GREEN HORIZONS
INSIGHT REPORT:2

Agri intelligence

ENHANCING THE ENVIRONMENT

www.agrii.co.uk

Agrii

Lasioglossum spp
(a mining bee)

CONTENTS

A BACKGROUND AND INTRODUCTION

GREEN HORIZONS

Green Horizons is Agrii's commitment to sustainable food production, and to taking a lead on principles and practices that can help to create a robust future for UK agriculture.

At its centre is our Five Point Plan to help prepare for, and meet, the challenges of tomorrow, while ensuring that agriculture remains sustainable and profitable.

The **Five Point Plan** covers the action we are taking in each of the following areas:

- **Increasing farm productivity and viability**
- **Providing integrated whole farm solutions**
- **Improving soil resilience**
- **Enhancing the environment**
- **Extending stakeholder engagement**

An Insight Report that pulls together all of the projects, research and ongoing work that Agrii is involved in, within each area, will be produced for each of the five points of the plan. This report focuses on **enhancing the environment**.

The future of UK farming depends on our stewardship of the natural resources that form the basis of food production – air, water and soil.

The development and maintenance of thriving natural ecosystems can help us to overcome many of the challenges that agriculture faces today. This will also be central to, and stand businesses in good stead for upcoming environmental land management policy around 'public money for public goods'.

Our objectives are:

- To help our growers build business resilience to adapt to climate change.
- To sustainably increase agricultural production and incomes.
- To help to reduce the carbon footprint of our industry and look after the natural environment.

Our ambitions under this section of the Green Horizons Five Point Plan are covered in detail in this report. **In summary, they are to:**

Collaborate with our customers to achieve net zero greenhouse gas emissions by 2040.	**SECTION 2**
Help our customers deliver public goods – partly through development of an accredited Agrii environmental training programme for agronomists and customers, but also through our tailored environmental advice services.	**SECTIONS 1-6**
Supporting and enabling customers to make environmental improvements on farm relating to BPS and ELMS.	**SECTION 4**
Launch a Green Horizons Research Challenge to reduce plant protection product inputs supported by biosolutions.	**SECTION 3**
Minimise the impact of PPPs on farm by encouraging best application practice on farm.	**SECTION 3**
Raising environmental awareness internally within Agrii and externally with our customers and the wider industry.	**SECTION 6**

SOME OF THE CHALLENGES THIS DOCUMENT AIMS TO ADDRESS:

- Habitat and species decline.
- Restrictions on use of fertiliser and crop protection products.
- The requirement for farming to deliver public goods.

BACKGROUND AND INTRODUCTION

B

REGENERATIVE AGRICULTURE AND PUBLIC GOODS

Our approach is based upon, and goes beyond the traditional tenets of conservation or regenerative agriculture.

Decades of research at our Technology Centres, and in conjunction with our partners on a range of research projects, have shown us the importance of looking at the whole farming system.

This holistic approach requires consideration of all aspects of land management in our decision making, and how all the different elements of the farm's natural environment interact with each other. It also takes into account the effect the farming system has on soil, water, air and the wider landscape – 'public goods'.

It looks at the different influences or pressures that different farms may experience – soil types, disease pressures, weather variations, and considers the best overall approach for management. This ecosystems approach is balanced against the needs and requirements of the viability and profitability of the farming business.

Please see Green Horizons Insight Report 1: Improving Soil Resilience, for more information on regenerative agriculture and Agrii's work in this area.

INTEGRATED FARM MANAGEMENT (IFM) & INTEGRATED PEST MANAGEMENT (IPM)

WHAT'S THE DIFFERENCE?

IFM

IFM is a whole farm business approach that aims to deliver more sustainable farming.

IFM combines the best of modern technology with more traditional methods to help deliver profitable farming that supports the natural environment.

Attention to detail is key: appropriate and efficient use of inputs combined with smarter approaches to business planning and the adoption of innovations and new technologies, all contribute to increasing productivity while protecting valuable resources.

IFM is at the centre of what Green Horizons aims to deliver, and forms the basis of Agrii's approach to agronomy.

IPM

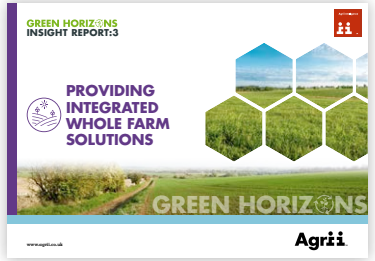
IPM is the careful consideration of all available plant protection methods and subsequent integration of appropriate measures that discourage the development of populations of harmful organisms, while keeping the use of PPPs and other forms of intervention to levels that are economically and ecologically justified.

IPM is the cornerstone of Agrii's approach to sustainable total farming systems, and always has been.

Crop protection products should never represent the first port of call when addressing any agronomic challenge.

Since the launch of Green Horizons, the proportion of Agrii trials including an element of IPM has increased from 85% to 98%. We are on track to achieve our target of 100% by 2022.

YOU CAN FIND OUT MORE ABOUT IPM AND IFM, AND THE WORK THAT AGRII IS INVOLVED IN, IN THESE AREAS, IN GREEN HORIZONS INSIGHT REPORT 3: PROVIDING INTEGRATED WHOLE FARM SOLUTIONS.



1 BIODIVERSITY AND HABITAT CREATION

PART TWO

Agrii sees quality habitat creation as a key element for delivery of biodiversity improvements on farm. Working with our extensive client base, creating and managing habitats is like managing a new crop, and would open up a meaningful way to improve the environment and enhance pollinator numbers.

WHAT IS BIODIVERSITY AND WHY IS IT IMPORTANT?

Biodiversity is the biological variety and variability of life on Earth. The more of the 'components' as described by E.O. Wilson, (see quote below), the greater the species diversity.

The greater the species diversity, the greater the robustness and resilience of the system, and its ability to react to external factors, resulting in stability.

HOW DOES THIS RELATE TO UK AGRICULTURE?

In agriculture, habitat diversity supports species diversity. The more diverse the cropping and surrounding non-crop habitats, the greater the diversity of wild species.

Many now realise that modern agriculture is losing above- and below-ground species diversity leading to a weaker, less resilient farming system. One of the main causes of this decline is habitat loss, which is a direct result of human activity. It is now in all of our best interests to preserve what's left and reverse species decline.

HOW CAN WE IMPROVE THINGS?

It is estimated that most of the decline in farmland wildlife is due to habitat loss, so the simple answer is to put the habitats back. Which habitats, where to put them and how to manage them is something on which Agrii can advise.

The government's Environmental Land Management (ELM) scheme offers a variety of payments for the delivery of 'public goods', many of which are linked to habitat restoration. This in turn benefits the farm business by enhancing natural systems on which the farm depends, e.g. improvements in soil health.

Please see section four of this document for more information.

Some 70% of the UK is farmland, so if we are to succeed in reversing habitat and species decline, farmland is where biodiversity improvements need to be focused.

These improvements should also complement the business of farming. To make all this work, Agrii believes there are three key areas to work on as part of Green Horizons:

1. **Growers must believe biodiversity is important**
2. **Quality training is vital**
3. **Payments for habitat creation need to reflect the true costs of delivery**

"Biodiversity is the key to the world as we know it and our wellbeing depends on it. If life in a local site was struck down by a passing storm, it springs back because enough diversity still exists. Opportunistic species evolved for just such an occasion to rush in and fill the spaces. This sets in motion the succession that circles back to something resembling the original state. This process has taken thousands of years to evolve and is dependent on enough components being present."

EDWARD O. WILSON, 'THE DIVERSITY OF LIFE'

BIODIVERSITY AND HABITAT CREATION

1

Following are some opportunities to increase farmland biodiversity which have been proven to work through science and research. These options, when sited and managed correctly, also make good business sense and are eligible for grant aid. Agrii promotes many of the opportunities outlined below and runs environmental training courses for farmers and agronomists.

WILDFLOWERS

Since the Second World War we have lost around 97% of our wildflower meadows. Flowers provide pollen and nectar which are vital to a host of insects, many of which are predators of crop pests. Some hedgerow shrub and tree species also provide blossom that is just as important to insects as meadow flowers.

Pollinating insects can emerge in March and remain visible throughout the summer. For these insects to thrive they need a continuous supply of food – pollen, and nectar.

- Protein-rich **pollen** is produced by the male parts of flowers and is used by female bees to build condition. Pollen is essential for egg fertility and is also used to feed the queen and larvae of both honey and bumblebees. Solitary bees also use pollen to feed their young.
- **Nectar** is a sugar solution used for energy "flying fuel".

It is essential to have a continuous and varied supply of pollen and nectar from March through to September. This may be provided by both unsown and sown flowers, trees, and hedgerow shrubs. The early flowering period, often referred to as the 'hungry gap' (March to May) is generally filled by the flowers of trees, shrubs, and some unsown wildflowers.

Later supplies are provided by commercial sown flower mixtures as well as wild plants. This means that the naturally occurring, unsown flower resource is vital for insects and should be retained where possible.

READ: MAREK NOWAKOWSKI'S GUIDE TO PROVIDING CHEAP AND EASY EARLY POLLINATOR LIFELINES HERE

POLLINATORS

Any insect that actively transfers pollen from plant to plant resulting in fertilisation can be considered a pollinator. Pollinators come in all shapes and sizes, but bees are those which most readily come to mind.

The UK food industry values pollinators at hundreds of millions of pounds but many are in decline due to changes such as habitat loss. In terms of pollination, we can separate bees into four types by the way they carry pollen:

- **Cuckoo bees** don't need to carry pollen as they lay eggs in other bees' nests.
- The **honeybee** is the only bee that makes honey. Honeybee workers collect pollen which they moisten with nectar and saliva, sticking this "wet" pollen into pollen baskets on their hind legs and flying home to feed this "larval loaf" to the queen and developing young.
- **Bumblebees** use the same process and also carry "wet" pollen in their pollen baskets.
- The so-called **solitary bees** can be subdivided into mining bees and cavity bees. Both kinds carry "dry" pollen on their bodies. Pollen is stored in the nest and eggs are laid on top of the dry pollen. On completion of this work the female seals the nest and then dies leaving the eggs to hatch later. On hatching, the larvae feed on the dry pollen before pupating and subsequently hatching as adults. This life cycle requires dry pollen, as wet pollen would spoil before the eggs hatched.

READ: MAREK NOWAKOWSKI'S BASIC INTRODUCTION TO FARMLAND BEES HERE AND HIS GUIDE TO CREATING HOMES FOR BEES HERE

WATCH: MAREK'S VIDEO ON FARMLAND BEES HERE, MAKING SPACE FOR BEES ON FARM HERE AND SUCCESSION PLANNING FOR POLLINATION HERE

PART TWO

1 BIODIVERSITY AND HABITAT CREATION

PART TWO

HEDGEROW MANAGEMENT

Hedgerows define many of the UK's regional landscapes. Many incredibly old, species-rich hedges are woodland remnants. Many hedges, particularly in the Midlands, were planted during the parliamentary enclosures of around 1750 to 1850.

These hedges transformed the existing open field farming systems by parcelling land into small fields ideal for rotational grazing by livestock. These straight boundaries were predominantly created from hawthorn, as it produces quick and easy stock-proof barriers. Over time, such hedges tend to became more diverse and develop a rich ground flora.

We previously mentioned the importance of early-flowering trees and shrubs filling the insect 'hungry gap'.

A March to May walk round farmland hedges will quickly identify which flowering species are present. In most cases it is worth adding species such as cherry plum, goat or grey willow, privet, crab apple, and dog rose.

Care should be taken if planting dogwood and blackthorn as these produce prolific suckers.

In 2007, a national hedge survey judged that less than half of hedges were in favourable condition. A common problem was annual cutting at the same height resulting in the formation of a "knuckle" unable to produce new shoots. Such hedges would often lose vigour and die back.

The solution to this is incremental hedge cutting. This is where the cutter bar is raised a few centimetres above the previous cut each time. This allows new shoots to grow, putting volume and density back into the hedge. Cutting every two or three years allows the production of berries. Trees and shrubs fruit on second year or older growth. Cutting should take place in January or February rather than September or October, as this helps to retain invertebrate life.

