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Can Maincrop potatoes be grown in a regenerative system?

Written by:

James Pick NSch

June 2025

A NUFFIELD FARMING SCHOLARSHIPS REPORT

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ISBN: 978-1-916850-71-2

Published by The Nuffield Farming Scholarships Trust
Bullbrook, West Charlton, Charlton Mackrell, Somerset, TA11 7AL
Email: office@nuffieldscholar.org
www.nuffieldscholar.org

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Date of report: June 2025

"Leading positive change in agriculture. Inspiring passion and potential in people."

Title	Can Maincrop Potatoes be grown in a regenerative system?
Scholar	James Pick
Sponsor	The Alan and Anne Beckett Award
Objectives of Study Tour	1. To understand how growers are implementing regenerative practices in global potato production. 2. Explore what changes can be made to standard farm practice in UK whilst still growing high yielding crops. 3. Create a plan for reducing high input demands for UK potato crops.
Countries Visited	Canada, USA, Australia, New Zealand, France, Belgium, UK
Messages	1. Regenerative agriculture is here to stay and potato producers have to find a way of making it work on their farm. 2. The years in between potato crops being grown are of greatest significance for driving positive soil health results. 3. Reductions in inputs are not viable without long term investment into soils; biology is going to be key in reducing input needs. 4. As soils improve, the cultivation requirements needed to establish a crop will reduce significantly, whilst returning to their original state of health faster following the potato crop.

EXECUTIVE SUMMARY

Potatoes are the third most important food crop globally. Grower numbers are dwindling in the UK and the cropped area is down nearly 30% since 2017. As farmers become more conscious of their soil's health, potatoes often find themselves as the first crop dropped from rotation. Burgeoning input costs and extreme weather events are also hampering the UK potato sector with poor returns being common recently on many farms. These issues can be addressed if a clear method is demonstrated that shows potatoes do not have to negatively impact soil management.

This study was conducted to establish how growers are implementing regenerative principles into the cultivation of potatoes, explore how these principles can be applied to the UK's soils and climate, and to create a plan for potato growers to reduce artificial inputs whilst still growing high-yielding potatoes.

I travelled to farms displaying the most innovative systems focused on regenerating soil in Canada, the USA, Australia, New Zealand and finally Belgium and France, countries with a maritime climate much like our own.

Growing high yielding crops of potatoes whilst improving soil health can be achieved in many ways, however, the most successful farms all tend to follow the five principles of regenerative agriculture:

1. Minimise soil disturbance.
2. Diversity through rotation
3. Keep the soil surface covered.
4. Maintain living roots.
5. Integrate livestock.

Despite some of these principles not lending themselves directly to potato production as a stand-alone principle, combining them can yield excellent results. Increasing numbers of arable farmers are recognising these benefits, and potato growers will, too, when following regenerative principles and applying them according to their specific goals.

Simple actions such as growing a well-established cover crop instead of leaving the ground fallow, and reduced cultivations throughout the crop rotation, leads to improved soil structure and reduces the cultivation needs of subsequent potato crops. The introduction of livestock and diversity into rotations further enhances the health of the soil and, over time, less fertiliser and pesticides are needed. Not only will soils begin to function better, but they will also bounce back from the major disturbance events of establishment and harvesting more quickly.

In conclusion, this report demonstrates the viability of main crop potatoes grown in a regenerative system. Integrating regenerative principles, such as minimal soil disturbance and maintaining living roots, results in multiple benefits including improved soil health and greater soil and crop resilience. While challenges during the transition to a regenerative system will be encountered, the long-term benefits on both the soil and a farm's profit margin can be substantial.

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The opinions expressed in this report are those of the author alone and not necessarily those of the Nuffield Farming Scholarships Trust, of the author's sponsor, or of any other sponsoring body.

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CHAPTER 1: INTRODUCTION

Figure 1: The author James Pick with his partner Lucy. Photo: Author's own.

Growing up in a rural East Yorkshire village meant agriculture was all around me and, like many other young children, I was tractor mad. As a slightly mischievous child, my obsession came to an end when we moved onto the family farm and I wasn't allowed into the yard for health and safety reasons. My pursuit to become a professional cricket player ensued. In the following 10 years I went on the represent and captain Yorkshire at age group and academy levels and play for the North of England in the national U15's tournament, Bunbury.

It wasn't until I left sixth form aged 18 that I found my love for agriculture again, or more specifically, soil. I intended to have a year on the farm to decide what subject to study at university and six years down the line I am still here with ever growing enthusiasm.

Inspired by authors such as Gabe Brown and farmers in the UK such as Ben Taylor-Davies, my farming philosophy slowly developed alongside my love for the natural world instilled in me by my late grandfather. In hindsight, I entered the agricultural sector at the same time as regenerative agriculture was entering the mainstream.

Working alongside both my parents, Dave and Liz, and my grandad, Henry, we farm around 260ha of arable crops and rent 150ha for potatoes, supplying a local customer, R S Cockerill Ltd, with both pre - pack and crisping potatoes. I am committed to making sure there is always space for nature to thrive in our small area of the countryside, a legacy and passion instilled in me by my late Grandad, Donald.

