THE FOUNDATION OF FOOD

- our vision for good soil health

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Introduction

Good soil health is crucial to our farming systems, providing the essential medium to grow our food and the foundation for our varied landscapes. Soils also deliver many wider benefits including sequestration and storage of carbon, diverse ecosystems, regulation of water and resilience to climate change.

David Exwood
NFU Vice President

But our soils continue to face challenges. The impacts of climate change are already being felt and are set to increase the threats to soil health such as erosion and loss of organic matter. Upland and lowland peatlands are valued as an important store of carbon, but these are also areas that are critical to producing food and hence our national food security. Global population growth and the inevitable spread of urban development adds additional pressure to produce more food from our land, at the same time as delivering public goods, such as clean water and mitigating the impacts of flooding events. All these threats and challenges are compounded by a lack of good data and information on the current condition of our soils[1].

Soil degradation is estimated to cost society around £1.2bn per year[2], mainly linked to loss of organic content of soils 47% (of total cost), compaction 39% and erosion 12%[3]. Soil erosion from extreme wind and rainfall, as well as agricultural practices, results in the annual loss of around 2.9 million tonnes in England and Wales. This is estimated to equal productivity losses of £40 million a year[4]. Soil degradation also has implications for flood prevention, with poor quality land less able to retain water.

The NFU's aspirations for **agriculture to become net zero by 2040** and to develop a more **integrated approach to our water management** as well as to deliver healthy food requires a combination of policies and practices. For these ambitions to be realised, and for agriculture to continue to deliver win-wins for food production and our environment, soil health needs to be a national priority.

This report builds on the work done on soils in the NFU's **'Our environment, our food, our future'** report. It shows in more detail the proactive work farmers and growers are doing to improve soil health. It looks at the benefits of good soil management, and the challenges and opportunities that farmers face in protecting and enhancing our soil while producing climate-friendly food.

Our vision

Our vision for the future sees a coordinated industry approach covering the complex and varied nature of the soils ecosystem. It will allow agriculture to anticipate and plan for the impacts on food, fibre and fuel production, driving clear policy through a broad lens which accounts for the needs of farm businesses.

Our soils are sequestering carbon from the atmosphere and building soil organic matter. The abundant biodiversity enables farmers and growers to optimise fertiliser use while improving productivity.

Public money for public goods will sit alongside private finance for additional **positive outcomes on the same land**. Future policy on soil management will be flexible and not oversimplified. ELMs will pay for mitigation and maintenance measures as well as allowing multiple funding streams so that farmers and growers can deliver for soil health, food, fibre and fuel production and the wider environment.

Data collection will be **more reliable and robust** to help farmers and growers make informed management decisions for their businesses. Data will be comparable and meaningful when used for national benchmarking across the nation's diverse soil types.

Following a free nationwide soil-testing programme farmers and growers will be carrying out more data collection and building this into their business systems. Clearer, more easily understood soil health metrics are the starting point in measuring soil performance. With accessible and affordable testing methods, a true picture of the multiple soil types across farms and within fields can be seen. Increased **soil testing** will become a business-as-usual activity as on-farm testing makes it more accessible and economic. Farmers and growers will be rewarded for the good management practices already undertaken to encourage continual improvements.

We will see **better knowledge exchange** with and between farmers and growers on soil health and greater collaboration so that all farmers and growers will be able to participate in the new markets alongside ELMs. Government continues to support through the AHDB and essential industry-led initiatives like Championing the Farmed Environment (CFE), Tried and Tested and the Voluntary Initiative (VI), alongside projects like Catchment Sensitive Farming (CSF). These continue to play an important role in **providing farmers and growers with the knowledge and skills they need to manage their soil better** and ensuring best practice is shared.

The tailored and holistic approach will encourage soil health in all sectors and in all areas of the country while maintaining high levels of food security. Opportunities for sustainable food production will increase in tandem with broader environmental benefits.

