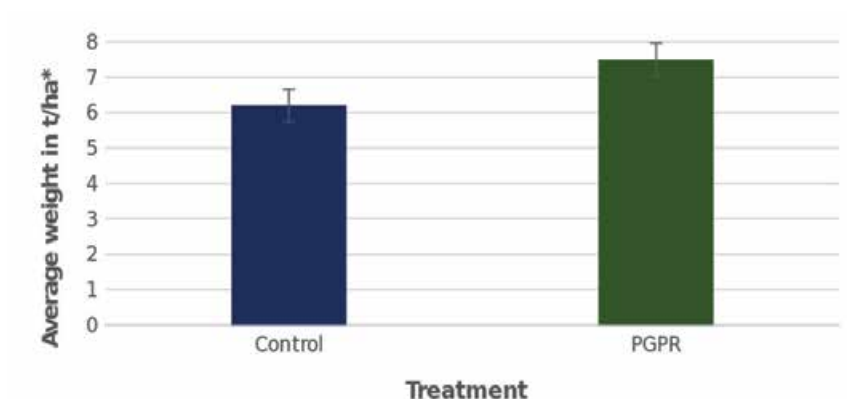
Sugar beet from field trials at Allpress Farms in Cambridgeshire showing 33% yield increase in PGPR treated roots (PlantWorks, 2017).

Sugarbeet plants treated and not treated with PGPR



Trials in 2017-18 on cereal crops grown on 6 farms throughout the UK showed equally impressive results in wheat and oats. Overall wheat yields measured in fertile tiller numbers and average grain weights were increased by approximately 10%.

Motts Farm - Simon Cowell Average Grain Weights*



* Hand-harvested trials showing 20-30% higher yields than combine readings

Conservation farmer Simon Cowell in Essex achieved an uplift of approximately 1.3t/ha

particular crop types. In trials over the past three years, researchers at PlantWorks Ltd have found that this one-size-fits-all approach may have drawbacks and hidden pitfalls.

A range of bacterial species produced by the company were tested in isolation on different crop types, with significant results. Yield results indicated that even within

the cereals group, plants did not necessarily share the same ideal bacterial partners. Field trials were established based on outcomes from preliminary glasshouse experiments and in 2017 these produced very encouraging results.

A sugar beet trial run in collaboration with Allpress Farms in Cambridgeshire, which utilised a

tailored beet inoculum, produced a statistically significant yield increase of 33% with no reduction in quality of the roots. Potato and field vegetable trials showed similarly positive and significant trends with i.e. 43% heavier leeks produced at Allpress.

* Average grain weights on Motts Farm in Essex. Measurements were taken from random quadrat readings taken throughout treated and control areas (PlantWorks, 2018).

Previous trial work at Mr Cowell's farm revealed that through no-till and low input farming systems, as well as rotations including mycorrhiza friendly plants such as Lucerne, the soils were highly biologically active. With wheat on the farm showing very high mycorrhizal colonisation levels of up to 80%. This background fungal network was thought to have further enhanced and supported bacterial function to achieve the positive yield noted.

This hypothesis was further illustrated by PGPR trials at GH Dean in Kent. Here, mycorrhizal and



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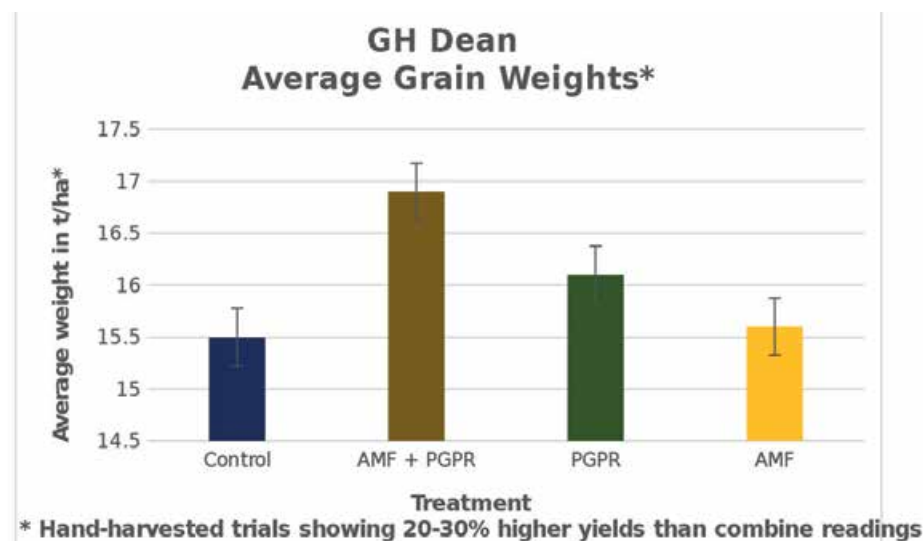


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GH Dean Average Grain Weights



Average grain weights showing positive interactions between arbuscular mycorrhizal fungi and plant growth promoting rhizobacteria (PlantWorks, 2018).

bacterial inoculants were applied in isolation and combination, revealing a positive interaction between the two types of microbes.

A tailored selection of bacterial inoculants for a range of cereal crops

has now become available within the PlantWorks' Smart Rotations range. Applied in liquid form these tailored PGPR consortia are easy and straightforward to apply using standard sprayers. Further products

to enhance mycorrhizal communities in farm soils can be added within crop rotations to build strong fungal communities to support bacterial function.

It is clear that the inclusion of biological inoculants such as PGPR and mycorrhizal fungi has vast potential to allow for more sustainable crop production with possible savings in mineral fertilisers, the use pesticide products as well as building healthy, balanced soils. It is an exciting time within farming, with a growing database of knowledge, ever more sophisticated advice and well tested products becoming available farmers can now, very practically, intervene within rotations to increase beneficial soil biology to enhance arable yields.

For further information contact Ms Jamie Stotzka, Consultant Bioagronomist, PlantWorks Ltd.

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<http://smart.plantworksuk.co.uk/>



www.base-uk.co.uk

BASE-UK was established in 2012 and is independent of all businesses or organisations. We provide a forum for members to share information, experience and ideas on conservation agriculture, minimum tillage, direct drilling, cover cropping, integration of livestock and other techniques offering more sustainable agriculture by working in harmony with soils and the wider environment as well as inviting industry experts to speak to

members.

On 3rd to 5th December 2018 BASE-UK is hosting Dr Jonathan Lundgren, a world-renowned expert and award-winning scientist in the fields of agroecology and risk assessment. He was a top scientist with USDA for 11 years and has strong ties with the scientific community, policy makers and regulators, and numerous farmers, ranchers, and beekeepers from around the world.

Jon is a biological farming researcher using biodiversity to solve problems such as root worm and corn borer in maize. He uses biodiversity to overcome major problems rather than using GM. His vision is that we can grow food and conserve the environment. His mission is to combine research, education and

demonstrate that this can support regenerative agriculture.

At the meetings Jon will explain his research and how to put it into practice on farm. To join us for an opportunity

to meet this world leading authority on pest control with biodiversity contact Rebecca on rebecca@base-uk.co.uk

More information will be available on our website: www.base-uk.co.uk



Dr Jonathan Lundgren

BASE-UK UP-COMING EVENTS FOR 2018/19:

For more information on any of these events please contact rebecca@base-uk.co.uk – Entry by pre-booked ticket only.

3rd December 2018

Dr Jonathan Lundgren at Whixley Village Hall, Whixley, Yorkshire YO26 8AP

5th December 2018

Dr Jonathan Lundgren at Glebe Farm, Poddington, Wellingborough, Northants NN29 7HP. (By kind permission of Bromborough Estate).

5th/6th February 2019

AGM Conference at The Haycock Hotel, Wansford, Nr Peterborough.

DRILL MANUFACTURERS IN FOCUS...

VÄDERSTAD

WHEN A SEEDHAWK JUST ISN'T ENOUGH

With variable soils and a range of crops on 2400ha at Down Ampney Estate near Cirencester, Glos, Farmcare Ltd's manager James Taylor relies on versatile drills from Vaderstad which can perform in demanding conditions.

"We've got everything from sandy clay loams over gravel to chalk downland and clay with flint," he explains. "We've been moving towards direct drilling over the past six years and have refined the machinery based on our experiences. I reckon that there's only 20-30% of our land that can be direct drilled every year, and 10% that is not suitable at all, so our drill fleet also has to be versatile enough to work in min-till or conventional seedbeds."

A Vaderstad Rapid A 600 S has proved to fit the bill precisely since its purchase in 2017.

It is configured with three rows of Vaderstad's disc coulters rather than



The Vaderstad Rapid A 600 S offers the flexibility to drill in a range of conditions presented by variable soils on Down Ampney Estate.

the standard levelling board and two rows of coulters, specified to improve soil flow through the drill, and giving the ability to work in mulch and direct seeding applications.

"In wet conditions, we have found that soil can gather behind a levelling board and block the coulters. If the land needs levelling, we can use a Dalbo Cultimax ahead of the drill, but generally our Simba SL cultivator does a good job of levelling."

He adds that when direct drilling with a two-row coulters layout previously, soil disturbance was also greater.

Mr Taylor compared a number of machines to find a solution to give him the versatility he needs.

"I viewed some Agrovista trial plots where the Rapid was pitted against many of the other direct drills and the results were impressive. It gives us the best of both worlds as it will work in those conditions or go into a

conventionally-prepared seedbed."

This drill comes into its own in the spring, Mr Taylor comments:

"It gives us plenty of options – it can go in after scratching a seedbed or even work into cover crops," Mr Taylor comments.

He asserts that he is not a 'direct drilling zealot'.

"The conditions have to be right; it's no good if it compromises crop performance, and we continue to compare the results with the same varieties established conventionally. We will use all the options open to us to achieve results – even ploughing as a 'reset button' if all else fails. But if the opportunity presents itself to save money we will do so."

To pare establishment costs to the minimum where possible, an 8m Seed Hawk direct drill was purchased in 2015. It uses tine openers and coulters at 25cm spacing and has underframe



James Taylor has been moving towards direct drilling for six years on 2400ha of crops in the Cotswolds.



Three rows of discs have been specified in place of the standard two rows plus a levelling board to reduce soil disturbance and work in testing conditions.

clearance of 30cm to cope with large amounts of trash.

"We looked at a wide range of direct drills but discs are not suitable for our stony land and some systems looked to present prohibitive running costs. Other tine drills were seen to smear the slot."

Mr Taylor's solution was to develop an approach to get the best out of the Seed Hawk, swapping for the Rapid if necessary.

"I assess each field after the combine and if it looks suitable, we'll just scratch the surface with a set of Carrier discs, allow it to chit and go in with the Seed Hawk."

Where soils need restructuring a 5m Simba SL and 5.5m Unipress create a seedbed in one pass.

"The SL has 12 legs to take out compaction and is pulled by 500hp Claas Xerion on wide tyres. We then de-weight the Xerion and put the Seed Hawk on. "This is preferred to using a smaller tractor on 710 tyres, which makes wheel marks that can cause 'slotting' of the seeds."

He comments that while the Seed Hawk could run on a smaller tractor, the Xerion pulls it at 1300rpm and uses minimal fuel.

One particular strength of the Seed Hawk, he suggests, is in drilling oilseed

rape.

"We looked at putting the rape in behind a subsoiler with low disturbance legs, but if there's compaction to take out, the SL and press does a good enough job for this drill."

There's plenty of clearance to tackle trashy conditions and the drill's split tank allows DAP starter fertiliser to be put down the spout at the same time.

"The 25cm spacing raises some questions for wheat, although with the demo machine and our own, we have not seen a yield drop from the wider rows."

Mr Taylor has increased seed rates slightly to take account of wider rows, at 290-300 seeds/sqm, compared to 250-300 seeds/sqm being the norm in September.

He is also considering placing Avadex in the drilled rows, which would cut costs from the traditional overall application.

He points out that the main impetus for using the Seed Hawk is the cost savings that it can offer in the right conditions.

"The labour and fuel savings are impressive – the SL, press and Rapid comes in at £60/ha while the Seed Hawk is £19/ha. If we can put 500ha in with it after harvest that's a £20,000 saving."

"As part of a farming group, we need efficient systems that provide timely returns rather than waiting for soil conditions to improve, and having equipment that is flexible enough to allow us to consider the soil's needs is key to that."



Cruiser winter wheat established with the Seed Hawk at 25cm row spacings.

LOW COST NO-TILL DRILL FOR 600 ACRES

There are many and varied reasons why UK farmers avoid making the change to No-till. They know it won't work on their land. They tried in the 1970s, drilling into the ash left after stubble and straw was burnt off, and yields soon declined. If these aren't enough the next argument against making change is the cost of machinery which is the deterrent. Spending £80k and more on a new machine which replaces a seed drill that's good for many more years seems inevitable.

Editor Mike Donovan explains

You may have heard of a farmer making his own, and this article shows the detail of how one farmer completed the project. It provides farmers in a similar position with useful ideas. With a great many farms falling into the 600 - 1200 acres bracket, here is a means of getting into direct drilling at a low cost - in fact this one was less than £10,000 and that includes the value of the components, some of which were found on the farm anyway.

It is especially valuable as it provides an economic answer for the small and medium sized arable farmer. This group remains the largest sector of farmers and the project provides a viable answer to those who might otherwise feel priced out of the market.

The Carswells Northamptonshire farm is 400 acres of arable and 250 of grass. Their cattle enterprise includes a bull beef enterprise and this provides valuable muck for the arable land. Like many farms in Northants their soil varies from blowing sand to heavy clay, and to emphasise just how variable the land is there's a brickworks on one side of the road outside their village, while on the other they are extracting sand! The variation makes it difficult to choose and buy machinery.

About ten years ago they figured that one way to solve the problem was to go to zero-till and put the whole business of cultivation behind. The change would have greater viability if the cost of the seed drill was low. Rather than buying a cheap, worn out machine and spending thousands on a refurb, the decision was to build that incorporated components already in the yard. The project took some time. As with most of such ideas the project developed, with features added when they were seen as necessary.



Angled aluminium seed closers are rungs of a ladder which have a natural non-stick surface. Note the neat ground drive metering.

The result has been satisfactory yields which in recent years have been on the increase, and of course the costs of crop establishment have been reduced considerably. The drill was built in 2010 with the idea of

using it to sow rape and beans but now is used for everything.

Drill is built on a 3 metre Bomford Superflow frame

Three metres seems small to many farmers who see 6 and 4



The Bomford legs are fitted with Simba tungsten points



The fan is hydraulic driven

it made from a pair of Newton Rigg cubicles. When the drill is raised the fertiliser pump is immediately turned off. He uses 18.27.0 NPK product, and the pump is a ShorFlow.

The seed slot is closed with angled boards that are parts of an aluminium ladder, and they work well. Being so far from the tractor they need to be lightweight as possible. Dale says the aluminium has a natural non-stick surface, and these are the best of many designs including wheels and boards made from plastic.

Using the drill

Dale never uses bout markers but closes the tramline coulters on the machine and does these bouts first, following the tramlines from the previous year. Once they have been drilled he resets the drill does all the bouts in between the tramlines. He uses a 24 meter tramline and so has 7 bouts between.

metre machines at all the shows and demos. They don't bother to demo the three metre version. Yet the acreage capacity of the smaller drill is considerably. Examples of 3,000 acres being planted with 4 metre machine sound impossible. Yet divide the land into autumn and spring sowing, spread the work over from August osr to beans in November and similarly in the spring. Then, most importantly, factor in the elimination of seedbed preparation. That 4m sounds like it might do the job okay. Not only this, it needs a smaller, lighter tractor.

The seeder is Accord, the frame is a Bomford cultivator, and the leg spacing is 34 cm or 13ins. The legs are the originals from the Superflow and the Bomford points have been changed to the Simba LD tines that are fitted as an option to the Simba SL cultivator to reduce surface soil disturbance. The points are tungsten and the wings are not fitted.

The seeding boots are cleverly designed by farmer Carswell who made them with a splitting action that spreads the seed in a band of around 5 - 6 ins, leaving a 7in space between plants. This gap provides sunlight to the sides of the crop and also provides a channel for wind to blow through the growing crop. In the USA they have found that wide-set breezy rows keep fungus out of soyabean crops and growers orientate their rows to take advantage of the predominant wind direction. More air blowing

down the rows lowers the humidity within the canopy. Starter fertiliser is added through a slender pipe which places it above the seed.

The Accord metering is ground driven using a set of wheels and tyres. The Accord fan is hydraulic driven.

The closing harrow is folded back hydraulically using a linkage that allows the frame to float and so not damage the rams when pushed up with field contours. The covering tines are have a constant pressure.

The liquid fertiliser is placed close to the seed. The 800 litre front fertiliser tank has a bumper around

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Clever use of a pair of old Newton Rigg cubicles used in the frame for the liquid fert tank and pump



NEW AUTONOMOUS MACHINES TO HELP NO-TILLERS SEED, SPRAY

Originally published in No-till Farmer USA, written By Mark McNeely posted on June 9, 2018

DOT Technology's driverless platform enables multiple implement use from a single machine, thereby increasing efficiencies on farms large or small.

Acceptance of autonomous farm equipment is growing, given its promise of greater efficiencies for both large and small farms.

The availability of these driverless machines could help no-tillers drive up efficiency even more on farms both large and small. But one barrier to adoption has been the lack of fully commercialized products.

DOT Technology Corp. is one manufacturer on the cusp of releasing its autonomous power platform that enables growers operate seeders, sprayers, grain carts and other implements with a single, driverless tool.

The Canadian company expects limited commercial production to commence in early 2019, but is first testing several machines throughout the 2018 growing season.

"Our goal is to have six machines

moving in the field throughout the 2018 growing season," says Cory Beaujot, managing director of marketing.

Run DOT Run

DOT's power platform features a 4.5-liter, 175-horsepower Cummins diesel engine that drives two hydrostatic pumps. Those pumps, in turn, drive hydraulic motors that run each wheels' planetary gearboxes, giving DOT a smooth operating speed range from creep to 12 mph.

Two auxiliary hydraulic pumps are available for implement operation.

The platform includes four hydraulically activated arms that lift and secure implements to the machine's receiving and centering dowels. Loading most implements from the ground can take as little as 12 seconds. Transport width is 12 feet, 4 inches for most implements, according to the company.

Beaujot says that DOT boosts horsepower efficiency by at least 20% over a conventional tractor/implement

arrangement, giving farmers added fuel savings. "Tractors need ballast in order to tow an implement and that ballast eats up horsepower and efficiency."

DOT operates in fields within prescribed, farmer-approved routes generated through the creation of highly accurate boundaries.

Positional information from an RTK



ALL BY ITSELF: Testing and initial commercialization is underway in western Canada for DOT Technology Corp.'s autonomous implement platform. The Emerald Park, Sask., company is testing the DOT platform throughout the 2018 growing season, leading into limited production release for no-tillers in early 2019.

GPS receiver mounted on DOT ensures it is only operating within the approved area. If DOT drifts from its prescribed path, movement is halted and the operator is notified.

Knowing Customers

DOT's geographical focus for 2018 is on its home turf in western Canada, working with a base of customers who use their sister company's SeedMaster products. The company is also working on partnerships with implement manufacturers to adapt their equipment to become "DOT Ready."

One machine will be utilized exclusively on SeedMaster's research farm near Regina in Emerald Park, Sask. Beaujot expects another unit to soon be used by a no-tiller who also seeds cover crops near Yellow Grass in the southern portion of the province.

A third DOT will be deployed near Lemberg, to the east of Regina. That machine will be used by Pattison Liquid Systems, an implement manufacturer who is developing a spray applicator

boom for the DOT platform. The sprayer is expected to have a 120-foot boom and 1,500-gallon capacity.

"For the remaining units, our primary directive is to have them on farms later in the season where they're air seeding winter wheat, for example," Beaujot says.

In its seeding configuration, DOT is currently using SeedMaster's 30-foot air-seeder implement, which is a no-till hoe drill with two knives placing seed and fertilizer in separate openings, followed by a packer wheel.