Away from work I spend my time with my red Labrador, Polly, watching and playing sports or travelling and finding great places to eat with my girlfriend, Lucy.

CHAPTER 2: BACKGROUND TO MY STUDY SUBJECT

The future of potatoes hangs in the balance on many farms across the UK, with considerable numbers having already taken them out of their rotation. This is due to multiple reasons: extreme weather events (such as droughts in 2018 and 2022 and heavy rainfall events in 2019 and 2020), rapidly increasing input prices, labour shortages and land availability, amongst others. These challenges occurring simultaneously has led to the UK cropped area dropping very considerably over the past few years, from 122,779ha in 2017 (AHDB) to an estimated 102,000ha in 2023 (World Potato Markets). For some, the risk has finally overtaken the reward.

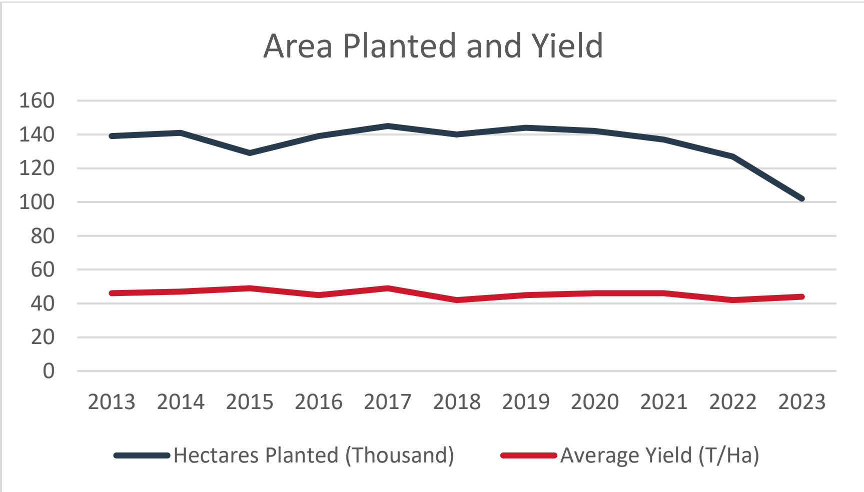

Figure 2: UK potato area. Photo: Adapted from AHDB and World Potato Markets data.

This risk is no different for our family business. Conversations have been had many times at our kitchen table about the viability of the crop in our current system as we are largely on rented, unirrigated land (90% of our potato rotation).

After the drought in 2018 and difficulty harvesting crops in late November 2019 and early December 2020, I realised we had to change the way we were trying to grow potatoes and increase the resilience of both our soil and system. At this stage my understanding of soil functionality and resilience were minimal. I understood basic concepts of how to improve soil, but I knew doing this in conjunction with potato production was going to be difficult.

Another great challenge to the business is finding land of high enough quality to rent to grow unirrigated potatoes. As more farmers look to farm in a more regenerative manner, they don't see potatoes as part of the picture.

CHAPTER 3: MY STUDY TOUR

My Nuffield travels allowed me to visit areas growing some of the largest volumes of maincrop potatoes, as well as some lesser-known places.

Where	When	Why
Canada and USA	May/ June 2022	Some of the largest players in maincrop potato production reside in Canada and USA. This trip allowed me to visit growers, breeders and processors who are some of the largest in the world, all whilst trying to build soil health.
Australia and New Zealand	October/November/December 2022	Australia and New Zealand have pockets of potato growers. Growers in both countries are globally renown for producing crops in testing conditions.
France and Belgium	February/ March 2023	Large areas of maincrop potatoes are grown on the European Plain. Soil health has been a growing focus in certain areas for many years with cluster groups of potato growers in northern France and Belgium being formed. Access to such knowledge in a relevant climate is invaluable.

CHAPTER 4: THE SOIL FRIENDLY POTATO CONUNDRUM

Potato farming traditionally involves methods that can lead to soil depletion, erosion, and chemical dependency. Conventional potato cultivation often relies heavily on tilling, synthetic fertilisers, and pesticides to achieve high yields. While these practices can be effective in the short term, they contribute to soil degradation, reduced biodiversity, and long-term unsustainability. This scenario is in stark contrast to the principles of regenerative agriculture, which aim to restore and enhance the health of farming ecosystems and soils.