Policy landscape

Soil health is of fundamental importance to the agricultural sector and is increasing in significance in a policy context. Latest developments reflecting this shift include:

- The Government's 25 Year Environment Plan making a firm commitment for all of England's soil to be managed sustainably by 2030.
- The Agriculture Act making provision for 'public money for public goods' through the Environmental Land Management scheme (ELMs), including for protecting or improving the quality of soil.
- The launch of the Sustainable Farming Incentive scheme within ELMs, focusing on soil health.
- Soil management being recognised as a key measure in delivering the government's Net Zero Strategy. Existing soil carbon stocks are estimated to be 10bntCO_2 (billion tonnes of carbon dioxide), which is about 80 years' worth of UK total greenhouse gas emissions.[2]
- The England Peat Action Plan setting out actions to prevent loss of peatland habitats and to restore peatland landscapes.
- A recent government commitment aiming to produce a Soil Health Action Plan (SHAPE)[5] to provide a framework of actions to improve and protect the health of soils.
- Additionally, we anticipate government to develop soil health metrics to measure our progress in improving soil health.

Our Policy Asks

Time is not on our side. The agricultural sector is coming together to improve soil management practice. To enable us to continue to be more efficient and to enhance soil health, future government policies should facilitate:

- **Investment in research and innovation.** There is still much to learn about how soil contributes to productivity, biodiversity and climate change. We need to assess the impact of soil management practices on physical, chemical and biological soil health. Research then needs to filter through to farm level in a practical and accessible way. Support for a network of demonstration farms is needed to deliver proof of concept of new technologies. The NFU is supporting **field-scale research and trials** on new soil amendments for landspreading (biochar, enhanced weathering minerals), which can capture carbon; their long-term interaction with soil ecology needs to be evaluated before their possible inclusion in soil management policy.

  The four UK Agri-Tech Centres, alongside publicly funded research organisations and institutes, are working with farmers and businesses across the agrifood value chain to support greater efficiency, resilience and profitability. While each organisation has its own unique focus, our soils are ubiquitous to all farming sectors and systems. Cross-centre collaboration on soils research, innovation priorities and solutions could be a powerful and resourceful contribution to the industry continuing to improve the way we manage our soils.

- **Data collection and processing.** Reliable and accessible measurement, reporting and verification (MRV) methods are needed to benchmark the current situation against future progress, and enable farmers and growers to make informed management decisions. Currently the cost of MRV can be prohibitive. A free nationwide comprehensive soil-testing programme, similar to that seen in Northern Ireland, would accelerate uptake and encourage farmers and growers to incorporate testing in business-as-usual management, which is broader and more frequent than the five year statutory requirement. For grassland farmers, soil testing is relatively new so additional support is needed to interpret reports and advise on implementation. More needs to be made of new technologies like drones, satellite imagery and DNA sequencing to aid data collection. Soil testing should be affordable and accessible to give a true picture of the high variance of soil types both across a farm but also within individual fields.

- **Facilitating the voluntary carbon offset market.** The developing market in voluntary carbon offsets presents both opportunities and long-term implications for agriculture. Farmers and growers need to have confidence that the rules and standards of the market are fair and accessible. The ELMs scheme and other government incentives must work alongside private finance to incentivise action to build further carbon stocks as well as reward maintenance to protect the existing stores. Markets should be accessible across a range of farm sizes, tenures and business structures, and, critically, farmers and growers must be fairly rewarded for the delivery of environmental goods. High quality offsets need to be additional, verifiable and permanent, all of which present challenges for soil carbon offsetting, particularly around soil science and the ability to maintain carbon stocks over time.

  For agriculture to engage in environmental markets at scale, there is a particular need to accelerate the development of a soil carbon code. A UK Farm Soil Carbon Code (UKFSCC)[6] is in development to set the principles and standards required for a soil carbon marketplace for farmers and growers, investors and the environment. The development of a UK-specific soil carbon code is some way off.

  All these factors need to resolve in reputable markets that work alongside the production of food, energy and fibre. The NFU is actively considering whether and how it can play a useful role in helping its members to engage with the emerging soil carbon offsetting market.

