SUSTAINABLE CROP ESTABLISHMENT

CLAYDON

SOIL

ITS HEALTH
OUR FUTURE

CLAYDON
LOVE YOUR SOIL

LOVE YOUR SOIL

"Their soil, their future, in our hands!"

Simon Revell
Export Sales Manager, Claydon

This booklet has been produced to share with farmers information on an alternative system of crop establishment that has a substantially lower environmental footprint than traditional or recently developed methods.

Claydon Opti-Till® has evolved over the last two decades through practical experience on a working family farm in the heart of Suffolk in the east of England. It has been driven by the need to reduce costs, without affecting output, whatever the economic climate, whatever the weather extremes.

The experience gained since the initial development of Opti-Till® has enabled Claydon to help other farmers benefit from the original key driver of cost savings. As Opti-Till®'s adoption develops, many secondary benefits have been discovered. Time saving is considerable, allowing crops to be sown at the optimum time, so promoting strong and even emergence.

Major changes to the soil have become very apparent due to Opti-Till®'s strip drilling process. One major advantage is the huge reduction in soil erosion, in some cases eliminating it completely. This has coincided with the increase in soil biota, which has improved soil health dramatically, providing numerous advantages for the grower. Soil is more stable, improving drainage, difficult fields become easier to work, water holding properties have improved, plant rooting is more prolific and the soil's ability to cope with heavy axle loads has increased.

We have noticed that generally yields are the same or have increased in many cases. With some of the extreme weather we are now experiencing, many growers are reporting that Claydon established crops are coping better, whether high rainfall events or drought conditions prevail.

Reduced fuel usage and improved soil health are significant factors providing huge environmental benefits, allowing our industry to sustainably provide food for future generations.

We are only guardians of this precious resource we call soil, which has taken thousands of years to evolve, but can be quickly destroyed.

Once you have read through this publication I hope that it stimulates thought about what you are doing within your own business and brings you to question; is there another way?

Simon Revell

CONTENTS

HISTORY – FROM THE GRO

Yield-o-Meter developed and fitted to CLAAS combine

The Claydon family have been farming at Wickhambrook, in the east of England, for 6 generations. Jeff Claydon is the latest family member to take on the challenge. Jeff, being a practical man and a thinker, came up with a solution of measuring yield at point-of-harvest; the Claydon Yield-o-Meter became very popular with farmers who used it as part of their management tools to monitor yield at harvest to give them a snap shot of the field's performance.

As the family had used CLAAS combines for many years, from nearby MANNS of Saxham who have been the UK CLAAS importer since 1947, Jeff developed the first units to work on those machines but also made units available for other harvesters.

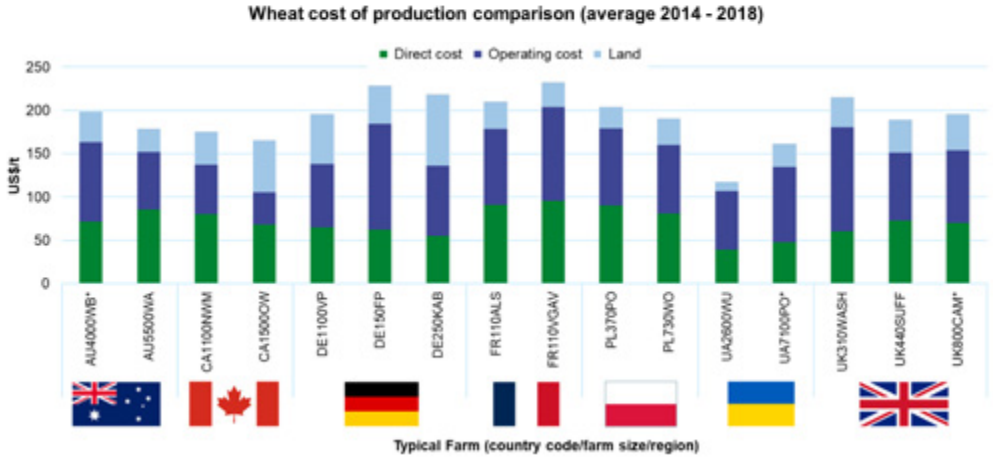
Over the years Jeff was motivated to improve efficiencies on the farm, which not only benefited the industry but satisfied the inventor in him. He took the opportunity to import plough-mounted Furrow Crackers into the UK, helping farmers on heavy land to reduce their costs.

The defining moment in the development of the Claydon business came in 2000 when UK farm incomes were under severe pressure due to low commodity prices with wheat prices averaging £60 (€67) per tonne. Jeff's main concern was how he could change the farm practice and reduce costs as crop establishment was the one area he knew could have an impact on the farm's profitability. Other areas, like harvesting and crop maintenance, would be very difficult to change without having a detrimental impact on yield – these were not viable options.

UK wheat production costs amongst highest

AHDB

agri benchmark



UND UP

Direct drilling solutions

After much thought and research Jeff realised what had been the shortcomings of previous attempts at direct drilling over the years which always seemed to gain short term popularity when commodity prices were low but very quickly lost favour due to weather, soil conditions and various agronomic challenges which invariably had a negative effect on yield.

Ideas started to form about the approach to a solution, a key consideration being what was best for the plant through its growth stages and how to cope with the changeable UK weather patterns. A reliable system was required to establish the crop ensuring there was no detriment in yield. Crop rooting is one of the key drivers to optimising yields.

Exceeding expectations

In 2002 the first prototype was developed. After a number of changes the first unit was built and sold for the autumn of 2003. This worked even better than expected, so much so that it was decided to officially launch at the LAMMA show in the following January of 2004.

Although the aesthetics of the field initially were very different from what many were used to seeing, particularly in the autumn, success was forthcoming as farmers quickly realised the benefits the drill could bring to their businesses.

The family farm has since had little if any cultivations other than the TerraStar shallow cultivator working to a 30 mm depth.

The workability of the soil and the reduction in diesel consumption are two of the many benefits the farm has seen since direct drilling began.

Much was said from many quarters at the time, that it wouldn't work, yields would drop and the often heard comment "not on my land." These are still heard even today, but have been proven wrong as an increasing number of farmers discover how the Claydon seeder and the Opti-Till® system really do benefit their businesses.

THE IMPORTANCE OF SOIL HEALTH

"Agronomic advisory companies and analytical services are beginning to develop products that can help farmers who want to study and monitor their soil health, but apply these with care as we have still got much to discover in the world beneath our feet."

Dr Elizabeth Stockdale
Head of Farming Systems Research
NIAB, Huntingdon Road, Cambridge

Dr Elizabeth Stockdale is one of a group whose practical approach to soil is helping us understand what farmers should be considering to change their approach to crop establishment.

Increasing awareness

"In 2015, The International Year of Soils was designed to pull together all aspects of the industry and governments to understand and focus on this fundamental resource that humanity relies on to live.

Scientific understanding of what resources are available in the soil, and how they interact to contribute to soil health, has accelerated in recent years focusing farmers, farming bodies and governments on just how important care of the soil is to sustainable food production. However we have just touched the tip of the iceberg!

Understanding soil

A healthy soil is one that can support crop and livestock productivity. It also maintains or enhances environmental benefits, such as clean water, carbon sequestration, improved air quality. In healthy soils, the interactions between chemistry (pH and nutrients), physics (soil structure and water balance) and biology (earthworms, microbes and plant roots) are optimised for the particular conditions in that place. Agronomic advisory companies and analytical services are beginning to develop products that can help farmers who want to study and monitor their soil health, but apply these with care as we have still got much to discover in the world beneath our feet.

Here I'll focus on the physical and biological interactions that underpin cultivation decisions. It is important to recognise that steel, roots, organic matter and soil organisms work together to maintain good soil structure. There is no single magic bullet (or machine).

Good soil structure increases the window of opportunity to seed at the right time. It also minimises tillage costs in terms of tractor hours, number of passes to prepare a seedbed and size of tractor and implements required.