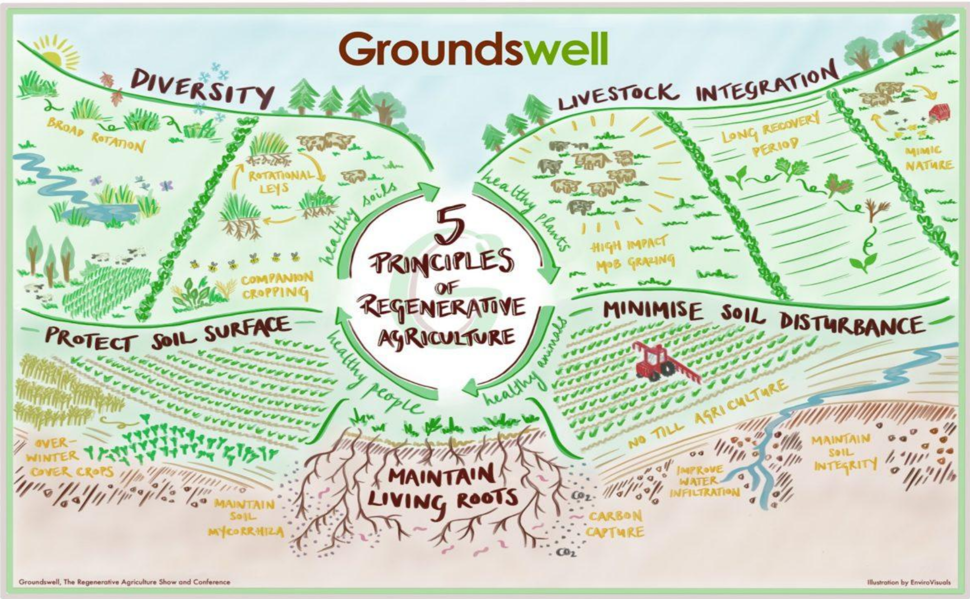

Figure 3: Five Principles of regenerative agriculture. Photo: Groundswell Ag.

Regenerative agriculture emphasises soil health, biodiversity, and the integration of more natural processes to improve crop resilience and environmental sustainability. Techniques such as cover cropping, reduced tillage, and maintaining living roots are fundamental to this approach, promoting improved soil structure and fertility while reducing the need for chemical inputs. When applied to potato production, regenerative practices can mitigate the adverse effects of conventional methods by enhancing soil organic matter, supporting beneficial microorganisms, and fostering a more resilient agricultural system through improved soil health and functionality.

The juxtaposition of conventional potato farming and regenerative agriculture highlights a critical shift in agricultural paradigms. While traditional methods focus on immediate yield maximisation, often at the expense of long-term soil health, regenerative practices offer a holistic approach that balances productivity with ecological integrity. This shift not only addresses the environmental impact of potato cultivation but also opens pathways for sustainable food production that can adapt to changing climate conditions and support biodiversity.

In this chapter I shall summarise the implementation of some of the regenerative practices in potato production.

4.1 Soil disturbance in potato cultivation

4.1.1 Establishment

Soil disturbance and potato production have gone hand-in-hand since the first crops were cultivated. The standard tillage passes for potatoes include deep subsoiling, inversion/non-inversion deep tillage, followed by bed-forming, bed-tilling and finally stone separating before planting the seed, with some of these passes (deep tillage or bed-tilling) often done multiple times. This goes directly against the principle of minimising soil disturbance.

The aim of tillage for potatoes is to create a fine seedbed to plant the seed into to ensure the seed has good soil-seed contact. This fine seedbed is desired to reduce disease susceptibility and increase the efficacy of pre-emergence herbicides to decrease weed pressure. It can also mean soils hold onto moisture better as the surface is 'capped'.

By creating this fine seedbed with intense tillage, the structure of the soil is being degraded and the particulate size of the soil decreases. Both impacts can lead to compaction, poor drainage and an anaerobic soil, which, in turn, will lead to poor rooting from the crop and an increased risk of soil erosion - one of the biggest issues surrounding growing potatoes. Furthermore, soil microbial communities will be seriously damaged by repeated disturbance and potential anaerobic conditions, especially the fungal population which is vital for nutrient cycling, water availability and pest, disease and pathogen suppression.

Whilst tillage is going to remain necessary to grow potatoes with current technology, recreational tillage is common place and partly to blame for plateauing yields globally; it also takes soils longer to recover from the intense tillage and harvesting processes.

4.1.2 Case Study: Buckley Farms, Mount Gambier, South Australia

Terry Buckley at Buckley Farms, South Australia, is a potato grower producing over 20,000T annually. Buckley farms use minimal soil disturbance throughout their rotation meaning they complete a rotational cycle from one potato crop to another with just seven disturbance passes - this is largely possible due a five or six year rotation which includes potatoes and pasture for sheep.

The soils at Buckley farms are a sandy loam meaning they are prone to capping. After years of over cultivation, Terry began to see nematode and disease problems such as pink soft rot, verticillium wilt and early dying.

To counteract these problems Buckley Farms began to cultivate less intensely to try to introduce more air into the soil, with a shallow pass of a power harrow followed by a pass of a Vaderstad Topdown to mix the ley residue into the soil and create tilth to form the seed bed. Once the crop is planted, a further pass is made with a custom cultivator between the potato rows and to remove all wheelings and to further introduce air into the soil and remove any compaction.

Buckley Farms have also moved away from the standard 85cm rows to planting two beds with three rows. Tractors have been adapted to straddle two beds to remove every other wheeling previously created.

As a result of increased air throughout the soil profile, a lower bulk density of the soil, and an overall increase in soil health, not only has Terry seen greater yields and quality, but the disease and pest pressures have been greatly reduced. Terry puts this down to an increased population of fungi in his soils which are feeding on the nematodes and soil-borne diseases.

Figure 4: Planted beds of 2 x 3 rows, Buckley Farms. Photo: Author's own.