- **Incentives** are needed to promote the urgent and widespread uptake of soil management measures which put an extra burden on a farm system.
  - ELMs includes some soil health management options like soil testing of organic matter, applications of organic manures and cover cropping. It now needs to evolve and address nutrient management and reduced tillage if appropriate to the farming system. Payment rates need to act as an incentive to participation. As custodians of the majority of the organic matter and carbon already in the soil we would like to see the conservation and maintenance of these stores properly rewarded.
  - A 'one size fits all' approach could be detrimental to soil health in some sectors and some areas of the country. ELMs should be flexible and accessible if we are to see significant uptake at the scale needed.
  - Stackable payments available in ELMs Sustainable Farming Incentive (SFI) will enable farmers and growers to take full advantage of both public and private funding opportunities.
  - Include soil health management options in any future productivity scheme to help with the costs of capital investment.
- **Flexibility in tenancy agreements.** Tenants, who make up at least 30% of the total land area in England and Wales, are increasingly under pressure from short-term tenancies and high rental costs. The tenanted sector underpins many existing farming businesses and provides an important route of entry for new farmers and growers. Flexibility in tenancy agreements could promote tenants' investment in the land, and in maintaining and managing good quality soil. **Tenancy legislation and private agreements should recognise and reward agricultural tenants for the additional benefit they add to soil quality – such as improving soil organic matter.**
- **Sustainable peatlands.** Peatland management has to prioritise farmers and growers, and sustainable food production. Protecting peatlands such as managing water levels and reducing carbon emissions must align with sustainable production. Policies should incentivise a balance between soil protection and production, and not be overly complex to farmers. Every peatland landscape is different so decisions must be made at local level to tap into the generations of expertise and knowledge of farmers and growers. A specific lowland peat SFI standard could include reduced tillage, grass leys, cover cropping and water management.
- **Knowledge exchange.** A greater exchange of knowledge, with initiatives like **Championing the Farmed Environment** and **Catchment Sensitive Farming** continuing to play a key role in helping protect and improve soil health.

CASE STUDY

We take a whole-farm approach which looks at how we can farm more productively while also managing our soils and the environment. We use drones and other new technology to help us understand the varying soil structures around the Fens, which can include peat, silt, sand and clay. We test the soil for macro and micro nutrients and produce an in-depth soil management plan for each field.

Name: **Charles Shropshire, Managing Director Gs Cambs Farms Growers**
Location: **Cambridgeshire**
Soil type: **Peat, skirt fen, sand, silt and clay soils**
Farm system: **Horticulture and arable**
Farm size: **4500ha**

THE BENEFITS OF GOOD SOIL HEALTH

Well managed soils are good for business, increasing profitability and efficient use of resources.

Food production and security

Healthy soils are the basis for healthy food production and soil is required for 95% of global food production[7]. In 2021, the **UK's overall food self-sufficiency was 60%**. The right environment needs to be provided for farmers and growers to increase our food security, not just for the UK's own food supply but also to help us **lead the way** on the global challenge of food security for a growing population.

The agricultural sector manages around 70% of land in the country, producing high quality, safe and affordable food, while playing an integral part in protecting, maintaining, and enhancing the countryside.

It is our most flexible, productive and efficient land that can best deliver our future food needs as well as non-food uses such as biomass, fibres and pharmaceuticals; it should be protected from other uses as a matter of principle. However, any proposal to change the use of any land away from agriculture should be fully assessed to consider the impact on food production and security, the production methods and carbon footprint of imports, the effect on rural communities, as well as the wider benefits that agricultural land brings for the landscape, the environment and public health.

There are many areas of the country that are iconic in terms of their underlying soil types which characterise the unique food production and agriculture systems they support. For example, the Fens is the largest contiguous area of lowland peat in the UK – one of the most carbon-rich ecosystems in the country – and 33% of England's fruit and vegetables are grown there[8]. In the South East, chalk soils define the mixed farming areas of the North and South Downs and the Greensand Ridge running from Kent through to Hampshire is a renowned fruit growing area. The peat areas of the Dark Peak in the Peak District contrast the nearby limestone plateau of the White Peak. However it is important to remember that soil can also vary greatly even within a field.

Climate change resilience

Well-managed soil is also more resilient to climate change. Increased organic matter in soil can soak up water during periods of rainfall and release it slowly to crops during dry weather, while increased vegetation and soil cover can reduce the speed at which soil dries out. A healthy soil balance of good structure, organic matter, nutrients, soil fauna and flora and skilful management, leads to good yields and increased productivity with reduced erosion. Better crop yields from productive land means less productive land could be used to provide services such as growing trees and storing more carbon.

Carbon storage and sequestration

Soils act as a huge carbon store – the second largest on the planet after the oceans. UK soils currently store about 10bntCO_2 (billion tonnes of carbon), roughly equal to 80 years of current annual UK greenhouse gas (GHG) emissions[2].