Soil structure is the architecture of the soil and is usually described by the size, shape and stability of units (aggregates) in which the individual particles (sand, silt, clay and organic matter) of the soil are held together. The pores between these aggregates control the balance of oxygen and water available to plant roots and soil organisms.

What is well-structured soil?

A well-structured topsoil has small, rounded, water-stable aggregates and a range of pore shapes and sizes that form a continuous network, allowing good aeration, root proliferation and better drainage. Plant roots and some soil organisms (such as earthworms) change the structure of soil by moving through the soil, moving soil particles around and extracting water. Supporting the biological processes of structure formation and increasing soil organic matter content have been shown to help create resilient soil structures that can both absorb heavy rainfall and hold water in drought; however, the details of the mechanisms supporting structural resilience are still not yet fully decoded by scientists.

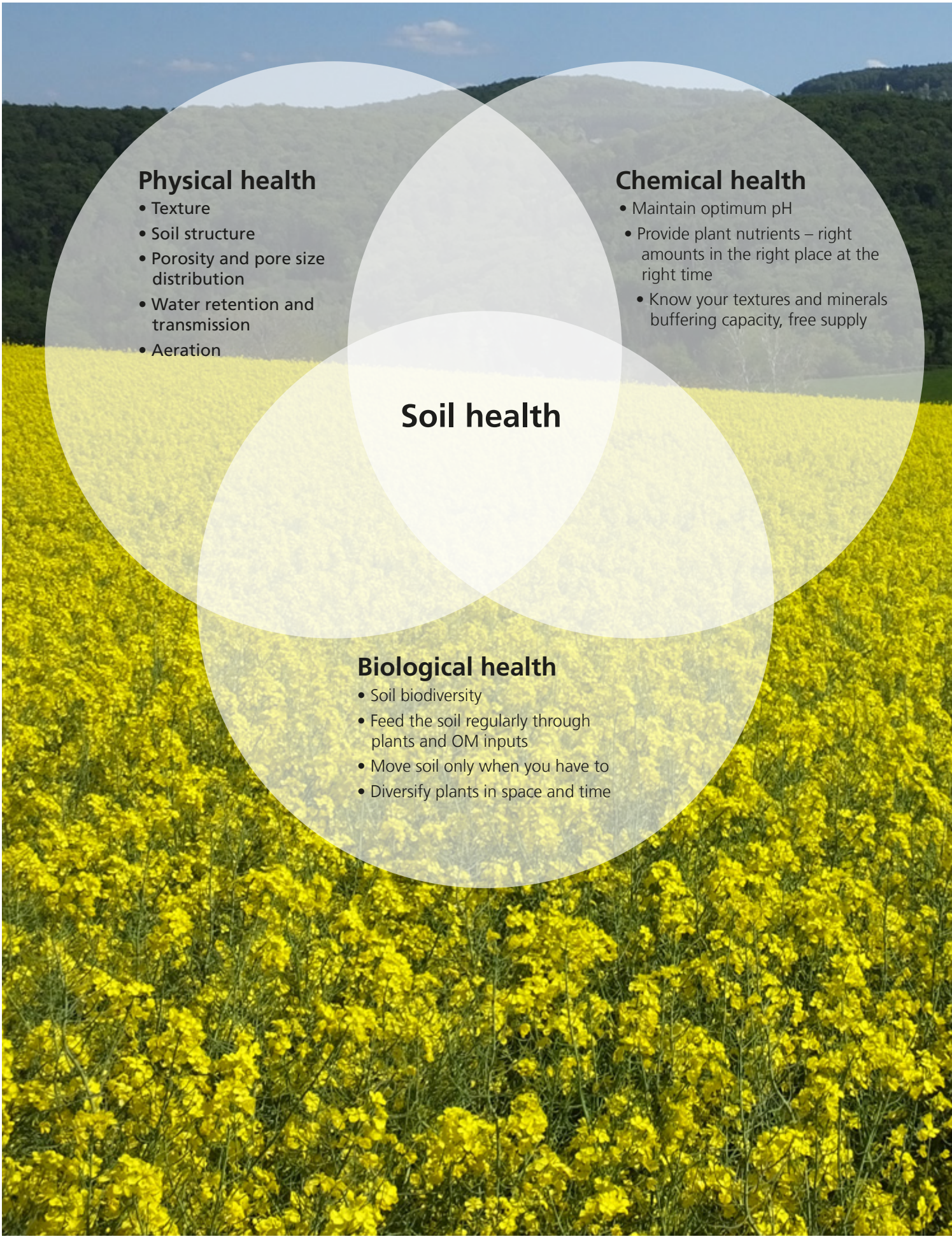
A well-structured subsoil has vertically orientated, often continuous pores and fissures which are formed by physical shrink-swell processes and then maintained by root and earthworm action. Between these pores, the soil forms column-like structures; in clay subsoils these may be single prismatic aggregates. These columns give the overall soil profile strength to bear the weight of machinery etc. Such soils are resilient and can better resist damage by compaction. Cultivations need to be carried out with care to avoid weakening any natural column strength.

A good way of seeing for yourself what your soil looks like in good physical condition is to look at untrafficked soil beside a hedge. Usually this gives a glimpse into what an undisturbed, biologically-structured soil of the same soil texture could look like. Equally, if you want to see for yourself what your particular field soil looks like when damaged, look in gateways and some headlands – it is always possible to find such spots. Because soils are highly variable in the landscape, comparing your soil with that seen on field visits or open days is not as useful as having a look on your farm. Examining soil physical structure should be done when the soil is in the moist to wet range – so early spring and late autumn are good times to get your spade out and have a systematic look.

Reducing tillage benefits soil biology

Recent analysis of data collected from a number of research studies has shown that reductions in tillage intensity have benefits for soil biology with marked increases in the larger invertebrate species, especially deep burrowing (anecic) earthworms, where inversion tillage is removed from the rotation. Tillage has much fewer direct effects on smaller soil organisms – however, tillage can have significant indirect effects on the soil habitat which will then affect the soil organisms. By its nature, tillage changes pore structures potentially increasing large pores in the surface but reducing connectivity to depth.

At the same time, aeration is increased (at least for the short-term), crop residues and roots are mixed and blended with the soil and organic matter held within aggregates is potentially exposed to decomposers. All these effects mean that tillage is commonly observed to give a short-term stimulation to decomposition and mineralisation processes with a consequent release of plant-available N (as well as S and P to a lesser extent).


Physical health
• Texture
• Soil structure
• Porosity and pore size distribution
• Water retention and transmission
• Aeration
Chemical health
• Maintain optimum pH
• Provide plant nutrients – right amounts in the right place at the right time
• Know your textures and minerals buffering capacity, free supply
Soil health
Biological health
• Soil biodiversity
• Feed the soil regularly through plants and OM inputs
• Move soil only when you have to
• Diversify plants in space and time

THE IMPACT OF CULTIVATIONS

The impacts of cropping systems–level innovation (tillage, crops, rotations) on productivity and environmental resilience can only be investigated over the medium/long-term and hence long-term multi-factorial trials have a crucial role. In AHDB-funded work (now reported in AHDB Final Project Report 574), NIAB has been working together with a number of collaborators to use existing long-term experiments and new focused studies to look at the changes in soil structure resulting from adoption of different tillage regimes and the use of a range of organic amendments, including farmyard manure, crop residues, compost and cover crops.

The project sites were:

- Several of the very long-term experiments at Rothamsted – Broadbalk, Hoos Barley, Woburn and some more recent (since 2013) organic amendment trials (Fosters, New Zealand)
- James Hutton Institute's Mid-Pilmore platform established on a sandy loam soil in Perthshire in 2003, contrasting five different soil management treatments
- NIAB's New Farming Systems project established in 2007 on a sandy loam soil in Norfolk, contrasting three soil management treatments funded by the Morley Agricultural Foundation and the JC Mann Trust
- NIAB's STAR experiment established in 2005 in Suffolk on a clay loam soil, contrasting three soil management treatments funded by the Felix Thornley Cobbold Trust and the Morley Agricultural Foundation

Trial results

Trial results on these sites showed that yields with non-inversion tillage were marginally lower than yields with ploughing, but when decreased costs of labour and fuel were factored in, gross margins under non-inversion tillage were better than under ploughed systems. Hence non-inversion tillage is advocated under 'normal' conditions. At these research sites, soil physical conditions in all treatments were well below optimal and in many instances restricted root proliferation. In soils under non-inversion tillage, we sometimes found large improvements in soil physical conditions over a growing season driven by the growing crop. Where there were no changes in the organic matter inputs, there were no gains in soil organic matter under non-inversion tillage (compared with ploughed systems). Where there were large annual additions of carbon (as compost in these trials), the amount of organic matter (and hence carbon stored) in the soil was increased irrespective of the tillage operation."