4.1.3 Case Study: Chad Berry, Under the Hill Farms, Cypress River, Manitoba

Like many areas around the globe, Under the Hill Farms are prone to wind erosion on their light soils. To try to counteract this, as well as to save fuel, increase water infiltration and reduce soil disturbance, Chad Berry has had a Spudnik planter adapted to direct plant. This means that potatoes can be established with just two passes, an autumn 'deep rip' (deep subsoiling) and a final pass with the planter, injecting fertiliser, planting the seed and forming the rows all in one pass.

After trials in 2020 and 2021, it has been determined that soil erosion is reduced due to having nearly 35% more residues left on the surface of the row. It also means there is a greater capacity to hold onto water when applied.

It has been noticed that the potatoes emerge one to two days slower when direct planted, however, this doesn't translate into a yield decrease with no significant yield response. It does, however, save both fuel and time against the farm standard of two deep tillage passes in spring prior to planting.

Unfortunately, when I visited in May 2022, a very wet winter meant a tillage pass was necessary to dry the soil to enable the planters to run and I didn't get the chance to see the direct planter in action.

Figure 5: Planter adapted for one pass planting, Under the Hill Farms. Photo: Author's own.

Key Messages

- Soils will recover from the major disturbance of potato cultivation and soil health will increase over the rotation cycle if not over-worked/broken down into too small size particles.
- Leaving residue on the row surface will lead to significant reductions in soil erosion.
- Moving less soil will not lead to a reduced yield if done correctly.

4.2 Diversity of species

Many farms I visited focused on the integration of a variety of plant species within the potato cropping system. This included cover crops, companion crops, and a broad rotation which enhanced soil health when implemented correctly.

Cover crops are commonly used to fix nitrogen in the soil, reduce erosion, and improve soil structure. Species such as oats, radishes, phacelia, buckwheat, vetches, and beans/peas are commonly used. These plants also can create a habitat for beneficial insects and microorganisms, further enriching the ecosystem and soil microbiome.

Companion cropping potatoes with flowering species that attract pollinators, such as buckwheat and beans, can reduce pest pressures naturally. With the latter being a legume you can also take advantage of the symbiotic relationship between the plant and soil microbes that will help fix nitrogen. Whilst companion cropping can bring some positives to your potato cropping, it can limit your herbicide choices greatly and more research is needed on the impacts it can have on fertiliser and pesticide demands.

4.2.1 Case Study: The Perry Family Farm, Chin, Alberta

When visiting Canadian scholar Harold Perry, I saw first-hand the impact a wide rotation featuring a broad spectrum of species in both cash and cover crops can have on soils and potato cropping. Harold grows cereals, brassicas, legumes and cover crops including up to 16 species in rotation with potatoes.

Harold selects cover crop species that won't affect the establishment and growing of potatoes. He cites some of the risks of cover cropping as hosting pests and diseases, introducing new weeds, and potential complications with residues at planting. Over years of growing cover crops he has tailored his mixes to mitigate these challenges. For example, he has phased out phacelia which is a host to root-knot nematodes.

Figure 6: Fava beans growing, The Perry family farm. Photo: Author's own.

4.2.2 Cover crops: Finding their role on your farm

The farms who were gaining the most from their cover crops had clear goals in place before a seed was sown. They simply asked themselves 'What are we hoping to achieve from this cover crop?' Or 'Why are we planting this?' What differed between each farm was what each individual farm hoped to gain.

Whilst some farms were using single species cover crops such as Brown Mustard to bio-fumigate and reduce reliance on nematicides (or Bento oil radish for similar purposes), the general trend was to use multiple species from different plant families. By having a mixture of grasses, legumes, brassicas and broadleaf plants, the land is less vulnerable to climatic and soil conditions. Harnessing the synergistic effect of multiple species, you are more likely to have plants growing in areas where a single species may fail due to fertility or environmental factors. In addition, you are more likely to have multiple areas of soil improvement, rather than just one as can be the case with single species.

4.2.3 Reduced cultivation demand

I have seen repeatedly over time how cover crops alter soil structure prior to planting a potato crop through increased soil aggregation, increased organic matter in the form of roots and exudates, and the stimulation of beneficial microbial activity.

The roots of cover crops and the relationships they foster with arbuscular mycorrhizal fungi (AMF) in particular helps bind soil particles together. Mucilage and other exudates, and Glomalin are secreted by roots and AMF respectively, which bind to soil particles and help to increase soil aggregation and aggregate stability in turn. As such, hosts to AMF such as: oats, beans, clovers, sunflowers and linseed should be included in cover crop mixes to try and build a larger AMF population for the following potato crop, which are also hosts. Whilst one cover crop containing hosting species will only have a small impact, implementing this throughout the rotation will deliver more sizeable changes. Cultivation will, however, break up these fungal chains.

Deeper, tap rooting species such as radishes alongside more fibrous, deeper rooting species namely buckwheat, sunflowers and some clovers can help to alleviate deeper compaction layers traditionally caused by traffic or ploughing at a constant depth. Incredible pressure is delivered by root tips but sometimes metal is still needed to break through the toughest compaction layers.

Partnering shallow, more fibrous species with deep-rooting ones eliminates the need for extra cultivation like ploughing or bed-tilling before planting.