WATCH: MAREK NOWAKOWSKI'S VIDEO ON INCREMENTAL HEDGE CUTTING HERE

READ: MAREK NOWAKOWSKI'S GUIDE TO THE ESSENTIAL POINTS TO CONSIDER WHEN HEDGE CUTTING HERE

WINTER BIRD FOOD

One of the biggest killers of farmland birds is winter starvation. The decline of mixed farming and the increase in autumn drilling have resulted in less 'food for free'. The efficiency of modern combines and annual hedge cutting have further removed food supplies.

For those wishing to provide winter bird food the answer is simple: sow some. Stewardship grants are available for sowing winter bird food. These areas can make good business sense if sited in difficult or less profitable areas of the farm.

There are many mixture options providing a range of seed-bearing plants. Mixtures can be annual or biennial, but the annual ones generally provide more seed. The aim is to choose plants which provide a range of seed sizes and if possible, retain their seed, such as triticale and fodder radish. Kale is also good as it hosts a range of invertebrates which help support insectivorous birds.

Like pollinators, there is also a hungry gap for birds, which is from January, well into April. By late January, most hedgerow berries are depleted, and the sown bird seed has either been eaten or has shed.

This is when supplementary feeding becomes a lifeline. A mix of seeds can be spread twice a week along a track, thinly enough so that the seed is all eaten in approximately 48 hours.

The next seed is not spread until the first lot has been eaten, to avoid attracting vermin.

INSIGHT REPORT:2 ENHANCING THE ENVIRONMENT

USEFUL RESOURCES

It is estimated that most of the decline in farmland wildlife is due to habitat loss, so the simple answer is to put the habitats back. Which habitats, where to put them and how to manage them is something on which Agrii can advise.

Agrii Wildlife Farming Consultant Marek Nowakowski has produced a series of wildlife information factsheets. You can view and download these from **www.agrii.co.uk/greenhorizons/the-environment**

1. **Providing cheap and easy early pollinator lifelines**
2. **A basic introduction to farmland bees**
3. **Creating homes for bees**
4. **Recognising two alien weed grasses: Barn Yard Grass and Bristle Grass**
5. **The basics of habitat creation**
6. **Raising the bar – the essential points to consider when cutting hedges**

Marek has also produced a range of quick videos on biodiversity and habitat creation, also available at **www.agrii.co.uk/greenhorizons/the-environment**

2 TOWARDS NET ZERO

WHAT IS NET ZERO?

Net zero is all about balancing greenhouse gases (GHG). Focusing on both reducing emissions and increasing offsets (levels of sequestration), it is about ensuring that the amount we emit is no more than the amount that is taken away.

Sequestration is the capture of carbon dioxide from the atmosphere. In agriculture, the main stores of CO_2 are soils and vegetation (including hedgerows, trees and pastures).

In addition to the UK Government's target of achieving net zero across all industries by 2050, the NFU has taken the ambitious approach for agriculture across England and Wales to become net zero by 2040.

Within the UK, the agricultural industry is responsible for 10% of GHG emissions (figure 1). Despite this contribution being smaller than other industries, agriculture is unique in its ability to fully cycle and therefore naturally sequester carbon. For this reason, agriculture has been seen as the 'solution' to climate change in recent years.

But just how much of an impact can we have? To explore this further, Agrii has been looking at the main sources and sinks of carbon, to identify what the biggest 'players' are.

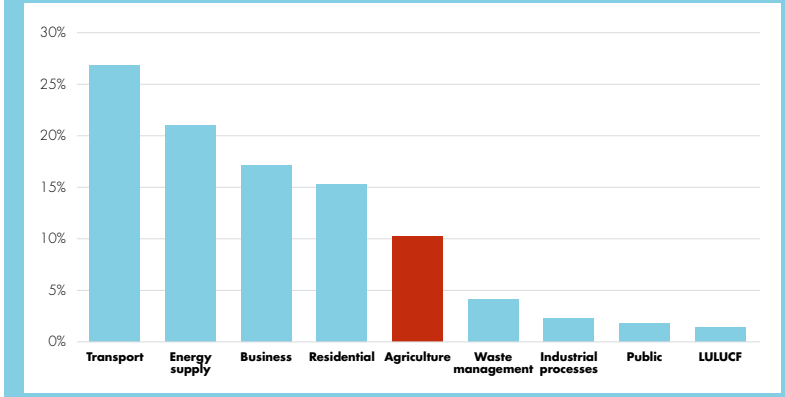


Figure 1: Territorial UK greenhouse gas emissions by NC sector, 2019

Source: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/957887/2019_Final_greenhouse_gas_emissions_statistical_release.pdf

-10T

By reducing our AN inputs by 10 tonnes (t), for example through the use of Liqui-Safe or other Enhanced Efficiency Fertilisers (EEFs), we can save approximately 18 T CO_2e*. Please see page 18 for more information on EEFs.

50L

A 50 litre reduction in red diesel consumption can save 170kg of CO_2e.

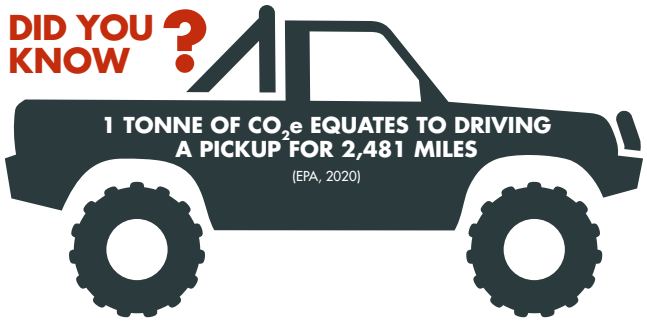
+0.1%

An increase of SOM by 0.1% per hectare per year can sequester an additional 8.9 tonnes (t) CO_2e – imagine the impact on a field scale!

1 HA

The Woodland Carbon Code states that a new native woodland can capture up to 300-400 tonnes (t) CO_2e per hectare by year 50. The amount of carbon that can be sequestered increases with the age of a tree.

*These figures vary with product type and application method.



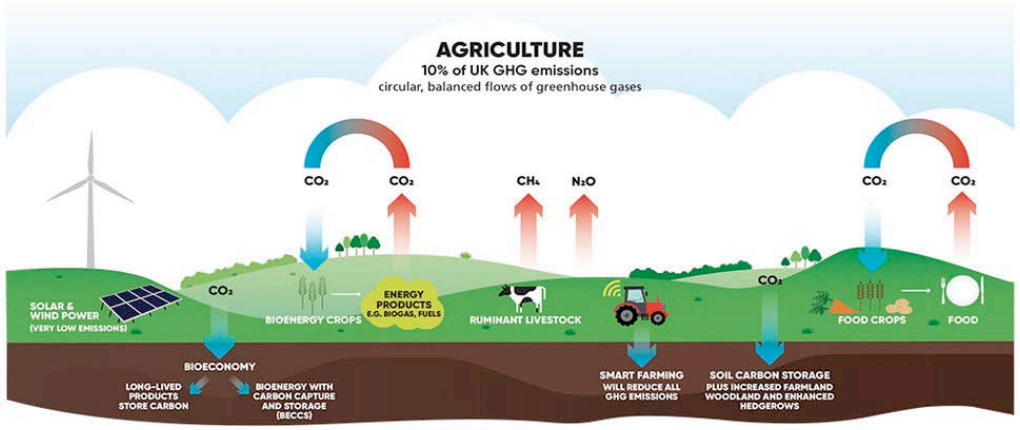
SOILS: THE CLIMATE SOLUTION?

All the talk around trees when net zero is discussed has caused us to divert the focus away from what's below our feet. The reason soils have potentially been given less thought until now is due to the complexity in measuring just how much carbon our soils can sequester.

However, as the science evolves in this area, we are beginning to learn more about the capacity of our soils to not only produce a healthy crop, but also to cycle carbon, improve Nutrient Use Efficiency (NUE), and increase our resilience to the changing climate.

At Agrii, we are working closely with organisations such as CEH to understand not only the potential of our soils, but also how we measure and improve their resilience, in order to enhance the carbon cycle. For more information, please see **Green Horizons Insight Report 1: Improving Soil Resilience.**

SOURCES AND SINKS OF GREENHOUSE GASES IN AGRICULTURE



Credit: NFU

MEASURING THE CARBON BALANCE ON-FARM

CARBON CALCULATORS

As part of our work towards net zero, we have been looking into the various calculators available on the market that enable the measurement of the carbon balance on farm.

Of those 60+ available, there are three tools which are widely recognised. It is difficult for any organisation to recommend which one to use, as it completely depends on what you are looking to achieve from using one, however we've summarised the main features of each of the three widely recognised tools on this page.

Please get in touch for more information on our research into each of these.

Farm Carbon Toolkit

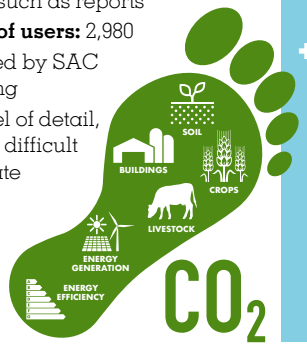
- "Led by farmers for farmers"
- **Best for:** looking at whole farm emissions
- **Cost:** Free for farmers
- **Number of users:** 2,500
- Developed for the Farm Carbon Toolkit
- Easy to use whilst also accounting for carbon in detail
- This is the most soils-focused tool

CFT COOL FARM TOOL

- **Best for:** Supply chain focus & calculating footprint per crop/field
- **Cost:** Free for first 5 assessments. Cost of circa. £1,600/year afterwards
- **Number of users:** 10,400
- Good for first timers – Simple to use, but not as much of a detailed analysis
- Developed by the Cool Farm Alliance
- High industry recognition with a number of members being part of the alliance

agrecalc

- **Best for:** Mixed or livestock farms
- **Cost:** Free version, but there is a cost to additional add-ons such as reports
- **Number of users:** 2,980
- Developed by SAC Consulting
- High level of detail, although difficult to navigate



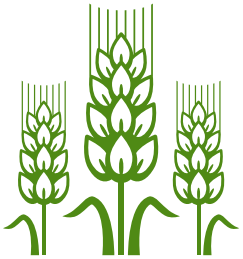
AGRII'S TOP TIPS FOR CHOOSING A CARBON CALCULATOR:

- **Whichever tool you choose, it is important that you stick with it** – outputs from these tools vary considerably, so it is important that you continue to use the same one to accurately monitor change.
- **Start data collection early** – figures such as your soil organic matter are important when calculating offsets.
- **You will need more than one year's worth of soil organic matter data** – you will need to demonstrate how much carbon you are 'actively' sequestering.
- **Use these tools to measure your efficiency** as well as measuring your emissions.
- **Identify the main areas of your system that have the largest footprint.** In an arable system, this is mostly your fertiliser inputs and fuel consumption. Making small changes to these parts of your system will make the largest difference to your overall carbon footprint.

MEASURING THE CARBON BALANCE ON-FARM
AVOIDING DATA PITFALLS

CROPS

When using a calculator for the first time, many people are alarmed by the amount of CO_2 emitted from crops.



This leaves many people questioning the fact that surely a higher yielding crop with higher biomass will mean more carbon is sequestered?

SOILS

Soils have a huge ability to store carbon, and reverse global warming. However, there are a lot of 'unknowns' about just how much can be sequestered.

Some tools account for carbon storage solely through Soil Organic Matter (SOM), whereas others don't require much detail for their calculations at all. SOM is currently the most accurate way of measuring how much carbon is stored in the soil.

However, there is a lot of work being done to look at how we can measure this more accurately. Please see **Green Horizons Insight Report 1: Improving Soil Resilience**, for more information.

We need to understand more about sampling as well. For example, at what depth do we sample for carbon? At what time of year? How many samples per field are a good representation?

There is a lot of guidance available for this, but every soil is different.

Although there is still guidance required in this area, one thing we do know is that consistency is key! Just like using the same calculator is important, so is keeping our sampling methods consistent. Measure at the same time of year when moisture levels are similar, use the same locations to get accurate comparisons, and also sample at similar depths annually.