The unit features the company's UltraPro seed metering system. Its four, frame-mounted seed and granular fertilizer compartments are ready for the numerous crop varieties seen in western Canada, Beaujot says.

"Canola is a big part of what's being grown here, as well as acres of pulse crops like soybeans, yellow and green peas, fava beans and chickpeas," Beaujot notes. "We're also planting the cereal grains like wheat, oats, barley and other oil seeds such as flax."

Putting Money Down

Earlier in 2018, the company began taking deposits for future production slots of the DOT platform and interest has been robust from all over the world.

"We could be selling DOT power platforms with SeedMaster implements in southern Ontario, throughout the Corn Belt of the United States, Australia or in Europe as early as next year," Beaujot says. "But for 2019, our focus will remain on western Canada and the northern United States, such as the Dakotas or Montana."

Beaujot notes that there's definitely interest from large farmers, but some of his more interesting conversations center on how the DOT platform speaks to smaller farmers' needs.

"Because of their size, smaller farmers are sometimes relegated to buying used equipment," he says. "DOT presents some innovative realities where they can buy into new equipment at a modest price, use a range of implements with one platform and keep their farm ahead of the technology curve."

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A baptism of fire into Direct Drilling

They say if you want to see the sunshine you have to weather the storm. That couldn't be truer of this year. From one of the wettest starts to spring followed by the hottest start to summer I can remember in my 34 years.

The first ever crop we direct drilled was a field of winter wheat last November. It was drilled into wet soils which got wetter as the winter progressed. The second crop that we have direct drilled was spring oats into wet heavy soils in April. Both crops then had to go from an extremely wet winter and early spring to drought conditions when they were supposed to be filling ears. Considering the conditions mother nature has thrown at us this year the crops have been very resilient. The wheat tillered out well and looked very healthy the whole way through the spring with very little disease. It also held on throughout the late spring and seemed too be a lot more drought tolerant compared to the conventionally drilled crops. As for the spring oats, they launched up out of the ground and grew away extremely quickly with moisture under them and sun above. They yielded well but the bushel weight was down significantly as a fair few groats hadn't filled out. Most of these will be fed to our herd of Limousins as they haven't made milling spec.

We also tried some direct drilled maize this spring which isn't looking so special. When we drilled it, I was sure the maize



Our drill

wouldn't be able to get its roots down. This wasn't however the problem with it. The root ball has grown down over a foot however the lack of moisture after establishment meant that the fertilizer sat on cracked out soil and was never taken up by the plants. This stunted the plants at the beginning of the summer when it should have been building biomass. I'll try direct drilled maize again in the future but for now the cattle will have to enjoy some whole crop wheat and the field in question will be used as a cover crop and chopped back into the soil, at least the worms will enjoy it.

Crops aside I have progressed in building my knowledge about the soil and how plants interact with the biology within it. This in my eyes is a vital part to direct drilling. I was told that going along to Groundswell would be an eye opener and it didn't disappoint. I would strongly advice anyone growing crops to take a day out and get them selves along to this event. I learnt more in a day at Groundswell then going along to the multitude of agricultural events over the years. As well as listening to some great speakers and seeing some new technology I got to have a chat



Drilling cover crops



Multi-variety cover crop mix



Spring oats



Left hand side is conventionally established wheat, right is direct drilled, both drilled in the same week

with farmers that have been running successful no till farms for decades.

A chat with a couple of renowned

conservation agriculturalists at Groundswell has made me think differently about how we treat the farm yard manure that we produce from our cattle herd. Previously the muck would have been heaped up in fields before spreading on the arable land. This year I have decided to compost it aerobically. The idea behind this is to build a healthy population of aerobic biology including bacteria and fungi in the compost. I have also added some wood chip to the manure to help increase the fungal populations in it. A lot of what I have learnt has come from reading articles and science papers from Elaine Inghams from the Soil Food Web and her approach to producing high quality compost.

As well as compost we are using cover crops to help increase the health of our soil. Our cover crops were established after winter barley using our Cross-slot drill. They will grow on through until Christmas. We will spray them off to allow the ground enough time to dry out before spring cropping.

As far as cover crop species goes I have selected a complex mix that Kings have produced for me. The mixture contains: Quinoa, Blue lupins, Buckwheat, Phacelia, Berseem Clover, Oil radish,



Vetch and Linseed. I've left the barley volunteers growing in the field as the cereal constituent of the mix. The covers will have digestate spread on them if they look like they are struggling, but I'm hoping they won't need any.

My first-year direct drilling has had some ups and downs but all together I'm happy with the results. On top of the economic side its been great fun learning a bit more about how natural processes and ecosystems in the soil work. This year, we will be establishing all our winter and spring crop with our Cross Slot, the heavy clay has cracked out over the summer to a depth of two feet which will help with a bit of drainage as we transition from tillage. I'll let you all know how it goes.

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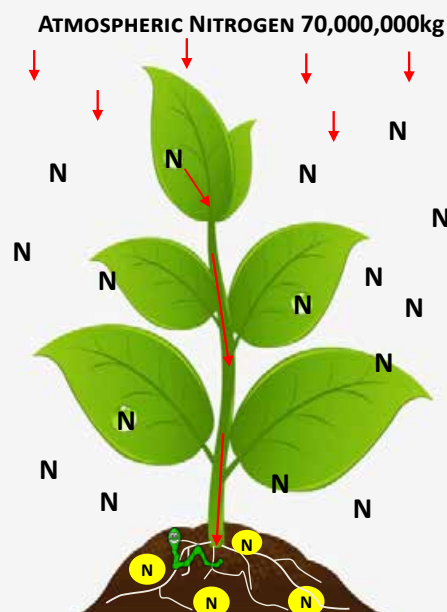
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GRAZING CROPPED LAND

The almost forgotten technique in the UK of grazing cereals is something being widely practiced across Australia in areas with widely varying rainfall levels. The Australian Grain Research and Development Council have produced a report titled Grain and Graze which sets out to evaluate the advantages and disadvantages of grazing a range of cash crops. We begin serializing this report over coming issues to explore what is currently an untapped resource.

Originally Published by Grain and Graze in Australia in 2016

The opportunities and potential downsides of grazing winter crops (why do it?)

Grazing winter crops is practiced across 19,000 mixed farms in Southern and Western Australia. In 2013 more than 2.7 million hectares of crop were grazed, representing 12% of the total area of crop grown. However the area grazed fluctuates from year to year, suggesting that grazing crops are often used as an opportunistic feed source rather than an annual feed supply.

Suitable winter crops have commonly been referenced as 'dual purpose' because they can be used successfully for grazing and grain. Yet just because a crop variety may not have the tag 'dual purpose' does not mean it cannot be used for both purposes (refer to side story 1).

Balancing the benefits and the costs

The decision to graze winter crops requires weighing up the potential benefits to the farming system against the potential losses. The most obvious opportunity in a mixed farming system is to graze the crop when it is tillering, eating the leaves at the time of year when other feed is often in short supply. The greatest potential downside is the reduction in grain yield as a result of this grazing.

Examination of trial data from 193 comparisons in the high rainfall and medium to low rainfall environments shows a big range in dry matter production and impact on grain yield from grazing compared to no grazing (figures 1 & 2). These results are sourced from a range of years, cereal types, varieties, sowing dates and grazing approaches, so present both 'good' and 'poor' practice. Importantly it shows the opportunity for valuable dry matter production with minimal or no impact on grain

yield if certain management choices and environmental conditions are met.

It also highlights the potential losses when circumstances are unfavourable.

Side story 1: What's the difference between dual purpose crops, winter and spring types?

As the name suggests, dual purpose crops can be used for more than one activity, usually grazing over winter, followed by hay, silage or grain production. The dual purpose tag comes from the ability of the crop to recover after grazing. Oats have traditionally been recognized as dual purpose, but recently some wheat and canola cultivars have been bred to remain vegetative (leafy) for a long period after sowing, enabling significant periods of grazing and then grain production. The long period of vegetative growth is determined by a gene bred into the plant that requires exposure to cold conditions to trigger commencement of head development. This requirement for a cold trigger gives rise to the term 'winter habit'. Varieties with winter habit often grow slower than nonwinter habit cultivars early in the season, but the dry matter difference at the end of winter can be reduced if crops are sown early - in March or early April. The time when the plant changes from vegetative growth is also more predictable with winter habit varieties because of the need for exposure to cold temperatures. Just because a plant does not have winter habit does not mean it cannot be grazed and then recover successfully. However, the opportunity to graze is reduced and the time when the plant changes from vegetative growth is less predictable.

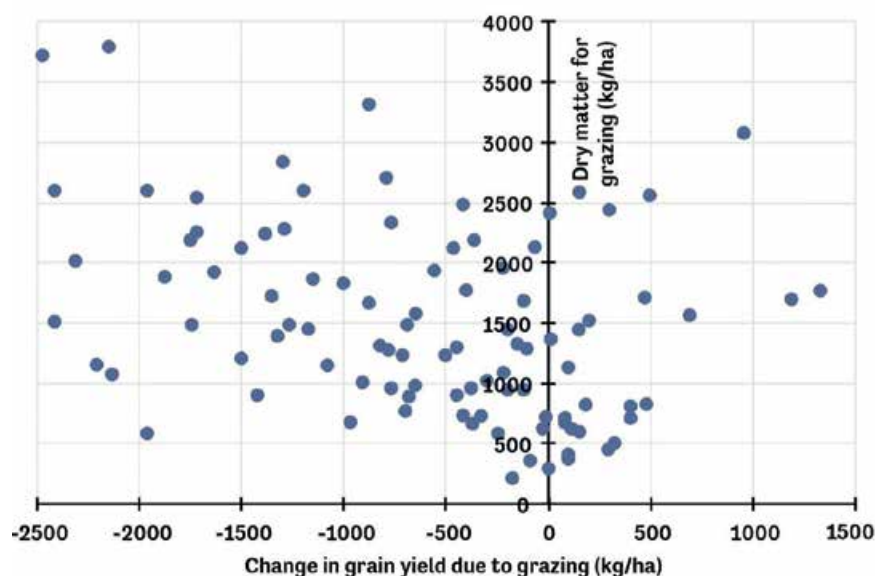


Figure 1: Dry matter produced at grazing and associated effect to cereal grain yield compared to no grazing in the 'high' rainfall zone (109 observations from 2004 to 2013).

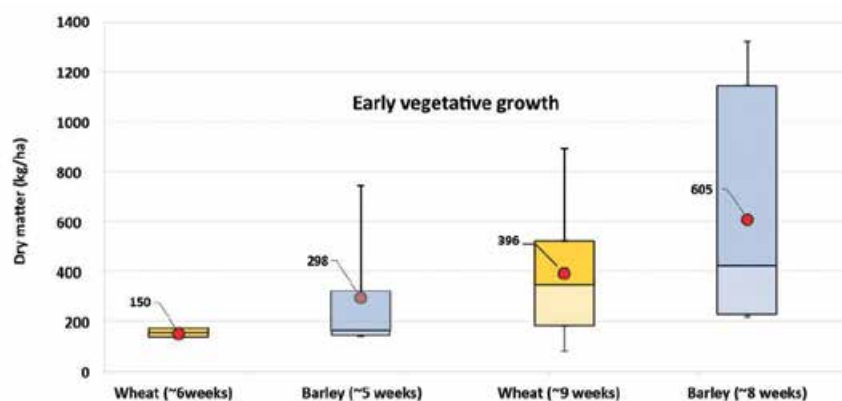


Figure 2: Dry matter produced at grazing and associated effect to cereal grain yield compared to no grazing in the 'medium' and 'low' rainfall zone (84 observations from 2006, 2008 to 2013).

However, the decision to grow and graze winter crops is more complex than just comparing dry matter against grain yield. Each individual farmer needs to evaluate the full range of potential benefits and costs associated with grazing winter crops to help decide if the opportunities outweigh the risks. The possible benefits and costs identified by farmers who have experience in grazing crops are summarised below. Greater discussion will be provided in further issues of Direct Driller.

Value to the livestock operation

- Provides high quality feed when fodder is often in short supply or replaces supplementary feeding
- Allows pastures to be rested to build a wedge of feed for use later in the year or for new pastures to establish
- Provides a worm free grazing environment
- Provides a place for animals to be 'parked' while pastures are treated with herbicides.

Costs to the livestock operation

- Grazing wheat crops for extended periods will require mineral supplementation
- May result in increased metabolic disorders, particularly with ewes in late pregnancy
- May require temporary fencing to ensure appropriate grazing
- Mobs may need to be 'boxed' to get adequate grazing pressure across a short time frame.

Value to the cropping operation

- Enables excessive crop

canopies to be managed, reducing possible lodging, incidence of leaf diseases and future stubble loads

- Conserves soil moisture that can be used by the crop later in the year
- Delays maturity which may avoid late frosts
- Can improve the efficacy of some herbicide treatments e.g. broadleaf weed control and weed control e.g. selective grazing of grasses from oilseed or legume crops.

The possible benefits (the upside)

Extra feed for grazing

The greatest upside with grazing crops is the additional high quality feed that is available in the winter period. The most common uses of this extra feed is to:

- Fill a winter feed deficit, avoiding underfeeding, reducing the need for supplementation or the need to sell stock at low prices

- Provide the opportunity to 'punt' and trade stock, by purchasing at times of low prices
- To 'spell' pastures from grazing, enabling them to 'get away' and reach pasture benchmarks for lambing or calving.

Examination of more than 500 measurements from 80 grazing crops trials conducted through Grain and Graze program over the past decade show a wide range in dry matter production. This variability is influenced by climatic conditions, type of crop, sowing rate, time from sowing to grazing and use of fertiliser, especially nitrogen.

To convey the variability in dry matter production, 'box and whisker' graphs and percentiles are used to summarise the information (see side story 2 on interpreting box and whisker graphs). Results for wheat, barley and canola are grouped around vegetative growth in low and high rainfall zones and for the start of stem elongation (high rainfall zone only) (figures 3 to 5).

The dry matter values are also presented in percentile tables (appendix 1).

Figures 3, 4 and 5 highlight a number of general, if not predictable, observations:

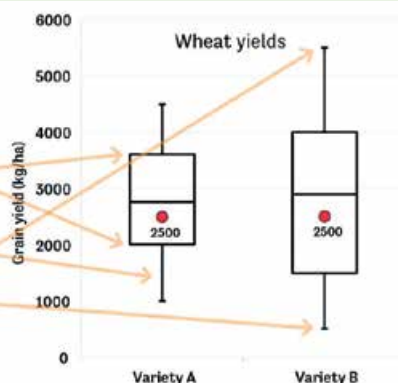
- Dry matter production is much greater in the high rainfall zone than the low rainfall zone for similar days from sowing. Rainfall, sowing rate and row spacing has a large influence on the measured difference.
- Barley provides more rapid early growth than spring or winter wheats or canola.

Side story 3: Interpreting 'box and whisker' graphs

Box and whisker graphs present information about the variability around the average result and can be useful in appreciating risk. There are four critical pieces of information in a box and whisker graph.

1. The average. These are represented by the red dot.
2. The ends of the box represents the range where half the results occur. The smaller the height of the box the less range in values.
3. The whiskers represent the highest and lowest 25% of results.
4. The end of the whisker represent the maximum or minimum value. Long whiskers means there are some extreme values that are included in the average.

Consider an example (right) comparing the yields of two wheat varieties. They both have the same average yield but the yields of variety B are more variable than variety A.



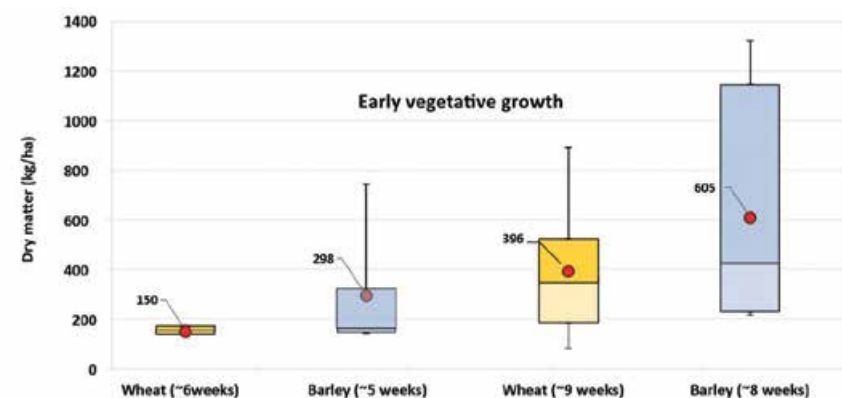
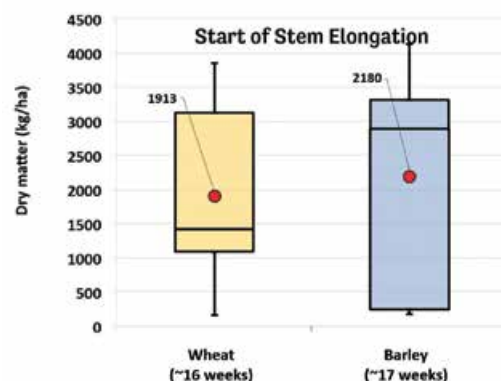
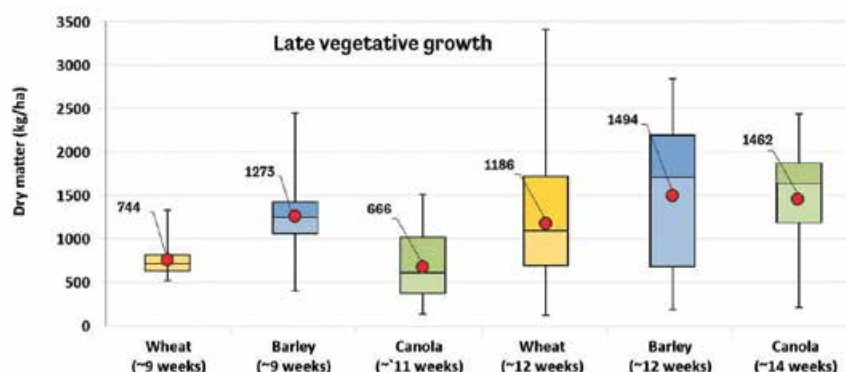


Figure 3 (left): Range in recorded dry matter in vegetative growth (5 to 8 weeks from sowing) for wheat and barley in the low rainfall zone.

Figure 4 (below left): Range in recorded dry matter in vegetative growth (9 to 14 weeks from sowing) for wheat, barley and canola in the high rainfall zone.

Figure 5 (below right): Range in recorded dry matter around stem elongation (16 to 17 weeks from sowing) for wheat and barley in the high rainfall zone.



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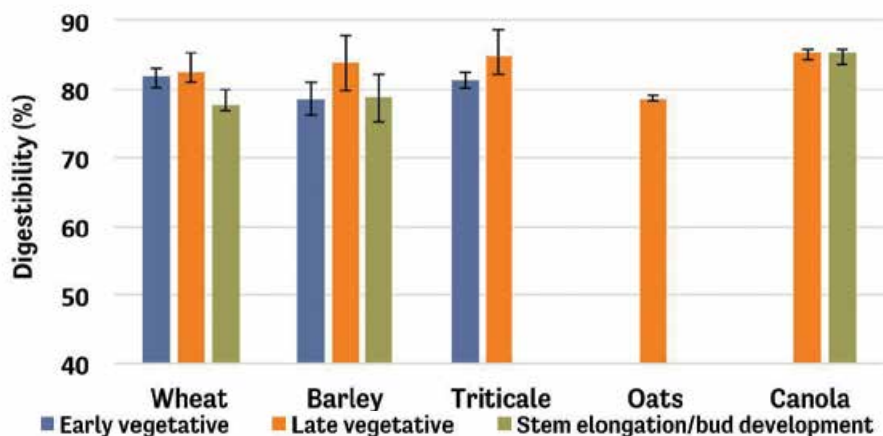


Figure 6: Average digestibility (%) for wheat, barley, triticale, oats and canola in the vegetative and early stem elongation phases (167 observations). Error bars represent the 50% range.