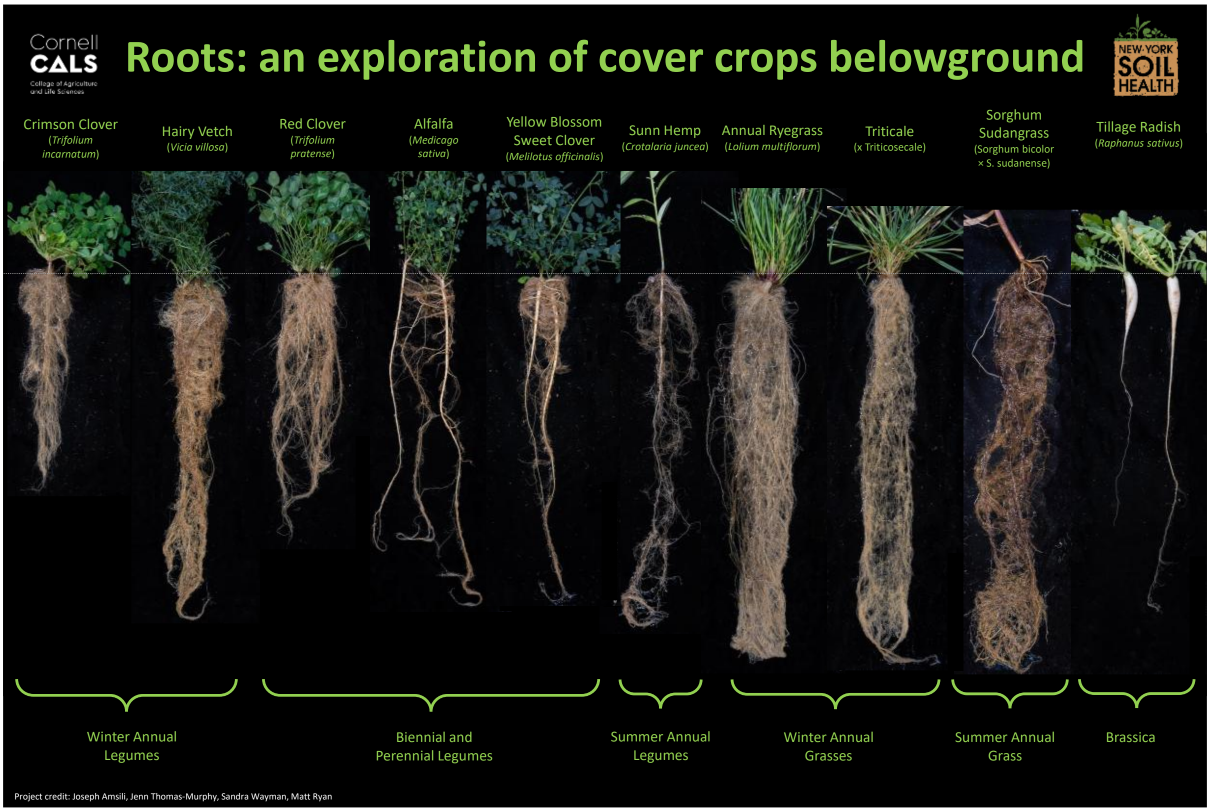

Figure 7: Differing root architectures from cover crop species. Photo: New York Soil Health Initiative.

4.2.4 Case Study: McCain Farm of the Future, Florenceville, New Brunswick

Farming in New Brunswick is no easy task. With steep hills, high rainfall and light soils, soil erosion is a major consideration before carrying out any task in the field. To combat this, the Farm of the Future has moved to creating rows (hilling) in the autumn and sowing a cover crop containing rye, vetch, buckwheat and clover. The fibrous root systems and quick biomass development of these species means the rows gain cover above ground to protect against wind and heavy rainfall, whilst the roots create stability within the freshly disturbed ground. Cold temperatures and snowfall through winter will thin the cover crop, with the remaining plants being desiccated with glyphosate.

In spring, the only cultivation is via a planter adapted to plant directly into the autumn created rows. Without the roots of the cover crop holding the rows together they would be prone to slumping and erosion meaning a further cultivation pass would need to be carried in the spring. With just one cultivation prior to and following the potato crop, the Farm of the Future can grow potatoes with just two cultivation passes in their rotation. As a result of this change in practice, both yield and quality have been observed.

Figure 8: Rows after planting (left) and undisturbed (right) Photo: Author's own.

4.2.5 Companion cropping

Companion cropping - only a niche practice in potatoes currently - will no doubt become ever more important as farmers look to improve soil health, increase soil fertility or attract more beneficial insects into their crops to control aphids. The most common species I have seen used are beans and peas as these tend to allow pre-emergence herbicides to be applied, however, where no herbicide is used or allowed in the case of organics, phacelia and buckwheat were successful.

With the inclusion of legumes, growers saw small amounts (single figures Kg N/ha) of nitrogen become available to the crop, however, like all species mentioned previously, they provide ground cover and roots delivering row stability and helping to reduce soil erosion. Furthermore, the more roots growing in the rows, the greater the capacity for photosynthesis and therefore more root exudates being pumped into soil.