Dr Elizabeth Stockdale

OPTI-TILL® EXPLAINED

Since product launch, experience has shown that the Opti-Till® system delivers excellent results even though it is surprisingly simple. It comprises just four machines: the Hybrid drill from 3m mounted units to 8m trailed machines; the straw harrow was quickly added to the system once it was understood how effective this could be with residue management. As volumes of residue have increased, along with the need to incorporate organic matter, the TerraStar was developed. Finally, the TerraBlade inter-row hoe was added to the system as a tool which offers mechanical weed control.

So, let's look at the various elements and how they fit into the programme of Opti-Till®, when they should be used ideally and what to expect, with advice on the dos and don'ts.

Harvesting

Combine harvesting is crucial to successful establishment of the next crop. Stubble height ideally needs to be 12 to 15cm unless crop and field conditions require otherwise.

Particular attention should be made to the chop of the residue. This ideally wants to be as short as the chopping mechanism of the harvester will allow.

Chopper blades need to be checked regularly and turned when blunt. Remember a blunt blade requires more power, burns more fuel and does not chop the straw short enough. A good tip is use blunt blades for crops like oilseed rape and new blades for cereals.

Drive belts to the chopper, if used, should be set at the correct tension so maximum transfer of drive is achieved to the chopper and spreader.

Chaff and seed pods must also be spread as far and as evenly as possible; this will help reduce concentrations of this part of the harvested plant which can have an influence on establishment and which, in high concentrations, provide an ideal habitat for slugs to proliferate. Again, settings, drive belts and directional vanes need to be maintained.

Straw Harrow

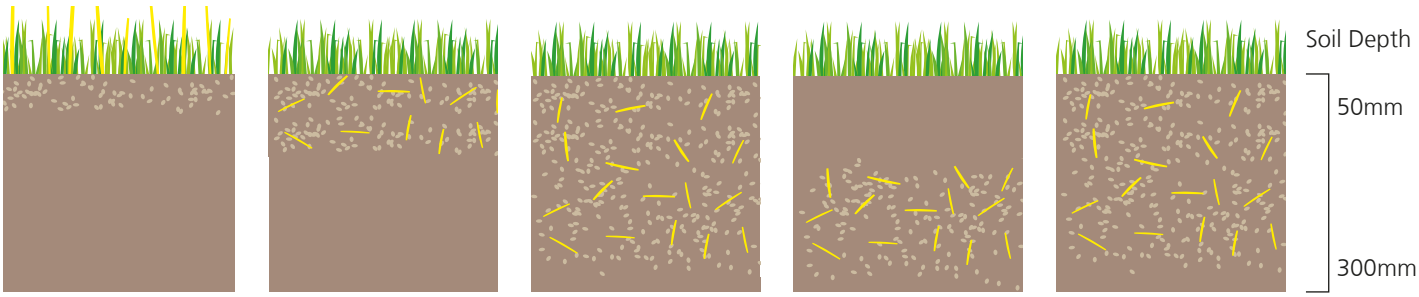
We would expect the straw harrow to follow within hours or days after the combine so preserving any moisture in the soil. It should work no more than 20-30 mm deep running at a slight angle to the direction of seeding. The harrow has high output and is effective at speeds of up to 25 km/h.

This provides several benefits –

- A mulch is formed over the soil surface minimising moisture loss.
- Weed seeds and harvested crop seeds (volunteers) are mixed into the soil surface providing the ideal environment for them to germinate.
- Straw is lightly mixed into the soil so starting the breakdown of the residue.
- Concentrations of straw and chaff are spread across the surface creating an even distribution again benefitting the next operation. This also ensures that any concentrations of residue are spread reducing conditions for slug nests.
- Any slugs eggs are exposed to the sun/light, destroying them as well as disrupting and destroying their habitat.
- The straw harrow is a very effective weeder, destroying weeds and volunteers that are encouraged to grow from the previous pass. We sometimes carry out up to 4 passes on some fields and will even straw harrow post seeding if necessary.

Harrowing is fast and effective at destroying weeds...

...and encourages another flush to germinate.



Claydon Stubble Management

Claydon Stubble Management provides a fast establishment of weeds and volunteers by retaining the soil's moisture and mixing the seeds in the top 30mm of soil.

Shallow 'min till'

Shallow 'min till' cultivations will usually move the top 100mm of soil creating a cloddy, dried-out seedbed which will typically produce inconsistent germination with weeds germinating all autumn.

Deep 'min till'

Deep 'min till' cultivations will mix weed seeds throughout the soil profile to a depth between 200mm - 300mm, creating weed germination all year and an unmanageable weed profile.

Plough

Rotational ploughing will turn weed seeds deep into the soil and bring up clean soil provided it's used in conjunction with the full Claydon direct system the other years.

Plough every year

Ploughing every year will turn in weed seeds but also mix them throughout the soil profile and lift weed seeds from depth, giving an uncontrollable seed profile.

Weed Control

An integrated control of weeds using the straw harrow shallow and directly following the combine has found to be very effective. Working at an angle and using the specially designed tines to move the soil across the working width of the machine has been found to encourage volunteers, grass and broadleaved weeds to germinate. Subsequent passes destroy the germinated growth without the need for chemicals.

Tests carried out by Claydon have found the frequency of the following passes is crucial to controlling weed flushes with this method. Timing is key – every time new shoots or growth appear, usually 7-14 days, depending on moisture. This ensures the plants do not get too large and the harrowing works effectively.

Only cultivating the top 30 mm of soil eventually diminishes the seedbank providing that seed return is kept to a minimum.

The cost of harrowing four times with a 15m Straw Harrow is very roughly the same as a full recommended dose of glyphosate which does not have the added benefits of the straw harrow previously mentioned.

In warmer climates it has been found that the straw harrowing effect, creating a mulch of crop residue over the surface, insulates the soil against evaporation. This preserves valuable moisture, greatly aiding germination in particular for early seeded plants like cover crop and oilseed rape.

If there are very high levels of crop residue, or manure is spread on the field, then the TerraStar® offers a solution without destroying the soil profile. It will cultivate deeper than the straw harrow leaving divots in the soil. The design of this two rotor machine cultivates just enough to incorporate residue into the soil whilst leaving soil structure undamaged. The divots in the soil created by the TerraStar® also inhibit erosion, particularly on hillsides.

Soil structure remains unaffected by the divots created by the TerraStar®

TERRABLADE

Experience has shown that the TerraBlade can be driven at speeds between 8-12km/h. It can be used quite late in the spring in favourable conditions, even when the crop is at growth stage 32.

In-crop weed control

A benefit of the strip drilling method of Opti-Till® allows us to weed between the rows using the TerraBlade inter-row hoe. Due to the banded seed row, and the distance from the edge of each seed row, we can effectively and very easily destroy weeds growing between the rows.

This provides a very cost-effective method of mechanical weed control. Using the tractor's front linkage this simple tool has proven itself as part of an integrated weed control system. The simple one-piece specially designed tines cut the weeds off just under the crown of the plant killing the weed with minimal soil disturbance.

Another benefit of inter-row hoeing is the mineralisation effect of residual nitrogen giving the plant a boost.

The TerraBlade is a surprisingly versatile machine that is vastly underrated but can form an important part of the Opti-Till® system depending on the farming operation and the topography of the farm.