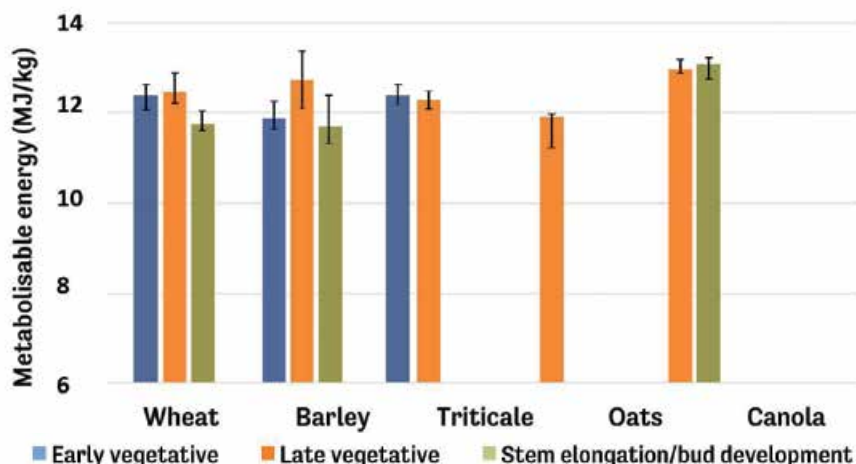


Figure 7: Average metabolisable energy (MJ ME/kg) for wheat, barley, triticale, oats and canola in the vegetative and early stem elongation phases (167 observations). Error bars represent the 50% range.

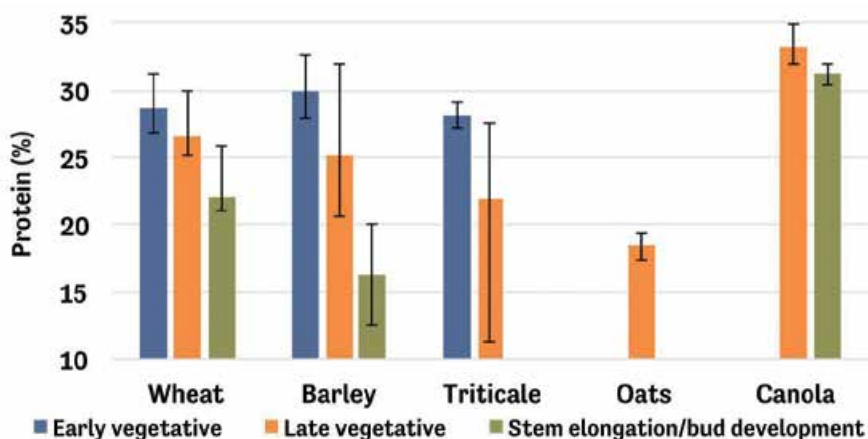


Figure 8: Average protein (%) for wheat, barley, triticale, oats and canola in the vegetative and early stem elongation phases (167 observations). Error bars represent the 50% range.

- Varieties within spring wheats, winter wheats or barley have much lesser influence on total dry matter when compared at the same sowing time, sowing rate and climatic conditions. This is not so canola, where hybrid varieties grow more rapidly under the same conditions.
- As the days from sowing increases so does the average dry matter production, however the range in dry matter production widens (seen by the taller boxes and longer whiskers).

High feed quality

Winter crops offer high quality feed which is equivalent or higher than typical pastures at the same time of year. Canola is slightly higher than the cereals in digestibility and metabolisable energy (figures 6 & 7). Digestibility and energy in the cereals appear to peak in the late vegetative stage and declines once stem elongation commences.

The protein content of all winter crops is very high in early vegetative growth, but declines as the crop matures, although the minimum protein levels remain well above the requirements of any class of livestock (figure 10). Maximum protein requirements for lactating or growing animal is around 14% to 16%. Animals are unable to store excess dietary protein, so any surplus protein is excreted by the animal in urine.

Potentially high animal growth rates

The performance of animals grazing winter crops (or pasture) is influenced by the quality of feed eaten and the amount available for grazing.

Cereals and canola tend to be less dense and grow more upright than pasture. This means it is much easier for a grazing animal to consume a greater quantity of feed for each bite with a winter crop than with a pasture, even though the total feed on offer (if cut to ground level) is the same or less (see side story 3 on comparison of feed on offer and height).

The difference in grazing height and the high quality of the winter crop has a considerable impact on intake and animal performance.

Side story 3: Comparison of feed on offer and height

The height benchmarks for pastures do not apply to winter crops because of the bare space between rows and the seeding rate. Measurements of height and dry matter for cereal crops sown at ~200 pl/m² indicates the following relationship compared to a moderately dense pasture.

Height (cm)	Dry matter crop (kg/ha)	Dry matter pasture (kng/ha)
5	225	1400
10	500	2200
15	825	2600
20	1200	2950

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IS THE FUTURE **BIOLOGICAL FERTILIZERS** AND **SOIL INOCULANTS**?

While usage of biological fertilisers and soil inoculants in other parts of the world is growing rapidly, it is possibly not something you have even heard a lot about in the UK. Over the last 15 years, research and development of bacterial soil inoculation, combined with the invention of state-of-the-art microbiological and biotechnological methods have yielded ranges of soil specific inoculants. These bacterial soil inoculations offer a way to improve soil health and promote plant efficiency.

Biotechnological and microbiological methods can help cut back on the use of nitrogen and phosphorus fertilizers once the correct soil levels have been balanced. Microbiological soil enrichment methods have been trialled for the past 20-30 years in Europe and the USA. These microbiological products have since progressed from experimental plots and spread to commercial plant production, in both field and greenhouse cultivations. Today, in Europe hundreds of thousands of hectares are treated with soil inoculants. So why have they not been adopted in the UK?

What we have seen in other countries

Trials in Hungary have isolated beneficial soil microbes including nitrogen-fixing bacteria that are capable of fixing and transforming atmospheric nitrogen into a plant available. Phosphate and silicate mobilizing soil bacteria can provide available mineral available phosphates and potassium to plants by solubilizing them. Phytostimulating strains should also be mentioned, they produce plant hormones and hormone-like substances, directly enhancing plant growth and development and improving abiotic stress tolerance. Research companies have spent years isolating and selecting these bacterial strains to create complexes of plant growth promoting, nitrogen-fixing, phosphate and potassium mobilizing soil inoculants commercially available, but relatively unknown in the UK.

Taking into account not only the beneficial properties but the rate of growth and metabolic activity of the

strains in acidic or alkaline pH and at low temperatures researchers have had to develop specific inoculant products for specific soils. Field studies in have shown that inoculation with the right products reduces nitrogen and phosphate fertilizer use and enhances crop yield in corn, wheat, barley, sunflower, soybean, rape, rice, sugar beet, cucumber, pea, sweet pepper and tomato cultivations. Exact numbers, of course, depend on the variety and the quality of the soil. Regulated studies for some products have confirmed - an 18% increase in corn yields and 39% increase in soybean yields. Results and efficiency of field inoculation is greatly subject to weather conditions, like virtually all agricultural procedures, so expected yields can only roughly be estimated. According to the official studies, the success of inoculation is marked by an increase in root length, stem height, number and surface area of leaves, total protein content, shoot mass and crop yield. Besides the increase in profitability, improving yields and possible savings on fertilizer costs, the reduced environmental load is also significant.

What now?

In the UK, it is certainly possible that these products have the potential to increase yields and reduce the usage of traditional fertilisers. However, in developing countries, where overpopulation and a rapidly increasing need for arable land exists, having biologically sustainable soils is critical to feed the population.

In China and India, the increased requirement for food production has driven the use of chemical fertilisers up by 60%. In nitrogen and phosphate

deficient African soils, the increasing but unsustainable agricultural production is promoted by subsidiary fertilizers and seeds. If the developing world continues to rely on chemicals and keeps increasing usage, they will soon face the severe issue of soil degradation that has been seen in parts of Europe and the USA.

Transportation, storage and application of live biological products brings new challenges to farmers. Products have a shelf life that can be extended through refrigeration, but how many farmers could currently store an 800-litre pallet of inoculants at refrigerated temperatures? While the wife may be happy for 10 litres to sit in your fridge, 800 litres just won't fit. Therefore, these products would need to be supplied on a just-in-time basis where products arrive on farm and are used within days ideally

Factors like exposure to UV light will degrade the products rapidly so they need to be incorporated to soils quickly after application or ideally placed in the slot with seed under a no-tillage regime.

There is still a lot for us to learn about soil inoculants. As more scientific and farm trials take place in the UK we will understand how effective these products can be and whether the margin over input cost when using them is returned. It is yet another interesting technology for farmers to understand and investigate over the coming years.

Trials in the UK

Trials are already underway in the UK, we will report on them as they are completed in future issues. If you are able to conduct a trial with such a product and want to test it this Spring then please do get in contact.

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BENCHMARKING COSTS IN RURAL BUSINESSES

Land Family Business were invited by Groundswell and Procarn to benchmark a group of farmers who have been practicing no-till crop establishment for several years as part of conservation agriculture. Using our own client benchmarking process, it gives the opportunity to assess the financial performance of no-till conservation agriculture – against other no tillers and also against conventional crop establishment farming businesses. The results have large variations at every level – therefore, there is a great deal to discuss and analyse

Some Background

The 2017 Harvest Land Family Business Rural Business Client Survey shows some interesting results. The benchmarking was started in 1992 and until this year, all businesses had been ranked on the arable farming margin. This year we have included all other outside business income in the ranking, only excluding Rent and Finance – therefore the farms are ranked on Rural Business Profit.

Setting the Scene

One of the most striking points is the margin from contract farming net of the power and machinery costs:

Top 25%	£42 per acre
Average	(£53) per acre
Bottom 25%	(£69) per acre

The relative contract area to the whole arable acreage is also significant:

Top 25%	24% contracted in
Average	43% contracted in
Bottom 25%	68% contracted in

Although the additional land generates a loss in margin, it does actually provide a contribution to overall costs because labour and machinery are fixed. If the additional land is given up the overall profitability will reduce

Therefore, many arable farming businesses are caught in a trap, or on a treadmill in having to expand acres to justify investment in machinery

Adding acres in a competitive environment is not the answer

The question is, are current contract farming arrangements really joint ventures or could machinery syndicates or share farming agreements be more effective in changing times?

It is particularly important to review current agreements for the potential change in the Basic Payment Scheme support. Profit before BPS, environmental payments and non-arable income is a loss of £10 per acre in the top 25% which indicates that farming businesses are increasingly reliant on other activities other than arable production. This may need a change in skillset for many farming families. What is also a little daunting is the increase in investment in machinery over the past year or so, with capital sometimes exceeding £300 per acre. The depreciation and contracting and hire costs from the Survey results added together:

Top 25%	£77
Average	£121
Bottom 25%	£126

This is the annual cost of acquiring and having the use of machinery. This is not sustainable in an arable business. A management tool that many would benefit from is a machinery capital budget on a spreadsheet. This would show many key indicators such as capital employed in machinery per acre (including hired in), horse power per acre and an indication of future changeover costs per annum.

Making business decisions based on correct financial information is vital however it is very difficult to obtain this information unless it is specifically produced and equally important – understood

As the industry faces one of the most radical changes in decades, many important business decisions will have to be made around farming kitchen tables over the next few months.

Accurate management data is fundamental in making business decisions within farming families.

These decisions could range from downsizing contract management agreements and selling land or property which could fund new enterprises to succession planning and retirement. It is quite common for example, for rental income to be subsidising arable losses. This is quite acceptable if it is a conscious business decision, however, all too often unless the accounts are prepared in management format these situations may continue undetected. Understanding the farm performance is crucial and we have a moral obligation to the next generation who are often asked to commit the rest of their lives to the business.

The fundamental problem with annual accounts on arable enterprises is that they will always cover an annual period which may not fit and conform to a production cycle. Typically, many farming businesses will have a 31 March year end which fits in with the annual tax period. But how does this relate to an arable farm with predominately autumn sown crops?

In simple terms there are 3 types of accounts or budgets that can be prepared for an arable farming business:

- Financial statements following standard accounting practice, normally prepared by the farm accountant.
- Management accounts adjusted to financial statements often prepared by specialist farming accountants.
- Gross margins and associated fixed costs covering a production cycle, usually a budget prepared by farm consultants.

The profit shown in the first may bear no resemblance to the other two

Once the homework has been carried out and a decision has been made to convert to a No Till Conservation



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Farming system – will it work on your farm?

Does No-Till Stack Up Financially?

The main points to be taken on board are:

- Yields of winter wheat average around 2.7 tonnes per acre – a reduction of around 20% from average conventional establishment yields
- Gross margin varies by around £100 per acre within the group – similar variation to conventional establishment. The average is lower than that from conventional establishment farms but the highest compares well with the Rural Business Survey average.
- Variable costs are £19 per acre lower in the no-till survey, this is significantly contributed to by a reduction in chemical costs.
- There is a substantial reduction in working capital requirement which will assist many businesses.
- Overall labour and machinery costs show a reduction of 43%.

Drilling down further into the detail, the reduction in labour and machinery costs per acre from £213 in the average of the LFB Rural Business Survey to £120 in the no-till survey is significant. A major contribution to the reduction is the capital tied up per acre in machinery, resulting in a reduction in depreciation. Most arable businesses have been breaking even over the last 2 or 3 years because of high inflation in machinery costs, equating to £300 capital per acre in many arable businesses. No-till provides a solution to this.

In summary, there are lower yields and lower costs, therefore one of the key indicators is the cost of production per tonne.

The cost of production per tonne for winter wheat in no-till is £101 and in conventional establishment businesses is £111. Inputs and paid labour costs in the no-till group are higher per tonne at £70 compared to £57 in the LFB Rural Business Survey. The big savings are because of machinery costs per tonne at £31 compared to £54.

Soil type and weather have a larger impact on no-till systems than conventional establishment. Therefore, they must be flexible to react to local

conditions during a season.

In conclusion, no-till establishment needs a completely different approach and way of thinking to the historic 'Yield is King' approach. This needs individuals who are prepared to question convention, take risks and be innovative. It must be remembered that no financial account has been taken for the increase in soil health and other environmental benefits.

The rewards are achievable, but



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we need to be sharing knowledge to get there. To discuss further and get involved in benchmarking, please contact Gary Markham on 07970 794495 or email gary.markham@landfamilybusiness.co.uk.



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HOW TO BECOME A **SOIL** HEALTH EXPERT ON YOUR FARM

It's clear that we need to build more resilient soils, both for the future of our farms and for the long-term health of the land.

The satellite images of muddy waters spilling out of brown rivers around the UK after a heavy rainfall are hair-raising. We can visibly see the soil gliding off fields, into water streams and off into the sea. At the very least this is quite literally money going down the drain for anyone working from the land, at its worst this is hundreds of years of top-soil formation being lost forever and part of a global disaster. Soil health advisors are quite certain that this scenario is avoidable, it's all down to how land is managed.

If this is the case then building soil health should be one of the top priorities on every farm. One major difficulty is how do we know if we are building soil health or not at a farm level? Science doesn't seem to offer a simple answer to this at the moment, which could be considered quite worrying, but we see it another way: This is an opportunity for farmers and growers to lead the way, to become experts on monitoring and building soil health on their own farm.

September and October are the best time to do most of the soil health tests in the UK. So prepare to soak up all the tips and tricks from what we have learned so far, and then get out there learning and observing your own soils in the coming months! This is the first step to becoming an expert on monitoring and building soil health for your soils.

How can Farmers monitor their own soils?

We started working with the Pasture-Fed Livestock Association (PFLA) and Soils Advisor, Niels Corfield, to investigate this very question. The PFLA ran a series of workshops where scientists and farmers came together and identified the most appropriate soil

tests, based on all the resources and research available. We took the most popular in-field tests and went out on multiple farms to see how it worked in practice. We didn't have an easy way of recording the results so we developed a version of our app, Sectormentor for Soils, that allowed us to record the observations and photos as we went for each field.

To understand the health of your soils it's important to see how things are changing over time and examine trends of different indicators. In order to do this we encourage growers to set goals for each field they are monitoring and then choose four to five tests that monitor the results as they change management practices to meet those goals. For example, one PFLA farmer in Kent, Fidelity Weston wanted to see if grazing her animals differently would improve forage and carrying capacity on the land, without compromising diversity. As she changes her practice, she is monitoring the percentage of grasses/broadleaves and sward stick readings above-ground as well as Slake test, infiltration rate and a visual evaluation of the soil below to see how the change affects her goal.

We have found the most effective tests are very physical measures that are immediately understandable. There

are lots of different protocols out there for how to do these tests, but we hope to provide a method with a good balance between being do-able for farmers and providing useful insights, as well as being based on sound science. You can find an equipment list, and clear guidelines for doing each test on our website soils.sectormentor.com. Here are three we have found particularly helpful:

Slake Test (Wet Aggregate Stability)

The Slake test is a simple in field test that allows you to really see how well your soil structure holds up in water. It is also an indicator of biological activity.

We have started to work with Soil Health Expert Jenni Dungait (previously soil health Professor at Rothamsted) and have adopted the in-field method she used in her research with farmers on multiple farms in Cornwall and Cotswolds regions.

Well-structured soil is composed of aggregates, so in this slake test you put a few small pieces of soil in a sieve, submerge them in water and then shake them around quite vigorously. Those small pieces that survive without breaking down at all are true aggregates, the water remains totally clear. For non-aggregates there is considerable break down of the pieces and the water can become murky. You score the breakdown on a scale of zero to eight, eight indicates a soil full of microbes and made up almost exclusively of aggregates. All details here

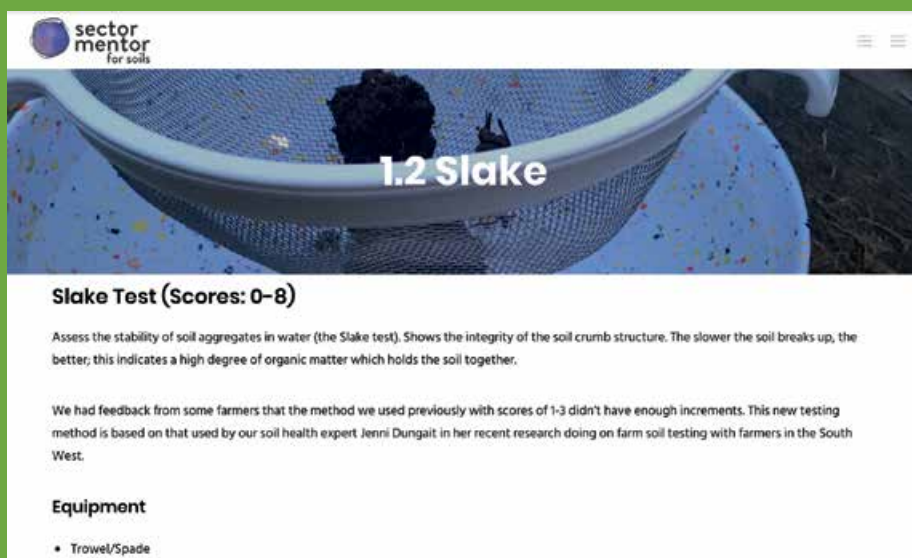
An additional benefit of this test was highlighted by Jenni Dungait's research (soon to be published) which shows that the slake test is an excellent proxy for Soil Organic Carbon.



Abby and PFLA Farmer Rob Richmond counting aboveground diversity



Charles Landless doing a visual soil assessment on his farm in Oxfordshire



Slake test protocol, art of the free soil testing guide on the Sectormentor for Soils website

Earthworms

All growers inherently understand the value of earthworms as we see them physically move nutrients around the soil profile. Earthworms are one of the larger organisms in the soil food



Earthworm count photo from Fidelity's farm in Kent, recorded using the Sectormentor for Soils app

web, so many earthworms is a good indicator of plenty of life in your soil. In

the UK, an average of 15-20 worms in a 20x20cm soil pit is considered good. Earthworms counts are best done in late September to early October.