The **NFU's goal of reaching net zero GHG emissions** across the whole of agriculture in England and Wales by 2040 is ambitious. There is no single answer to this challenge but improving land management and changing land use to capture more carbon – through bigger hedgerows, more woodland and more carbon-rich soils – are core elements of this ambition. Enhanced soil carbon storage could deliver GHG savings of five million tonnes of CO_2 equivalent a year[9]. In July 2021, the NFU hosted a **soil carbon science workshop** to give clarity on the management activities that promote increased soil carbon and identify gaps in knowledge. The NFU will continue to work with the scientific community to address outstanding questions. Opportunities for building further stores through the conversion of CO_2 by plant photosynthesis and increasing soil organic matter lie mostly in enhancing arable soils. Studies indicate that carbon volumes could be improved in approximately 40% of arable land.[10] In maintaining grasslands, livestock farmers play an important role in protecting essential carbon stores. Many long-term grassland areas in the UK may already be at saturation point depending on soil type.

The regulation of water

As set out in the NFU's **Integrated Water Management Strategy,** well managed soils have an ability to store, filter or slow the flow of water. Appropriate soil cultivation, combined with the use of cover crops and buffering at field margins, locks moisture into soils so that it is available to meet crop needs, keeps more soil and water in the field and reduces the pollution impacts of soils entering water courses. This can also help reduce surface water flooding.

Soil biodiversity

Soil is home to a plethora of life. A single handful can hold billions of individual organisms consisting of thousands of species. Soil organisms such as earthworms, bacteria, fungi, nematodes and mites play roles in key processes such as nutrient uptake and cycling, soil structure and breakdown of organic matter. Maintaining a healthy soil, with a large diversity of species and abundance of organisms, such as earthworms which promote a more efficient response to crop inputs, is known to increase agricultural productivity through the recycling of nutrients from organic material[11].

Soil nutrients

Most commonly measured are the chemical properties of soils; the primary nutrient content, namely nitrogen (N), phosphorus (P), potassium (K) and magnesium (Mg), as well as pH level of the soil, all of which provide farmers and growers with valuable information for effective management.

Soil organic matter

For farmers and growers, profitability may well be linked to the organic matter in their soil[12]; it acts like a sponge and can hold up to 20 times its weight in water, making soil more resistant to drought and erosion[13]. Maintaining soil organic matter is a major challenge for many arable soils. Most soil organisms use organic matter as a food source, leading to nutrients being more readily available for crop roots. Soil carbon is a constituent part of soil organic matter and both are important to the health and functionality of soils. 38% of farmers keep track of soil organic matter and 63% of farmers know the soil types for each field on their farm[14].

CASE STUDY

"We regularly test our soil's nutrients and structure to check the condition of the soil. Healthy soil is less likely to leach nutrients into the water, it will be more resilient, and cheaper and easier to work.

Getting the correct rotation for the soil you have is the key to keeping it healthy. We use a seven-year crop rotation which has been in place for nearly 20 years. Having a longer rotation helps build up nutrients in the soil but it also helps stop root disease problems developing, which can be an issue if you plant the same crops over and over again in a shorter rotation."

Name: **James Beamish, Farm Manager**
Location: **Norfolk, East Anglia**
Soil Type: **Sandy loam over chalk**
Farm System: **Arable, beef and sheep**
Farm Size: **3500ha**

CASE STUDY

Since organic conversion, I've seen an increase in the soil organic matter content on my farm from 2.9% to 5.5%. This change, over a period of 20 years, has been achieved through a number of changes, including the reintroduction of livestock into our rotation and the use of green manures.

Name: **John Pawsey**
Location: **Suffolk**
Soil type: **Hanslope series chalky boulder clay**
Farm system: **Organic arable**
Farm size: **650ha**

FARMING SYSTEMS FOR SOIL

There is no right or wrong farming system and in reality many farmers and growers will adopt a blend of approaches from different systems. Some well recognised systems include:

Organic farming

There are benefits for soil health from organic farming, which alternates leguminous plants that help build soil fertility with "cash" crops. Leguminous plants increase the amount of nitrogen and carbon while allowing a period without cultivation, which helps stabilise soil structure. The fertility building crops are then usually buried or recycled along with weeds by ploughing or livestock grazing. It is an essential part of the process, breaking down plant material to release nutrients to benefit the subsequent crops.