The TerraBlade is also very effective at destroying larger weeds, making it the ideal tool for organic and traditional farmers.

SEEDING WITH THE CLAYDON HYBRID DRILL

Timing

Again, with almost all operations, timing is key remembering that cultivations previously carried out become redundant unless soil restructuring to depth is required and if conditions allow for the operation to be completed successfully.

The Claydon drill is designed as a direct drill. If you are to gain the best from the system, any cultivations carried out beforehand should be shallow – no more than 40-50 mm.

Optimum timing, suiting your own conditions, seed variety, soil, climate and area need to be considered including the situation with resistant weeds that may be problematic.

Operation

Whether a mounted or trailed drill is used, some simple rules need to be remembered to obtain the best from the drill. Firstly, the Hybrid drill has a minimum power requirement of 50 hp per metre. This may well reduce as the adoption of the system increases and the behaviour of the soil changes due to the benefits of using Opti-Till®.

It should be noted that the recommended forward speed for best results and good output is between 10-12 km/h.

It is important that the drill is working level whether mounted or trailed so that the seeding depth is the same front to back. The leading tine can be set independent of the seeding depth allowing the optimum cultivation depth to suit the crop allowing the roots to develop unimpeded. This is vital at the start of a plant's development. The leading tine also breaks up any shallow compaction reinstating the water and air balance into the soil providing good drainage so water can get away from the rooting zone. This eliminates ponding through the later autumn and winter period.

The seed is spread across the working width of the A-Share used, various widths are available, using a higher percentage of the field so encouraging the plants roots to scavenge more of the soil utilising nutrients and moisture more efficiently.

SEEDING WITH THE CLAYDON HYBRID DRILL

Fig1

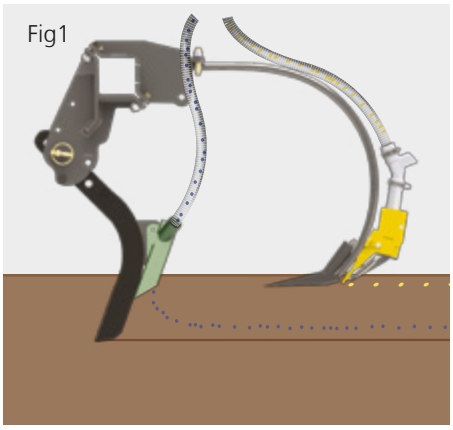
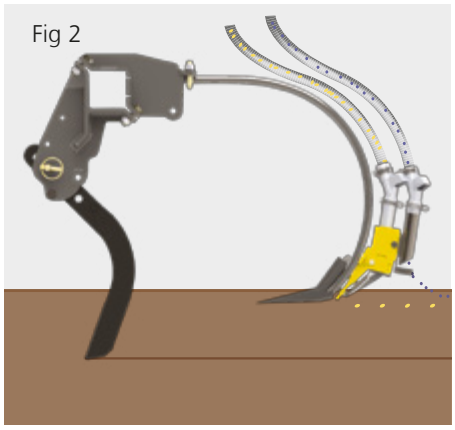


Fig 2



Fertiliser

Fertiliser can be applied with the seed Fig 2 or can be applied with the leading tine Fig 1 at a greater depth or using both options combined.

Large seed hoppers allow high volumes of seed and fertiliser to be carried so downtime is kept to a minimum.

Root development

We know that root development is so important to yield. Independent trials have shown that a greater root mass before the winter shutdown is crucial to yield for winter crops but equally important for spring crops so they can establish and grow away quickly.

The seed is placed on firm soil either side of the leading tine (darker area in the middle of the row below). The leading tine creates micro-fissures providing drainage, aeration and rooting paths crucial to the plant's development.

Levelling the field

Due to the Hybrid's design, fields become level over time as cultivations are eliminated (full cultivation practices generally cause unevenness in the fields). The A-Share seeding coulter design not only provides consistent seeding depth it also does a fantastic job of levelling the fields.

Another major benefit of Opti-Till® is the natural structure of the soil is not destroyed by cultivations so soil density remains consistent through the profile. This ensures the natural capillaries are not damaged allowing water infiltration and unimpeded rooting at all times minimising crop stress at any time during its life cycle.

Zonal cultivation

The zonal cultivation design of the leading tine and seeding coulter provides targeted seeding, so rooting is encouraged but earthworm burrows and old rooting pathways are left. The natural structure of the soil is kept in its optimum state benefitting the crop and improving soil health.

We have noticed over the years how farms that have adopted the Opti-Till® System benefit from an increased capacity to support traffic in the field. The increasing demand for higher output harvesting machinery is constantly pushing up the weight of those machines so load-bearing pressure on the soil goes up proportionally.

Tramlines on the Claydon farm and on customer farms are typically much shallower than they used to be when more intensive cultivations were used. Full cultivation of soil upsets its natural structure and changes its density allowing tyres to compress the soil increasing the likelihood of compaction and deeper tramlines.

Crop performance

Headlands usually suffer some yield loss in conventional cultivation. This is eliminated with the Claydon Hybrid drill; the leading tine action and the pillars ensure that crop performance is the same on the edge of the field as it is in the centre of the field.

The drill has the capability of seeding a wide variety of crops from oilseed rape, poppies, linseed through the cereal spectrum including sunflower, soya, peas, maize and beans. Notable successes are establishing soya directly into green crop barley stubbles in Italy then seeding winter wheat directly into the soya stubble. This is producing very good yields from both crops but also saving the grower in time and cost.

We are also finding benefits when using the seeder to establish maize for silage and anaerobic digestion plants in many areas. Again the benefits are substantial with secondary advantages of higher starch and less cellulose in the harvested crop.

▲ *Soya* ▼ *Maize*

OPTI-TILL® – GETTING OFF TO THE BEST START

"If you are unsure how to identify problems in your soil, contact an expert soil specialist or ask Claydon for advice."

Simon Revell
Export Sales Manager, Claydon

In the last 20 years an increasing number of growers have found multiple benefits when using the Opti-Till® system – and not just the obvious cost and time savings.

In the following pages we explain what to look out for and the secondary benefits of adopting Opti-Till®, to help you gain the maximum from our and other farmers' experiences. Claydon endorses absolutely that we have to preserve the resource that we are all fortunate to work with, wherever you are farming – that is the soil.

Soil condition to depth

Cultivation pans can occur at various depths (P1) and in certain soil conditions. They are usually formed by continuous cultivation at the same depth over a period of time, cultivating when the soil is over-moist or the design of the soil engaging parts of the cultivator causing problems.

A very important issue that many overlook when ensuring maximum benefit from the Opti-Till® system, is their soil structure to depth. This must be checked. If any compacted layers are present then remedial action must be taken. As with any establishment system, irrespective of what type is used, good soil structure to depth (P2) is one of the fundamental requirements allowing any given hectare to perform to its optimum.

There are some observers that believe that roots will repair soil damage alone and yes, several plants do have powerful roots that can penetrate thin layers of compaction. If cover crops are used for this purpose then consideration has to be given to the depth and thickness of the compacted layer as the plant may not have the strength or the time to develop its root structure to depth to break through the compacted layer. It may well mean that a subsoiler needs to be used, although choosing the right subsoiler with the correct tine design is vitally important.

Getting the foundations right

Making sure you have the correct drainage in a field is vital to any establishment system.

Using a subsoiler with a straight low angle tine will ensure the soil profile is left in its zones so the topsoil and subsoil are not mixed.

Soil is fissured from depth with minimal surface disturbance so moisture is retained. This ensures clods are not formed from the subsoiling pass creating the need for extra remedial cultivations.

Benefits of good drainage

by Rob Burtonshaw

www.claydondrill.com/soil#drainage

Choosing the right subsoiler

by Dick Godwin

www.claydondrill.com/soil#subsoil

Aggressive tines mixing subsoil with topsoil can have detrimental effects on the crop

Soil structure research over the past thirty or so years has established that cultivation destroys soil structure. For example, Havlin et al. (1990), Haines and Uren (1990) and Pankhurst et al. (1995) showed the inversion of soil and resultant exposure of roots and the soil organisms to desiccation and ultra-violet light irradiation removes the structure building and stabilising effects of organic matter and a substantial proportion of populations of earthworms and other forms of macro- and micro-organisms living in the soil.