This year we are preparing to do slightly more detailed earthworm counts based on the work of soil scientist Jackie Stroud at Rothamsted. There are three main types of earthworm: the litter-feeders which break down organic matter on the surface of the soil; the top-soil worms who work on soil aggregation and nutrient mobilisation; and then the deep-burrowers that keep water flowing from the soil surface to deep pools below, as well as increasing aeration and root development. Jackie's research shows that if you identify numbers of each type of worm, it can tell you what the worms are working on and uncover any changes you might need to make in your soil management

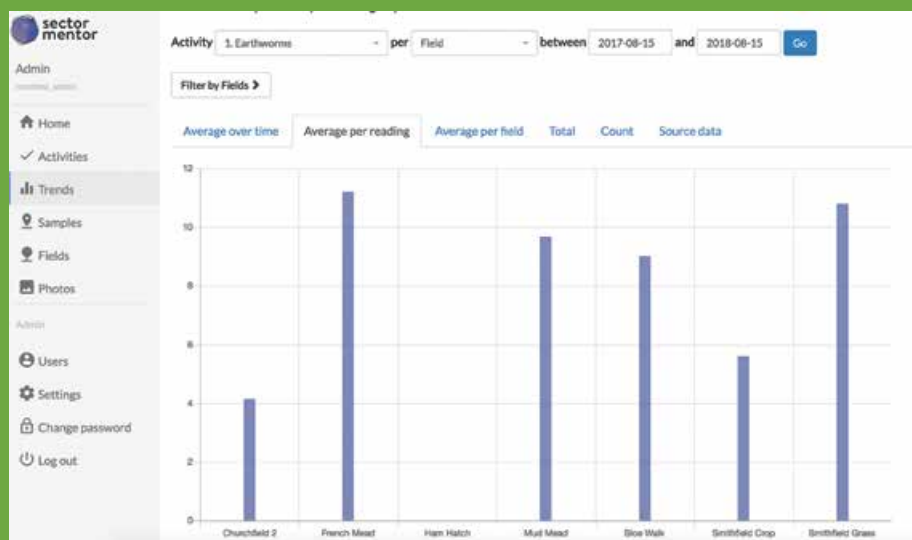


Chart comparing the earthworm count per field at Fidelity's farm on her Sectormentor for Soils account

to encourage all types – ideally you want to have all three types of worm working in harmony.

Jackie Stroud is running a #30minworms citizen science project in September where she is asking farmers all around the country to dig 5 pits in a field and do earthworm counts and send her the results. You can find out more in the earthworm test protocol on our site, where you will also find a link to Jackie's Worm ID Quiz, which is a brilliant way to learn how to identify types of worm for yourself.



Fidelity Weston and her helpers doing an earthworm count and visual soil assessment

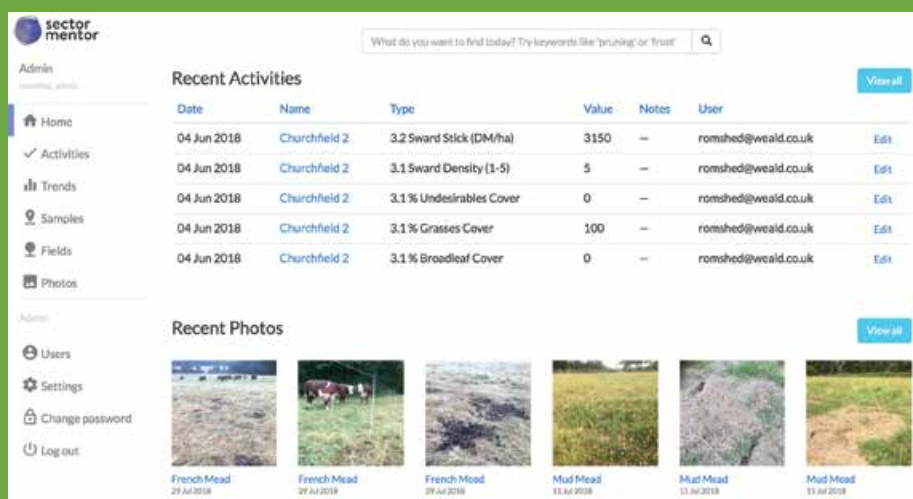
Infiltration rate

The Infiltration rate test clearly shows how ready your soil is to soak up water when it comes.

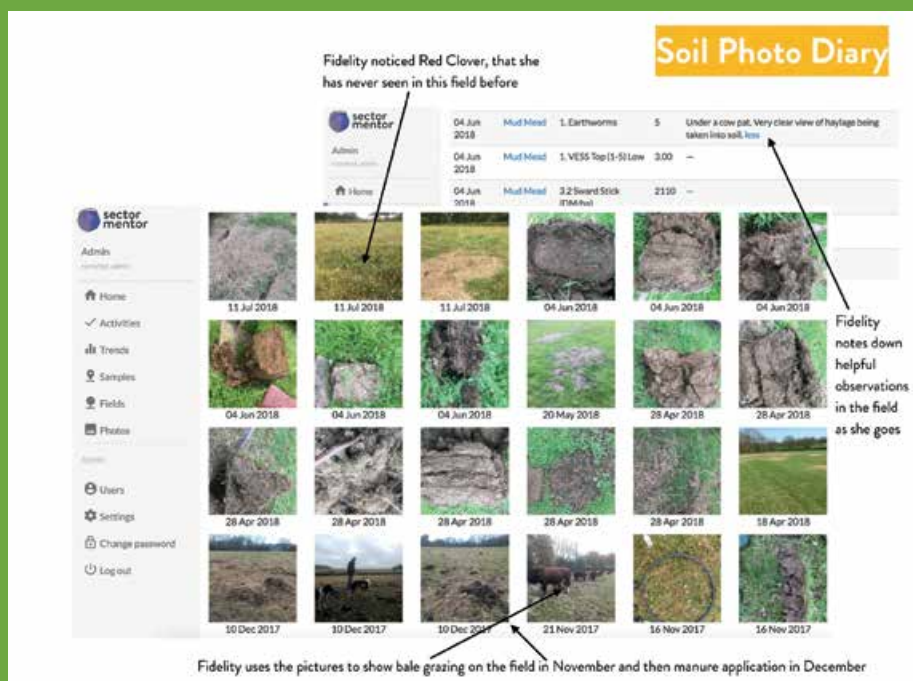
To do this test we use a 150mm diameter pipe (actually part of a chimney flue) and hammer the pipe 75mm into the ground. Then we pour in a set amount of water and time how long it takes the water to infiltrate. Originally we used a much smaller diameter baked bean tin to do the infiltration tests but we were finding it took over 20 minutes for the water to infiltrate which made it impractical to do in the field. One thought was forcing such a small diameter cylinder into the ground was causing artificial compaction in itself, which is why we have moved to a larger diameter cylinder. Our aim is to



Infiltration Rate test using a small diameter cylinder



Homepage of the Sectormentor for Soils App for Fidelity's farm, showing both photos and numerical results



Sector FidelityWeston Field Diary and Notes with explanation in Sectormentor for Soils App

find a method that takes a maximum of five minutes in most soils. This test is so relevant, imagine if every farmer and grower around the land had a clear idea of the average infiltration rate in each of their fields. We would definitely be better equipped to prevent those muddy rivers and top-soil losses.

The value of the app - soil health



Close up of soil structure from Fidelity's field on the Sectormentor for Soils app

trends and patterns on your own farm.

You can use all three of these tests, combined with above-ground observations to build up a picture of the health of your soil in each field, and see how it changes over time. This is how you start to become a soil health expert on your farm, go out and look for yourself, observe, document, ask questions and build up a picture over time.

The Sectormentor for Soils app makes it easy to record these observations in the field as you go, and then turn those observations into graphs and insights. Just a few taps and you have everything recorded, alongside photos showing what you saw both above and belowground. Essentially you can build up a visual diary for each field

combined with numerical results from the tests. All those results are easily searchable (no more shuffling through piles of papers to try and find those scribbled notes) and quickly show how your soil health is changing over time.

Shared Perspectives and Added Learning

One other important piece of the puzzle for many farmers and growers is the power of discussion and other people's perspectives. When you are out in the field taking these observations, in order to become an expert and understand better what's happening we have found that it's important to share your observations with others and get other perspectives. This is a big part of the learning. Where possible it's great



Fidelity Weston and soils advisor, Niels Corfield, discuss how to do a soil test on Fidelity's farm

if you can go out in a group, or with your agronomist. The digital diary on the app is perfect for this as it's easy to share photos and results with other farmers, or to discuss things you have seen with an agronomist.

That is a summary of our learnings for now. We are excited to support many more farmers and growers to get out there and become confident monitoring their own soils, head to our website soils.sectormentor.com where you will find more info about the app, our free online guide to the different soil tests and a blog filled with resources, case studies from different farmers and more. This is a brilliant opportunity for farmers and growers to move from here-say and anecdotes about what works on their farm into a more structured evidence base, not scientifically rigorous data, but just what is needed to build up the patterns and stories on your farm. This is about becoming a soil health expert for your farm.

FARMER FOCUS

CLIVE BAILYE



Farming mostly light soils is easy, isn't it? I'm often told I farm "Boys' land" and well, I guess in many ways it is. A bigger working window, low slug and blackgrass pressure all seem to make life that bit easier for me than colleagues on proper heavy clay "man's land". My gap year from agricultural college was spent in North Yorkshire, an absolutely stunning ring fenced farm with 100% "man's land". I spent most of my year ploughing up slabs of clay with the biggest, heaviest, high horsepower tractors I had ever driven. It was a dream job for a 21 year old horsepower-mad student and I promised myself that one day I would farm such land and grow the barn busting yields it was capable of.

Returning from college to my "easy" sandy loams and now with an unhealthy addiction to horsepower, it made perfect sense to set about them with similar huge tractors. Ploughing was far too slow though. The "tillage train" was very trendy, and I rapidly worked my way through the model ranges until the pinnacle of 600hp plus tractors was reached. Who needed heavy soils to justify these big and impressive monstrous machines?

I wasn't alone. The trend towards high horsepower quickly became something any self-respecting large farm must do. Marketed well by the likes of Simba and Monsanto as "eco-tillage" (although I'm not quite sure what exactly was "eco"

about it all) many farms used this new method not only as a great excuse to fill their barns full of very sexy big kit but also as a way to spread existing labour over many more acres, FBT, contract farming etc... you were a nobody in farming terms if you were not shooting with Lord of the manor and his best pal land agent mates.

The FBTs got more expensive, the contracting margins slimmer as the land agents saw lower operating costs as a way to squeeze margins tighter and push up rent. It quickly became a rather pointless game to play if you wanted to actually make a living from farming and were not just in it for a couple of days shooting at the 'big house'.

However, there was a far more serious consequences to all this than lack of farmer profits. Tight rotations of wheat and rape combined with min-till and cultivator drills was the perfect breeding ground for grass weeds and pests, especially on that heavy land that I had so coveted as a student.

The more I saw others losing the battle against black grass and the plagues of slugs the more I started to see the advantage of my "boys' land".

Trouble is, light land has one VERY big drawback drought! Especially if it happened at grainfill when so often a couple of dry weeks at the wrong time will see an otherwise fantastic, clean, grass-weed-free crop go from hero to zero it less time than a pre-harvest family holiday in the Med will last. Even in a good year (read wet!) on lighter land my yield maps read like soil moisture maps, and it was this realisation a decade or so ago that set me out on my journey into no-till farming.

In an epiphanous moment, whilst filling a CAT Challenger with 1000L of fuel for the second time that day, it occurred to me that a dry year in the UK was the normal in many other grain growing areas of the world. What we call a drought in the UK is a mere sunny spell in Australia. I wondered how they coped? How did they farm around this issue?

Manic research followed. The internet was a slow beast back then but eventually it became clear that the last thing any self-respecting cereal farmer in a dryland area would do is cultivate his soils. Evaporation was the enemy and cultivation and bare soil are the fastest way to lose any moisture that's in the soil. Soil structure was the next thing I kept hearing others talk about, it made perfect sense to capture as much



Looking east over cultivated land 24th June 2018

of the rain that fell on the soil, reduce run off and hold the moisture in a rich sponge of organic matter for as long as possible. Apparently, worms were to become my new best friends: They along with a host of other soil organisms I had never even heard of before could apparently create this structure for me. All they asked in return was that I stopped destroying their world with cultivators and ploughs. Seemed like a fair enough deal to me and my journey as a no-till farmer began.

2018 - the year that could have been

So, a decade or so on and along comes 2018 - the year that could have been. Autumn establishment was pretty much ideal, and crops got away well. A long wet and cold winter followed, and social media started to paint a grim picture for some of the heavy land farmers. Blackgrass loves wet, heavy soil but our land was dealing with whatever mother nature threw at it just fine. The structure (well the soil life really) we have built was dealing with the rain well.

Spring came and as applications went on, with the near perfect timing that lighter soils facilitate, crops got better and better. Disease pressure was low in cool conditions, so we were able to pull back on inputs. Crop yield prediction models based on satellite radar images were forecasting yields the like of which we had never seen on this farm before and even my father (a notoriously hard man to impress) made the occasional comment that he had never seen the farm look so good. We all got terribly excited and I went away on my pre-harvest family summer holiday looking forward to returning to the harvest of a lifetime. I was happy with my boys' land.

Then the inevitable happened, no rain through grainfill. The temperatures continued to rise, and the yield forecasts fell. It was visibly changing every day and the change wasn't good. Crops were dying quickly and it's a depressing thing for any farmer to see such potential just fade away in front of their eyes.

Then whilst browsing Facebook one Sunday evening I came across a local drone photographer who had posted a few pictures taken while flying overhead that weekend. He had been out and about taking various pictures around



Looking west over 10 year no-till land 24th June 2018

our area mostly to show up outlines of old building and roads in fields that the dry weather was showing up. A couple of his pictures caught my eye, they were taken from one of our boundaries and looked west over our land and then turned 180 deg east across land farmed by a couple of our neighbours. The contrast was stunning, our crops still looked pretty good, green and even however the view west over more conventionally cultivated land was very different, uneven and clearly much more affected by the drought at that point.

The deeper into no-till farming over the year I had got the more I had lost sight of why that journey had begun. Moisture was what it was all about for me and finally it seemed there was some tangible evidence that all those changes were making. Of course, there are many factors to consider here, my neighbours may have been growing different varieties, different drilling dates, different agronomy etc but the thing that was consistent is that we had all received the same amount of rain over the past month and for all of us that was nothing!

Harvest came early, in fact the earliest start ever for me here and that's not something that bodes well as early combining means low yields as a rule. We started on the OSR and despite our lowest input spend ever on an OSR crop we were pleasantly surprised with yields slightly above our 5 year rolling average figure and interestingly very close to the numbers predicted by the satellite yield forecasting models. On to wheat and the news wasn't so good. About half a tonne down on those rolling averages but at least milling quality was there and considering how dry it had been, the easy nature of harvest and the lack of need to dry anything it felt like a lucky escape and not too bad a result after all.

So, do I still want that "man's land" I farmed as a student? Well "yes" is the answer. And indeed we do farm some stronger stuff for others as contract farmers. But I have come to learn that a nicely hedged position of light and heavy is probably the ideal place to be. Boys' land and man's land both have their pros and cons but with the correct management either can be farmed successfully under a no-till system.



2018 Seminar Programme

The CropTec Show Opening

Opening Address

Adrian Gough, UK and Ireland Leader, Corteva AgriScience

Prospects for the Combinable Crops Sector

Jack Watts, NFU Chief Combinable Crops Adviser

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Crop Breeding

Session Chair: Keith Norman,
Technical Director, Velcourt

Shaping the Recommended List for the future

Jenna Watts, Senior AHDB Crop Production Systems
Scientist and RL Lead and Catherine Garman, AHDB Crop
Health and Protection Scientist (diseases)

Designing future wheat

Alison Bentley, Director of Genetics and Breeding, NIAB

Trait development

Sponsored by



Crop Establishment

Session Chair: Brian Barker,
AHDB Strategic Farmer, Suffolk

Measuring, managing and improving soil health

Stephen Haeefe, Systems Agronomist, Rothamsted
Research

Testing times for crop establishment: What might I do differently?

Discussion panel: Stephen Haeefe, Systems Agronomist,
Rothamsted Research; Andrew Ward, Lincolnshire Farmer;
Russell McKenzie, Cambridgeshire Farmer; Adrian
Whitehead, Norfolk Farmer

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Crop Nutrition

Session Chair: Mark Tucker, Agronomy and
Business Development Manager, Yara UK

Managing potash and sulphur

Natalie Wood, Arable Agronomist for UK and Ireland,
Yara UK

Managing digestate: What's its true value and how to use it

John Williams, Principal Soil Scientist, Soils and Nutrients
Team, ADAS Boxworth

Managing biostimulants; What are they; how might they help?

Muhammad-Imran, Crop Nutrition Research Scientist,
Hanninghof Research Centre, Germany

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Crop Protection

Session Chair: Guy Smith,
NFU Deputy President

Crop protection post Brexit

Chris Hartfield, Senior Regulatory Affairs Adviser. NFU
Plant Health Unit

Biological solutions for disease and pest control

Rob Edwards, Head of Environmental Sciences School,
University of Newcastle and Roma Gwynn, Director,
Biorational

Preventing weed and disease resistance

Paul Neve, Weed Biologist and Leader Smart Crop
Protection Project, Rothamsted Research

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STEPWISE MOVE TO **NO-TILL** DRILLING HAS PROVED A SENSIBLE APPROACH

A stressful time trying to establish autumn crops is what originally prompted Northamptonshire estate manager, Andrew Mahon, to move away from traditional cultivations. But it's been a journey that's paid off.

As manager of the 1,000 ha Bromborough Estate at Glebe Farm, Podington near Wellingborough – with 840 ha of owned land plus 165 ha under a farm business tenancy agreement – Andrew Mahon has overseen some significant changes during his 10 or so years in the post.

Farming on heavy clay soils brings with it problems of blackgrass. But this hasn't stopped him making a success of moving from a traditional plough/min-till based system to no-till. And in a fairly short space of time.

"The rotation is driven by blackgrass," Andrew explains. "In our low blackgrass situations, winter wheat is followed by a second wheat, which we then often follow with two years of spring crops. In a high blackgrass situation, winter wheat is followed by one of the spring crops. And in a moderate blackgrass situation, it's followed by winter barley.

"We dropped oilseed rape from the rotation three years ago because of problems with cabbage stem flea beetle, pigeons and slugs. But we are growing some this year after growing some again last year," he adds.



Moving to a strip-drill first, before going to a full no-till system with the Cross Slot drill, was the right thing to do because it provided a gentle introduction, says Bromborough Estate manager, Andrew Mahon

Initially, the idea of moving to reduced tillage was triggered back in 2012, when the wet harvest meant Andrew not only saw a 30% drop in yields, after struggling to get crops combined, but then also struggled to get crops drilled.

"Back then we were using ploughing and min-till," he continues, "ploughing about a third of the arable land every

year. It was a really stressful autumn, so we looked at what we could change. We're on heavy, predominantly Hanslope series, clay soils so therefore couldn't really change our cropping.

"At the same time, the BASE UK (Biodiversity, Agriculture, Soil and Environment) group was set up and I joined. After researching conservation agriculture and reduced tillage, I thought that was the way forward."

The following year, 2013, Andrew took his first step by ordering a strip-till drill that only cultivated a four inch to nine-inch band of soil for drilling into. At the same time he sold the plough, a set of discs, a press, and two tractors, the latter being replaced with one tractor that was hired in.

"We started using the strip-till drill in autumn 2013 and through 2014 and 2015. It became apparent in the first year that it was working. We saw no drop off in crop performance.

"However, I felt we were still moving quite a bit of soil and still having problems with blackgrass. So the next step was to look at no-till. In March



Our establishment costs are the lowest they've ever been, says Andrew Mahon



As part of the move to conservation agriculture, cover crops are also drilled

2016 we ordered a 5-metre Cross Slot No Tillage Systems drill. It's been brilliant. We had good establishment and good crops again this last year."