Regenerative farming

Regenerative agriculture is a farming system that is broadly based around principles and practices that restore soil health, and is about increasing the resilience of the farming system. The types of practices associated with regenerative agriculture include the introduction of managed livestock grazing, cover crops, reduced tillage cultivations and use of hedges and trees in the landscape.

Integrated farm management

LEAF's integrated farm management[15] can encourage soil biology as well as enhancing structure, fertility and drainage. This management plan includes diverse crop rotations, reduced traffic farming, cultural control, cultivation techniques and use of natural fertilisers. Cultural control describes how farmers and growers use cultivation techniques like crop rotation, delayed drilling and increased seed rates, to help reduce pest problems.

CASE STUDY

Soil health is at the heart of our farming systems and we are continually learning new ways to improve management.

The introduction of grass and herbal leys complements our existing cover crops and increasing livestock numbers are now grazing them. We're using existing and developing agri-environment options to help build soil fertility and health.

With more organic manures, wider rotations and reduced cultivations our regenerative approach to sustainable food production continues to help build our soil organic matter.

Name: **Tom Dye, CEO Albanwise Farming**
Location: **Yorkshire and Norfolk**
Soil type: **Peats, sands, silty loams and clay**
Farm system: **Arable, pigs, cattle and sheep**
Farm size: **10,000ha**

IMPROVING SOIL HEALTH

A flexible approach to improving soil health will allow farmers and growers to choose the best options for their location.

Cultivations

The cultivation of soil has changed over the years; different systems have developed as technology has advanced. Ploughing is traditionally the primary method of cultivation, and it provides many positive aspects for soil structure – turning the soil, burying the remains of previous crops, releasing nutrients to plants, aerating the soil and controlling weeds – key roles in crop establishment in arable soils. But cultivation releases the carbon stored to the atmosphere as CO_2[8] and it can also have negative impacts on earthworms and other soil organisms, as well as increased energy costs. As climate and weather patterns change, cultivation practices will change as well.

Although not suitable for all soil types or certain weather conditions, direct drilling and minimum tillage have both increased in popularity, driven by improvements in equipment although investment costs can be high. Reducing cultivations lowers costs of crop establishment in the long term through less machinery, fuel and labour costs. However, there are challenges with reduced cultivations such as grass weeds, slugs and surface compaction and this practice is not appropriate for all soils. It is important that the right cultivation practice, introduced systematically over time, is adopted[16].

Nutrient Use

Nutrients are critical for crop growth and good yields. As organic matter decomposes the nutrients are incorporated into the soil and made available to plants. Farmers and growers need to have effective plans in place for optimum nitrogen and phosphorus use[17], and match applications to the growing crop requirements where possible. Excessive use of inorganic or organic fertilisers can have a detrimental effect on the wider environment. Application of nitrogen and phosphorus in organic and inorganic fertilisers decreased between 2000 and 2020, with an estimated soil nutrient balance for nitrogen decreasing by 17% and phosphorus by 27%[18,19]. **Tried and Tested** is an industry initiative to promote good nutrient management, and provides helpful tools and advice to farmers and growers about nutrient management planning.

Soil testing and metrics

Healthy soil has a good balance of physical, chemical and biological properties. Many farmers and growers already routinely test their soil and use the data to maintain or improve crop and livestock productivity, as well as environmental benefits. But **we need to see more farmers and growers testing their soils more frequently.** Testing soil should be accessible for farmers and growers, and it's important to make sure that the soil test and the soil

CASE STUDY

We looked into the concept of no-till farming for several years before buying our own direct drill in 2016. There were some initial challenges, including slug control, but the benefits have included improved productivity, and savings in fuel and machinery costs. It's reduced our greenhouse gas emissions and we've seen an increase in the worm population which is helping to improve the soil. We have reduced fertiliser and agrochemical use, and maintained good levels of yield and crop quality. No-till crop establishment can be challenging, particularly on heavy soils, or with root crops in the rotation, but we're hoping to see increasing crop yields in the future, along with further improvements to the soil and reduced use of crop protection products and fertiliser.

Name: **Philip Bradshaw, arable tenant farmer,**
Location: **Cambridgeshire Fens**
Soil type: **Various soil types including skirt Fen, peat, silt and sand**
Farm system: **Arable, tenanted**
Farm size: **220ha**

laboratory used are consistent to provide more accurate results. The Agriculture and Horticulture Development Board (AHDB) is developing a soil-health indicator system akin to traffic lights and an MOT[20] to guide farmers and growers as they check their land. Using standardised soil sampling techniques to achieve a representative sample is key. The use of location apps such as what3words[21] can locate three metre by three metre squares within fields, giving sampling greater location accuracy.