SO, WHY DON'T OUR CROPS SHOW NET CARBON SEQUESTRATION?

Although a typical grain crop fixes a large amount of CO_2, this carbon is then released back into the atmosphere when the grain is consumed and when residues are decomposed in the soil.

So, unless this carbon is retained in a stable form, such as in Soil Organic Matter (SOM) (which the tools do take into consideration), there is actually no net reduction.

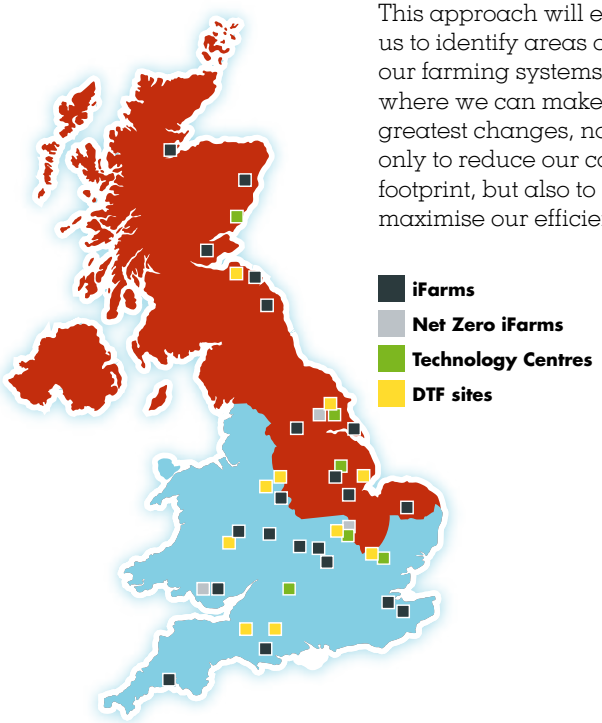
AGRII NET ZERO iFARMS

Agrii has a network of 28 iFarms and Technology Centres across the UK, kindly hosted by Agrii clients, where local farmers and growers can view demonstrations of new agronomic innovations, and discuss how they can be put into practice on farm.

Our iFarm trials cover a whole range of crops from arable and grassland, to fruit, veg and innovation crops.

As the UK's leading agronomy provider, we have the responsibility to be looking ahead in the fast changing world we are facing. In response to the NFU's ambition for agriculture to reach net zero by 2040, we have established three new net zero iFarms.

This approach will enable us to identify areas of our farming systems where we can make the greatest changes, not only to reduce our carbon footprint, but also to maximise our efficiency.



MIDLOE GRANGE, CAMBRIDGESHIRE

This 240 acre arable enterprise is home to a number of our Green Horizons Projects. It is also a LEAF Demonstration Farm.

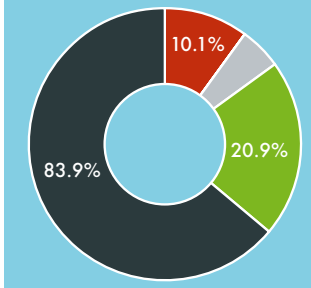
ACTION PLAN

The Midloe team are exploring how best to reduce inputs while maintaining outputs similar to a conventionally grown crop, but with a reduced environmental impact. This is part of the Green Horizons Challenge Project – please see page 31 for more information.

One example of work being carried out is a project with LEAF and the Environment Agency to look at ways of preventing and capturing soil and sediment that may transport nutrients and pesticides into water.

David Felce, Midloe Grange

CARBON BALANCE



Emissions Totals

Type	t CO_2e/year
Fuels	19.90
Materials	0.11
Inventory	10.02
Crops	41.23
Inputs	125.91
Total:	**197.17**

In addition to the Green Horizons Challenge work at Midloe, we are looking along the lines of existing projects to see how the farm's emissions can be reduced through improved fuel use efficiency.

By tracking fuel consumption per operation, we are starting to recognise where the majority of fuel is consumed, and explore ways of reducing that.

One method is by having the correct tyre pressures. This not only helps from a fuel consumption perspective, but also by reducing soil compaction – and we are all aware that a well structured and functional soil will absorb more carbon.

Given the difference in organic matter levels at Midloe compared to farms which have access to organic amendments, we are beginning to explore methods of 'growing organic matter' without access to organic inputs.

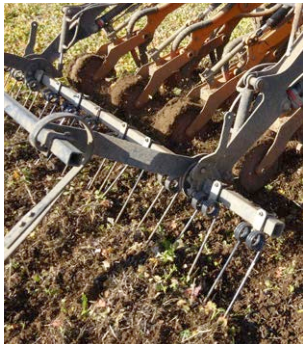
This includes techniques such as cover cropping and minimising disturbance, which we will be comparing to areas treated with farmyard manure.

BISHOP BURTON

Bishop Burton College's 355 hectare farm is split between arable and grassland for livestock including beef and sheep. There is also a 1500 head pig finishing unit.

ACTION PLAN

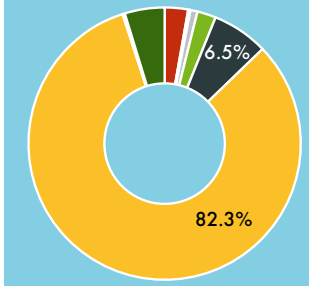
- The College Farm is currently going through a transition phase into strip till drilling where the use of cover crops and organic manures along with a diverse rotation will help to keep soil in good condition going forwards.
- The use of RHIZA variable rate technology has been widely adopted as of autumn 2020 with all soils on the farm mapped and analysed so variable rate inputs can be applied across the farm.
- This spring, soil maps will be used to variably apply phosphate and potash.
- RHIZA satellite imagery will be used throughout the growing season to variably apply nitrogen.
- Manure from the farm's sizable pig unit will be used more and more in crop nutritional programmes on the farm. Trials using different forms of nitrogen are being conducted to investigate N efficiency.
- The use of robotics is being trialled with the view to field autonomous applications within the next two years.



Images courtesy of Jim Carswell

CARBON BALANCE

Carbon Balance (t CO_2e)



Bishop Burton are in a different position to other iFarms, because the majority of their emissions are generated from livestock.

When we look into this in more detail, a large proportion (almost 80%) is associated with the protein source fed to the pigs. Soya is used in most intensive farming systems, providing animals with a substantial source of protein. However, the life cycle associated with soya means that it has a large carbon footprint. Therefore alternative sources of protein are being investigated, along with trying to understand what others in the wider industry are doing to reduce this footprint.

The college has its own engineering department, which enables the farm team to explore new innovative technologies for the sector, including the possibility of developing a robotic soil sampler. This would allow more accurate sampling of soil carbon, maintaining the same GPS locations and depths each year.

Another reason that Bishop Burton's overall carbon score is high, is because when collecting 2020 data, they only had one year's worth of whole farm soil organic matter figures. In order to calculate how much carbon the soil has actively sequestered, a minimum of two years figures is required.

Emissions Totals

Type	t CO_2e/year
Fuels	103.73
Materials	11.87
Inventory	26.70
Crops	76.79
Inputs	225.82
Livestock	2,855.57
Distribution	6.84
Land Use	160.78
Total:	**3,468.09**

TYTHEGSTON FARM, SOUTH WALES

Richard and Lyn Anthony farm approximately 1200 ha in the Vale of Glamorgan, South Wales, with their enthusiastic and hardworking team.

BACKGROUND

The predominant soil type on the farm is a silt loam, which is very productive and fertile and the area receives, on average, 1,200mm of rainfall annually.

With a diverse rotation of cereals, oilseed rape, maize, grass and latterly novel pulses in trials, the business has moved to a reduced tillage cultivation system over the past 15 years.

The team have a passion for soil management and have tirelessly worked towards improving their organic matter levels. On land they have been farming long term, the organic matter levels are consistently between 6-7%, when regular testing is carried out.

ACTION PLAN

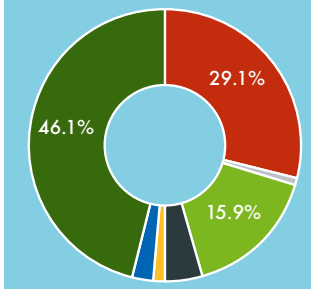
- With the purchase of a Mzuri drill, the farm now practices strip tillage, in an attempt to further improve soil management.
- The business has invested in a biomass boiler to reduce the use of natural gas for the drying of grain on the farm. They are now using 100% renewable sources of fuel in a combined heat and power unit to dry grain on the farm and export electricity back to the grid.
- The use of manufactured fertiliser has been dramatically reduced, with the adoption of liquid digestate as the main fertiliser source, from a sustainable green waste anaerobic digester, gathering food waste from local councils in South Wales.
- Located in a productive area, but with the challenge of high annual rainfall, the business utilises cover/companion cropping, genetics and other IPM strategies in cereal and break crops to reduce and minimise their use of inputs such as insecticides. Alongside habitat creation, they hope that this will boost the numbers of beneficial pollinator populations on the farm and surrounding areas.
- The farm would like to take a step towards direct drilling on certain blocks of land, which are in good health and where they can further reduce their environmental impact.

CARBON BALANCE

-21,303

Carbon Balance (t CO_2e)

0



Emissions Totals

Type	t CO_2e/year
Fuels	4,030.26
Inventory	93.06
Crops	2,197.38
Inputs	643.56
Livestock	195.90
Distribution	317.44
Land Use	6,385.32
Total:	**13,862.92**

The majority of emissions at Tythegston Farm are from the fuels, crops and land use section. Reasons:

- **Fuels** – the farm has a large biomass boiler so they utilise a lot of woodchip. How different that would look if fossil fuels were being used to generate that energy is something we are looking into as part of the farm's Action Plan.
- **Crops** – at immediate glance the large figure under the crops section looks alarming. The reason for this is because the digestate food waste is inputted under the 'crops' section rather than 'inputs'.
- **Land use** – these figures are from where the farm has seen a decline in their soil organic matter levels.

Overall – the South Wales iFarm is sequestering more carbon than they're producing, because they have seen large increases in their organic matter levels – mainly due to the addition of digestate. This shows the important role that soil plays in achieving net zero.

Please see **Green Horizons Insight Report 1: Improving Soil Resilience**, for more information on how to measure and increase your soil organic matter levels.

CARBON IN PERMANENT PASTURE

Permanent pasture builds and maintains soil organic carbon (SOC) faster than rotational arable cropping.
The absence of cultivations and continued cover prevents carbon losses from occurring. We often talk about how we can increase carbon stocks in arable systems, but how can we improve stocks in an existing grazing system?

1 Grazing management

Implement a system that maximises production rather than offtake. Systems such as rotational or mob grazing could be used for this (please see box 1).

2 Improve species composition

Sow species that are more resilient to grazing and weather variations. Also consider using species that enhance soil fertility (e.g. through N-fixation).

3 Restoring degraded land

Enhance the productivity of all areas, increasing carbon inputs and therefore sequestration.

4 Include grass in a rotation

A consideration for arable systems, to reduce disturbance and return organic matter through grazing.

With increased talk of carbon markets, it is important to start thinking of carbon as a commodity. Practices that increase carbon sequestration can also enhance adaptation to climate change and productivity.

PEATLAND

Peatlands store vast amounts of carbon through photosynthesis. The plants grown in these areas don't fully decompose under the wet conditions, meaning less carbon is lost. In the UK, this land locks in an estimated 3.2 billion tonnes of carbon. However, the high fertility of these soils make them extremely profitable agricultural land, which has led to the drainage of around 80% of UK peatlands – releasing carbon back into the atmosphere. Now, large programmes such as the Peatland Code are underway to manage these lands as a carbon store. This creates significant opportunities for land owners to sell carbon in a future market.