Overall, Andrew sees three parts to conservation agriculture – cover cropping, diverse cropping, and no-till.

With hindsight, he says moving to the strip-drill first before the no-till unit was the right thing to do. "It was a stepping stone – a gentle introduction. If we'd have gone straight to no-till we'd have struggled.

"Your whole mindset has to change because you're drilling into trashy conditions and cover crops. Also, the soils need time to adapt. So you've got to be patient. And you've got to start

slowly.

"That said, even in our first year of no-till the soils travelled better – with better trafficability. Also, our establishment costs are the lowest they've ever been – with reduced diesel and machinery expenses.

"We've also now got a wider drilling window. We can drill a bit earlier or a bit later. And there's a lot less stress.

"Using no-till, we also conserve soil moisture and reduce soil erosion, but you also get the natural drainage you need through worm channels by minimising soil disturbance. If you plough, the seagulls eat the worms straightaway. In one field we min-tilled and cross-slot drilled, there were about

17 worms per unit area of soil. Where we ploughed we found 5 worms. And where we no-tilled for two years we found 27.

"There are still areas that we need to mole drain, but soil structure is definitely better. Anywhere that we need to subsoil we've done that," he adds.

In preparation for the no-till drill, straw is chopped and left on the surface and then drilled-into. Another benefit of the approach is that stubbles are left longer, which increases combine output, Andrew says. Organic matters are reasonable across the farm at 5-6%, he notes.

"If you're serious about conservation agriculture, you also have to encourage the soil mycorrhizae. I'd say the ability to minimise soil disturbance is key for mycorrhizae. They form fungal networks but are very fragile," he adds.

Allied to this, as well as changing tillage practices, 2013 was also the year that Andrew introduced cover crops as part of his move to conservation agriculture, planted directly behind the combine.

"We started with various mixes. I think they are an integral part. Keeping green cover or living roots in the soil for as long as possible in the calendar year is the name of the game. Cover crops also stop surface compaction as they decay.

"We're going increasingly to diverse cropping anyway because of blackgrass. We started with 60 ha of spring cropping, we're now at 275 ha.

"In spring 2016, I also noticed that where we had cover crops and sprayed them off with glyphosate four weeks prior to drilling, the material on the surface helped retain soil temperature and moisture because the soil wasn't exposed to drying winds."

Having transitioned through the experience, Andrew reckons the biggest issue with the move to no-till was the change in mindset that was needed, but he needs no convincing of its benefits.

"I feel we are more sustainable for the long term. Brexit will have a huge effect on agriculture, and we are gearing our cost of production per tonne to be lower.

"We're also starting to see if we can reduce inputs such as nitrogen as we increase soil health, and we're looking

at putting humates on and using seaweed extracts. No-till hasn't been a magic bullet against blackgrass, but there have been some gains," he says.

ProCam offers agronomy help and trials

Making the move to conservation farming can be very much a learning process. For a number of years, and during the conversion, Bromborough has been working with leading agronomy firm ProCam.

As well as providing strategic agronomy advice and a range of chemical inputs, the company also carries out soil and tissue tests and has been heavily involved with the estate in conducting conservation agriculture-based trials. "I'm pleased to see them involved in conservation agriculture," Andrew explains.

"I'm there as a sounding board," agrees ProCam agronomist Richard

Rawlings, who has a strong, personal interest in the whole approach.

"We are another head in the decision-making process when it comes to talking dose rates for various inputs and discussing things like whether to apply fungicides, and we provide a helping hand in crop nutrition. Plus, we're working closely with the estate in at least three significant areas of trials.

"We've done a lot of trial work in a direct drilled situation with herbicides and blackgrass control. We found that we can control blackgrass in direct-drilled crops quite well, but have noticed some issues with brome. So we're now looking at trials to control this without compromising the blackgrass control.

"This season, we're also about to start a medium-term, two year project looking at planting a companion crop of clover with wheat, spelt and spring wheat at different times – to gauge the response to the nitrogen

fixed by the clover and the uptake of nitrogen, as well as the level of crop competition that the clover provides.

"In 2018, working with the company PlantWorks, we have also tried one of their soil-applied bacterial products to see if it would improve nutrient uptake. The theory is that bacteria in the soil interact with the roots to improve initial uptake of nutrients during the early stages of plant development. We're awaiting the final analysis of the results."

All the trials are very practically-based, Richard explains. "There are no tried and tested protocols for what to do, so we're trying something different every year.

"We're finding by adopting even some small changes, we can make a clear difference," he concludes.

Growers wishing to find out more about how ProCam can help with conservation agriculture techniques can contact richardrawlings@procam.co.uk



Although black-grass is a concern, trials have shown it can be controlled quite well in direct-drilled crops, says ProCam agronomist Richard Rawlings, who works closely with Andrew Mahon

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AHDB NORTHAMPTON MONITOR FARM LAUNCH 4TH JULY



Report by Chris Fellows, Direct Driller Magazine

Recognising an interest in reducing soil movement, AHDB has picked a new Monitor Farm that predominately uses a system of reduced tillage. The 4th July was the first event held at Rick Davies' Newton Lodge Farm. It was a great chance for us to get to know Rick and understand how he farms at the moment and how he wants to move forward and change to meet the challenges of the future.

The evening started with a brief introduction by Harry Henderson from AHDB. Held in one of Rick's barns, Harry talked about why they had chosen this new Monitor Farm and why AHDB felt a Monitor Farm with a keen focus on cost control provides an interesting platform for local discussion. Giving the growing relevance of direct drilling and soil health in the UK and the fact that Defra and Michel Gove himself are keen to promote (and maybe even push) the benefits of no-till practices then it's interesting that this Monitor Farm joins a long line of Monitor Farms that have abandoned the plough. Therefore, the level of direct drilling representation at a Monitor Farm level is growing all they time just as overall interest in the practice grows.

Table 1

£ per tonne	Top 25%	Middle 50%	Bottom 25%
Average yield per hectare (t/ha)	9.92	9.47	8.83
Total Seed (£)	5.68	6.92	7.57
Total Nutrients ie fertiliser, (£) trace elements	16.45	19.04	19.02
Total Crop Protection costs (£)	19.18	23.94	24.77
Total Sundry ie agronomy (£)	1.06	0.99	1.16
Total Variable Costs (£)	42.37	50.89	52.52
Total Employed Labour (£)	8.76	13.25	16.84
Total Equipment and Power (£)	15.49	18.80	25.52
Total Property (£)	9.53	11.93	12.11
Total other general costs (£)	3.47	4.88	6.80
Total Finance (£)	1.24	1.99	3.78
Family Labour (£)	3.41	2.47	5.43
Imputed rent on owned land (£)	8.75	14.27	17.50
Total depreciation (£)	10.58	10.82	15.40
Total Overheads (£)	61.22	78.41	103.38
Full economic cost of production (£)	103.60	129.30	155.90

The important thing Harry stressed is that a Monitor Farm isn't a demonstration farm, it is chosen as an example of a typical commercial farming business. Harry also introduced AHDB's Farmbench. Farmers can use Farmbench to better understand their

cost of production. It allows them to compare their farm figures and performance against other growers in the local area and region. It is a confidential system that allows farmers to anonymously share information and by being able to talk to each other at meetings, learn from each other to find out where different systems can cut overheads. We will be discussing this topic of costings a lot in Direct Driller over the next few issues, as it is often



A great turn out for Rick's first Monitor farm event.



Harry presents the Harvest 2017 Winter Wheat Group 4 figures.

so difficult to compare farms that are using conventional tillage to those using no-till and so often the benefits described have been anecdotal.

significant labour cost even though he does some of it himself. But it is one of the most effective ways to control black-grass.



Rick presenting at his first Monitor Farm event

Harry presented a summary of Harvest 2017 Winter Wheat Group 4 figures, with a full economic cost of production per ton ranging from an average of £103.60 for the top 25% through to a average of £155.90 for the bottom 25%. The full breakdown of these figures is in Table 1.

Given the average sale price of Group 4 Wheats over the past 5 years, then some farms would be struggling to make a profit based on these figures.

Harry then handed over to Rick, who talked about his farm. Rick is 4th generation and the family have been farming in Clifton Reynes since 1926. It's predominantly an arable enterprise, with 404 ha farmed which is a mixture of owned and FBT. As with all farms, they have also diversified in several ways to help pay the bills. At Newton Farm they also have 14 office units, 4 industrial units, 52 Container Storage units and a Turf Sales and distribution business.

The big battle Rick is fighting is against black-grass. He even uses a plough (there we said it) as the "reset button", should he think he has lost the battle in any given field. However even that doesn't solve the problem, it just buries it and allows you to start afresh. He's using a different rotation in the fields that have a black-grass problem in conjunction with manual rogueing mid-season. However, rogueing, comes a

Rick told us that he is happy with the way he farms, but feels there are significant improvements that can be made to both the way he farms and to the profitability of his business. This was one of the main reasons he wanted to become a Monitor Farm. To open himself up to criticism and bring in ideas from other farmers. It's a brave thing to do, when you know you aren't perfect as there are always ways to improve and to put the way you farm on display for the world to see means everyone gets a "warts and all" view. However, if you want to improve your business, then bringing in outside ideas is the best way to do it.

Rotations

In the fields that are black-grass free the rotation is: Winter Wheat, Winter Wheat, Spring Barley, OSR.

In the fields with black-grass the rotation is: Wheat, Spring Barley, Spring Barley, OSR.

These feel too tight for me and in the long term will struggle to be sustainable. I would expect that more beans and oats would need to be used in the future if Rick is to progress in his no-till development.

He uses a Claydon 4.8 m drill for his drilling, rake and using a 12m Cambridge rolls to achieve a suitable seedbed. For first winter wheat he will

Dyna-drive, then drill with the Claydon, rake and roll. For second Winter wheat, he drills with the Claydon, rakes and then ring rolls. For the Spring Barley, Rick will Dyna Drive in the autumn, then drill with the Claydon, rake and roll. Oil Seed Rape he just uses the Claydon and then ring rolls. Rick will also Flat-lift where required at OSR and second Winter Wheats.

The thing that did surprise me was that Rick wasn't using cover crops at all and he admitted it was an area where he didn't have a lot of expertise. It would certainly help with organic matter levels and given he uses the Dyna-drive in the autumn anyway prior to Spring Barley then he could seed at the same time and not involve an additional pass.

Machinery

In terms of the machinery Rick is currently using on the Farm. They are as follows: 4.8m Claydon (2011). Then in no particular order he has: John Deere 7530 - 4250 (2008), John Deere 6620 - 6950 hours (2006), John Deere 6430 - 2100 hours (2012), Massey 3085 - 6900 Hours (1995), Case 1494 - 5700 hours (1984), Massey 7380 25ft - 1100 Hours (2013), Manitou 9m Telehandler - 7100 hours (1998), Amazone 24m Mounter 2800lt (2012), 3m Dynadrive (2015), low-disturbance flat-lift 2.4m (2018), Claydon 7.5m Rake (2012), 12m Twose Rolls (2000), 6 Furrow KV (1998), 8m Spring Tines (1995), 4m SKH Crumbler (1990), Rabe 4m Powerharrow (1985), KV 24m Spinner (2013), JCB 3CX - 5500 Hours (2002), 2 x Baileys 14T and a Warwick 16T.

Direct drilling is known to have a lower horsepower requirement. The 2006 John Deere has depreciated well. The reality is that this is still a lot of machinery for a no-till farm to have, but given the machine ages you could also say there is no harm in keeping them as they have very low depreciation.

Soil Pit

The first stop on the farm tour was the soil pit with Dr Jackie Stroud or Rothamsted and Ian Robertson of Sustainable Soil Management. The pit had been dug on the edge of a

field adjacent to the river on part of the flood plain. As you would expect, even in the dry summer we had, the moisture levels were still good. The crops looked excellent at this location and Rick estimated that this part of the field would yield 12t plus per hectare. However, you could see a line in the field where the crops became drought stressed as the land raised up from the flood plain. So the field average was not going to be this high and he hoped it would yield just under 10 for the whole field. Rick explained that over the wet winter we had, although the land had flooded, it had not done so for extensive periods of time. Jackie explained the importance of worm activity in the soil and found some example for us to see and how reduced levels of tillage encouraged worm activity.

Ian went on to explain about root structure in reduced tillage situations and how the crops were able to better access moisture in the soils. These crops had roots going down 4ft into the soil and they were still green and growing well. With 6 weeks to go until harvest it is possible that the crops in



Rick talking on the Farm Tour part of the Monitor Farm Event

this location never became drought stressed at all and will have excellent yield potential. Just one of the benefits of farming on a flood plain.

Farm Tour

Rick took us around a number of fields, given some fields were on a flood plain, there were vast differences in the crops. Drought stress had meant that some were really struggling. We stopped at some of the better OSR with Rick saying why he felt this field had done better than the fields by the entrance that we all drove past on the way in.

By Rick's own admission, he certainly isn't proud of some of his crops this year, but given the weather conditions, it looked like he was still going to get good yields overall, but nothing ground breaking on average. It will be good to get an update from Rick in the future on what his yields were and how much they were down on 2017. It has been theorised that no-till farms wheat will yield closer to average figures than conventional tillage farms in a year that has had limited rainfall. Hopefully we will have more data on this in the coming issues.

This year Rick explained that he was growing 242 Ha of Milling Wheat (Crusoe, Skyfall, Gallant and Zyatt), 55 Ha of Oil Seed Rape (V316, Campus and Elgar), 64 Ha of Spring Barley (Explorer), 17Ha grass and 26 Ha of margins, mid-tier and tracks.



Dr Jackie Stroud and Ian Robertson explaining the important aspects of the Soil on this Monitor Farm.

Cost of Establishment

Looking specifically at the cost of establishment, which for many is the key driver to a move to a reduced tillage system, Rick was able to share a number of figures. The figures themselves had come from Labour and Machinery reviews being conducted by Strutt & Parker across the Monitor Farms.

What can be seen from these figures is that there is clearly room for Rick to reduce his cost of establishment further. On a no-till farm you could see fuel usage as low as 3-4 litres per hectare. And with this reduced fuel cost, comes reduced repair and labour costs.

Having said this, the review showed that Rick had one of the two lowest wheat operational costs, with the other lowest cost producer also direct drilling. However, in general, they said there wasn't a significant correlation between establishment strategy and labour/machinery costs. Some of the cheapest producers were still using the plough in the rotation. The reviews recognized that this is because these producers had lower labour, depreciation and repair costs, and therefore the type of cultivation or increased fuel usage made less of a difference.

Taking into account all farms, when



Everyone enjoyed the BBQ at the end of the evening.

investigating a farm's machinery costs. The labour and machinery reviews found that on average 26% was fuel, 35% was depreciation and 19% was repairs. Therefore, if a grower was adopting a mixed cultivation strategy and running well-maintained 2nd hand machines and implements it could still be as competitive as a direct drilling

farm, despite the higher fuel costs. As always, it is so difficult to compare like for like in these situations, but it doesn't seem that there was a lot of no-till farm data in the mix here.

The Evening BBQ

The evening ended enjoying the summer whilst having a BBQ and chatting to the other farmers who had turned up from the local area to find out more at the Monitor Farm event. The number of farmers attending is a testament to the Monitor Farm programme and the part it plays in helping farmers learn from each other.

My lasting impression was of Rick's eagerness to keep learning and keep improving the way he farmed. He recognised that he still had his fair share of problems and having made the big leap to massively reduce the amount of ploughing, he now could make further changes to improve his profitability.

Future meeting dates at the Northampton Monitor Farm:

27th November 2018, 18th December 2018, 22nd January 2019 and 13th February 2019. For further information, please visit: cereals.ahdb.org.uk/Northampton or contact Harry Henderson on harry.henderson@ahdb.org.uk.

Establishment Costs of 1st Wheat

Dyna Drive	£17.8/ha
Claydon 4.8m Drill 2.8 ha/hr	£27.4/ha
Claydon 7.5m Rake 8 ha/hr	£8.2/ha
Twose 12m Roll 8 ha/hr	£5.0/ha
Total fuel for establishment	£58.40 /ha 14 l/ha

Establishment Costs of 2nd Wheat

Claydon 4.8m Drill 2.8 ha/hr	£27.4/ha
Claydon 7.5m Rake 8 ha/hr	£8.2/ha
Twose 12m Roll 8 ha/hr	£5.0/ha
Total fuel for establishment	£40.60 /ha 9 l/ha

Establishment Costs for Ploughed Wheat

KV Plough 6f 1.6 ha/hr	£28.3/ha
SKH Crumbler Press 3.5 ha/hr	£10.9/ha
Power Harrow 4m 1.5 ha/hr	£23.1/ha
MF 30 Drill 4m 3.2 ha/hr	£14.2/ha
Twose 12m Roll 8 ha/hr	£5.0/ha
Total fuel for establishment	£81.5 /ha 23 l/ha



TO TILL, OR NOT TO TILL, THAT IS THE QUESTION. FINLAND HAS THE ANSWER

Written by Harry Henderson of the AHDB, August 2018

Take a look at the European Conservation Agriculture Federation website and you'll see Finland has the highest percentage of arable cropping in a no-till system in Europe – 13 per cent (the UK stands at 8 per cent).

While you can understand dry-land countries, such as Brazil and Argentina, moving almost completely to a no-till system, why would a country where the southern tip is at the same latitude as the Shetland islands (and, presumably, a maritime climate similar to Scotland) have the greatest uptake of no-till cereal production in Europe?

It seemed the only way to find out was to stand in a field with a Finnish farmer and hear for ourselves. So in late May, bags packed, I flew to Helsinki with our strategic director Martin Grantley-Smith.

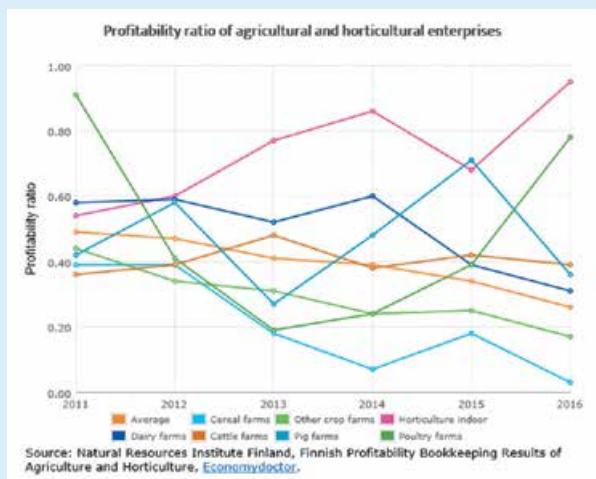
First things first is day length. We landed at midnight. Although the sun had set, it was still reasonably light. By the time we got the hotel at 1am, it was already getting lighter. More on day length later...

Some facts on Finland

- There were a total of 48,562 agricultural and horticultural enterprises in Finland in 2017. The number of farms dropped by approximately 1,000 on the year 2016.
- The average utilised agricultural area of the farms was 47 hectares.
- The average age of farmers on privately owned farms was 52 years.
- About 86 per cent of farms were family run farms and nine per cent were farming syndicates, less than three per cent were heirs, and less than two per cent were limited companies.
- Approximately 9 per cent of all farmers on privately owned farms are under the age of 35 and 27 per cent are over the age of 60

- Nearly 70 per cent of farms have plant production as their primary production line, and nearly 30 per cent of farms are classified as livestock farms. The rest of Finnish farms are mixed farms, with no clear primary production line

Look at the yield figures and profitability of Finnish farming and you soon get the sense that things are fairly tough. Yields, in particular, are poor.