There are many metrics for monitoring and measuring soil health.

- Diseased leaves, weeds and areas of bare soil provide indicators to allow precision application.
- Leaf nitrogen analysis: Mobile apps can perform leaf nitrogen analysis to assess more accurately a crop's requirements from the soil.
- Remote sensors collect soil data at varying landscape scales.

Visual assessments can be readily carried out by non-soil scientists and include the scale of friability or compaction, size of clods, root density, penetration resistance, bulk density, infiltration rates, earthworm counts. **How to count earthworms.**

Developing technology is allowing farmers and growers to use drones to pinpoint and manage larger data sets.

Most soil carbon offset companies are now using a hybrid measurement approach, from sample testing to digital mapping, remote sensing, satellite tracking and modelling. Baselines have become more sophisticated, tracking against how previous farming practices would have performed in current climate conditions to assess the difference achieved with new farming practices. This dynamic baseline approach allows for natural fluctuations, so that if for example there was a drought, CO_2 would be released, but less so than under the old farming practices.

Improving and maintaining organic matter

Cover crops are crops that are not harvested but are grown to protect and enrich soil between periods of regular crop production. They help add organic matter to the soil, reduce erosion and run-off caused if soil is left bare, increase soil biodiversity, conserve soil moisture and help protect water quality. Between 2014 and 2015 the total area of cover crops, nitrogen fixing crops and fallow land increased by 45%, 29% and 19% respectively[17]. Cover crops are not suitable for every situation, for example their use can depend on soil type and rotation.

Role of organic manures

Farmyard manures and alternative organic sources such as digestate, compost and biosolids, can increase soil organic matter in arable soils, provide valuable sources of nutrients such as nitrogen, phosphorus, potassium, phosphate, sulphur and magnesium[22], and improve soil structure. Increasingly, farmers and growers are conscious of the importance of checking the nutrient contents of organic manures and testing soils to ensure these sources are suitable for and complement crop production. However there are limitations. Quantities required to achieve optimum nutrients may exceed regulatory application levels. Overall supply is finite and availability depends on location.

CASE STUDY

A thriving soil biology is reliant on the nutrients generated through photosynthesis by growing plants for nourishment. This has led us to include cover crops in our rotation, initially using stubble turnips but now with a broad mix of varieties. The variety of root depths and structures helps with drainage and improves soil health. The use of cover crops has brought other advantages too, with above-ground insect numbers thriving which is attracting increased numbers of farmland birds.