Identifying compaction in soil

Ascertaining where to set the subsoiling depth requires investigation.

A soil pit should be dug deep enough to see below the depth of recent primary cultivation, being mindful of the drain layout. You should be able to see the soil profile and the rooting of plants from both current and previous plants. These are good indicators and will show if there are any problems.

Many will investigate the soil with this method after the harvest has been completed when soil conditions are very dry. This makes it very difficult to identify the compacted layer, if there is one. Investigations should take place in the late autumn or spring when soil humidity and fresh rooting takes place.

If you are unsure how to identify problems in your soil, contact an expert soil specialist or ask Claydon for advice.

▲ ▼ *Good soil structure promotes deep and healthy rooting*

Monitoring your soil

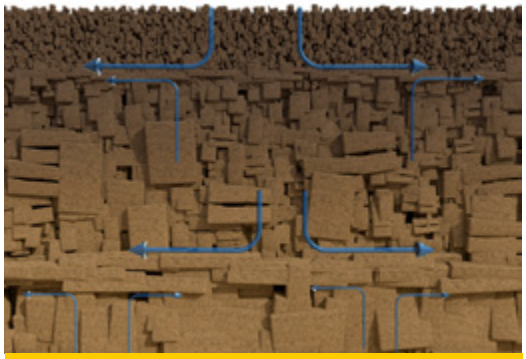
Powerful rooting plants can reset the soil structure in areas which don't have thick compacted layers. Where a double layer of compaction is found, using power and steel is more often the only way to reset the structure and start from the best position possible.

Cover crops help improve soil structure

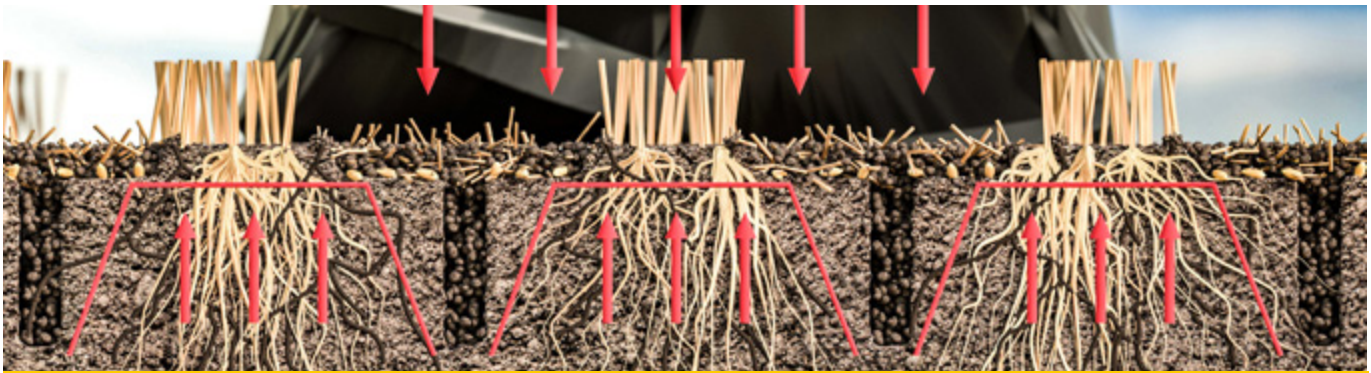
You cannot afford to wait for compaction to happen. You should be aware of what is happening to your soil at all times of the year. We have found, as have many of our customers, that once the soil is reset and the Opti-Till® system is used correctly, the requirement for deep remedial cultivation is almost eliminated unless extreme conditions are experienced during the harvesting operations.

Certainly, using Opti-Till® the carrying or trafficking ability of the soil is greatly enhanced, and the permeability of the soil is improved due to the action of the strip-seeding. As worm numbers increase then aeration and drainage improve allowing the soil naturally to cope with high precipitation.

Good soil structure allows unrestricted rooting and water movement through the soil profile



Poor soil structure with density changes or compacted layers restricts rooting and water movement indicated by the blue arrows



The Claydon's zonal cultivation leaves soil structure intact which helps the field support following traffic

Soil erosion

Opti-Till® has been shown to practically eliminate soil erosion in many regions. Recent studies have shown that where intensive cultivations are practised erosion is a major problem and, in some cases, with heavy precipitation events occurring more often, severe erosion results. It is a fact that agricultural soil is eroded year on year, the extent depends on topography, cultivations and soil type.

Neighbouring fields in France: conventional tillage (left) vs Claydon (right)

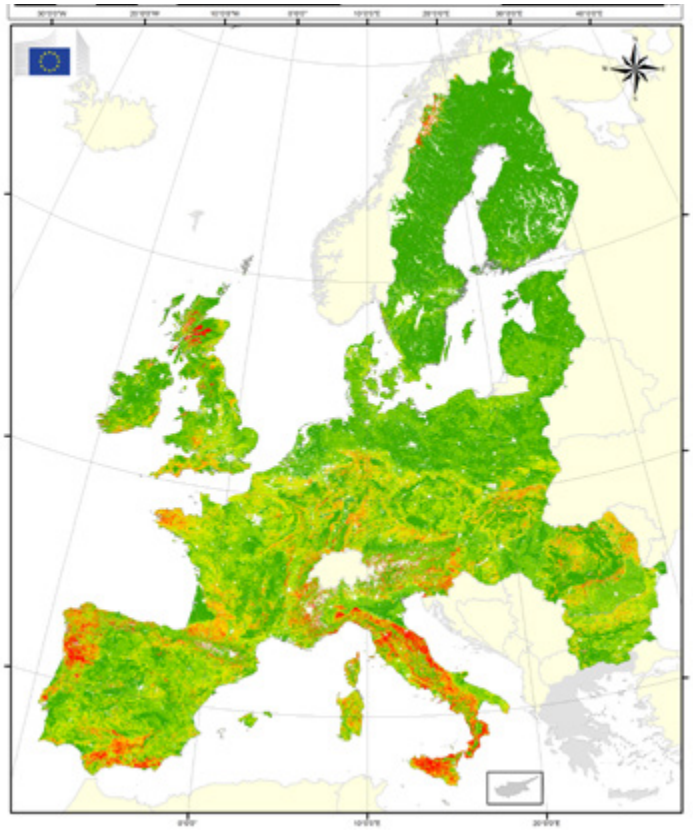
European Soil Data Centre

Studies by the European Soil Data Centre (ESDAC) confirm that no tillage reduces soil erosion occurrences by 19% with min-tillage lower than conventional tillage practices. A combined crop management scenario which incorporates cover crops (in order to protect bare soil against storms in winter and spring) and leaving the crop residues on the field resulted in a 35% reduction in soil loss in the Belgian loess belt (Verstraeten et al., 2002).

Over-cultivation of soil can result in wind erosion, particularly in the spring

Soil erosion under conventional tillage in Suffolk, UK

Erosion by water in Europe

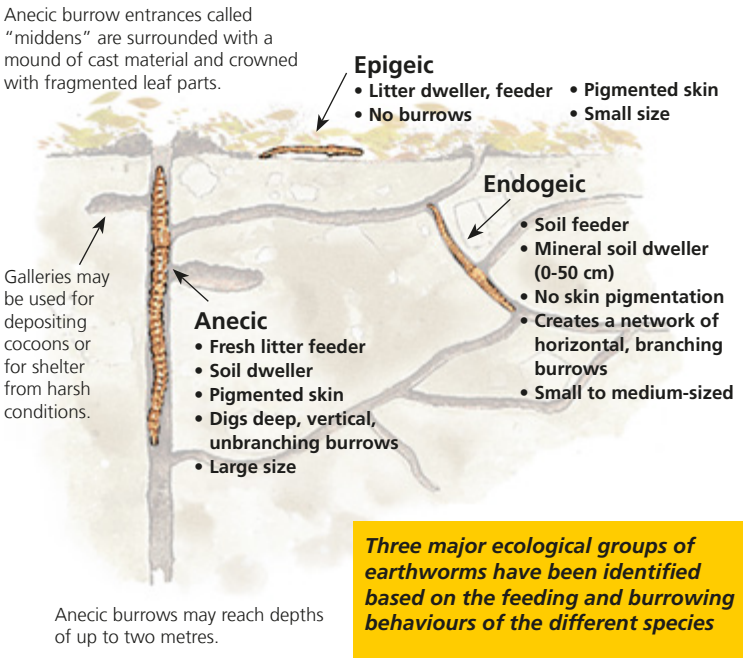


Erosion by water 2006.