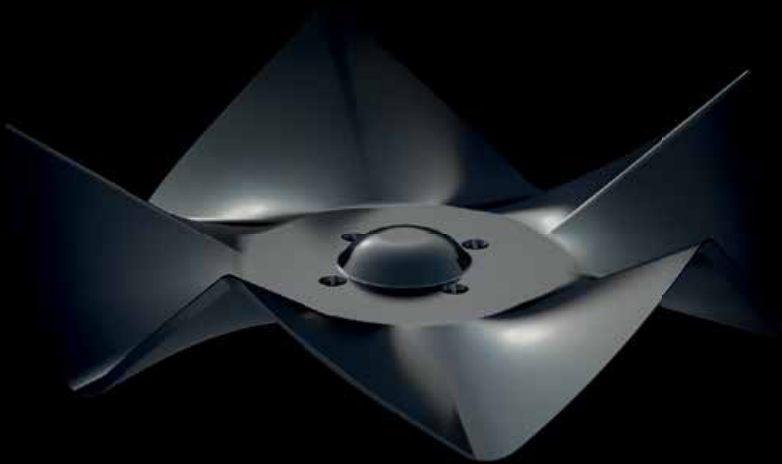


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VÄDERSTAD

The perception is that long summer days, 22 to 23 hours of sunlight at high summer, is good for plant growth and yield. But due to the cold, deep winters – where the sun rises at 9:30am and sets at just after 3pm, giving just under 6 hours daylight at the shortest day – the stress on the plant with the advancing spring is just too much to produce yield. For both winter and spring sown crops.

This limits yield and with costs being similar or more than in the UK, income from growing cereals in Finland is hard to come by. Looking at the chart below, costs of growing a cereal crop have hovered around the 1350 to 1400 Euro per hectare mark. Divide this cost by an optimistic yield of 5.5 tons/ha of winter wheat brings a cost per ton of 255 Euros. With reducing EU support in recent years, this has made farming a financially tight business, if not a loss-making activity.



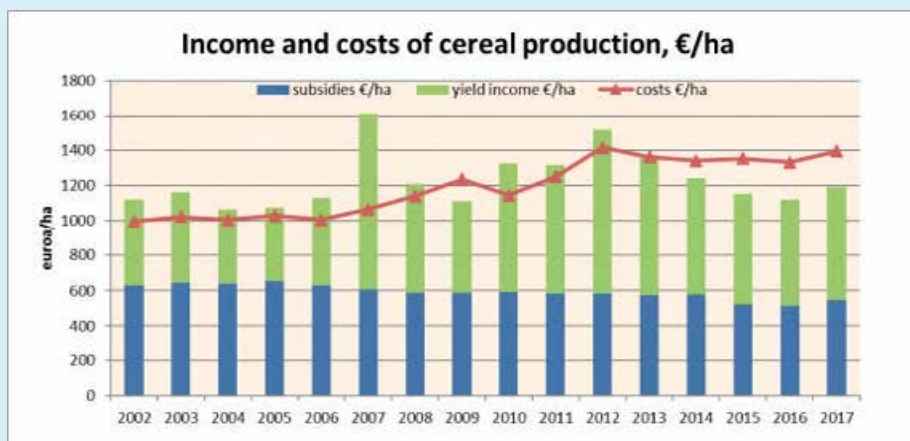
small amount of set-aside. Finland is, in fact, the world's largest exporter of caraway seed, a semi-permanent crop that is combined for seed for several years and is a good addition to the gross margin.

with a high traction requirement and so limit the chance of any compaction getting into you soils. Did I mention that compaction is absolutely avoided? Need more capacity? Have to be getting-on and not messing about with tiny drills? Get your neighbour in with their drill, set up a double shift and just get on with it! Finnish farmers were keen to get across that the hectares can be covered, if you keep the drill running. The drill was simply built to keep costs down, they doubted that air-seeders gave a justifiable improvement in seed placement and, while quite aware of precision farming, Finnish farmers just couldn't see the cost benefit, preferring to focus on good farming practice.

Having said all that, there's a little twist. The Finnish government financially supports no-till farming.

Yup. I've said it now. You may well think; 'well no wonder they are so keen' but to be fair there is a good reason. I've mentioned the cold winters. After Christmas, temperatures regularly get to -20 Celsius and rarely get above freezing for two to three months. That can freeze the ground to a depth of 50cm. Permanent snow cover starts typically after Christmas in the Southwestern corner, but before mid-November in most of Lapland. The maximum snow depth is usually found around March.

Snowmelt contributes to spring floods. In the north, the peak flow of rivers always happens in spring; in the south 70 to 80 per cent of floods happen in spring. In the south, maximum flow happens in mid-April, in the north, in mid-May. And it's this high risk in saturated fields with the huge potential of nutrient run-off, especially phosphate



With this, Finnish farmers have done two things. Cut costs to the bone and gone out and got a second job. A few farmers have taken on neighbouring land but an iron grip on costs still prevail, getting bigger does not mean bigger tractors for all, it means longer hours in the same tractor, double shifting with the wife in the peak time of spring.

After hearing this, it dawns on you that no-till is not a choice, it's a necessity. Allowing compaction to creep into your soils and going out and correcting it mechanically is just not affordable. Finnish farmers had heard of the British love of recreational cultivations and smiled at us sweetly.

Looking at no-till in Finland, they run a finely tuned system – all cost driven. The rotation is long, often containing winter wheat, faba beans, caraway seed, spring barley, oilseed rape and a

The tractors are, for all field work, fitted with dual wheels all-round and are light high power-to-weight ratio 100hp to 140hp machines, nothing above 200hp at all. Unsurprisingly, the most common make is the home-built Valtra, built 190 miles North of Helsinki at Suolahti.

The drills are also supplied domestically, either by Tume or Multiva. They are simple box drills, capable of handling seed and fertiliser and, importantly, able to work in a plough-based seedbed or no-till. Both are disc-based with attention paid to seed-depth control (essential for working in a range of conditions and soil types) supplied by rubber-tired depth wheels running close to the seeding disc. While a six-meter version is available, the vast majority are either three- or four-meter. The thinking here is that if you limit the size of the drill, you don't need a big tractor

and topsoil loss, that leads the Finnish Government to pay farmers not to create a tilth that is more vulnerable to soil loss.

The Finnish farmer receives 30 to 40 euros per hectare each year for every field drilled, and/or left undisturbed.

So. Key learnings to take home from Finland:

1. Compaction. Compaction. Learn to avoid it, rather than buy something to remove it. This is going to be tough for UK tractors adorned with ever-increasing sizes on weight boxes up front.

2. Rotation. Rotation. A long rotation and plenty of spring crops feature here. No time in the Finnish growing season for cover crops. All crop residue is left on the soil surface, as



much as possible.

3. Farmer mind-set. If you expect no-till to fail, it will. The key component is the person in the tractor seat. If the attitude is not right, forget it – it's not for you.

4. Be flexible. Finnish no-till farming is driven by economics, not fashion or religion. Most farms own a plough (they have a low resale value so it's not worth selling) and will use it

if needed. Also, if weather has delayed drilling, they are happy to use a light spring tine cultivator to open up the soil a little and drill.

5. Small machinery. Did I mention compaction? Less weight, more units, more hours in the seat (when the land demands it). So, 24-hour running is not unheard of at peak times. Time is short, summer is coming and while long days help, the season is short.

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SOIL ASSESSMENT METHODS



Soil Health

Farmers and growers are concerned about the current health of their soils. Most farmers and growers understand the importance of soil health for the productivity, sustainability and profitability of their business, but many face significant challenges when interpreting results from the laboratory analysis or when choosing suitable methods for assessing the health of their soils beyond the standard pH, phosphorus (P), potassium (K),

magnesium (Mg) analysis.

To be of value to farmers and growers, methods for soil assessment should not only measure soil health, but should also provide information that can be used to inform decision making in relation to soil management. This AHDB information sheet provides an overview of the various methods currently available.

Indicators of Soil Health

The functioning of soil depends upon a

complex interaction between organisms large and small, chemical reactions in solution and on the surface of clay particles, within a structure determined by natural processes and modified by soil management.

A broad range of appropriate indicators of soil health are therefore needed to evaluate the effects and sustainability of agricultural practices. The most commonly agreed and used indicators can be grouped in the three categories of (1) biological, (2) chemical and (3) physical parameters.

Latest information	Action
A number of new methods are available but require careful consideration and interpretation	Develop a soil management plan taking into consideration physical, chemical and biological indicators of soil health
Assess soil health, beginning with assessments you are comfortable with, progressing to those that are more complex	At several locations in 'good' and 'bad' areas of the field, representing different soil types, assess soil texture and structure

Assessment methods







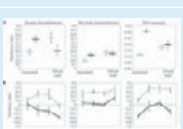
During a series of grower consultations in autumn 2015, regional grower groups

in Great Britain discussed different approaches to soil assessment, what methods they found useful and reasons why other are not very commonly

used. They were asked to rate a list of categorised soil assessment methods, and the results can be seen here.

Soil assessment tests evaluated and rated by growers

1 = low; 5 = high rated by growers	Skill req'd	Time input	Cost input	Suitable for	Not suitable for	Comments from growers	
Spade diagnosis (depth 30cm)	1	1	1	Easy, quick, good indication of soil health, fast general impression of the soil status	Subsoil assessment, quantitative nutrient levels	Most common method used, very easy and informative; 'spade is always with me'	
Plant health monitoring (current and previous crop, weeds)	1	1	1	Early signs of nutrient deficiencies or compaction	Specific or quantitative information	Seasonal, need some experience and additional tests for details	
Total soil organic matter (SOM) (usually in %)	1	1	1	Total SOM (labile, stable and inert fractions of SOM)	Monitoring labile SOM (providing/releasing energy and nutrients)	No need to do annually, need specific sampling technique	
Visual soil assessment tools (eg AHDB Healthy Grassland Soil methods)	1	2	1	Good overview of a wide range of soil health indicators (roots, worms, soil structure, colour)	Quantitative assessment of nutrients	Assessment speed comes with experience, easy to learn, need the tool only at first	
Standard lab test (macronutrients and pH)	1	2	2	Soil nutrient content P, K, Mg and pH	eg soil life, structure, compacted layers, root development	Regularly done, directly informs fertiliser strategy	

Visual evaluation of soil structure (eg SRUC VESS tool)	2	2	1	Soil structure and compaction detection	Quantitative assessment of nutrients	Some specific knowledge required	
Earthworm counts	2	3	1	Good indicator for soil structure and health, soil life and activity, soil biodiversity	Quantitative assessment of nutrients, subsoil assessment	Seasonal fluctuations, some skill required for species identification	
Micronutrient test	2	2	3	Trace elements/ micronutrient levels in the soil	eg soil life, structure, evaluation of compacted layers	Done only if deficiencies suspected in plants	
Soil pit/profile (depth range 30–150cm)	3	3	1	Subsoil assessment, horizons and exact location/depth of compacted layers	No quick results, is a rather destructive method, location of sampling important	Very useful results if done properly, good for structure assessment	
Soil health test	3	2	3	Measures pH, available P, K, Mg, texture, total SOM and respiration rate	In-depth evaluation and meaningful results/conclusions	Skill required for interpretation of overall results, eg respiration rates	
SOM balance modelling tool	5	5	2	Input/output estimation of SOM levels on field or farm level	Beginners in SOM assessment, basic day-to-day assessment	Not commonly used in UK yet, but might be a promising planning tool	
Soil life suites (eg food web tests, enzymatic activity, basal respiration etc)	5	2	5	Bacteria and fungi, number, species and diversity (no standards yet)	eg soil structure, compaction evaluation	Skill required for adequate sampling and high skills for interpretation	

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WANT TO ASSESS YOUR SOIL HEALTH? TRY THE FREE #30MINWORMS SURVEY THIS AUTUMN

If you think of soil health, the best place to start is with ecosystem engineers – earthworms. The results from the spring pilot farmland earthworm survey indicated that turning over a spadeful of soil in any field, and you are highly likely to find at least one earthworm.

There are 3 types of worms that make up the earthworm community in farmland soils, the first type are the small (often matchstick sized) red worms 'surface' worms that live in the surface of the soil, feeding on surface litter or organic amendments like muck, and are a good source of prey for native wildlife. The second type are the pale worms that live in the topsoil - 'topsoil' worms, horizontally burrowers that mix and aggregate the soil together, mobilising nutrients for plant uptake. The third group are the large drainage worms or 'deep burrowing' type, distinctive by being pigmented and often the size of a pencil, which make deep (up to 2m) vertical burrows, supporting deep crop rooting and water infiltration.

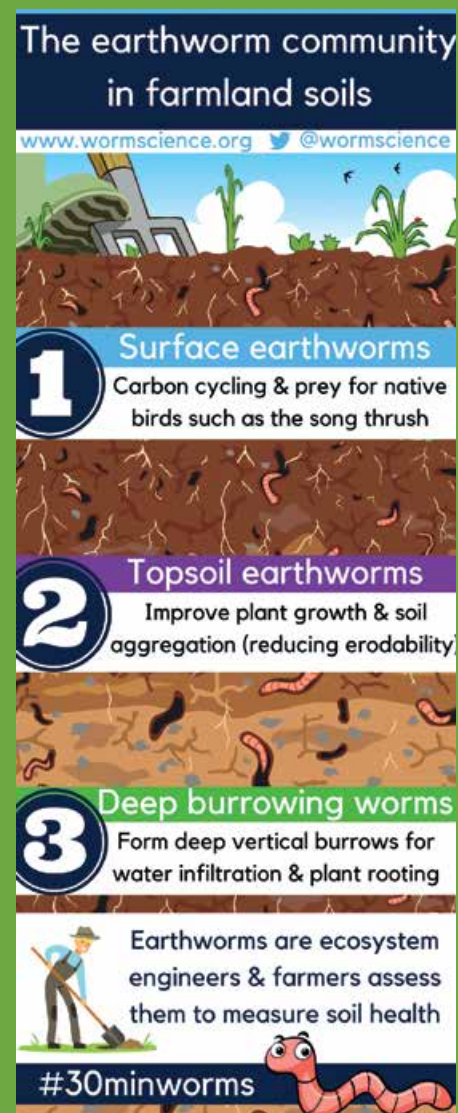
The surface worms and drainage worms are vulnerable to soil

management, becoming rare or even locally extinct in over-worked farmland soils. The Spring survey indicated that 48 % of fields had no sightings of at least one of these earthworm types – with implications to soil structure and wider ecosystem services. If there is no evidence for basic earthworm biodiversity in-field, this is an early warning sign of potential over-cultivation (intense, frequent tillage) or under-fed (no organic matter return) soils, that may benefit from a change in soil management practices (for example, reducing tillage intensity, cover cropping or application of organic matter).

The pilot worm survey went well (>1300 ha was surveyed by farmers around the country) with farmers recording the quality (types of worms present) and quantity (counting the total number of worms present) of earthworms in their fields. In terms of quantity, the average was 9 worms per 20cm³ soil pit, high numbers of worms (>16 worms per pit) were rare although the top fields could support 27 worms per soil pit. The feedback from the participants was to shorten the protocol to enable more within and between field comparisons, and the data analysis and statistics indicated this was robust - leading to the new #30minworms survey, which involves digging 5 soil pits across the field. Participants also wanted more support in earthworm identification, so the new survey booklet provides more detailed pictures, and there are online resources including an earthworm identification tutorial quiz and YouTube demonstration.



When to sample? Autumn or Spring are the best times for earthworm assessments, the #30minworms survey will run between the 15th September to the 30th October, with full details, method support and the survey booklet available at www.wormscience.org.



#30M WORMS METHOD

Equipment

- Spade & ruler
- Mat
- Pot for worms
- Bottle water
- Booklet & pen

Procedure

5 soil pits per field using standard W shape field sampling

1. Dig out a 20 cm x 20 cm x 20 cm soil pit and place soil on mat (30 sec)
2. Hand-sort soil (5-minutes), placing each whole earthworm into the pot. Note if pencil size vertical burrows are present and tick/cross on the results sheet
3. Count the total number (adults and juveniles) of earthworms and write down
4. Separate earthworms into adults (only a few) and return juveniles to soil pit. May need to rinse worms with water to detect if a saddle is present
5. Count the numbers of each type of adult earthworm (key shown) and write down.
6. Return worms to soil pit and back fill with soil
7. Check the soil surface for the presence of middens (key shown)
8. Repeat steps 1 - 7, until 5 soil pits per field have been assessed
9. Please input your data at www.wormscience.org for results analysis

ID Step 1 of 2:

Separate Adult vs Juveniles Only adults have a saddle or belt (worm at top of each picture)

ID Step 2 of 2:

Practice your ID skills on the worm ID quiz at www.wormscience.org

Type 1: Surface worms e.g. *Lumbricus castaneus*, *Lumbricus rubellus*



Small (matchstick) size <8 cm when not moving Red bodied worm. They breakdown surface litter and good food source for native birds.

Type 2: Topsoil worms e.g. *Aporrectodea caliginosa*, *Allolobophora chlorotica*



Small - Medium size Pale worms: grey, pink or dark green colour. They mix soil & mobilise nutrients for plant uptake, supporting crop productivity

Type 3: Deep burrowers e.g. *Lumbricus terrestris*, *Aporrectodea longa*

Large (pencil) size Heavily pigmented (red or black headed earthworms). They are the 'drainage' worms - can form 2

m vertical burrows, helping with water infiltration and deep plant rooting

Deep burrowing earthworm presence

Deep burrowers may not be captured in the topsoil so look out for these indicators of their presence and note down on the data table:

1. Pencil size vertical burrow
2. Surface permanent burrows



#30minworms data table

Field name		Field size (ha)		Crop		Date	
Was straw retained? Yes/No		Tillage? Plough / Mintill / Notill					
Cover crop prior? Yes / No		Manure / Compost etc. This year?					

	Pit 1	Pit 2	Pit 3	Pit 4	Pit 5
Large vertical burrows or middens present?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Total number of juvenile AND adult worms	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>
Total number of adult surface worms	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>
Total number of adult topsoil worms	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>
Total number of adult deep burrowers	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>

#60M WORMS OUTCOME FROM THE SPRING 2018 EARTHWORM SURVEY

Written by Jackie Stroud, Rothamsted

Earthworms are primary candidates for national soil health monitoring as they are ecosystem engineers that benefit both food production and ecosystem services associated with soil security. Supporting farmers to monitor soil health could help to achieve the policy aspiration of sustainable soils by 2030 in England; however, little is known about how to overcome participation barriers, appropriate methodologies (practical, cost-effective, usefulness) or training needs. This paper presents the results from a pilot #60minworms study which mobilised farmers to assess over >1300 ha farmland soils in spring 2018.

The results interpretation framework is based on the presence of earthworms from each of the three ecological groups at each observation (20cm³ pit) and spatially across a field (10 soil pits). Results showed that most fields have basic earthworm biodiversity, but 42 % fields may be

at risk of over-cultivation as indicated by absence/rarity of epigeic and/or anecic earthworms; and earthworm counting is not a reliable indicator of earthworm biodiversity. Tillage had a negative impact ($p < 0.05$) on earthworm populations and organic matter management did not mitigate tillage impacts. In terms of farmer participation, Twitter and Farmers Weekly magazine were highly effective channels for recruitment.

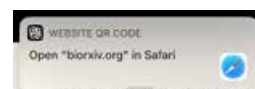
Direct feedback from participants included excellent scores in trust, value and satisfaction of the protocol (e.g. 100 % would do the test again) and

57 % would use their worm survey results to change their soil management practices. A key training need in terms of earthworm identification skills was reported. The trade-off between data quality, participation rates and fieldwork costs suggests there is potential to streamline the protocol further to #30minuteworms (5 pits), incurring farmer fieldwork costs of approximately £1.48 ha⁻¹. At national scales, £14 million pounds across 4.7 M ha⁻¹ in fieldwork costs per survey could be saved by farmer participation.

To read the full report open up the camera on your smart phone (assuming you have IOS 11 and above on your iPhone) and point it at this code



Your phone should bring up this option at the top, once you get the hang of this you will find it useful to go from print to digital.



HARVESTING IN FOCUS...