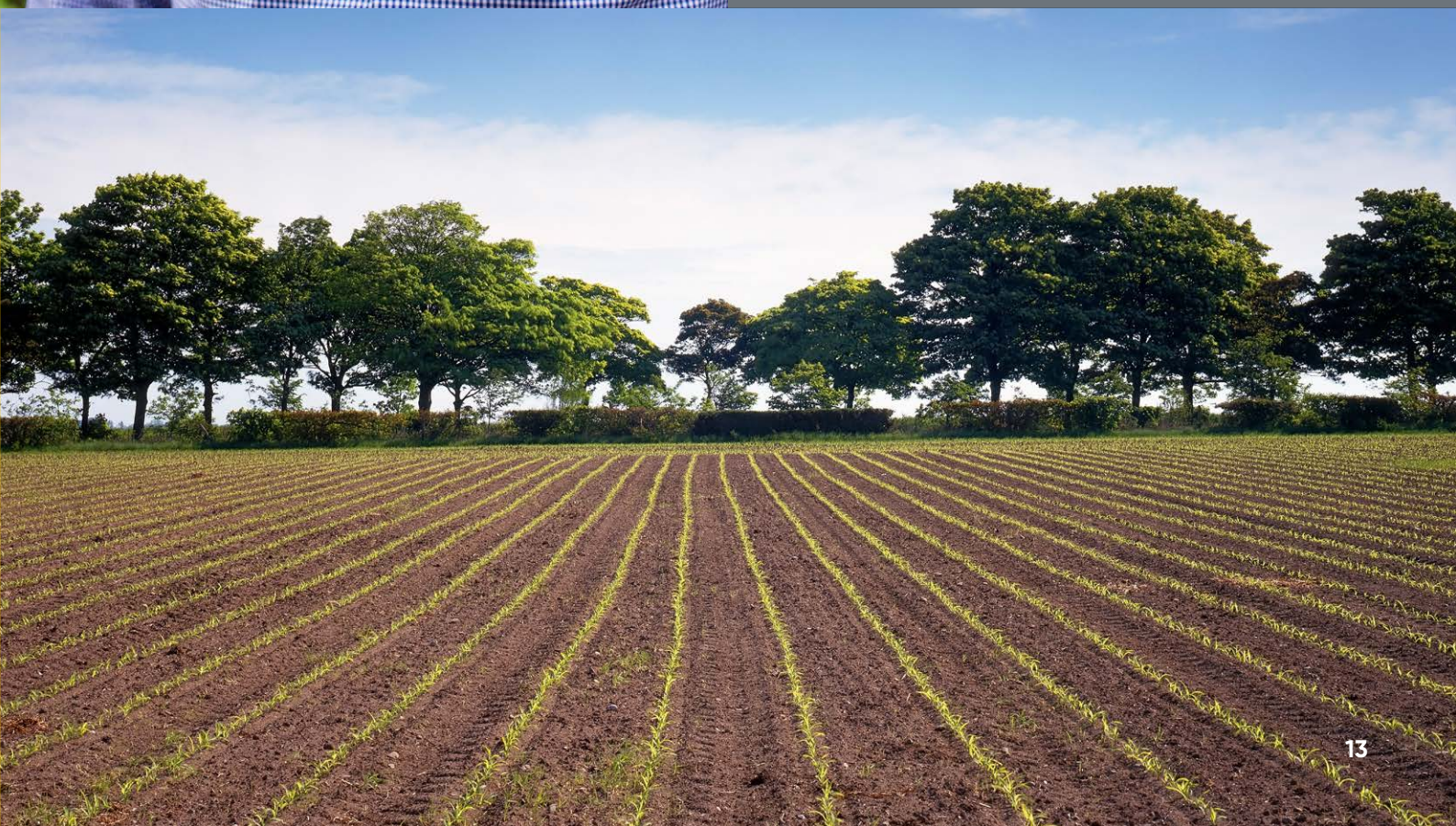
Name: **Caroline Knox, owned & tenanted land**
Location: **Arreton Valley, Isle of Wight**
Soil type: **Sandy loam**
Farm system: **Arable**
Farm size: **400ha**

CASE STUDY

Being an all livestock farm, we value organic manures as an important resource. Returning slurry and farmyard manure back to the land is essential for soil health as it is an excellent source of nitrogen (N), phosphorus (P) and potassium (K) – essential nutrients for our upland grassland to thrive and feed our grazing livestock.

The spreading of organic manure is beneficial for soil health and helps us to build the organic matter back into our soils. Upland grassland is a valuable carbon sink. So it is vital that we do this to maintain our soil carbon stocks, decrease our reliance on expensive manufactured fertiliser and cut our carbon emissions. Provided best practice is used, this is a good example of resource use efficiency.

Name: **Robert Brunt**
Location: **Peak District, North West**
Soil type: **Heavy loam**
Farm system: **Dairy, beef and sheep**
Size: **190ha**



Crop rotations

Crop rotations build up soil health and soil fertility, and are an important part of integrated pest management. Longer rotations with a variety of crops can help combat pests, weeds and diseases[23,24] and increase diversity in the farming landscape. Mixtures of crops including cereals, oilseeds and higher nitrogen content crops like forage or grain legumes provide a diverse source of food for soil organisms which, in turn, recycle nutrients.

Inclusion of grassland in rotations

Including medium term (three to five year) grass leys in arable rotations can improve soil organic matter through grass root growth[25]. Where systems can use livestock it can also help control grass weeds, like black grass, by preventing fresh seed shedding. As with cover crops, introducing herbal leys with plants that root at different depths also helps soil structure and builds fertility[26], with deeper roots helping to break up compacted soil.

Agroforestry

Introducing more trees into the farming landscape could help restore degraded soil while allowing a productive growing system where trees and crops and/or livestock share the space. As set out in the **NFU's Tree Strategy,** choosing the right tree for the right place is fundamental to the success of trees in a farming landscape. Trees can also provide additional income streams through fruit or nut crops and coppicing, as well as benefits such as more wildlife and water conservation.