Where I saw the biggest benefit to companion cropping was its ability to increase beneficial insects into potato monocrops. With flowers developing in companion species within six to eight weeks of planting, beneficial predators can be in the field when aphid risk it at its highest. These beneficial insects such as ladybirds and lacewing are attracted to the field as the companions, pre-flowering, release specific volatile organic compounds (VOCs).

Figure 9: Phacelia flowering inter-row Photo: Victor Leforestier.

Key Messages

- A broad rotation involving cover crops tailored to your farm's context can deliver reductions in soil borne pests and disease.
- A well grown cover crop can replace one cultivator pass and/or tillage intensity.
- The inclusion of companion cropping could be pivotal as we continue to battle resistance to insecticide.

4.3 Maintaining living roots

The presence of living roots throughout as much of the rotation as possible can contribute to improvements in soil structure, biological activity, and nutrient cycling, particularly in systems where potatoes, with their inherently disruptive establishment techniques, feature prominently. This extensive cultivation, which in turn accelerates the breakdown of organic matter and disrupts fungal networks such as those formed by AMF. By contrast, maintaining living roots between cash crops helps to offset some of this disturbance by supporting the continuous development of soil microbial communities, stabilising soil aggregates, and preserving biological function.

Inclusion of multi-species cover crops, catch crops or companions provide opportunities to extend the period in which roots are growing in the soil profile. These roots continue to exude sugars and organic acids which stimulate microbial life, feed fungal networks, and mobilise nutrients that might otherwise remain inaccessible. More than just 'anchoring' the soil, living roots serve as the driver of biological fertility in the soil. Without them, microbial populations quickly decline, aggregate stability begins to diminish, and nutrient availability becomes more dependent on artificial inputs.

While potatoes themselves offer little in the way of sustained root presence post-harvest, the strategic placement of living roots before and after their cultivation can help to rebuild soil function more effectively and reduce the cost of disturbance. Timing, species selection, and integration with existing equipment and operations remain critical to success, but the long-term benefits to soil health and crop performance make this a valuable practice for growers seeking to build resilience into their rotation.

4.3.1 Case study: Vincent Rimette, Offoy, France

With an earlier harvest than the UK, Vincent Rimette uses the two additional weeks post-harvest and the warmer autumn temperatures to grow two cover crops prior to potatoes.

The summer cover crop contains vetch, beans, radish, phacelia and sunflowers with the winter cover crop containing triticale, radish, vetch and beans. The inclusion of phacelia and sunflowers means during the warm late summer months with peak solar radiation, rapid biomass will be produced within the first eight weeks of growth. In contrast, once this green, high nitrogen cover crop is destroyed and the winter cover crop is planted the growth will be slower. As a result of the triticale in the mix and with the days shortening, none of the species will mature enough to set seed and will remain green and vegetative.

If the summer cover crop was left unchecked, all species would have gone into their reproductive phase and root growth would have stopped. As with all species once they move from their vegetative to reproductive stages, there is a marked reduction is sugars shared to the soil therefore potentially depleting microbes of a primary food source. By planting two successive cover crops, Vincent is ensuring his soil microbiome is well-fed for a longer duration, whilst also ensuring no seed is returned.

Figure 10: Winter cover crop in February. Photo: Author's own.

Key Messages

- Selecting species that will not mature in autumn or double sowing cover crops in summer/autumn will lead to improved results from cover crops due to continually growing roots.
- Constant, living roots are pivotal in developing large, thriving microbial populations due to the sugars excreted.

CHAPTER 5 – SOIL BIOLOGY AND ORGANIC AMENDMENTS

5.1 The living, the dead and the very dead

The first destination on my study tour took me to Canada where I was lucky enough to meet Canadian Nuffield scholar Eric Ritchie. When he told me I needed to focus on "*The living, the dead and the very dead*", he didn't realise he had given me advice that would influence the way I have farmed ever since. So, what does this mean?

The living is all things alive within our soils: bacteria, fungi, arthropods, earthworms, plant roots and residues.

The dead refers to easily broken-down carbon sources within the soil. These include fresh organic matter and microbially active compounds such as sugars and amino acids as well as soil binding glues.

The very dead is more commonly called soil humus. Humus is responsible for maintaining soil aggregation, porosity and water-holding capacity. Cation exchange capacity is also linked to humus as it provides negatively charged sites for essential cations such as potassium, calcium and magnesium.

5.2 The rhizophagy cycle

Upon meeting Allen Philo in Wisconsin, I began to appreciate how healthy soils naturally re-balance themselves. It's the microbial activity - driven by plant sugars - that underpins this process. Sugars released through root exudation act as an energy source for microbes, which in turn deliver improved infiltration rates and nutrient cycling, particularly in soils with a history of organic matter build-up from dead organisms. It is thought microbial necromass can account for up to 50% of soil organic carbon.

The relationship between plants and microbes is dynamic and highly communicative; what Allen humorously referred to as "*casual sex!*" This microbial promiscuity fosters resilience, complexity, and adaptability in the soil ecosystem, supporting high-functioning nutrient cycles and structural repair following major disruptive events like the preparation of potato seedbeds or harvesting the crop.