CLAAS TUCANO – NEW CONTROL CONCEPT AND MONTANA HILL-SIDE LEVELLING

A new CEBIS terminal, an extended model range and optional hill-side levelling are among the highlights of the new-generation TUCANO from CLAAS.

For the first time in this range, models with MONTANA hill-side levelling are available. In addition, the operator assistance systems AUTO CROP FLOW, which controls the crop flow to allow the combine to be worked to its maximum potential, and AUTO SLOPE, which adjusts the fan speed to ensure minimal losses and optimum grain cleanliness, are now also available in these combine harvesters, along with a grain tank capacity of up to 11,000 l.

There is also a new top-of-the-range model in this series – the TUCANO 580.

New top-of-the-range TUCANO 580

The TUCANO series for 2018 has been extended to a total of 8 models, ranging from the new 381hp TUCANO 580 through to the 245hp TUCANO 320. All TUCANO models are powered by Mercedes Benz engines that comply with the Stage V (Tier 5) emissions standard and also now feature DYNAMIC POWER.

Originally introduced on JAGUAR forage harvesters, DYNAMIC POWER matches the engine power curve to the prevailing operating conditions. When less power is required, for example when not chopping and just leaving a swath, engine power is reduced so saving fuel. If more power is needed, for instance when unloading, the full engine output is immediately available again. The machines offer further scope for savings through the reduction of the full-load engine speed to 1,900 rpm and the reduction of the idling speed to 850 rpm.



MONTANA hill-side levelling

For the first time, five TUCANO models are now available ex-factory as MONTANA variants. This system compensates for slide slope inclines of up to 16%, or up to 18% for the TUCANO 560 and 430. In the field, all the functions run automatically with the current tilt and cutting angle displayed in CEBIS.

The MONTANA models are equipped with a 2-speed manual transmission with automatic adjustment of the engine load. In both gears there are two drive ranges which are selected on the basis of the load on the ground drive. No manual selection is necessary, the machine switches automatically to the lower drive range when high traction is required.

The new all-wheel-drive axle in the MONTANA models provides up to 70 % more tractive power compared with the standard all-wheel-drive axle. A differential lock for the front axle is available as an option. Hill-side levelling is also available for the

APS HYBRID TUCANO 580, 570 and 560 machines as well as for the APS 6-walker TUCANO 450 and the APS 5-walker TUCANO 430.

New touchscreen CEBIS control

In the cab, the new TUCANO features the new touchscreen CEBIS terminal which, in combination to the redesigned armrest, allows the operator to control all the key functions of the combine harvester intuitively – without any previous knowledge of the machine.

CEBIS can be controlled as before by means of a control panel, but also through direct access to the functions using the touchscreen. A touch of a finger on the threshing unit image, for example, activates the user-friendly dialog for adjusting the drum speed. Here, too, the operator makes the adjustment intuitively – in the familiar way that settings on a smartphone are adjusted. All the key machine functions can also be adjusted directly by means of switches on the armrest.

CEBIS complements this quick access mode with a favourites management system, in which the



When working uphill, the fan speed will be automatically reduced to avoid losses and then increased again as it goes downhill to ensure grain is cleaned sufficiently.

The grain tank capacity on the largest models has also been increased to 11,000 litres, including on MONTANA versions and an automatic flap on the discharge auger reliably prevents residual crop outflow, even if the auger is still full.

The standard specification for the latest TUCANO models also includes:

- A feeder housing dust extraction system for improved visibility in dusty conditions and in the dark.
- The returns are shown in CEBIS and can be assessed along with the losses.
- More stowage space for tools and maintenance parts.
- Additional and enlarged maintenance panels for the engine and residual grain separation system.
- On-board water tank for hand washing.

operator defines specific machine control functions which can then be called up very quickly when required via buttons on the CMOTION multifunction control lever.

Excellent visibility under all conditions is ensured by a wide range of terminal adjustment options. It can pivot from its normal position in the operator's field of vision completely to the right, next to the armrest. This means that the operator still has an full visibility over the entire cutterbar even when working at the edge of the field or in laid crops.

AUTO CROP FLOW and grain tank capacity of up to 11,000 litres

AUTO CROP FLOW, the operator assistance system previously only available in the LEXION series, is now available in the TUCANO models for the first time.

The AUTO CROP FLOW system uses sensors to continuously monitor the speed of the APS drum, residual grain separation system, straw chopper and engine and will automatically react and alert the operator to a potential blockage or overload. This allows the operator

to confidently push the combine closer to its performance limits under varied conditions, and is also ideal when the combine is being operated by less experienced operators. The new AUTO SLOPE function in the TUCANO has already proved itself in the LEXION and guarantees the cleanest possible sample and minimal losses on uneven terrain. The system continuously adjusts the fan speed relative to the angle of the combine.



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DRILL MANUFACTURERS IN FOCUS...



The Triton seed drill from Cambridge is designed to sow all seeds, into all soils, in all weathers. The Triton sidepress seed drill has 12 patent applied features which enable seed to be set securely with air and rooting zones into ideal conventional seed beds or when direct drilling into wet clay in winter the beat black-grass. With milling wheat at £200/t and rape at £330/t the Triton allows farmers to go back to a highly profitable wheat and rape rotation. The Triton seed drill often pays for itself in just one field of wheat drilled in November since the alternative of a poor field of spring beans drilled with a conventional drill in May 2018 would have made a loss. Triton drills have undergone extensive testing from Kelso stoney land to London clay and so long as the stubble is cut short with straw chopped to 4inches the Triton will drill any land on any day of the winter. A Triton drilled a field of Gravity wheat into Essex clay on December 21st and it yielded 4.12t/acre in the drought of 2018.

Triton farms cover 5000 acres from Kelso to Northants including farms in Cambridgeshire and Norfolk over different soil types with different



requirements. Triton farms had been operating most of the different seed drills on the market but without much success. No seed drill was capable of direct drilling wet clay from November onwards and so poor performance break crops were used which were destroying farm profits and black-grass was building up rapidly in first wheats to boot. Using a Triton seed drill, Triton farms gave themselves a 5 year programme to get back to a pure wheat and rape rotation but managed to get there in one autumn of 2017.. such was the reduction of blackgrass in our earlier planted wheat that we scrapped our plans for peas, beans and spring barley and went wall to wall wheat finished in late December, we applied no herbicide and the Gravity yielded 4.12t/acre. The Triton Delta sowing blade sweeps black grass seed down below the germination layer as it drills and with no inversion the fields are very clean. The savings on chemical are very considerable but the potential increase in farm output is even greater.

The Triton uses a soil heave system to shut the drilling slot so that no rear roller press or harrow is required. The wetter the soil the more easily the slot it shut. The Triton Rock-Hopper version allows day long drilling into marginal or stoney

ground without stoppages. AminoA Flo is applied to all our crops and 2018 saw farm records broken across all our farms even in the drought. AminoA will boost the late sown crops so that the crop performs like an earlier drilled crop but without the black-grass. There are some farmers who say you should drill in November but the Triton will drill on every wet day in October too so it puts the seed programme on course whether its drilling sprong barley in late Feb, or spring wheat in mid-November, or first wheats in autumn.

The output from a Triton drill is considerable .. the Triton can be pulled at 20kmh and continues to perform just the same. A deep rooting channel of 6 inches is cut below every seedling for maximum yield and compaction removal by vertical tillage. No rolls are required afterwards which is arguable better than CTF because Triton only goes across the field once and lifts the soil as it goes. Triton is stand alone seeding system starting from £13,950 excluding the front seed hopper. Most Triton seed drills have been sold to big farming companies who want to use their existing tackle early in the autumn in tandem with the Triton but then in the late autumn the Triton continues on its own drilling wheat to



a rotation running over many years. 'Its like playing a game of chess with black-grass as the opponent.. the blackgrass keeps putting the farm in check but the farmer is hopeful of winning in the end.. so the farming system and equipment is kept on until the chess game is finished, even if a better strategy is available.' Over the last 20 years seed drills have become heavy, high maintenance , and more limited in late season use. The Triton reverses this. 'There is a lot at stake for Triton farms and we will only use the most capable seed drill on the market. All our previous drills from 6 established manufacturers are for sale. We would not be using a seed drill unless it was creating a big advantage for us.' All the Triton parts are made in Retford and Leeds , manufacture would be cheaper in Eastern Europe but Simon Chaplin insists that every Triton is fully British, even the blank steel has to be produced in the UK. Triton runs all New Holland tractors and combines. All Triton farm vehicles and private cars are British made. 'With or without Brexit , Britain will flourish if we all invest in what our fellow UK workers are producing.'

reduce the spring cropping area of poor performance drought prone crops.

The ultimate all weather capability of the Triton is invaluable when adjusting the rotation because if black-grass does proliferate in a late drilled crop then it can be sprayed off and re-direct-drilled straight away or left till early spring. The Triton gives spring crops the best chance of yielding well because spring cereals can be drilled in late february

into wet clay. Slugs and aphids are largely inactive in the deep winter so the crops grow on unchallenged, applying AminoA gives the plants growth and should be timed for when the seed energy has been used up at two or three leaves as there is no sun energy in December. Changing a farming system is a hard decision for farmers .. generally a farmer already has equipment that suits the soil, and

Take-All and Black Grass come hand in hand with easy drilling...

The Triton drilling system is designed to drill in any conditions and leave seed secure in November returning rotations to wheat and rape. Crop established with a Triton drill is exceptional and with the seeding blades cutting 6 inches deep, the rooting capability is double that of the nearest competitor drill and several times deeper than many disc systems, making the Triton the only direct drill to consider. Triton recommends AminoAflo on all as complimentary to the Triton late drilling system.

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PRODUCTS IN FOCUS...

NEW BIOSTIMULANT PRODUCTS PRODUCE EXCELLENT RESULTS IN 2018 DROUGHT CONDITIONS

British biotechnology company, AminoA Biostimulants launched their new liquid range of biostimulant products in July 2017, so harvest 2018 has been an excellent test of their performance in some extreme conditions.



AminoA FLO is a highly concentrated L-isomer amino-acid complex developed for the large scale arable farmer, and is manufactured in the UK. It contains synthetics and the latest crop penetrant technology to make it suitable for mixing with other agrochemicals. There are no restrictions on its use, apart from in organics, and it is competitively priced against comparable products. It is recommended for use in all fungicidal tank-mixes at a rate of 1 litre ha.

In the case of severely stressed crops or to encourage protein synthesis in Wheat, pod fill in OSR or other key target growth stages it is recommended to apply 2.5 litres ha.



The Company have also launched AminoA GRO, a liquid L-isomer amino-acid complex formulated from vegetal source material and fluvic acid to maximise plant uptake. AminoA GRO is fully approved for use in Organics. The recommended application rate is between 2-5 litres ha.

"Our products are deliberately designed to have broad spectrum activity as they contain every essential amino-acid that plants synthesise throughout their growth cycle. Therefore, if applied to the plant at any stage from sowing to maturity they can contribute positively to yield and quality if the plant is not already producing an optimal level of amino-acids itself.

We are satisfied that repeated use of our products in combination with other agrochemicals will enhance their effectiveness and produce a yield response in the crop.

Most of our customers are conventional arable farmers who have realised that the judicious use of biostimulants can boost yields and profits whilst at the same time sustaining the fragile ecosystem in our soils.

We have been delighted to work with Triton Farms across their 5000 acres in the UK and it is very rewarding to see that they have achieved farm record yields with a very low input system." Richard Phillips Managing Director AminoA Ltd.

Direct drilled crops often suffer from low levels of available nitrate in the Autumn, as low soil disturbance does not mineralise nitrogen as traditional cultivations do. The programme used successfully at Triton Farms this season, in OSR and WW was 3 applications of 2 litres of AminoA FLO. For crops sown at traditional timings it is important to make applications in the Autumn before growth stops and then again as early as possible in the Spring. For late sown crops apply as soon as the crop has emerged and there is sufficient leaf area to take up the product.

Further applications should be made at boots swollen to mid-flowering in WW to boost proteins and at petal fall in OSR to extend pod fill or in the event of stress on the crop.



At Triton Farms we conducted several tramline trials in OSR and WW. The results in OSR were dramatic and the untreated areas produced less than 50% of the biomass of the treated area, the farm average yield of 5.04 t ha was a record for OSR. The entire WW area had already had 2 applications of 2 litres of AminoA FLO, so trials were conducted to establish the effect of 0, 2 or 4 litre applications at mid-flowering. The average yield increase from the 2 litre application was 7.5% and 13% from a 4 litre application. Hectolitre weights were also extremely good and increased up to and average of 86 kg hl at the 4 litre application rate.

Overall the farm achieved its best yields ever, with a low input herbicide programme, farm saved untreated seed, a 12 ha fungicide programme and 220 kg Nitrogen. As a result they have already ordered 6000 litres AminoA FLO for the coming season.

Our OSR trials in France saw a pleasing 540 kg yield increase from a 2 x 2 litre application programme and we are expecting spectacular results in Sunflowers.

Independent fully replicated WW trials in the UK (variety JB Diego) showed yield responses of 0.5 t ha from single applications of 3 litres ha AminoA FLO at either GS30 or GS39, when both timings were used yield increased by 1 t ha.

AminoA FLO is effective in all crops and we would recommend growers use at least 1 litre ha in every fungicidal tank mix. In many cases this should not be an added cost as other products can normally be reduced as their efficacy will be improved.

AminoA Biostimulants are available direct or through selected distributors, for more information see www.aminoa.co.uk call 01633894300 or email enquiries@aminoa.co.uk

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We know events are one of the best way to learn as so many of us consume information better face to face. But the next best thing is hearing what another farmer thought of an event. You will see write-ups in this magazine of a Monitor Farm event on the 4th July, the NOCC event in Telford and Groundswell 2018. We hope to have many more event write-ups in the future.

What about open days and free to attend events like monitor farm? If you do a write up of a free to attend event and we then publish that, we will send you a ticket to Groundswell 2019 on us. All our Farmer Focus writers also get a free ticket to Groundswell too, so if you are interested in being a featured farmer, like David White in this issue or one of our team of farmer focus writers, then please do get in touch.

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FARMER FOCUS

TOM SEWELL



"To bale or not to bale"

Life is full of compromises! Any of you who have been married for more than a few years will know this is to be true!

I love my wife dearly and without her I'd be completely lost. Not only is she a wonderful woman, mother and cook. She also doubles as farm secretary, go-getter, deliverer of harvest lunches and dinners and the one who knows exactly when I'm doing things wrong! Unfortunately she's almost always right! Next year we will celebrate our 18 year anniversary and part of the reason we are still happily married is our ability to talk and compromise on things.

"What on earth has this got to do with conservation-ag and no-till farming?" I hear you ask!

Well this year as a farmer who has been 100% no-till farming for 5 yrs I found myself becoming quite set in my ways when it came to the issue of baling straw.

Having spent 2 years travelling the world on my Nuffield Scholarship looking at successful no-till techniques and finding farmers who had been carrying out this practice for up to 40 years, I became a bit of a fanatic about chopping straw, creating a mulch and feeding the worms and soil biology with all forms of crop residue. I have been very proud to say that our lack of P and K applications in bagged form for now over 18 years have

been largely down to chopping straw as well as adding some compost, FYM and cover crops in small amounts recently

However this year the hot dry spring and summer in the UK saw many more arable farmers than normal bale straw behind the combine! This was prompted by the stock farmers, who found that summer grazing ran out, and conserved winter supplies had to be fed during summer. The hashtag #farmershelpingfarmers was created on twitter to help champion the plight of the suffering stock farmers and champion the roles of the selfless arable farmers who rushed to the aid of their fellow farmers by baling every blade of straw in sight. It's interesting that this coincided with record prices for both straw in the swath and by the ton!! Part of me found this frustrating! "Don't they know they're ruining their soils and wrecking their soil organic matter levels?" was the thought going through my head if not on my twitter timeline! It did make my blood boil that certain farmers would publicise their generosity to the nation whilst taking a price for that straw which, if truth be known, the stock farmers will struggle to justify even if they barely can afford!

A soil advisor of mine once said "straw is a crop so treat it as such. Put half the money in your back pocket and spend the other half improving your soils"

With this in mind and the arrogance of youth (41 is still young for a farmer!) I obviously chopped everything this year!



Having just applied a second dose of slug pellets (ferric phosphate of course) to my struggling Oilseed Rape today (10th September) I'm beginning to wonder whether I should be compromising on my "no baling" rule particularly pre OSR! Perhaps baling the straw and applying some compost/FYM etc would have helped emergence?! (And my bank balance!)

This year we used a cane molasses product with our liquid nitrogen and this seems to have worked well. Our aim has been to soften the negative effects and also reduce our overall N rate. We have done this by 10% on the previous years rate, with yields and quality very pleasing given the difficult grain fill period. I am planning to use this product, called "Boost", with all fungicides, liquid N and glyphosate at a rate of about 5L/ha for the coming season at @ cost of about £3/ha per application.

Given the hot and very dry weather following harvest we chose not to establish any cover crops this year. Our self sown volunteer Oilseed Rape is growing away nicely as a free cover crop pre wheat. Ironical that no slug pellets, fertiliser or pre-emergents have been used.

So thoughts now turn to autumn and next years projects and planned purchases! Having broken 16 shear bolts on our flat lift in as many yards, an auto reset subsoiler and perhaps a big straw shed are on the shopping list!



FARM WALKS WITH THE SOIL FARMERS OF THE YEAR 2018

The winners of the FCCT Soil Farmer of the Year competition opened their gates over four days and provided a veritable masterclass in managing soils. Spanning a range of soil types, management systems and enterprises, attending farmers gained insights into their award winning management and a better understanding as to why these farms had been picked as the top three in this year's competition.

The Soil Farmer of the Year Competition, now in its third year, is run by the Farm Carbon Cutting Toolkit and Innovation for Agriculture. The competition aims to find farmers and growers who are engaged with, and passionate about managing their soils in a way which supports productive agriculture, reduces greenhouse gas emissions and builds soil health, organic matter and ultimately, carbon. For the first time this year, some of our finalists were presented with their certificates at

been working on improving his soils for the last 20 years, and moved to a no-till system 12 years ago, being flexible with both management and rotations to prioritise soil health. Simon was chosen as the winner this year because of his passion and enthusiasm for soil management and this was evident during his farm walk. Simon focusses on building soil health with a combination of no-till, the use of homemade compost and a diverse rotation which grows healthy plants, allowing for a reduction



layered up in rows and then turned using a compost turner, every day to begin with and then less and monitored by using a temperature probe to keep the material below 70 degrees C, to protect the beneficial microbes. Once the compost has stopped heating up and is left, the fungi can start to grow, colonise the woody material and build associations. It is then left to mature, and then applied at between 2-4 tonnes per acre on the surface of fields that need it. Simon explains, "Compost is the best thing ever. If the soil is not in the right condition, when you apply biology it will not thrive. However if the biology make their home in the compost, when the compost is applied to the soil, they won't die off, they have a stable home and can thrive. It is changing my soils, within a few weeks of an application you can see a visible difference." This year Simon is aiming to apply a lower rate of compost across a wider acreage to maximise the benefits.

After the compost heap the group continued looking at some of the different crops growing and discussing rotations.

His long term vision is to get the soils into a position where they can generate all the nitrogen the crops need (he hasn't applied P or K for the last 20 years), and get it so biologically active that the weeds won't grow and the



Groundswell, which was a fitting venue to recognise their achievements.

The competition this year attracted a large number of high quality entries. Judging them is always challenging. However, from a list of high calibre finalists, the top three were announced and very kindly agreed to host farm walks to showcase their management to other farmers, explain a little bit of the journey that they have been on to get to this point and share ideas.

Simon Cowell, this year's winner, farms 400 acres of heavy clay with a large acreage below sea level. Simon has

in inputs. These were all things that were discussed during the walk. The first stop was the compost heap.