Reduce compaction

As the weight of machinery travelling across farmland has increased, so has compression of the soil structure leading to compaction. The implications are numerous – poor plant root development, restricted plant growth, reduced nutrient recycling and lower yields. Livestock can also compress soils in wet conditions, leading to poorer water infiltration, nutrient losses and flooding.

Adopting practices like controlled traffic farming (CTF) reduces soil compaction by limiting all farm machinery to fixed tramlines across fields. This means that machinery will drive on 25% to 40% of the field during farming operations in one season using CTF, compared to 85% in a conventionally ploughed field[27]. Improvements in soil structure due to CTF can lead to increased yields of between 15-30%, better nutrient uptake, reduced erosion and improved water infiltration so more water is available to crops and the risk of flooding is reduced. Farmers practicing CTF have seen improvements in biology, a reduced need for deep cultivations and lower labour and fuel costs. CTF can be used on any arable, grassland, mixed or horticultural farm. It works well with no-till or min-till farming[28]. In addition some farmers are using machinery with offset wheels to spread the load over a wider area.

CASE STUDY

We have never really had a soil erosion problem on the farm but extreme rainfall events in recent years have highlighted some of the higher risk areas, particularly where we have had poor establishment of winter crops. Minimising soil compaction and ensuring that all field operations promote a good soil structure is a very high priority for us as well as maintaining a fully functioning field drainage system. We do have 12m margins along water courses where there is any slope and this has definitely served to protect our water from soil run-off in recent years. Winter cover is also very important, either in the form of a winter crop or intact stubble.

Name: **Saya Harvey**
Location: **Leicestershire**
Soil type: **Heavy clay soils**
Farming system: **Arable**
Farm size: **120ha**

Drainage maintenance

Good drainage is essential for healthy soil, productivity and resilience against climate change. It extends grazing seasons on grassland and improves the workability of arable land, promoting good crop establishment. Poorly drained soils are slow to warm in the spring, increase weed burdens, and reduce the length of the growing season and compromise harvesting. Effective drainage reduces waterlogging after periods of heavy rainfall, which prevents damage to the soil structure and greenhouse gas emissions of nitrous oxide. The increased infiltration reduces the likelihood of surface erosion and losses of nutrients and sediments to watercourses, as well as reducing the risk of compaction[29]. Heavier soils benefit from well-functioning drainage systems, which in conjunction with good soil porosity and organic matter levels, can provide twin benefits of reduced flooding and increased water holding capacity.

Successful drainage, as part of integrated water management, brings multiple environmental benefits on top of boosting productivity. Controlled drainage is a long-term and significant infrastructure commitment requiring investment, which can be an issue for tenant or contract farmers. Riparian buffer strips provide environmental drainage helping prevent erosion, collect sedimentation and reduce nitrate run-off.

Peatland management

Organic and peat soil make up 11% of England's total land area. Only 13% of England's peatlands are in a near natural state. However, modern farming systems are evolving to better manage peat and optimise the potential of varying grades and classes of soil, including silt and clay soils. To protect peat and high value vegetable crops, farmers and growers are utilising cover crops. There is also increasing adoption of peat conservation practices such as subterranean and trickle irrigation, precision farming (which uses machinery guided by satellite technology), minimum till technology, and no-till technology.

The Fens is the largest contiguous area of lowland peat in the UK – one of the most carbon-rich ecosystems in the country[8]. The Fens cover less than 4% of England's farmed area but produce more than 7% of England's total agricultural production. In the Fens, agricultural production is worth £1.23 billion and the whole food chain, from farm to fork, generates more than £3 billion a year for the economy. 80,000 people are employed across the whole food chain in the Fens. Loss of such areas would likely **increase our reliance on imports.**

While Defra research has established that lowland peats in England and Wales are large sources of greenhouse gas emissions, it concludes that major emissions reductions appear achievable through changing the management of agricultural peatlands[8]. This could include reduced tillage, grass leys, cover cropping and water management, which could be introduced through ELMs SFI.

Whilst the uplands may represent better opportunities for restoration, in order to ensure the long-term future of sustainable farming businesses delivering at reasonable cost, we are not convinced by the argument that 'all blanket bog can be restored'. The value of uplands farming, both economically and environmentally, must not be overlooked. The **uplands contain** 44% of England's breeding ewes and 40% of England's beef cows.

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