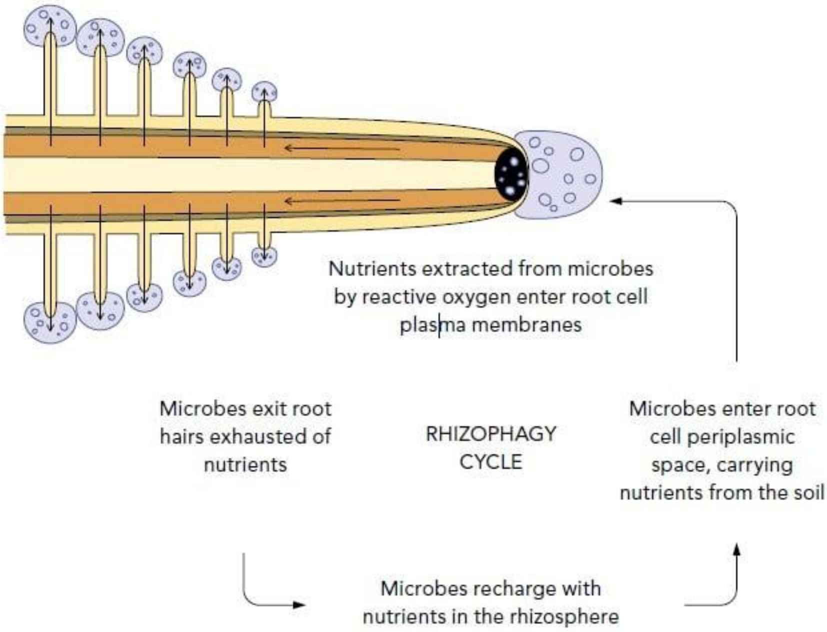

Figure 11: The Rhizophagy cycle - teaming with bacteria. Graphic: Jeff Lowenfels.

The rhizophagy cycle is where plants draw microbes into their root tips, extract nutrients from them, and then release them back into the soil. It begins when microbes are attracted to root exudates rich in sugars and amino acids. As they cluster around the root tip, the plant pulls them into the root, where they are exposed to oxidative stress. This stress strips them of key nutrients which the plant absorbs directly. Once depleted, the microbes are expelled through root hairs to re-enter the soil, recover, and repeat the cycle.

This process acts as a nutrient pump, enabling plants to bypass some of the limitations of chemical nutrient availability by using biology to access what they need. Continuous root presence and microbe friendly management - such as cover cropping and minimal disturbance - are key to supporting this system. Like many biological processes in soil, it relies on the steady rhythm of exchange: sugars for nutrients, microbes for minerals, and plants as the orchestrators of the whole system.

Allen explaining this cycle to me really hit home that true soil health is about more than just immediate fertility. It is the soil's ability to function and to return to that function after disturbance. This resilience is rooted in feedback loops—where plants, through photosynthesis, release exudates rich in carbon, and microbes, in return, provide mineral nutrients and other growth-promoting substances back to the plant. It is this tightly coordinated exchange that keeps soils biologically active and cycling efficiently.

Functional soils aren't a result of chance but of an ongoing biological conversation, constantly fed by root exudates and regulated by microbial interaction. Managing for this - rather than simply for chemistry or structure -

builds not just soil, but a system capable of withstanding shock and supporting high-yielding, high-functioning crops like potatoes.

Key Message

- In order to nurture soils into a position to rebound from extreme disturbance events such as potato establishment, strong networks of bacteria and fungi such as AMF need to be established throughout the rotation.

CHAPTER 6: DISCUSSION

UK potato production, by its very nature, has always involved a high level of soil disturbance. The usual suite of cultivations used to prepare potato seedbeds - deep tillage/ploughing, further cultivation passes, bed formation and stone separation runs counter to the principle of minimising disturbance, a foundational pillar of regenerative agriculture. While these practices have traditionally been justified based on improving seed-soil contact, optimising herbicide performance, and enhancing moisture retention through surface capping, they come with significant biological and physical trade-offs.

Repeated and intense tillage degrades soil structure, reduces aggregate size, and leads to compaction and poor drainage. This was evident at Buckley Farms in South Australia, where years of over-cultivation on sandy soils led to issues with disease and nematodes. Only when cultivations were scaled back, and air was reintroduced through shallower, targeted passes, did soil health begin to recover. This was further supported by modifications to machinery and bed configuration which reduced the number of wheelings and improved infiltration. The result was improved crop performance, and crucially, a resurgence in beneficial fungi - highlighting the biological consequences of our mechanical choices.

Similarly, Chad Berry's experience at Under the Hill Farms in Manitoba proves that less disturbance doesn't necessarily mean lower yields. By adapting machinery to allow direct planting with just two passes, he's managed to leave more residue on the surface, reduce erosion and conserve soil moisture. While a slight delay in emergence was observed, there was no measurable yield loss, and the system saved time and fuel - showing that in certain conditions, less is indeed more. This system is perfectly suited for areas of low to zero stone content soils found in the UK.

What links both farms is a clear intent to understand and respond to soil limitations - be it capping, erosion or compaction - rather than blindly following a traditional approach.