For more information on incorporating livestock in the rotation, please see **Insight Report 1: Improving Soil Resilience.**

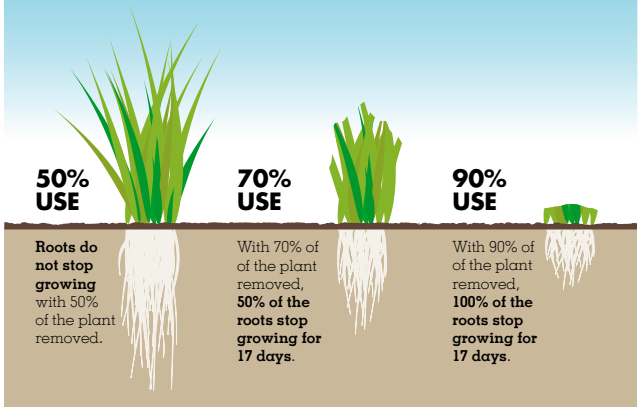
Large programmes such as the Peatland Code are underway to manage lands as a carbon store, creating large opportunities for land owners to sell carbon in a future market.

BOX 1: MOB GRAZING

With **almost 60%* of UK agricultural land used for livestock**, grazing management is an important part of achieving net zero within agriculture. Good ruminant grazing can help maintain or even enhance soil carbon stocks. However, this is location specific, emphasising the importance of understanding what works in your system.

In many cases, overgrazing can degrade pasture quality and increase losses of soil carbon. However, a well managed grazing system can lead to greater accumulation of soil carbon compared to a non-grazed system.

Mob grazing is a method commonly referred to when talking about sustainable livestock management. This is where land is grazed for a short duration under a higher stocking density with a longer grass recovery period. It should lead to uniform forage consumption and trampling of animal manure, equally distributing carbon. The method has shown benefits to soils, livestock health and costs. Using this grazing technique helps to increase soil organic matter levels over time, helping to reach net zero targets.



References: *https://www.theccc.org.uk/wp-content/uploads/2020/01/Land-use-Policies-for-a-Net-Zero-UK.pdf

FOOD VERSUS ENERGY

With global population on the rise, our demand for food is going to increase. Coupled with a concurrent increase in fuel and energy demands, we are left with a dilemma as to whether we use land for food or energy production. This is a debate that has been going on for many years, and one that developments in new technological solutions will help to solve.

MAIZE

No other grain crop utilises sunlight more effectively than maize, giving it the best grain energy value amongst cereals. This trait makes it the perfect source of energy for human and livestock consumption, but also renewable energy. Maize is commonly known for its use in making biofuels, providing a more environmentally friendly option to fuelling transport and energy. This provides huge opportunities to help decarbonise our whole economy. However, it won't come without its costs.

GROWING SYSTEM

With variations in weather coupled with the ever-growing environmental focus of food production, growing a maize crop is becoming more challenging. It is all about improving the resilience of your system, which all starts with variety selection and establishment methods. Growing maize in a more sustainable way, will also help to reduce the crop's overall carbon footprint.

Here are some top tips:

Ground suitability – before even considering maize within the rotation, you should think about whether the land is suitable. Things to consider would be: topography, soil type, inherent risks, climate and end markets.

Variety selection – If the ground is suitable, you then need to consider varietal traits. Travelling on the soil in poor conditions can lead to a depletion in soil structure and therefore carbon stocks. Ideally, you want harvest to be completed by mid-October to maximise chances of travel. Selecting early maturing varieties such as Resolute or KWS Avitus will prevent the risk of carbon losses and damage to soil structure.

Undersowing – for later maturing varieties, undersowing should be a key consideration, particularly where a cover will be difficult to establish post-harvest. Grass is usually a good option for undersowing, and this can either be sown at the same time as the maize, or after it has established. This will help to maintain carbon stocks over winter, by keeping living roots in the soil which stabilise the structure and offer protection in bad seasons.

Given the known environmental consequences of growing maize, considering more sustainable options is vital when looking to decarbonise your farming system, maintaining carbon stocks and soil resilience for future crops.

More information in our news article here:
https://www.agrii.co.uk/blog/reducing-the-environmental-impact-of-maize/

3 REDUCING PLANT PROTECTION PRODUCT (PPP) INPUTS

PART TWO

A key part of Integrated Farm Management and Integrated Pest Management is reducing our reliance on plant protection product (PPP) inputs.

Reducing these inputs has widespread positive implications for the natural environment including air and water quality, soil health and biodiversity, but also in improving business resilience and reduced reliance on chemical inputs and active ingredients in the face of resistance and legislation.

Key areas considered here, are:

1. **New fertiliser technologies**
2. **Use of biosolutions**
3. **Targeted application**
4. **Best practice application guidance**

For more information on the use of cultural controls, please see **Green Horizons Insight Report 3: Providing Whole Farm Integrated Solutions.**

1 New fertiliser technologies

Agrii is at the forefront of new technologies in fertiliser development and we continue to research and develop products that target our key requirements:

- Improve Nutrient Use Efficiency (NUE)
- Increase yield
- Provide a cost saving to market alternatives
- Have a lower environmental footprint

Some examples are included here, and more information is also provided in **Green Horizons Insight Report 1: Improving Soil Resilience**.

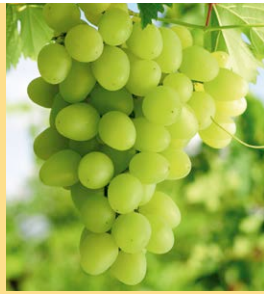
P-Reserve, a key active ingredient in our range of phosphate fertilisers, was our first **Enhanced Efficiency Fertiliser** (EEF), which has led to improved nutrient usage by allowing better utilisation of phosphate, while also resulting in increased yields.

Ammonia emissions from nitrogen fertilisers, both directly and indirectly through intensive livestock production, are one of the lesser known causes of air pollution, and a major area of attention within the Government's Clean Air Strategy (2019).

Intensive use of nitrogen fertilisers also has negative implications for soil health and biodiversity, and water quality as a result of run off. We have been working for many years on NUE technologies and the management of nitrogen. We have been researching urea inhibitors since 2006 and have a strong understanding of the effectiveness of the products on the market, their environmental footprint, and their role in reducing N use. Our current agronomy package looks at NUE and measures to improve it, and we are also working with water companies in many areas to look at erosion control and reduce nutrient run off into water courses.

We also have a range of ongoing projects looking at the role of different types of **organic manures**. Please see page 12 of Insight Report 1: Improving Soil Resilience for more information on our long running organic manures trial at AgriiFocus.

FOCUS ON FRUIT



One of the areas of ongoing research for Agrii's Fruit and Technical teams has been the role of biorational products in the agronomist's toolkit, and how and where products like Frutogard, Amylo-X and other new biorational products can be used to maximum effect. These biological or defence inducing products need a targeted approach.

For example, Frutogard allows growers to use a smaller quantity of phosphonates to equal effect, whilst reducing overall residues on the crop and improving both crop protection and crop quality. Products based on living organisms often have more stringent pH requirements to maintain their efficacy in the spray tank and can benefit from being applied under certain environmental conditions, for example, more humid conditions. Trichoderma products like Vintec now bring a sustainable option for growers to use against grapevine trunk diseases, which are difficult to control.

As we progress towards the National Farmers Union (NFU) goal of Net Zero by 2040, the role of viticulture and other perennial crops will become imperative, acting as sink for carbon without the requirement for intensive annual cultivation.

UNDERSTANDING THE CARBON FOOTPRINT OF THE PRODUCTS YOU BUY ON FARM

Almost 50% of the emissions associated with fertilisers are from the manufacturing process. Many manufacturers are now looking at ways to reduce these emissions, as well as the efficiency of the products themselves. One example is the NUTRI-CO_2OL® carbon footprint calculator developed by Origin Fertilisers and independently verified by ADAS. It enables Origin Fertilisers to quantify the carbon footprint for any individual product, and provides site-specific carbon footprints for their 13,000+ fertiliser grades from source to Origin's site gate.

NUTRI-CO_2OL

LIQUID FERTILISER: ENVIRONMENTAL BENEFITS

Liquid fertiliser is becoming more popular for its agronomic, economic and performance benefits. Considering a change to liquid can also have a positive impact on the environment – including air, water and soil quality.

- Liquid sprayers have a much lower coefficient of variation (the variability across a spreading width) than solid fertiliser, resulting in highly accurate nutrient delivery from liquid fertilisers. This makes it possible to provide precise placement of fertiliser right up to the crop edge – without losing fertiliser beyond the boundary into the hedge bottom or close to ditches. This significantly reduces the risk of polluting water courses and also protects field margins that are under management schemes. Accurate application also reduces overlap – preventing lodging and over-application of fertiliser.
- Liquid fertilisers suit variable rate systems (more information on page 22) – they can be combined with other nutritional and protective products and applied in one pass. This can result in savings of time and fuel, and consequently carbon emissions.
- Using liquid fertiliser tanks reduces the need for bag disposal and reduces plastic waste. Agrii provides a full Environmental Impact Assessment ahead of tank installation.
- Three sources of nitrogen in one targeted fertiliser product (ammonium, nitrate and urea) reduces the risk of leaching and volatilisation. With liquid fertiliser, nitrogen losses are lower and functionality is higher.

FOCUS ON LIQUI-SAFE

Liqui-Safe is a unique urease and nitrification inhibitor for liquid fertiliser, which enables yield increases while benefitting soil biology. Liqui-Safe slows down the loss of nitrogen to the air and water by maintaining higher levels of nitrogen in the ammonium form in the soil, for the growing crop to use more efficiently. As an organic compound, Liqui-Safe degrades in the soil to leave only carbon, hydrogen and oxygen. This is how the technology achieves its environmental and NUE benefits.

Benefits of Liqui-Safe:

- **Reduces the environmental impact** of liquid fertiliser on air quality by reducing volatilisation of ammonia.
- **Reduced impact on water quality** as a result of reduced movement of soil mineral nitrogen (SMN) through the soil profile, even after heavy rainfall conditions. Liqui-Safe has also been shown to reduce nitrate levels in the outflow from field tile drains.
- Addition of Liqui-Safe has been **shown to increase mycorrhizal colonisation** in the soil post-application. This is important as fungi improve the uptake of certain nutrients for the plant – further improving NUE.
- **Reduced impact on aquatic organisms** – various sources have demonstrated no mortality when assessing toxicity of Liqui-Safe to freshwater fish, no immobilisation of water fleas, and no inhibition of growth for unicellular green algae.
- **Improved nutrient use efficiency** and crop quality.
- Fewer passes means **reduced fuel usage** and travelling across the field – reducing compaction and emissions.

MORE INFORMATION

For more information on the above benefits and studies into Liqui-Safe, you can download our Liqui-Safe information document here.

PART TWO

3 REDUCING PLANT PROTECTION PRODUCT (PPP) INPUTS

2 Biosolutions

FIRSTLY, WHAT DO WE MEAN BY BIOSOLUTIONS?

For the purposes of this document, Agrii views biosolutions as being evolving technologies that may be used as well as, or instead of, conventional Crop Protection Chemistry products (CPCs), to enhance crop health, plant metabolism, yield, crop protection, nutrient use efficiency or reduce the effects of stress.

They include the following:

BIOSTIMULANTS

A material that contains substance(s) and/or microorganisms whose function, when applied to plants or the rhizosphere, is to stimulate natural processes to benefit nutrient uptake, nutrient efficiency, tolerance to abiotic stress, and/or crop quality, independent of its nutrient content.

ENDOPHYTES

A bacterium or fungus that lives within a plant without causing apparent disease. Endophytes may enhance host growth, nutrient uptake and improve the plant's ability to tolerate abiotic stresses such as drought and decrease biotic stresses by enhancing plant resistance to pests and pathogens.

ELICITORS

Extrinsic or foreign molecules often associated with plant pests and diseases. They attach to special receptor proteins located on plant cells and trigger intracellular defence signalling. This can result in enhanced synthesis of metabolites which reduce damage and increase resistance to pest, disease or environmental stress.

BIOPESTICIDES

Crop protection agents based on living micro-organisms or natural products. They include bioinsecticides, biofungicides and bioherbicides.

WHY ARE WE INCREASING OUR COMMITMENT TO 'FAST TRACKING' THE DEVELOPMENT OF BIOSOLUTIONS?

As with all new technologies which become available to UK farmers, Agrii operates a 'What Works?', evidence-led approach. Our Green Horizon manifesto states that we will be fast-tracking the research and testing of biosolutions in order to introduce them as rapidly as possible onto the UK market.

Why have we taken this decision?