Tonnes/ha/year

<0.5	10-20
0.5-2	20-50
2-5	No data
5-10	outside coverage

Earthworms in the ecosystem



Three major ecological groups of earthworms have been identified based on the feeding and burrowing behaviours of the different species

The importance of worms

Healthy soil is another major benefit of the Opti-Till® System. By only cultivating the seeding zone the natural processes in the soil begin to prosper with crop residue on or near the surface. Earthworm numbers increase, in particular the anecic type, which are the deeper working vertical labourers creating natural small labyrinths of tunnels. These channels aid aeration and drainage providing passageways for roots to proliferate deep into the soil and break it down. They work alongside their endogeic cousins, who shallow work the soil horizontally. This broken down residue provides further sustenance to the many forms of soil biota that start to increase as the soils are disturbed less.

Stabilising soil

Ageing of soil after disturbance increases its water stability and its ability to resist mechanical stresses. The binding together of soil by roots and fungal hyphae can also induce stability, as can the exudates from roots and other soil organisms. Roots are particularly important because of the biopores which they leave when they decay. Biopores (comprising root channels and earthworm tunnels) can provide important pathways for root penetration of subsequent crops. (Et al. Dexter).

Where has all the straw gone?

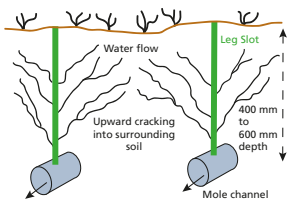
The picture below shows how worms harvest the crop residue. This field was straw harrowed twice the previous autumn following a 10.9 tonne crop of wheat. This picture was taken the following April just before it was drilled with oats. The worm middens can clearly be seen.

The complex interaction between the soil's extremely diverse forms of fungus, bacteria and other microorganisms (including other minute animals) and the exudates from the roots of all plants (whether seeded or volunteers) create the ability for the soils health to improve providing multiple benefits.

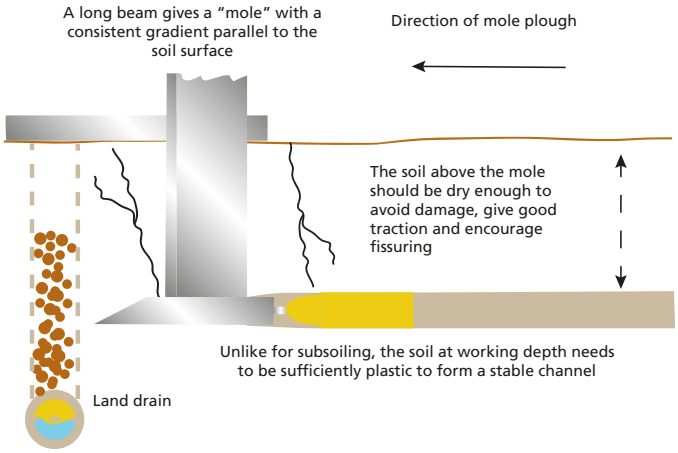
On our own farm in Suffolk, for example, our heavy Hanslope series chalky boulder clay has never been in such good condition. There have been no deep cultivations on the farm for 18 years resulting in high yields and very low fuel consumption.

Mole ploughing

Mole ploughing is an important soil management operation on heavy soils. It creates semi-permanent drains when field conditions require it. It is crucial that mole ploughing is carried out at the correct time of year when soil conditions are suitable.



Appropriate conditions for forming a mole drain



Strip till banding generates strong growth and improved tillering

Slake test is proof

Soil specialist Dick Neale (from UK agronomy group Hutchinsons) carried out a simple slake test to assess the health of the soil on the Claydon farm. He compared it with soils of the same type farmed under a traditional cultivation regime.

Healthier soils are proven to be able to withstand extremes in weather and help crops produce optimum yields whether high humidity or drought conditions are experienced during the life cycle of the plant. The workability of the soil is vastly improved providing wider weather windows for seeding. This allows optimal timing, benefitting crop germination and emergence.

Dick Neale uses blue dye to assess the deep water infiltration on the Claydon farm's heavy clay soil

"After 16 years of developing the Claydon Opti-Till® system, the soil structural condition and health here at the Claydon Farm are testament to the system's success."

The structure in particular is among the very best I have seen. These are strong, sandy clay soils, but they now have remarkable water infiltration rates, rooting depth and drainage due to the high porosity, low bulk density and abundant earthworm populations resulting from the tillage technique employed. The natural aggregation, worms and invertebrate activity are all indicative of good biological health."

Dick Neale

www.claydondrill.com/soil#slaketest

Ploughing

Ploughing either heavy or medium to lighter soils creates increases in cost, extra cultivation passes, wheelings and moisture loss. Other issues caused by ploughing include releasing CO_2 (depleting soil organic matter), mineralising N and destroying soil micro-organisms. Mixing sub-soil into the topsoil can have detrimental effects on crop performance as images P1 and P2 show.

P1

P2

Drill into stubble for optimum soil health, cost benefits and fuel savings

COVER CROP

Jérôme Vasseur,
International Sales Manager, Jouffray Drillaud

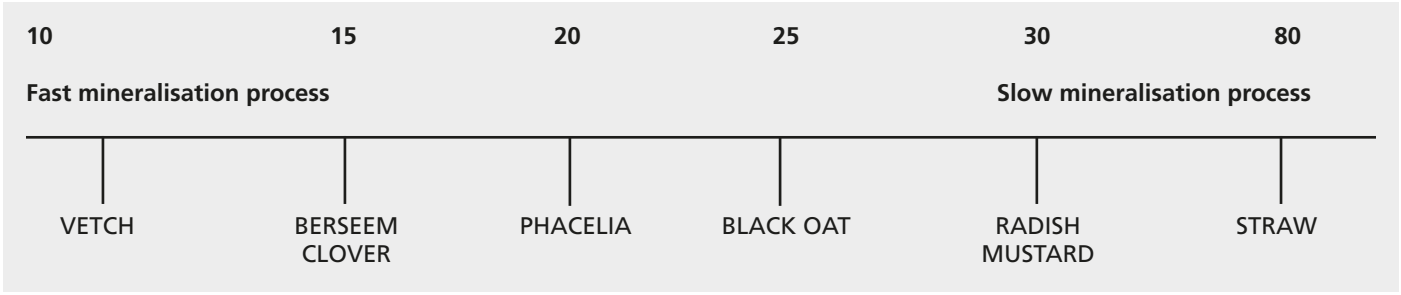
Why consider cover crop?

- **To trap fertilisers during the autumn and winter period and avoid nitrogen leaching**
- **To colonize the ground and leave less free space for weeds**
- **To improve soil structure through root action**
- **To release nitrogen and other nutrients for the benefit of the following crop. Up to 30 kg of nitrogen / ha can be released by the cover crop for the next crop.**

KEY SUCCESS FACTORS

Breakdown ability

"The cover crop is not going to be harvested. It will be destroyed (mechanically, chemically or by frost) and will then start to break down and release nutrients gradually (N, P, K, etc) for the benefit of the next crop. The mineralisation ability of the cover crop can be measured through its C/N ratio:



Legumes have a low C/N ratio, which means that they provide a strong green manure effect on the following spring crop.

Biomass

The more biomass you can achieve with your cover crop, the greater the benefits.