Compost

In the last 5 years, Simon has refined his compost making technique to produce a highly effective biological inoculant that makes a visible difference when it is applied. The compost includes horse manure, woodchip and garden waste, as well as gypsum (providing calcium and sulphur in a biological form) to counteract his high Magnesium levels, and is made to a strict method. The materials are

crops dominate. His aim is to lessen the impact of management on the soil and allow it to 'bounce back'. He explains, "In a completely natural environment, all is balanced and correct. Everything that we do, changes it. If you gently ploughed it as the only intervention, the soil would recover. However everything that we do knocks it back, ploughing, cultivation, fungicides, etc. We need to lessen the impact of all these things."

On-farm trials

One of the ways that Simon has managed to lessen his impact is to change to more spring cropping, which has dramatically cut his Nitrogen usage. He is keen to push this further and see how far he can go and what can be achieved. To this end he has a range of trials on the farm, including looking at how wheat performs without artificial Nitrogen, and whether the mycorrhizae will work with the bacteria and fix nitrogen out of the air and feed the crop.



Simon explains – "In a normal situation, the wheat would just go all yellow and be hopeless without Nitrogen, but it's looked quite decent all year. It didn't tiller out and there are fewer ears there definitely but it's quite a reasonable crop."

As well as the Nitrogen trials, Simon is also testing a range of wheat varieties to see if they behave differently in a no-till system. He drills all his wheat with a mixture of 4 varieties (Conqueror, Gator, Diego and Panorama), and this trial was a good opportunity to compare his hybrid variety in terms of yield and

performance. Trials were done last year, and the results were positive; Simon's mix yielded the highest, and as such, the trials have been repeated, and modified this year. As well as testing the varieties, this year he is looking at varying inputs, varying fungicide, herbicide, growth regulator and trace element levels to assess the impacts on yield, performance and costs. The group were looking forward to seeing the results, as this year the trials will be cut with a plot combine.

Simon echoed again the main reason for trialling new ideas, improving soil health. He explains, "Soil health is so important, and is the overriding factor in all decisions made, much more than financial implications. I am farming for the long term rather than one year at a time. It's so difficult to get the crops to grow, the less I do to my soil the better. The driving factor is to do a better job and improve my soil, saving money is just a help."

Simon finished the evening with

his best piece of advice for anyone considering changing their management.

"You've got to make the decision yourself, it's got to come from you, wanting to understand the soil and how it works in terms of its biology. I won't claim that you can maintain artificially high yields, it's a different way of looking at things, but I've massively lowered my cost base. Biological systems are not predictable."

Our second place farmer this year was Angus Gowthorpe, who farms 400 acres in York with a mix of arable crops and grassland for his pedigree cattle.

Angus manages a variety of soil types from blow away sand to heavy clay and has completely changed the focus of his management to concentrate on soil health to benefit the business and the next generation as well as the wider environment. Making the most away from tillage 5 years ago, he has seen the soil structure start to improve especially on his heavy land.

The first crop that the group looked at was some wheat which had followed linseed. Along with discussions on the benefits in terms of input reductions that can come with a transition to a no-till system, there was a good sharing



of experiences of the use of cover crops, as this field had had a cover crop prior to the linseed. Angus explained the process that he had gone through over the last three years of using cover crops; starting out using a basic mix of oats, phacelia and buckwheat, gradually adding other species including sunflowers, peas, millet and vetches to create a diverse mix. This cover crop was grazed by sheep and the benefits of grazing cover crops including the addition of beneficial biology through manure deposits to turbo charge the soil was discussed. While talking about livestock, Angus explained about the cattle and the wish to move towards a mob grazing system in the future to further improve soil health.

Following a look at the wheat, the group then moved on to look at a field of barley and talked about weed control, drainage, whether or not to apply gypsum and muck as well as the benefits of reduced tillage systems in the dry weather in terms of holding onto what little moisture was there. After another field of barley and more discussions about the importance of soil structure, drainage and encouraging the worms, the attendees gravitated towards the machinery and specifically Angus' John



Deere 750a. Questions around drill selection, adaptations, liquid fertiliser kits and different discs carried on for a long time along with ideas around how to take some of the ideas away and work on them at home.

Our final walk took place at Little Pix Hall Farm in Kent, which is managed by this year's third place winner in the competition, Will Steel. Will has transformed the farm into a business where soil management takes priority and is sustained for the long term. The focus of this farm walk was looking at how farming and the environment work together to create resilience, and looked at how to make the most of the assets on the farm. Will explained how getting the soils to work and be more productive was a crucial part of the long



term strategy of the business.

The farms soils were tested when it was derelict in 1987 and had a soil organic matter percentage of 5%. This dropped to 2% in the 1990s using a plough based system, and Will has been working since 2000 to increase the organic matter percentage back up to 5% using a combination of minimum tillage, no till and cover crops.

Walking round the farm it was possible to understand how the different 'assets' fit together and how the environmental features on the farm form part of the business. Stopping at a field of spring oats,

Will explained how cover crops are a key part of helping build soil health and fertility. The field had previously been down to a second wheat, with a cover crop planted immediately after the combine with an 8 way mix to maintain green cover. The aim of the cover crop is to grow fertility – it avoids the expense (and paperwork) of importing manure and the risk of compacting the soil when the manure is spread. Will terminates the crop by rolling on a frost when the temperature is minus 5 and is getting good results using this method. As with all of the farm walks, how the crops were performing in the dry weather was a hot topic of conversation, and the importance of organic matter in terms of holding onto the moisture was well recognised. Will also recognises the importance of worms (as all of our finalists do) and through regular worm

counts is seeing the numbers rise from 12 million per hectare two years ago to 15.3 million per hectare this year. He puts the increase down to the improved organic matter levels and the management of residues as well as a reduction in tillage.

As with all Soil Farmer of the Year farm walks, there is always a lot of time standing around a soil pit and this was a highlight on this farm walk. Will explained about the challenges of managing soils in this area of the High Weald, the importance of magnesium as the soils have a high calcium content, and how he is managing his 8 inches of topsoil. He is seeing the beneficial effects of changing his management including retaining the soil in the field explaining "when we were ploughing, there was a fair bit of soil erosion, the cover crops protect it over winter and you can walk out on the fields after three inches of rain without wellies, it just stays where it should."



This is a brief summary of the farm walks and the conversations, ideas and plans that were set in motion. A big thank you and congratulations to the three winning farmers of 2018 as well as our three other finalists, Simon Drury, Martin Howard and David Lord, as well as the kind sponsors of the competition, Cotswold Seeds and NRM. If this has inspired you to enter the competition next year, then the competition will open again on World Soils Day 2018 and more information is available on the FCCT website at www.farmcarbontoolkit.org.uk.

DRILL MANUFACTURERS IN FOCUS...



SELECT TOOLS FITS FOR PURPOSE FOR EFFECTIVE MINIMUM TILLAGE

The benefits of minimum tillage or no-till drilling systems are well established, and – whilst there will always be a significant role for the plough – there is no doubt having a wide range of cultivation options is important if arable margins are to be maximised.

The key point is to use the correct machine for your individual requirements and/or conditions, first understanding precisely what it is you are seeking to achieve.

Minimum tillage is as much about improving the soil and plant ecosystem as it is about saving costs. Keeping organic matter in the surface layer of the soil encourages humus development, and this in turn leads to the higher levels of micro-organism and earthworm activity that will improve soil structure and stability.

The aim must be to minimise soil compaction and ensure any crop residues are spread evenly across the field. It is then a matter of finding the right pre-drilling cultivation to create the friable, aerated and well-drained soil that is so essential to successful












ESPRO range extended

crop establishment.

With so much variation in conditions across farms, and indeed within

individual fields, UK farmers need flexible systems to achieve the best results consistently.

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Depth	Work	Machine used				Volume of soil mixed
		OPTIMER	DISCOVER DISCOLANDER PROLANDER	CULTIMER	PERFORMER	
0cm	Shallow work					
10cm						
20cm	Deep work					
35cm						

NEW FROM KUHN

ESPRO range extended

KUHN has added a 4-metre version of its combination min-till seed drill to its expanding range of ESPRO trailed machines: the new ESPRO 4000 RC is a 4-metre working width, foldable machine which enables seed placement and fertiliser application in one pass.

The ESPRO 4000 RC joins KUHN's existing line-up of trailed min-till drills which includes the 3-metre rigid ESPRO 3000, the 4-metre and 6-metre foldable ESPRO 4000 R and ESPRO



Roller option extends PERFORMER versatility

6000 R, and the foldable combination ESPRO 6000 RC.

Roller option extends PERFORMER versatility

KUHN has enhanced the versatility of its range of PERFORMER deep tine-disc cultivators by adding a new 'Double-U' roller to the range's list of optional equipment.

Already available on KUHN's PROLANDER seedbed cultivator, the Double-U roller is now available on all models in the PERFORMER range, with machines available in 3, 4, 5, 6 and 7 metre working widths.



Stubble cultivator suited to lower power tractors

Stubble cultivator suited to lower power tractors

KUHN has launched two mounted versions of its OPTIMER stubble cultivator for use with lower power tractors.

Available in working widths of 3 or 4 metres, the new OPTIMER XL 100-series machines feature two rows of independent discs followed by a roller bar which can be equipped with a variety of KUHN press wheels.

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Best regards John Gilgunn - sent April 6, 2017

“You have a great wee magazine that I look forward to receiving every quarter. I will send you some pictures of our little inventions one day and if you are ever in NZ then look me up.”
Regards Allen Collinson (NZ) - sent April 7 2017

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Many thanks Geoff Case

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Best wishes to all readers of Direct Driller *Mike Donovan*



DRILL MANUFACTURERS IN FOCUS...



ENERGY & ROW CROPS, STRIP TILL AND SOIL HEALTH, BY GEORGE SLY

A lot of the attention on no-till and zero-till is on cereal grain production and it is very encouraging as a manufacturer to see so many enquiries for our Boss drills both in the UK and Europe. Less focus is on the fresh foods we enjoy every day such as root veg, salads, potatoes, sugar beet and energy crops such as maize. All of these generally have very intensive tillage regimes as the "risk" is seen too high to venture off the beaten path.

As well as being a shareholder in Sly as an equipment manufacturer I also farm 280 hectares of clay/silt land at Gedney Hill near Spalding in Lincolnshire. We are cropping Winter Wheat, Winter Triticale (Forage), OSR, Maize (Forage), Sugar Beet and Spring Oats. All our cereals are either scratch till or no-till and are drilled with our Sly Boss 6m drill. All our row crops (Maize, S.Beet and OSR) are planted either no-till with our precision planter or behind strip-till with our precision planter. There is no ploughing or full surface deep cultivation. This means we are doing the very least amount of cultivation we can with trickier crops. We are also placing fertiliser very accurately and growing cover and companion crops.

We are pushing the boundaries of strip till technology for maize production, and we have had very encouraging results so far, I am confident we can match yield on any conventional crop on the same soil with strip till versus conventional providing it is managed correctly with significantly lower costs. 55,000Ha of maize is grown for A.D now in the UK and its vital we do this as efficiently as possible to avoid bad press. In 2019 we will try to use this same system on salads, vegetables and pumpkins in the UK.

We have a customer in Tasmania that grows 800Ha of Broccoli and Cabbages and they are now 100% using the Stripcat for tillage and fert placement. Meaning a 70% reduction in tillage to produce a large part of Melbourne and Sydney's winter veg.



Rob Wade and Joe Cook from Tasmania now grow 800ha of broccoli + cabbage using the Sly Stripcat direct into stubbles

Benefits of Strip till include:

- Up to 70% reduction in overall diesel use
- Less capital in expensive high horsepower equipment
- Up to 40% reduction in fertiliser use by placing it accurately
- Up to 60% reduction in damage by harvest traffic (a major issue with UK Maize)
- Cultivate 30% of the field not 100%, you are only tilling where the plant will grow
- Reduced run off
- Improved use of rainfall (water runs into the strip)

Image below shows the result after one pass with the Sly Stripcat 2 utilising



Sly Stripcat 2 followed by our precision planting units planting maize directly into cover crop

offset coulters to plant the interrow with a cover or companion crop. The oil radish and oats are in the inter-row and the tilled strip is where maize will be planted in 6 months time. In theory this field is being fully cultivated, half by plant and half by machine. Interestingly the radish managed to "loosen and aerate" about 20 cm deeper than the tine was running when we did a test dig in the spring.

Combining Strip till with the very latest in planter technology can ensure





Smartfirmer both firms seed into the seed trench, applied liquid starter and scans the and feeds live information to the cloud and control system

the success of the system. At Sly we are working with precision planting in the USA who manufacturer control and sensory technology for planters. Our first planters are working on my farm and my partners farm in France and we have been amazed at the performance. The

planter features:

- Row by row downforce control, even in rougher conditions on strip till our seed depth uniformity is above 95% (depth is more or as important as spacing)
- The Smartfirmer (A sensor running

in the seed trench) is monitoring organic matter, soil moisture, soil temperature and furrow cleanliness and uniformity and adjusting population and fertilisation levels on the move.

- Furrowjet is allowing us to fertilise both in furrow and both sides of the furrow whilst planting. We are giving the plant both starter fertiliser and its early-mid stage requirement and placing it with extreme accuracy.

All these small things we are monitoring by hand harvesting the crops that have been given different treatments.

The Stripcat 2 units and planter units are available from 4 to 18 rows, 2m-12m versions and from 40-125cm row spacings. They can either be together on a trailed machine or as separate toolbars. On lighter soils it is possible to combine both strip till and planting. On heavier soils it is always advised to separate the two jobs. Our planter units are expected to be commercially available from mid 2019.

We do hold open days at our farm and if anyone wants to see what we are doing we welcome visitors.

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UPCOMING EVENTS

6th - 14th October 2018	Festival of Science - www.fetedelascience.fr/
18th October 2018	Sky Roadshow at College Farm - www.sky-agriculture.co.uk/roadshows
November/December 2018	Future of Farm Thinking Conference - Small Robot Company
5th November 2018	Agri-Tech Week 2018
6th November 2018	Plant Pathogen Diagnostics: From Symptoms to Sequence - www.niab.com/shop/civcrm/event/info?reset=1&id=2881
15th and 16th November	Organic Congress
November 2018	YEN Annual Conference - http://yen.adas.co.uk/About/YENAnnualConference.aspx
27th November 2018	AHDB Monitor Farm Event - Newton Lodge Farm - https://cereals.ahdb.org.uk/northampton
28th & 29th November 2018	Croptec 2018 - https://www.croptecshow.com/
3rd & 5th December	BASE-UK hosts Professor Jonathan Lundgren, Bluedasher Farm.
4th & 5th December 2018	AHDB Agronomists' Conference - https://cereals.ahdb.org.uk/events.aspx
7th December 2018	Solebiom Conference - www.agro-transfert-rt.org/colloque-solebiom-7-decembre-2018/
18th December 2018	AHDB Monitor Farm Event - Newton Lodge Farm - https://cereals.ahdb.org.uk/northampton
3rd and 4th January 2019	Oxford Real Farming Conference - http://orfc.org.uk/orfc-2019/
8th and 9th January 2019	LAMMA 2019 - www.lammashow.com/
8th to 11th January 2019	2019 National No-Tillage Conference - Indianapolis USA - www.no-tillfarmer.com/events/185-2019-national-no-tillage-conference
22nd January 2019	AHDB Monitor Farm Event - Newton Lodge Farm - https://cereals.ahdb.org.uk/northampton
28th January 2019	Reducing the Fertilizer Budget - www.notill.org/events/reducing-the-fertilizer-budget-integrating-nutrition-and-biology-toward-plant-and-soil-health
29th & 30th January 2019	23rd Annual Winter Conference - www.notill.org/events/23rd-annual-winter-conference
5th February 2019	NIAB TAG Leek Agronomy Open Day 2019 - www.niab.com/shop/civcrm/event/info?reset=1&id=2857
5th and 6th February 2019	BASE AGM Conference at The Haycock Hotel, Wansford, Nr Peterborough.
13th February 2019	AHDB Monitor Farm Event - Newton Lodge Farm - https://cereals.ahdb.org.uk/northampton
13th February 2019	NIAB TAG Outlook Conference 2019 - www.niab.com/shop/civcrm/event/info?reset=1&id=2846
26th and 27th June 2019	Groundswell 2019 - Weston, SG4 7AL - www.groundswellag.com/

CLASSIFIEDS



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DRILLS: VADERSTAD - RAPID 400F

2001 Vaderstad Rapid 400F, X pattern Disc system drill, Fenix metering, pre emergence markers, following harrow, manual & some spares. £7950 plus VAT

Contact: 07966239436



£4900 +vat

DRILLS: SIMBA - FREEFLOW

4m simba freeflow. Good bit of kit, barn stored and kept as a backup after moving to a weaving drill. Price a guide only, open to offers.

Contact: thomaspaton@hotmail.co.uk



£13000 +vat

DRILLS: CLAYDON - CLAYDON 3M HYBRID 2010

Claydon hybrid 6 meter + Font fertilizer tank 2010 Claydon 3m Hybrid Sulky Hopper Drilled approx 250ha per season Ultron MS Metering System Simple RDS control box Leading tines new 150ha ago Full selection of A shares/

3" spoon/ long bean coulters

Depth wheel has some weld on a repaired crack

In good working order ready to go

Contact: 07966239436



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DRILLS: CLAYDON - 3M SR

Excellent condition. Carefully looked after by owner /driver since new. Stored undercover. This drill has a twin tool bar with new harrow tines on. The bushes on the pivot pins have just been replaced, so no wear there. It has a new set of A shares on. It has twin pipes feeding each coulters so beans and high sowing rates

aren't a problem, it also has the overflow valve in each line incase a pipe gets blocked, can't remember one ever getting blocked tbh though. It also has an RDS Athene controller so variable rate drilling can be done off VR plans on a SD card. Viewing welcome,sensible offers considered. Price plus VAT

Contact: 07974781170



Open to offers

DRILLS: HORSCH - HORSCH CO4 4M TRAILED DRILL

Horsch CO4 4m for sale due to change of establishment policy.

Good working order.

2007 machine. Car tyres. Pre-em marker.

Rear harrows.

Tines re-nued in last year of use.

Would suit a conversion to metcalfe/ dutch openers for a cheap entrance into direct drilling

Contact: 07854111235.



£20,000 +vat

DRILLS: CLAYDON - HYBRID 3M C/W AUTO RESET LEGS

For sale our Claydon Hybrid 3m due to change in farming policy (entered countryside stewardship which will involve drilling 80hc+ a year of grass reseed). Had a lot of success with this drill over the last 3 years but sadly difficult to justify when having to pay contractor to drill grass in. In

great condition, owned since new and only done approximately 300hectares. Auto reset legs so stones are no problem (and we have ALOT of them!) It is a 2014 production, but very late 2014 and only did one demonstration elsewhere before we took ownership and started using spring 2015. Drilled cereals, beans and rape/turnip all with success. 7inch Points/Coulter's still plenty of life left in them 70% plus, legs probably 50% so still plenty left in them and batter boards probably 50% also. Harrows new last year so plenty left in them.

As shown in photos had a crack in frame after a run in with a huge rut and going to fast but saw it early and welded and braced before any issues and absolutely fine now.

£20000+VAT. Payment must be made before any collection

and viewing preferred.

Location: Wallingford, Oxfordshire

Contact: Jim Bullen - 07717 681795



P.O.A

DRILLS: GREAT PLAINS - CDA300

Used Great Plains CDA300 Drill C/w 167 Spacing, 3000Ltr Hopper, Single Press Wheels, Turbo Coulters, Basic Control Unit, Cat 3 Cross Shaft Tramlining x2,

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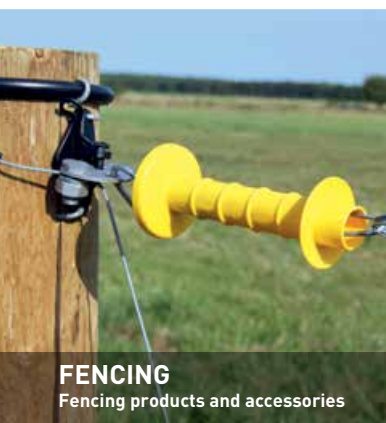
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