- **We need alternative agronomy solutions:** Conventional Crop Protection Chemistry (CPC) is becoming more challenging to discover and more expensive to achieve the high standards required by the UK registration system. Therefore, we have gaps in the 'agronomy toolbox' that need a solution. Biosolutions are getting more reliable and may help plug that gap.
- **To use in Integrated Pest Management programmes:** Biosolutions may in some cases be a more benign partner to CPCs when used in IPM programmes. In addition, they may help protect CPCs and reduce selection pressure for pest, weed or disease resistance.
- **To speedily identify potential biosolution candidates to refine priorities for small replicated plot trials:** These are expensive to do and the failure rate for achieving statistically significant field results is high. Development of a 'fast-track' method for screening allows rapid identification of potential candidates, allowing us to be more targeted with the resources we have.
- **They may play a role in the drive toward zero residue food production:** Identification of reliable biosolutions which might enable reduced rate CPCs to be used, would help lower residues in food stuffs.

REDUCING PLANT PROTECTION PRODUCT (PPP) INPUTS

3

WHAT CROPS ARE WE LOOKING AT?

Agrii is examining the potential for biosolutions in all the main combinable and non-combinable crops grown in the UK. This includes cereals, oilseed rape, potatoes, sugar beet, pulses, and many fruit and vegetable crops.

WHAT TESTS ARE BEING USED IN THE FAST-TRACK PROCESS?

As a precursor to replicated field trials, a variety of different laboratory tests have been identified that can indicate which processes in the crop might be affected by the application of a biosolution. These can then be used to compare different products and allow us to select those with the most positive effects for field trials.

- **Direct effects** on plant growth/vigour (Green Leaf Area, height, root development).
- Ability of treated crop to **withstand stress** due to drought/waterlogging.
- **Effects on biochemical processes** in plants such as catalase production or levels of photosynthetic pigments which can help break down damaging free radicals produced by the plant in response to stress.
- Effects on plant growth which may help the **crop resist pests or disease**, such as increasing cell wall thickness.
- For biopesticides, **direct effects** on pests, weeds or disease.

CONCLUSION

It is our view that, having identified whether a product might offer some potential as a biosolution, and satisfy a need we have identified, that by adopting the processes above we will be able to introduce more products at a faster pace. We will share more specific information in Green Horizons Insight Report 3: Providing Integrated Whole Farm Solutions.

MORE INFORMATION

We have produced an essential guide to biosolutions, which summarises our approach, trials information and research results so far. 'Biosolutions explained' is available from www.agrii.co.uk/greenhorizons/the-environment/

PART TWO

3 REDUCING PLANT PROTECTION PRODUCT (PPP) INPUTS

PART TWO

3 Targeted application

Agronomic inputs have traditionally been applied uniformly on agricultural fields despite the spatial variability in soil type and quality and the local landscape. Taking spatial variability into account can have efficiency benefits for agronomic management and yield, and consequential improvements for the local environment.

PUTTING IT INTO PRACTICE ON DIGITAL TECHNOLOGY FARMS

In conjunction with RHIZA, Agrii has put into place a network of Digital Technology Farms (DTFs) around the country, to test the value of current digital agronomy and data-based information systems, demonstrate their most profitable use and provide the broadest base for future improvements. Two of the key areas of interest in the DTF programme are nutrient use efficiency and variable rate nitrogen application.

USING TECHNOLOGY TO IDENTIFY POTENTIAL AREAS FOR 'GREEN SCHEMES'

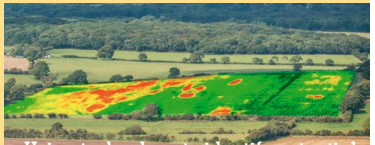
Soil and yield maps can also be used to identify and segregate under-performing areas, which could be of greater financial benefit if taken out of production and put into an environmental scheme. Utilising at least four years of yield maps together with information on soil type and quality, we can identify such trends in lower yielding areas of the farm.

FOCUS ON THE POSSIBILITIES FOR VARIABLE RATE CROP PROTECTION

One area that the RHIZA and DTF teams are looking into is the use of variable rate PGRs, including trials in WOSR, winter wheat and winter barley looking at the application of PGRs based on crop biomass. While not a new concept, it is an area that has developed more traction over the past few years, and will be important in future with public money being awarded for environmental improvements. The results from these trials could help improve efficiency and reduce our environmental footprint.

Another area the RHIZA team are investigating is utilising field maps to apply variable rate crop protection, e.g. Avadex, or nutrition, such as phosphate at the same time as variable rate seeding. This could allow an even more precise and targeted approach to agronomy and crop management.

Both of these developments could increase efficiency of applications, reduce waste, and have benefits for the local environment. Reduced traffic could also mean improvements for soil quality and lead to reduced fuel usage and lower emissions.



Using technology to identify potential areas for 'green schemes'

RHIZA DIGITAL AGRONOMY

Our RHIZA precision and decision support tools are designed to support the most timely and effective decision making.

These tools harness the power of modern information technology to help reduce the uncertainty and guesswork involved in key management decisions by the most effective analysis, interpretation and integration of agri-intelligence data from a variety of sources.

- Variable rate lime, P&K and nitrogen plans target nutrients and reduce inputs
- Growth stage prediction allows more accurate application timings and planning
- Hyper local weather data helps to analyse and predict pest and disease pressure

CASE STUDY

VARIABLE RATE LIQUID FERTILISER APPLICATION

Location: **Oak Tree Farm near Northallerton**
Sprayer: **Agrifac sprayer operated by Agrii contracting team**
Nutrition applied: **Liquid 13.4% N, 17.5% SO_3 (114kgN/ha at 850l/ha)**

VR map on Agrifac AgLeader display

Phil Reed and his Agrii team created their variable rate (VR) nitrogen plan for Oak Tree Farm using satellite (NDVI) imagery from RHIZA's free Base service. The team didn't end up using any more or less fertiliser than if they'd gone with a blanket approach, but the aim was to apply nitrogen exactly where it was needed, to create more of a level canopy and ensure less wastage to the environment. 'I'm impressed with how this worked' says Mr Reed. 'I'd like to try doing our next VR lime application using NDVI imagery with the Agrii contracting team's lime spreader.'

4 Best practice application guidance

Following best practice guidance for application of plant protection products can lead to increased efficiency, less waste and reduced environmental impact.

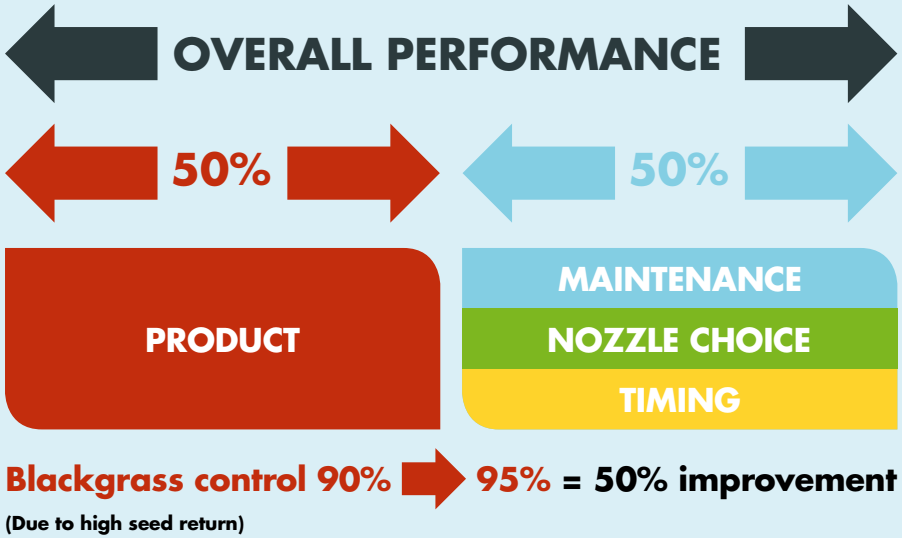
Good spraying depends on:

- Good timing (logistics).
- Good application.
- Good communication.

The Voluntary Initiative
Promoting responsible pesticide use

It is important to:

- Protect both the crop and any environmental payments being received.
- Protect water quality and the pesticides we need to use.
- Have a well managed and recorded spraying system, which will demonstrate compliance and help to protect the environment.



VOLUME OF APPLICATION

- **Coverage of 'canopy'** – larger canopies; higher volumes (soil = large 'canopy')
- **Dilution of actives in tank mix** – can help compatibility and some reduction of crop effect
- **Coverage of small targets;** lower volumes – higher 'loading' of active ingredients
- **Be aware of minimum volumes** supported by manufacturers to comply with Cross Compliance SMR10

SPRAY QUALITY

- **Determines number of droplets produced** at any given volume of application
- **'Fine' sprays** = lots of droplets, good coverage, but potentially more drift
- **'Coarse' sprays** = fewer, larger droplets, less drift but less coverage of a target (especially small ones)
- **'Medium' sprays** are preferred where conditions are suitable

FORWARD SPEED AND PRESSURE

- **Rate controllers increase pressure** to maintain desired application rate with increasing forward speed
- **Increasing pressure** – increases the number of small (driftable) droplets
- **Increasing speed** – increases turbulence and may affect boom height/stability
- **Delivers less consistent application** and variable results

DOUBLE FORWARD SPEED → 4 x THE TURBULENCE

GETTING IT RIGHT – NOZZLE SELECTION

- **First determine your target** – soil/small grass weeds (upright, narrow) or broad leaf (prostrate). Consider if larger leaves are shading small targets.
- **Consider product mode of action** – systemic or contact acting.
- **Select nozzle size according to:**
  – Target application rate.
  – Forward speed.
- **Selection of nozzle type:**
  – Flat fans operate best at around 3 bar
  – Air inclusion nozzles operate better at 4 bar +.
- **BE AWARE of LERAP 3* rating parameters** when operating the nozzle to reduce buffer zones and comply with LERAP/DRT.

3 REDUCING PLANT PROTECTION PRODUCT (PPP) INPUTS

PART TWO

For all, the following steps need to be taken as basic water protection advice:

REDUCING THE RISK

If at least five of the following criteria are met, then the risks to water will be significantly reduced.

		✔ or ✖
1	There is no risk of heavy rainfall within 48 hours of application	☐
2	Field drains are not flowing and unlikely to flow within seven days of application	☐
3	Field slope is less than 5% (1 metre fall in 20 metres)	☐
4	The field is NOT bordered by a watercourse	☐
5	The field has a 6m grass buffer strip adjacent to water	☐
6	There are NO field drains	☐
7	The field has NOT been deep sub-soiled (below plough layer) or mole-drained within the preceding six months	☐
8	The crop has been established with true minimum tillage working the top 4-6cm only by direct drilling	☐

REMEMBER TO...

- **Always read the product label.**
- **Check the MAPP number is current.**
- **Select appropriate nozzle/speed/pressure.**
- **Record soil/weather conditions at application.**
- **Record application details and buffer zone applied.**

IN SUMMARY

- **Select a nozzle type and angle** to deliver the best combination of coverage and drift control.
- **Select the nozzle type** based upon the target and canopy structure.
- **Select nozzle size appropriate** to the flow rate required.
- **Aim to operate flat fans at 3 bar** (not 4 bar) – subject to LERAP requirements.
- **Slower operating speeds** often give better results due to:
  - Maintaining consistent boom height (50cm)
  - Less turbulence
  - Fewer driftable droplets
  - Better canopy penetration

MORE INFORMATION IS AVAILABLE IN AGRII PUBLICATIONS:

- The art of good spraying
- Buffer zones and pesticide applications
- Agrii's virtual sprayer operator courses are available at https://www.agrii.co.uk/events/nroso-training-events/

THE FUTURE OF ENVIRONMENTAL LAND MANAGEMENT SCHEMES (ELMS) 4

There are three new government schemes that will replace both the Basic Payment and Countryside Stewardship schemes.

These ELMS schemes are intended to support the rural economy by rewarding environmental land management whilst also achieving the goals of the Government's 25 Year Environment Plan.