Considering the late sowing date of cover crops (end of summer) and the short period of time for the growth of the cover crop, very early species and varieties should be considered. 3 to 5 tons of dry matter per ha should be reached.

Within each species, there are significant growth rates between early and late varieties.

Using early varieties is a way to obtain a fast crop establishment and produce a large amount of biomass.

Note: the earlier the variety, the better it is.
There are 2 exceptions to this rule :

- Black oat (avena strigoza)
- Mustards and radish

These species are naturally very early and in such cases, later varieties should be chosen in order to avoid volunteer issues.

Companion cropping

Why not sow the cover crop inside the main crop? This is what we call companion cropping by establishing frost-sensitive legumes inside the oilseed rape as shown in the above picture. Weed control, soil structuring effect, nitrogen release in spring when the oilseed rape needs it, there are plenty of good reasons to companion plant."

Jérôme Vasseur

Last but not least

Although the cover crop is not going to be directly harvested, it is important to carefully consider the drilling technique in order to get a good cover crop establishment.

Many farmers are using the Claydon drill to establish cover crop in the summer/autumn providing excellent establishment and then seeding the commercial crop in the spring with fantastic results. One grower in Bulgaria uses this method and then plants his maize direct with a precision planter directly into the seedbed following the cover crop established with the Claydon 8m drill. This preserves valuable moisture as well as reducing costs, the maize benefits from the soil structure and nutrient availability from the cover crop enhancing yield.

An important point to remember is you do not want to use a cover crop species that

a) becomes a weed.

b) is of the same family as your commercial crop as disease carry over could become problematic.

c) creates an issue in the spring with high amounts of residue if you are in a cold or traditional climate that suffers with high spring precipitation. Attention should be given to the desiccation of the crop, if frost does not destroy it over winter, and the timing of the desiccation, allowing the field to dry before seeding.

TYRES

COMPACTION. FUEL CONSUMPTION

MICHELIN

"Tyre pressure remains one of the most, if not the most, important factors. "

Gordon Brookes

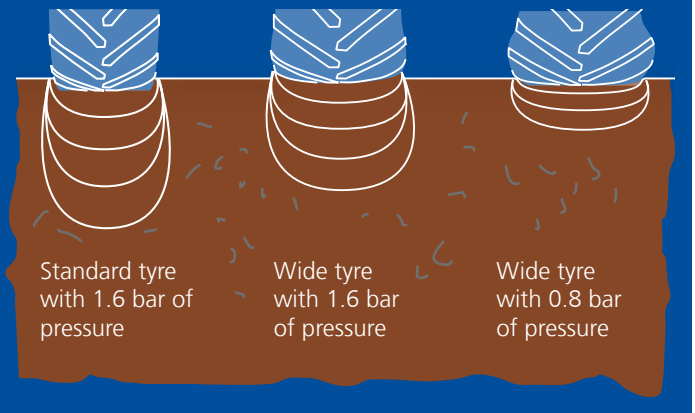
Europe North Zone – OHT
Customer Engineering Support Manager

Correct tyre pressure and its impact on the soil

For a tyre used both in the field and on the road, 1.6 bar of pressure is generally used. However, this pressure is often too high in the field. Because high pressure reduces the tyre's contact patch, it leads to wheel slippage and soil damage due to compaction.

Using twin tyres or wide tyres provides a bigger contact patch, improves traction and reduces pressure on the soil.

Contact patch and soil compaction



Impact on fuel consumption

Overinflated tyres result in:

1. The so-called bulldozer effect. The tyre "digs" a rut, pushes the earth forward and creates a mound, which increases fuel consumption.

2. A smaller footprint and fewer lugs in contact with the soil, which leads to a loss of traction that increases wheel slippage and fuel consumption.

The bulldozer effect

For greater efficiency, the inflation pressure of towed machinery should also be adjusted.

The tyre flattens out

Tyre pressure that is adjusted for use in the field increases the size of the contact patch. This is due to the tyre flattening out. A larger number of lugs are in contact with the ground, which improves traction and results in reduced fuel consumption.

Test results show fuel savings of up to 20%*

During field studies, Michelin and the South Westphalia University of Applied Sciences demonstrated the connection between tyre pressure and fuel consumption.

Impact on working time

Slippage results in lost time for farmers, because when the wheels spin, the tractor moves forward more slowly.

Lower tyre pressure means less lost time

Tyre pressure that is adjusted to working conditions in the field lengthens the ground/tyre contact patch. With more lugs to grip the ground, traction is delivered more effectively.

Test results show time savings of up to 20 %*

A 50 % decrease in tyre inflation pressure – from 1.6 to 0.8 bar – results in a 20 % increase in driving speed and a corresponding reduction in work time.

This gives potential savings in figures of:

- if a tractor's operating costs amount to € 50 an hour
- and one hour is needed to till a hectare,
- a farmer can save € 10 per hectare.

Meaning € 2,000 and just one pass for a surface of 200 hectares

** Source: South Westphalia University of Applied Sciences, Soest, Germany*

In recent times, a greater understanding of the importance of correct tyre set-up on any agricultural vehicle on crop production and efficiencies has driven tyre manufacturers to innovate. They have developed new tyres and incorporated new technology making it easier to adjust pressures, so improving all aspects of farming operations. However, although fundamental, tyre pressure remains one of the most, if not **the** most, important factors.

Certainly, correct tyre specification has a major influence on tractor performance, but incorrectly set tyre pressures can lead to a substantial increase in fuel consumption. Tests have shown fuel consumption can increase by as much as 20% if tyre pressures are not set to the correct pressure for the job in hand.

Michelin technical manager Gordon Brookes explains how you can optimise in-field performance and fuel consumption.

Tyre pressures mostly overlooked

"From my experience one of the most overlooked aspects of practical farming is tyre pressure on agricultural machinery. This has significant impact on outputs and fuel consumption and can limit damage to the soil particularly when you think that all arable farming operations have interaction between rubber and soil! Output efficiencies are also compromised when tyres are not inflated correctly which can reduce outputs significantly. Operation efficiencies are substantially compromised decreasing output by ¬¬20%

The effect of soil compaction, depending upon its severity, can significantly reduce crop yields by 10 to 15%, increase tillage energy requirements by 200 to 300% and drastically reduce water infiltration rates, increasing the problems of run-off, pollution and flooding.

To counter soil compaction and to ensure optimum vehicle / machinery / agronomic performance on soil it is absolutely paramount to have the correct tyre and wheel operating at the lowest pressure for each operation performed. This can only be achieved by having a detailed knowledge of an individual tyre's construction, the loads required by a tyre to function effectively, the loads and speeds each tyre will encounter, soil types to be worked and the topography of the land, plus a comprehensive understanding of the operations and how they are performed. With all this information to hand an appropriate tyre choice (or not, as there may not be one) can be made by the Michelin Team.

In terms of which tyre equipment to give maximum soil preservation, you look for the lowest inflation pressure possible combined with the most flexible casing. This choice is impacted by three main factors:

1. tyre load
2. operating speed
3. how much torque will be applied to the tyre.

Tyre inflation pressures of 0.4 bar (6psi) is our goal to counter the effects of soil compaction. Up to 1 bar (14.5psi) is to be considered a maximum in the field."

Gordon Brookes

OPTI-TILL® COST BENEFITS

It is well proven that direct drilling has a huge cost benefit to businesses. However, it must be pointed out that previous attempts at minimal disturbance direct drilling haven't always been successful. In some cases, severe yield penalties have been experienced over the long term. Crop yield must be the goal for any grower providing a strong foundation for the business ensuring that commodity price volatility has less impact on profitability.