What emerged from many visits was the significant, often underestimated, role that living roots play in building resilience into our cropping systems. Throughout this report, living roots have been a recurring theme; whether from cover crops, companion species or catch crops, they act as a driver for microbial activity, soil aggregation, and nutrient cycling. The Perry Family Farm in Alberta illustrated this beautifully with a complex rotation of up to 16 species, carefully selected to avoid pest and disease issues. Their success wasn't accidental - it was the result of years of observation, trial and refinement. It was a similar story at the McCain Farm of the Future, where cover crops helped stabilise autumn-formed rows and reduced erosion on light, undulating soils.

What united the most successful farms was a clear goal behind each decision: whether it was choosing cover crop species to support AMF networks, selecting for root architecture to relieve compaction, or ensuring cover crops remained vegetative to avoid seed return and maximise exudate release. None of these changes reduced yields - in fact, many growers reported improvements. But more importantly, they saw reductions in pest and disease pressure, input reliance and soil erosion.

The presence of microbial communities - especially fungi - proved vital. These organisms underpin the biological functioning of soil systems, with roles ranging from nutrient cycling to pathogen suppression. The rhizophagy cycle, explained to me by Allen Philo, brought this into sharp focus. It showed how microbes, attracted by root exudates, are consumed and recycled by plant roots in a self-sustaining loop of nutrient exchange. This interaction reinforces the importance of maintaining living roots in the system for as long as possible. It is not simply about having 'plants in the ground'—it's about sustaining biological activity that supports the soil's ability to rebound after extreme events like potato planting.

In summary, the findings suggest that while tillage remains necessary in potato systems, it should be treated with restraint. Each cultivation pass should serve a clear purpose, and opportunities to reduce intensity - through residue management, root-driven structure, or altered planting systems - should be embraced. Potatoes are a high-demand crop on soil, but the case studies I've provided prove that with careful management, it is possible to maintain productivity while allowing the soil to breathe, recover and function more naturally.

CHAPTER 7: RECOMMENDATIONS

I've visited many different farms with a wide range of soils and end markets, all looking at their current system with varied end goals. With such a broad range of learnings I have come to these conclusions which I hope can help to deliver quantifiable improvements to both your soils and your bank accounts:

- The healthiest soils used all regenerative principles throughout the rotation. Trial and error is needed to work out how to implement them all on your farm. Make small changes on small areas.
- A wide, diverse rotation is needed to allow recovery after the harsh events of potato cultivation. This can come in cash and cover crops with as little time with no crops growing as possible.
- We are overworking our soils prior to potatoes. As soil movement decreases, yields will increase. Shallow up, reduce the intensity. Farms with low to no stone content should focus on making a one pass planting system work.
- Thriving biology is going to allow reductions in pesticides and fertilisers. Focus on the living, the dead and the very dead.

Figure 12: Organic potatoes growing in Wisconsin Photo: Author's own.

CHAPTER 8: AFTER MY STUDY TOUR

Being provided the opportunity to do a Nuffield Farming Scholarship has transformed the way we farm.

I was fortunate enough to meet many people who shared all their successes and, more importantly, their failures, with me. Their methods have positioned them at the forefront of the potato growing community focussing on soil and environmental health.

These methods include: reduced cultivation, focussing on growing good cover crops with more diverse and left field species and improving our soils biological function have enabled me to have the confidence to remove pesticides from some of our crops. In 2023, we supplied our first crop grown without any pesticide into factory, I believe this to be the first of its kind in the UK. This is something I firmly believe we can continue to build upon, delivering great cost savings to the business whilst helping deliver for nature.

With more experience, I plan to help move these practices onto other farms by offering consulting services to other farms or those in the supply chain. I also intend to transfer my knowledge into other high value crops, taking advantage of our location in a tourist hotspot by selling direct to consumer.

CHAPTER 9: ACKNOWLEDGEMENT AND THANKS

Whilst doing a Nuffield Farming Scholarship has been the most fruitful journey of my life in terms of knowledge and understanding of my subject, it has also led to huge personal development. This rare opportunity to travel alone for so long couldn't have happened without the help and support of my family and friends, so thank you to you all. Thanks especially to my parents who made sure nothing was left undone whilst I was away during in busy period on the farm.

A special thank you must go to my fellow 2022 Scholars who have been incredibly supportive through some tough periods; we have been blessed with some very special moments over the past few years which I shall cherish forever.

The wider Nuffield Farming Scholarship community has also played a huge role in helping me get to this point, be it for support or a point of contact in an obscure region of South Australia, nothing has ever been too much to ask.

Before I set off travelling, I was constantly told by previous Scholars I would meet the most incredible people along the way. This proved to be very true as so many strangers were willing to have me on their farm, provide me with food and a place to stay. A particular thanks must go to Mark Phillips, Harold Perry and Victor Leforestier for your hospitality and help in finding more places to visit.

Most importantly, thank you to my sponsors Alan and Anne Beckett. You saw potential in an enthusiastic 23-year-old and I will always be so appreciative of the chance to do this Scholarship. I will carry Alan's entrepreneurial spirit with me through life.

978-1-916850-71-2

ISBN: 978-1-916850-71-2

Published by The Nuffield Farming Scholarships Trust
Bullbrook, West Charlton, Charlton Mackrell, Somerset, TA11 7AL
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www.nuffieldscholar.org