The three schemes are:

SUSTAINABLE FARMING INCENTIVE

This will pay farmers to manage their land in an environmentally sustainable way. The scheme will be made up from a set of standards. Each standard is based on a feature like hedgerows or grassland and contains a group of actions that you need to do. Payments will be based on doing the actions within the standards chosen.

Pilots are being carried out during 2021 before launch in 2022.

LOCAL NATURE RECOVERY

This scheme will pay for actions that support nature recovery and meet local environmental priorities.

The scheme will encourage collaboration between farmers, helping them to work together to improve their local environment.

The scheme will begin piloting in 2022 and launch in 2024.

LANDSCAPE RECOVERY

This scheme will support landscape and ecosystem recovery through long-term projects such as restoring wilder landscapes in appropriate places, large-scale tree planting and peatland and saltmarsh restoration.

The scheme will begin piloting in 2022 and launch in 2024.

"Most farming businesses should actively look well beyond the new Environmental Land Management Scheme (ELMS) to replace lost Basic Payment Scheme (BPS) income. This means careful planning to capture the all-round value essential to make environmental improvements sustainable."

Simon Rollinson, Agrii Environmental Advisor

For the latest information, please get in touch with your usual Agrii contact, or a member of the Agrii Environmental Consultancy Services Team.

These schemes are designed for farmers and other land managers to be paid for delivering the following 'public goods'. We've included after each one, some examples of how these can be achieved on farm:

Clean and plentiful water:

- Water can be physically protected with buffer strips.
- Improvements can be made to NUE e.g. by utilising legumes in the rotation.
- Water storage and rainwater harvesting.

Clean air

- Reduced emissions, e.g. ammonia.
- Take out areas of the farm that are not productive and waste diesel and other inputs – utilise corners and margins and replace break crops where they're loss leaders.

Thriving plants and wildlife

- Build biodiversity on farm e.g. through wildlife margins and wildflower plots.
- Use an aerial map to identify wildlife corridors and join up a matrix of habitats on farm.
- Plant hedges and woodland.

Protection from environmental hazards

- Reduce the risk of flooding and build resilience.
- Build soil organic matter to improve water holding capacity.
- Avoiding bare land, e.g. by including grass in the rotation can reduce sediment losses.

Reduction of and adaptation to climate change

- Improve NUE to reduce ammonia losses.
- Increasing soil organic matter – legume fallows, margins, wildflower plots.

Beauty, heritage and engagement with the environment

- There are likely to be more public access options in future – e.g. we're already seeing new educational options within stewardship applications.

THE SHORT TERM FUTURE

With the loss of direct payments by 2027 and ELMS not likely to make up the shortfall to the bottom line, thinking about a Countryside Stewardship application now can help to bridge the gap: providing both a financial boost and helping to develop experience in what works for your farm.

At the moment, we don't know what the exact details of ELMS will be, however with ELMS being driven by the headlines in the 25 Year Environment Plan, anything put into place under stewardship now will help you to prepare for future funding which will be based on delivery of public goods.

It provides the opportunity to trial approaches that might work on your farm and begin to build your farm's environmental and financial resilience.

5 PROTECTION OF WATER RESOURCES

WATER QUALITY

Water is a key 'public good' listed under the Government's 25 Year Environment Plan. Responsible use of crop protection products and reduced reliance on them (pages 18-24 of this document) both have a key role to play in maintaining and improving water resource quality on and near our farms.

WATER AVAILABILITY MANAGEMENT: DROUGHT AND FLOODING

Climate change brings with it the likelihood of increased instances of extreme weather – including more occurrences of both drought and flooding events.

Improving the farm's general environmental resilience can help to reduce the impact that these more frequent, severe weather events might have, for example:

- **Using cover/catch crops** to reduce erosion and run-off into water courses.
- **Improving soil organic matter** can increase water holding capacity.
- **Paying careful attention to crop and variety choice** based on the prevailing environmental conditions.
- **Correcting drainage issues on site, in advance** – repairing existing drains, looking after ditches, reducing soil compaction.

CASE STUDY

COVER CROPS: SOUTH FARM, TARRANT HINTON

The team at South Farm are currently going through a transition from a predominantly plough-based system to adopting an entirely zero-till system. Three years ago they embarked on a cover crops and soil health project with their Agrii agronomist, Mat Hutchings. The project began with strips of different cover crops, straights and mixes, being drilled and monitored through the autumn and winter. By year two, the team had managed to get the majority of local machinery dealers involved and had also started working closely with Wessex Water.

Together they have designed a chequerboard type trial looking at different establishment systems and cover crop mixes crossed by various fertiliser programmes. The aim is to get the best establishment out of the cover crop, balanced against cost, as well as monitoring nutrient capture and release. Working with Agrii and the farm team, Wessex Water have installed porous pots and taken soil mineral nitrogen (SMN) samples from across a range of plots to monitor nutrient loss.

Following these cover crop trials, differences are beginning to show up in the current spring barley crop. Work will be undertaken to understand the reasons for, and implications of, these differences through the season.

DROUGHT AND THE IMPLICATIONS FOR CROPS

What effect does drought have on wheat? Water is important for tiller survival, optimum grain numbers and specific weight. The effect of moisture stress on yield depends on when it occurs. Towards the end of April the crop has required only a quarter of the total it will need during the growing season, so water stress up to flag leaf may only reduce yields by a maximum of 10%. However water stress after booting and in particular at flowering has a far greater effect, with final yields being down by 40%.

Increase in food requirement for projected population growth needs to be achieved against a backdrop of climate change within which periods of drought are likely to increase in frequency and where sufficient water supply is not guaranteed to meet in season crop demands. The provision of a sustainable source and volume of water to match the dynamic requirements of crops means greater resilience in our water supply capability but also necessitates the adoption of smarter approaches to water management.

RAINWATER HARVESTING

Mains water savings are an obvious draw for those with indoor cattle, pigs or poultry. But faster sprayer filling, fewer spray pump and line problems in hard water areas and no need for water conditioners are proving additional arable attractions in the drive for greater sustainability.

CASE STUDY

RAINWATER HARVESTING PAYS DIVIDENDS FOR ANGUS FARMER

At North Mains of Dun, harvesting rainwater with an Agrii system is saving David and Jenny Warden around a third of the annual mains water bill for their mixed arable, pig and soft fruit business.

Installed 10 years ago, the 10,000 litre above-ground tank system has already repaid the family's investment many times over and still has plenty of life left in it.

"Mains water is expensive," says David Warden. "Especially when you're fattening 3000 pigs a year, each drinking 6-7 litres a day and growing strawberries, blackberries, raspberries and blueberries.

"We have a 4 million gallon irrigation pond filled by natural offline water abstraction from our local watercourse for the fruit we grow as part of Angus Growers.

"Alongside this, capturing rainwater from our 800m^2 livestock shed roof is invaluable. With our pigs alone consuming over 1.5 million litres of water each year, we reckon it's saving us buying around a third of what we need."

"Harvesting water from the roof helps restrict the pressure intense rainfall puts on our farm drainage system," he adds. "So, it's good for the environment as well as our business. Being as sustainable as possible in every way is essential for a small farm like ours. It's all about making the very most of every resource we have and wasting as little of anything as we can – most importantly the water we get free of charge."

CASE STUDY

EAST WRYDE FARM

At East Wryde Farm, consecutive wet winters and increasing blackgrass issues have highlighted the importance of drainage and identified a need to fully refurbish the existing drainage infrastructure – a situation that has been repeated across many farms over the last couple of years.

Background

Located on the edge of The Fens at Thorney in Cambridgeshire, East Wryde Farm is owned and managed by Trumpington Estates. Although there is 81 ha of winter wheat this year, most of the farm is spring cropped, including 320 ha of spring wheat, 278 ha of forage maize for anaerobic digestion and cattle feed, 52 ha of grass silage and 54 ha of sugar beet. There are also 10 ha of game and wild bird cover and some 35 ha of grass margins in Countryside Stewardship alongside most of the ditches. Because of blackgrass issues, cabbage stem flea beetle and weed control challenges, oilseed rape has been dropped from the rotation this year, although it could return to the rotation in the future. Organic matter is returned to the farm both as cattle manure and digestate from neighbouring farms.

A five year drainage plan

Discussions between Estate Manager David Knott and Agrii Regional Technical Advisor Will Foss resulted in the creation of a five-year plan to completely overhaul the farm's drainage system, including re-profiling ditches and clearing land drains, with practical work getting underway at the start of January.

Four ditches maintained by the North Level Internal Drainage Board (IDB) divide the farm into rough management blocks. "The 230ha block, which we are currently focusing on, is

serviced by the Fish Fen Drain running west to east into the New Cut drain, which in turns flows into the Old Wryde Drain to the south of the farm," explains Will. "The IDB provides clear ditches for the farm drainage system to run into. We have a system we can drain into and we have split the farm into four or five management blocks from a drainage point of view."

Most of the field drains run in parallel to each other and straight to the ditches, avoiding the complications of herringbone layouts. The oldest recorded drainage schemes date from 1974 and consist of tile drains, with other later installations in the 70s and 80s, together with a few additions over the last 30 years. After reviewing the farm's drainage maps, the first task this winter has been to mark the location of the field drain outfalls, expose the outfall ends (most of which are fitted with concrete headwalls) and then clear the culverts joining the farm drainage ditches to the IDB ditches.

"Most of the culverts were very silted up and clearing them has allowed the ditches to flow freely," says Will. "The farm ditches are due to be dug out and re-profiled. Whilst some of the drain outfalls sit well above the water level, due to undulations in the fields and the state of the farm ditches, many of them now sit below the water level. We have also located a number of un-mapped outfalls during the initial phase of the works, so there are obviously other drains in place too."

Drainjetting

In early January, the farm took delivery of a new S-S Professional Drainjetter, manufactured in the Netherlands and supplied by Stowmarket-based Mitchell-Rowlands. The £20,000 machine has been specified with a number of optional features including a larger 600m hose reel, a second high-pressure hose for manual use with stubborn blockages, and a fully featured remote control for the arm and hose.

At East Wryde the smaller hose is fed in first to clear any blockages up to 100m from the outfall, followed by the main hose, which is pre-programmed to the length of the drain. The water intake is placed upstream in the ditch to avoid sucking in the dirtier water coming back out of the drain, and the arm is pinned in place at the outfall to avoid it getting pushed back if the hose encounters a blockage.

"One of the concerns is whether the tiles themselves have shifted under the weight of modern heavy machinery," adds Will. "If we find a blockage, at first we don't know whether it's a tile that's shifted or whether the drain has just silted up. A record is kept of every drain as it is jetted with some requiring further remedial action. Thankfully, the majority were backfilled with stone which means most of them should still work well

once they have been cleaned out with the drainjetter and the fields mole drained."

In case the drainjetter encounters a more significant blockage, the farm has invested in a radio tracking device. This is screwed onto the end of the hose in place of the standard head and fed into the pipe. A handheld receiver then locates the signal broadcast from this head, allowing the location of the blockage to be found from the surface.

A long-term project

Will stresses that this is a long-term project that will take several seasons to complete and deliver benefits to the farm. "This needs to be viewed in the context of increased interest in soil health and regenerative agriculture," he says. "There are various basic principles which need to be addressed before farmers get too caught up with new regenerative practices, and in my view, drainage is the most important of these. The immediate practical benefits will be a wider window to work the soil in the right conditions and travel across it with machinery without causing structural damage. It will also help to reduce and manage the blackgrass problem and ultimately produce higher-yielding crops.

"It is also important that we don't create any negative effects, such as leaching of pesticides or nutrients through the drains. As well as careful planning, we will be looking at possible mitigation methods to reduce the potential negative effects of drainage, through the use of silt traps and filters for example. Projects like this show the benefits of farmers talking to their advisors and agronomists and working together to solve longer-term wider management challenges; not just shorter-term in-season crop management."

You can watch the video case study from East Wryde Farm at www.agrii.co.uk/cambridgeshire-farm-improves-field-drainage

5 PROTECTION OF WATER RESOURCES

CASE STUDY

NEWTON PURCELL iFARM

As the local iFarm team have found at Newton Purcell over the last five years, a good mole drain system can go a long way in making up for lack of land drains.