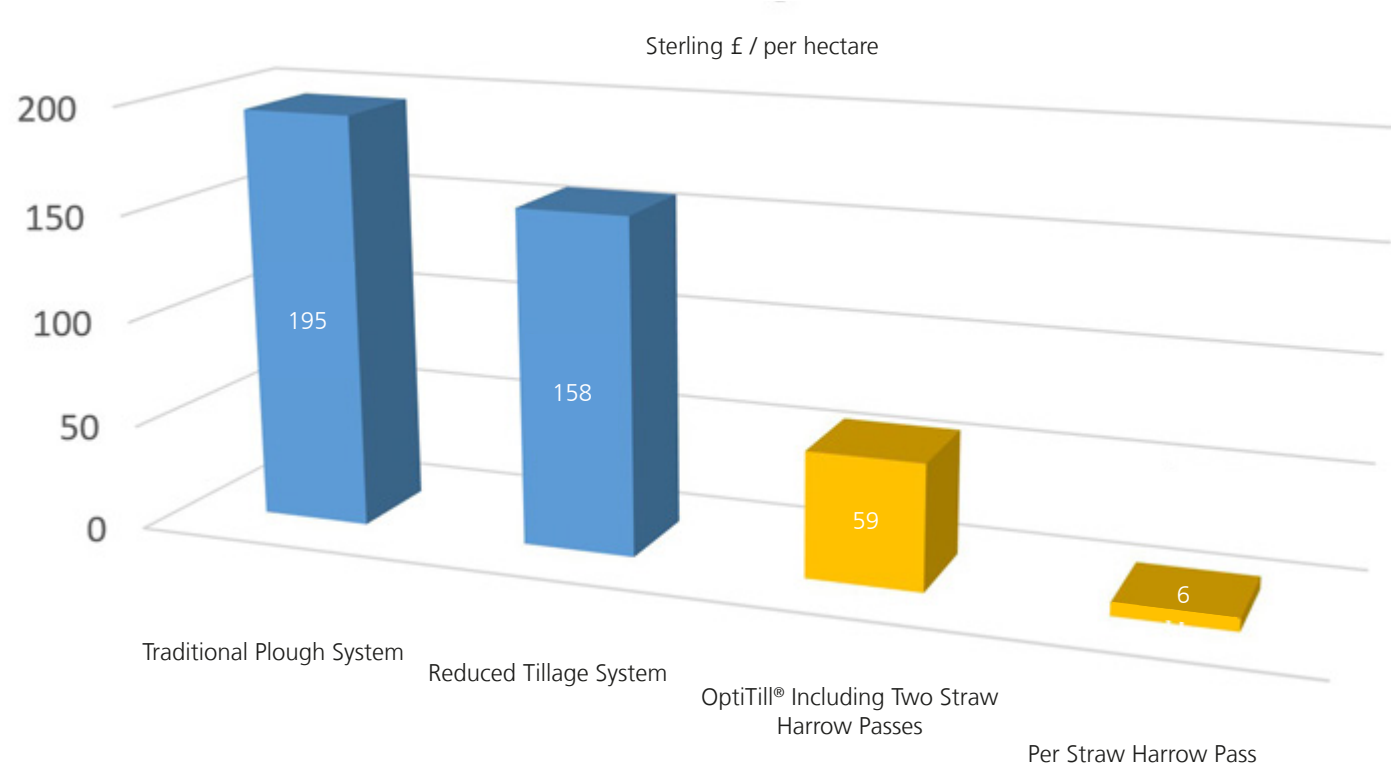
Operational costs must be taken seriously irrespective of the farming operation, its location, farming type and size. Question whether the cultivation you are using is for you, or the crop? Does it need it?

Not only must machinery running costs and depreciation be assessed, environmental matters should also be considered: fuel consumption, soil stabilisation, soil organic matter retention, moisture preservation and soil nutrition depletion.

Understanding your cost per tonne is a good benchmark to use whatever region of the world you are farming.

A typical cost for using Opti-Till® is approximately £59 ha. This includes straw harrowing and seeding using the Hybrid drill. It is typically a third of the cost of a traditional plough-based system.

Cost comparison of different establishment techniques on heavy land



Operational costings are taken from the Claydon cost calculator. To compare your costs with the Claydon Opti-Till® system, please visit www.claydondrill.com/savings-calculator

Cost comparison

The costs in the graph above are based on establishment techniques using best farm practice on heavy land. Soil type would have an influence on the number of passes required.

Some assumptions have been made concerning the comparison for each operation 1) the plough-based system includes subsoiling a percentage of the farm each year using 5 passes. 2) reduced tillage system uses 1 x short disc pass, 1 x disc tine combination deep cultivator, 1 x finisher and finally a cultivator drill. 3) the Opti-Till® system uses a Claydon Hybrid drill and a 7.5m straw harrow.

Using Opti-Till® also saves you time, although this is influenced by the width of the machine used, forward speed, tractor horsepower and field size.

Other time saving benefits include –

- Seeding is carried out at the optimum time
- As later seeding becomes part of an integrated weed control policy cultivating and seeding at the same time reduces lost time due to weather issues.
- More work can be carried out with fewer inputs using machinery and operatives.
- Allows contracting/expansion possibilities with minimal investment.

FUEL SAVINGS

Straw harrowing

Second pass straw harrowing with a 15m Claydon straw harrow, only using 1.7 litres of diesel per hectare achieving nearly 29 ha/h.

Seeding

Seeding spring oats with a 6 metre Claydon Hybrid drill, using 6.6 litres of diesel per hectare at 10.8 km/h.

COST COMPARISONS

Operational

When using this comparison please note that we have used averages based on established and published data collected from various sources and from our experience using Claydon Opti-Till®. We are aware that how you cost your operations may well be different to your peers. There will be many differences that will influence the final figure, how you depreciate your equipment, bank borrowings, whether you rent or own the land you farm and economies of scale.

We have developed an online Cost Calculator to assist you with this task so you can compare Opti-Till® with your current establishment system. Please use the link:
www.claydondrill.com/savings-calculator
– you may well be surprised.

Claydon Opti-Till®	Cost per pass (£)	Your current system (£)	Your cost per pass (£)
Straw Harrowing 7.5m	6		
Straw Harrowing 7.5m	6		
Seeding Claydon drill 4m	47		
Total			

Fuel usage

On page 29, fuel consumption figures were included for the two principle operations of Opti-Till®: straw harrowing and seeding. The number of straw harrow passes varies, but even when we carry out 4 passes with a 15m Straw Harrow in combination with a 6m trailed Hybrid drill and a 300 hp tractor, the most fuel used is 18 litres/ha.

We understand that agricultural diesel usage is subject to different pricing and end of year rebates, dependent on the government policies of each country. However, diesel is usually one of the highest costs to any farming operation, particularly when establishing crops. Soil type can also have a high influence. Please take time to compare your business with Opti-Till® – it isn't only the cost to the business to consider, it is the cost to the environment of using vast amounts of fuel.

Claydon Opti-Till® fuel usage	Litres per hectare	Your current system	Your litres per hectare
15m Straw Harrow	2		
15m Straw Harrow	2		
6m Trailed Hybrid Drill	9.2		
Total			

YOU, CLAYDON AND SOIL HEALTH...

What drives Claydon?

The motivation that drives Claydon forward is the need for the farm to produce high quality crops it can market profitability and sustainably. This ethos has been adopted on the Claydon Drills side of the business from Jeff to his four co-directors, wife Denise, brother Frank, sons Oliver and Spencer and throughout the team at Wickhambrook.

When discussions regarding new developments take place between the various departments, they are very much focused on cropping, economics and yield, not just for the family farm and its contracting business, but also for its farming customers throughout the world.

As a team we constantly question the farming operation, how we can improve what we do, how can we make a difference. I would encourage you to do the same on your enterprise irrespective of the size of your operation, where you are farming, the cropping, what type of soil you have and your average precipitation within the year.

Talk to us

We would love to be given the chance to discuss with you how you can benefit from adopting Opti-Till®. We offer free advice and support to guide you through the process. This doesn't stop after you start using Opti-Till® – this we promise because, as farmers, we realise that establishing crops is never an exact science!

Simon Revell, Export Sales Manager, Claydon

Our dealer and agency network spans across the whole of Europe. For demonstrations, quotations and after-sales service, please visit our website to find your nearest Claydon dealer: www.claydondrill.com/dealers

CLAYDON

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