For the last few years, iFarm hosts, Mike and David Markham, have employed a contractor to put in their mole drains but this year they decided to do it themselves. With an interest in classic tractors, combined with wanting a tractor that earned its keep, they purchased a Massey 4840 – a larger version of the classic articulated 1200. They also purchased a single leg Simba Mole plough.

It did not take long for the moles at Newton Purcell to start carrying water in autumn. A well set up mole system can move considerable amounts of water in either augmenting a tile drain system or in this case as a stand alone system.

However it is not just a case of pulling the mole across the field as it is all too easy just to move water from one part of a field to another.

Watch the video to see them and their kit in action, here.

TOP TEN TIPS FOR MOLE PLOUGHING

Courtesy of Professor Dick Godwin and Gordon Spoor.

1. **Check the subsoil** at 450 - 600mm for a clayey soil.
2. **Ensure an appropriate outfall for the drainage water**, namely: clay or plastic field drains and/or ditches.
3. **Ensure that:**
   - The field drains are free of any blockages and have a gravel backfill to connect the water flow from the mole cavity to the field drain, and
   - The outfall ditch is well maintained.
4. **Determine the direction of moling** to provide sufficient "grade" (downhill slope) for the water in the mole drains to flow to either clay or plastic field drains or a ditch.
5. **Mole at spacings** of 2 to 3m wide.
6. **Adjust "long beam" mole ploughs** to avoid a hard scrubbing action – as this will reduce the draught force required to pull the plough.
7. **Use an expander** – trailed behind the mole foot – to clean and smooth the mole cavity.
8. **Ideally undertake the moling operation in a drying cycle** as this gives time for the clay around the channel to "cure" and will improve the life of the mole channel. If conditions are not ideal the mole channel life may be shortened.
9. **The need for re-moling can be assessed by checking the rate of discharge** from the drainage system after the start of a heavy rainfall – if this is sluggish then re-moling may be required.
10. **If there are no clay or plastic field drains** then moling from a ditch is an option, in this case:
    - Ensure that any spoil from the construction or maintenance of the ditch (berm) is removed and/or distributed in the field to avoid a back fall in the mole channel at the ditch.
    - Lower the plough leg into the ditch and draw the plough into the field.
    - Insert a length (c.1m) of pipe into the mole channel entry point to protect the mole cavity and ditch bank from erosion.

Good moling systems should last 5 to 10 years, and should discharge water relatively quickly after the start of rainfall.

RAISING ENVIRONMENTAL AWARENESS

6

TRAINING

As part of our Green Horizons manifesto, we set out to deliver a package of environmental training modules for both our customers and agronomists. Our training programmes will work to complement existing industry courses, such as those run by BASIS, providing a baseline understanding of how to make efficient use of resources.

Knowledge sharing is the driver to success within the industry, and there is a lot of work that goes on both within our trials and also on farm to learn from. Our **Green Horizons Farmer Network** will enable us to work closely with a number of farmers towards our shared goal of sustainable food production. However, through our training programme, we will be able to deliver this knowledge on a wider scale for all our customers.

Throughout 2021, a number of these topics have been delivered through various external webinars (e.g. Enhanced Efficiency Fertilisers) and others through internal training (including webinars on the environment and biodiversity, and regenerative agriculture and soil health). Over the next year, we will be working to develop these topics into an informative training programme, which we aim to offer externally in 2022, consisting of various modules designed to support the **Green Horizons Five Point Plan**.

These modules will be tailored annually to new challenges and opportunities arising, and based on the feedback we receive from our customers and agronomists.

Through these training modules, we will provide topical information along with science-backed data from our trials. By using data to cut through the fact and fiction, we will provide insight into how farmers can work to increase the resilience and sustainability of their farming businesses.

TRAINING MODULES THAT WILL BE OFFERED AS PART OF OUR EXTERNAL PROGRAMME IN 2022:

- ENVIRONMENTAL & BIODIVERSITY UPDATE
- UNDERSTANDING & IMPROVING SOIL RESILIENCE
- HOW TO USE AND COMPLETE CARBON CALCULATIONS USING A CARBON CALCULATOR
- BIOSOLUTIONS: SORTING FACT FROM FICTION
- ENHANCED EFFICIENCY FERTILISERS
- VARIETY SELECTION USING VARIETY SUSTAINABILITY RATINGS
- REGENERATIVE AGRICULTURE & SOIL HEALTH

6 RAISING ENVIRONMENTAL AWARENESS

As part of the Green Horizons initiative, we have introduced an annual Innovation Award to ensure that we continue to welcome and celebrate new innovative ideas from agronomists and farmers.

When deciding new projects, we always consider three core questions:

A Is it providing a solution to one of today's many agronomic challenges?

B Will it increase productivity in a sustainable way?

C Will it improve farmer profitability?

Entries submitted as part of the award could provide ideas on how we:

- **Achieve net zero**
- **Improve soil resilience**
- **Enhance biodiversity**
- **Provide a digital solution**
- **Use nutrients as efficiently as possible**
- **Or anything else that provides a new solution to an agronomic problem.**

Find out more at **www.agrii.co.uk/greenhorizons**

EVENTS

WEBINARS

Members of our environment and sustainability teams have recently given talks on future environmental payments and carbon calculators as part of our live webinar series. You can view past events on-demand **here**.

iFARM EVENTS

You can find out more about our work as part of the **Green Horizons Initiative** by attending one of our regular iFarm or upcoming Net Zero iFarm events. Dates are published at **www.agrii.co.uk**.

Alternatively, please ask your usual Agrii contact for more information, or email **info@agrii.co.uk**

SPRAYER OPERATOR COURSES

We run annual training courses for sprayer operators.

For more information please visit: **www.agrii.co.uk/events/nroso-training-events**

GREEN HORIZONS CHALLENGE PROJECT

At our Midloe Grange Net Zero iFarm, our Green Horizons Challenge Project aims to bring together all of the aspects discussed in this Insight Report to develop and demonstrate 'the field of the future'.

AIM: to devise a way to grow a high yielding winter wheat with reduced conventional inputs, supported by 'green technologies' and following IPM principles.

TARGET: to achieve as close an economic outcome as possible to conventionally grown wheat, with a lower carbon footprint – alongside/as part of a Net Zero iFarm.

R&D AREAS TO BE INCLUDED AS PART OF THE CHALLENGE PROJECT:

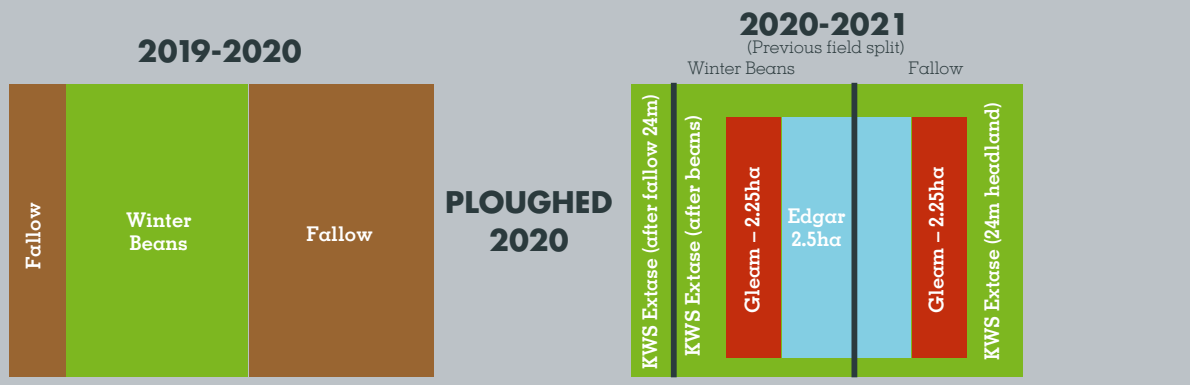
- Varieties/genetics
- Cover crops
- Healthy soils
- Crop nutrition/NUE
- Environmental improvement
- IPM
- Biosolutions
- Water resource quality improvement

This project is being supported by:

CORTEVA agriscience · UPL OpenAg™ · BAYER · BASF We create chemistry · FMC An Agricultural Sciences Company · INTERAGRO THE ADJUVANT EXPERTS

2020-2021 TRIAL PLAN 1

Drilled 19/10/20 All 375 seeds m² Vibrance Duo



Can we use genetics and green technologies to grow a high yielding winter wheat with reduced conventional inputs?

No.	Treatment (T0, T1, T2, T3)
1.	Conventional approach
2.	Targeted PPP & Biosolutions
3.	Targeted PPP alone

Across Gleam and Edgar (ie. 6 treatments x 4 reps)

WATER FROM FARM INTO CATCHMENT... "PUBLIC GOODS'

Water leaving farm

- SSSI 1
- SSSI2
- Great Ouse
- Grafham Water

Collaboration with Anglian Water to improve water quality at 2 exit points

PART THREE

BRINGING IT ALL TOGETHER

Agrii actions relevant across all five Insight Reports:

- Green Horizons Challenge Field of the Future reduced input R&D project (more detail included in the table)
- Agrii annual Innovations Award Scheme (please see page 30 for more info)
- Fast-track biosolutions screening programme (more detail in the table and on page 20)
- Accredited environmental training (please see page 29 and the table for more info)
- Extended enterprise benchmarking
- General company drive towards net zero (please see Insight Report 5 for more information)
- Target of 100% of Agrii trials to include an IPM element by 2022.

This Action Plan will be continually updated as our work progresses.

You can view updates at **www.agrii.co.uk/greenhorizons**

Agrii's Action Plan for Improving the Environment

Action	Details	Timescale	Where to go for more information?
Develop accredited Agrii Environmental Training Programme	Please see page 29 of this Insight Report for more information	Agronomists training delivered in Jan 2021, and then annually. Work is ongoing to develop this into a customer training programme.	**www.agrii.co.uk/greenhorizons** or please speak to your agronomist
Development of three Net Zero iFarms and use of Farm Carbon Toolkit to develop net negative carbon budgets for those sites	Three sites: South Wales, Bishop Burton and Midloe Grange	Net Zero iFarm demonstration sites set up March 2021, annual reports and on-site/virtual engagement events produced by end of 2021	Please see pages 13-15 for more information. Please see our on-demand webinars for presentations on the carbon toolkit options that we have investigated – **www.agrii.co.uk/online-events**
Continued support of the Soil Centre's Soil and Water Conference		December 2021 annual conference	Details of the 2020 conference here: **https://soilandwater.org.uk/**
Sharing of best practice for achieving net zero greenhouse gas emissions through Green Horizons Farmer Network	GH Farmer Network launched Jan 2021. Annual Network event – first one to be held in Jan 2022.	Ongoing, Conference to be held November each year	Updates at **www.agrii.co.uk/green-horizons**
Expand range and use of fertilisers with a low carbon footprint. Aim for 20% of Agrii fertiliser sales to have low carbon footprint (currently at 11%)	Product development and trials ongoing. Internal and external communication programme ongoing. Aim to provide more information on the carbon footprint of the products we sell.	By 2023	More information on page 18 of this document.
Fast-track biosolution screening programme being run with our sister company, Fortgreen, in their cutting edge laboratory and glasshouse facilities.	With Fortgreen, we are trialling more than 130 biostimulants, elicitors, endophytes and biopesticides. With a high failure rate of these products, we are looking to develop a screening method to speed up the trialling process. By putting products through a set programme for testing, we aim to be able to fast track results to our customers.	Ongoing	More information on page 20 of this document.
Launch virtual sprayer operator workshop to maximise best practice	To be supported by ongoing literature and promotion around best practice	First workshop launched 2021 – a new workshop to be available every spring	2021 workshop available at: **www.agrii.co.uk/events/nroso-training-events**
Develop Green Horizons Challenge project	Work being done at Midloe Grange to achieve as close an economic outcome as possible to conventionally grown wheat, with a lower carbon footprint, as part of the Net Zero iFarm work on the site.	2021 onwards	Project updates at **www.agrii.co.uk/greenhorizons/the-environment**
Continue to raise awareness of farmland biodiversity	Develop further wildlife information sheets, podcasts and videos to supplement the current range. Promote these at Agrii events and external events including shows and Open Farm Sunday.	Ongoing	Please visit **www.agrii.co.uk/greenhorizons/the-environment** for all currently available resources. These will be added to as more resources become available. Please also see pages 6-9 of this document.
Support customers in adoption of stewardship measures prior to, and during, the introduction of ELMS		Ongoing	Please visit **www.agrii.co.uk/greenhorizons/the-environment** for updates, or speak to a member of the Agrii Consultancy and Environmental Services Team.

WHERE NEXT FOR MY FARM?

For more information on anything that you've read in this brochure, or to discuss how to enhance the natural environment on your farm, please get in touch with your usual Agrii contact, call us on 0845 607 3322 or email info@agrii.co.uk

You can also keep up to date with the latest news from our environmental improvement projects as part of Green Horizons at **www.agrii.co.uk/greenhorizons**

INSIGHT REPORT:1
IMPROVING SOIL RESILIENCE

This is INSIGHT REPORT:2
ENHANCING THE ENVIRONMENT

INSIGHT REPORT:3
PROVIDING INTEGRATED WHOLE FARM SOLUTIONS

INSIGHT REPORT:4
INCREASING FARM PRODUCTIVITY AND VIABILITY

INSIGHT REPORT:5
EXTENDING STAKEHOLDER ENGAGEMENT

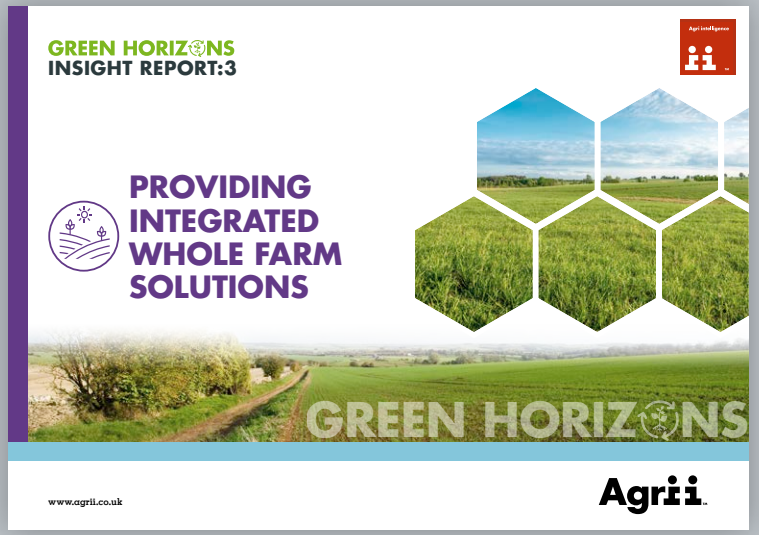
This Insight Report is one of five produced as part of Green Horizons: Agrii's Commitment to Sustainable Food Production.

Find out more at:
www.agrii.co.uk/greenhorizons

The next Insight Report in this series is

Insight Report:3

PROVIDING INTEGRATED WHOLE FARM SOLUTIONS



GLOSSARY

Biodiversity:
Biodiversity is the biological variety and variability of life on Earth. It includes diversity within species, between species, and of ecosystems.

Biopesticides:
A contraction of 'biological pesticides' which includes several types of pest management intervention, through predatory, parasitic or chemical relationships. In the EU, biopesticides have been defined as a 'form of pesticide based on micro-organisms or natural products.' They are obtained from organisms including plants, bacteria and other microbes, fungi, nematodes etc. They are often important components of IPM programmes, and have received much practical attention as substitutes to synthetic chemical PPPs.

Biosolutions:
A biological or naturally occurring solution to a problem. In this context – the possibility of utilising naturally occurring organisms for pest control.

Biostimulants:
A plant biostimulant is any substance or micro-organism applied to plants, seeds or the root environment with the intention of stimulating natural processes, to benefit nutrient use efficiency and/or tolerance to physical (abiotic) stress and/or crop quality traits. This effect is independent of the substance's nutrient content. This means that a biostimulant's main role should not be to provide fertilisation or pesticidal activity. This definition is currently under debate/review.

Buffer zone:
There are several different ways the term 'buffer zone' is used in an agricultural context, including:

- An area of cropped land adjacent to watercourses, ditches or field boundaries that cannot be sprayed.
- A strip of land maintained in permanent vegetation that helps to control air, soil and water quality, and provide habitat for wildlife, and managed separately from the rest of the field.

Carbon balance:
The process of identifying and quantifying carbon in form of carbon dioxide (CO_2) added to, or removed from the earth's atmosphere, due to natural and human activity.

Carbon calculator:
Farm carbon calculators are used to calculate the carbon footprint of a farm, often using the activities and processes on the farm to calculate its carbon balance.

Carbon footprint:
The amount of carbon dioxide released into the atmosphere as a result of the activities of a particular individual, organisation, or community.

Carbon sequestration:
Carbon dioxide is the most commonly produced greenhouse gas. Carbon sequestration is the process of capturing and storing atmospheric carbon dioxide. It is one method of reducing the amount of carbon dioxide in the atmosphere with the goal of reducing global climate change.

Carbon stocks:
The quantity of carbon contained in a 'pool' or reservoir or system that has the capacity to accumulate or release carbon. Soils can be described as a carbon pool.

Climate change mitigation:
Actions that can avoid and reduce the emissions of greenhouse gases into the atmosphere, and actions that can reduce the impact of resultant global warming on populations and practices – improving resilience to the impacts of climate change.

Conservation Agriculture:
The terms conservation agriculture and regenerative agriculture tend to be used interchangeably, but conservation agriculture has three guiding principles rather than five: minimum soil disturbance, maintenance of permanent cover and encouraging a wide diversity of crop species.

CO_2e (carbon dioxide equivalent):
This is a metric measure used to compare the emissions from various greenhouse gases on the basis of their global warming potential. It is calculated by converting amounts of these gases to the equivalent amount of carbon dioxide with the same global warming potential.

Cultural controls:
The practice of modifying the growing environment to reduce the prevalence of unwanted pests. Using cultural control before chemical control can reduce detrimental effects to the ecosystem surrounding the growing environment.

Elicitors:
An elicitor is a molecule that triggers the hypersensitivity response in a plant. Elicitors can attach to special receptor proteins located on plant cell membranes. These receptors are able to recognise the molecular pattern of elicitors and trigger intracellular defence signalling. This response results in increased synthesis of metabolites which reduce damage and increase resistance to pest, disease or environmental stress.

Endophytes:
Often a bacterium or fungus, which lives inside a plant for the entirety of its life cycle without causing apparent disease. Most endophyte/plant relationships are not well understood. Some endophytes may enhance host growth, nutrient acquisition and improve the plant's ability to tolerate stresses such as drought, and decrease biotic stresses by enhancing plant resistance to insects, pathogens and herbivores.

Enhanced efficiency fertilisers:
Forms of fertiliser, including nitrogen fertilisers, designed to reduce nutrient losses to the environment and increase nutrient availability to crops.

Environmental Land Management (ELM):
The ELM scheme is the cornerstone of the UK Government's new agricultural policy. Founded on the principle of 'public money for public goods', ELM will provide a powerful way of achieving the goals of the 25 Year Environment Plan and commitment to net zero emissions by 2050, while supporting our rural economy.

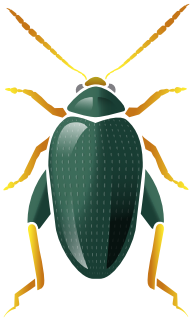
GLOSSARY

More information at https://www.gov.uk/government/publications/environmental-land-management-schemes-overview.

Greenhouse gases (GHGs):
Gases that contribute to the greenhouse effect (or warming of the earth's atmosphere) by absorbing infrared radiation. Greenhouse gases trap heat – they let sunlight pass through the Earth's atmosphere, but prevent the heat that the sunlight brings from leaving the atmosphere. Many GHGs occur naturally in the atmosphere, while others are synthetic. Carbon dioxide, methane and nitrous oxide are all naturally occurring greenhouse gases, however human activity has led to their rapid release into the atmosphere – accelerating the greenhouse effect.

Integrated Farm Management (IFM):
A whole farm business approach that aims to deliver more sustainable farming. IFM combines the best of modern technology with more traditional methods to help deliver profitable farming that supports the natural environment. Attention to detail is key: appropriate and efficient use of inputs combined with smarter approaches to business planning and the adoption of innovations and new technologies, all contribute to increasing productivity while protecting valuable resources.

Integrated Pest Management (IPM):
The careful consideration of all available plant protection methods and subsequent integration of appropriate measures that discourage the development of populations of harmful organisms, while keeping the use of PPPs and other forms of intervention to levels that are economically and ecologically justified. IPM offers a toolbox of techniques that can be tailored to different cropping systems, climatic conditions, pest pressure and availability of solutions. By using a combination of techniques to manage a combination of approaches to crop threats, IPM can be seen as a systems based approach where the entire system effect is greater than the sum of individual components.



Net Zero:
Refers to the balance between the amount of greenhouse gases produced and the amount removed from the atmosphere. We will reach net zero when the amount we add is no more than the amount taken away. The NFU has set the goal of reaching net zero greenhouse gas (GHG) emissions across the whole of agriculture in England and Wales by 2040.

Nutrient Use Efficiency (NUE):
A measure of how well plants use available mineral nutrients. NUE can be defined as yield (biomass) per unit of nutrition input.

Plant Protection Products (PPPs):
Traditionally 'pesticides' that protect crops or desirable or useful plants.

Pollinators:
Any animal that actively transfers pollen from plant to plant, resulting in fertilisation, can be considered a pollinator – this includes birds, bats, insects and small mammals. Pollinators sustain our ecosystems and produce our natural resources by helping plants reproduce.

Public goods:
Public goods are commodities or services that benefit all members of society. Those which form the cornerstone of the UK Government's 25 Year Environment Plan, are:

- Clean and plentiful water
- Clean air
- Protection from and mitigation of environmental hazards
- Mitigation of and adaptation to climate change
- Thriving plants and wildlife
- Beauty, heritage and engagement

Regenerative Agriculture:
Regenerative agriculture is all about regenerating degraded soils to improve soil biology, enhance the water cycle, increase carbon drawdown and improve nutrient cycling. There are five key guiding principles to regenerative agriculture: keep the soil surface covered as much as possible, try to limit physical soil disturbance, integrate grazing livestock into the system, keep living roots in the soil for as much of the year as possible, and encourage a wide diversity of plants and crops to increase soil biodiversity. Please see page 5 for more information.

Soil Organic Matter (SOM):
This is the organic matter component of the soil. It consists of plant and animal tissue in various stages of breakdown, roots and microorganisms, and substances synthesised by soil microbes.

Soil Organic Carbon (SOC):
This refers only to the carbon component of organic compounds in the soil. SOM is difficult to measure directly, so laboratories tend to measure and report SOC.

The hungry gap:
The hungry gap refers to the time of the year when weather conditions are at their harshest and natural food sources for wildlife – such as seeds, berries and pollen – are scarce or unavailable. March to May tends to represent the 'hungry gap' for insects, while December to March represents a 'hungry gap' for farmland birds.

Zero residue food production:
This term refers to the use of organically derived biopesticides and biofertilisers to protect crops and augment their growth.

FIND OUT MORE ABOUT GREEN HORIZONS:

Visit: **www.agrii.co.uk/greenhorizons**

Contact us at: **info@agrii.co.uk**

Go to **www.agrii.co.uk/online-events** to sign up for our latest Green Horizons webinars and view past events

THE GREEN HORIZONS FARMER NETWORK

This network of like-minded Agrii customers is working collaboratively, sharing knowledge and answering its own questions around how to produce sustainable and profitable food. Please get in touch for more information about how to get involved.

CONTRIBUTORS

Clare Bend
Head of Technical

Beth Metson
Agrii Farm Environment Advisor

Amy Watkins
Sustainability Project Manager

Marek Nowakowski
Wildlife Farming Consult

Tom Land
Regional Fertiliser Manager

Andrew Richards
Agrii Senior Agronomist

David Felce
Regional Technical Advisor

Will Foss
Regional Technical Advisor