NUFFIELD
Farming Scholarships

Effective Monitoring Methods that Measure Ecological Outcomes in Grazing Systems

Written by:

Jimmy Stobart NSch

May 2025

A NUFFIELD FARMING SCHOLARSHIPS REPORT

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

Date of report: May 2025

Title	Effective monitoring methods that measure ecological outcomes in grazing systems
Scholar	Jimmy Stobart NSch
Sponsor	AHDB Beef & Lamb and The Company of Merchants of the Staple of England
Objectives of Study Tour	• To study how farmers should be rewarded for providing ecosystem services. • To discover what is the true value of natural capital.
Countries Visited	Papua New Guinea, Australia, Chile, Uruguay, Argentina and the UK
Messages	• Building natural capital is key to building resilient farming businesses. • Farmers are uniquely positioned to benefit from providing ecosystem services. • A mindset shift is required if farms are to become more resilient and ultimately more profitable.

EXECUTIVE SUMMARY

It might sound selfish, but I was once told that doing a Nuffield Scholarship is something that you do for yourself. For me, this couldn't be truer, and it all stems from my choice of study topic. Growing up on a generational hill farm, with a deep-seated love for the land and farming, I have always been driven by a passion to enhance the environment for future generations. As I began my Nuffield studies, I soon realised that, without even knowing it, I had been studying this topic for over a decade.

I set out to examine how and what simple methods farmers can use to measure natural capital in sustainable livestock production systems. Farmers are uniquely positioned to observe and evaluate these critical elements daily - biodiversity, soil health, water and air - they all form the foundations of sustainable grazing systems. By combining their practical experience and awareness of environmental changes, farmers can use this knowledge to measure how day-to-day decisions directly affect the natural capital asset.

The basic methods that land managers can use are visual assessments of pasture health, soil structure tests, biodiversity observations and tracking water quality in streams and ponds. These low-cost, observation-driven approaches empower farmers to integrate monitoring into their routine practices without the need for expensive equipment or specialised expertise.

Case studies included in this report showcase examples of farmers faced with different climates, soil types, business structures and scale. Despite all these differences, these examples demonstrate how regular observations of ecological indicators can help farmers make informed decisions about grazing management, improve productivity and enhance environmental outcomes.

Whether a system is classed as mob grazing, regenerative, silvopasture, MSO (maximum sustainable output) or conservation grazing, the common environmental goals are all the same. This leads to very open conversations and a willingness to exchange knowledge. Listening to all the people involved, there is a very positive outlook on not just their own businesses but the future of the environment and livestock production. The industry faces many challenges - land use, market volatility, climate change, emissions, public disconnect, future policy and inheritance tax to name a few.

This journey has reaffirmed my belief that farmers and land managers who focus on grazing systems that allow ecosystem function are key to securing the health of the environment and the well-being of future generations.

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DISCLAIMER

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, Jimmy Stobart. Photo: author's own.

Farming was always going to be the direction of travel for me. I was very lucky to grow up on a tenanted hill farm in the Eden Valley in Cumbria and, like all farm kids, my childhood was spent on and around the farm.

After leaving school, I began working at home whilst doing a modern apprenticeship at Newton Rigg College, Penrith. During my time in college, one of the new skills that I learnt and really enjoyed was shearing. This led to me starting a local shearing run; over the years this has grown to shearing 30,000 sheep in the summer months, mainly in Cumbria. Shearing has also given me the opportunity to travel and I have worked in New Zealand, Australia, Norway, France and all around the UK. Alongside so many brilliant people which I have met, I think it's fair to say that shearing on farms and seeing different systems around the world is what set me well on my way to applying for a Nuffield Scholarship.

Together with my brother, I joined the family business at a young age and the decision was made to purchase a neighbouring farm. In the time that has passed since, our system and business has undergone a lot of change. Moving from a traditional sheep heavy set stocking system to mob grazing cattle with a strong focus on environmental gain. Alongside this, the business also diversified with a campsite, sawmill, music festival and direct meat sales.

I am married to Amy and am the very proud father to our son Freddie.

"Opportunity is missed by most people because it is dressed in overalls and looks like work." Thomas Edison

CHAPTER 2: BACKGROUND TO MY STUDY SUBJECT

Due to the wide range of skills you need as a farmer, I often refer to myself as a jack of all trades and a master of none. I am certainly not academic, a scientist or an ecologist, but I am very proud to call myself a farmer. For this report, I set out to meet people who are 'doers', who are passionate, practical and make things happen. The industry needs to find a way to support and reward these people. Hopefully, my positive outlook and practical hands-on approach comes across in this report.

The idea for my choice of study topic came from some questions I had been asking myself for a few years. As my own farming system and mindset has shifted over the last decade or so, I began observing how the land was reacting to a change of management. Going about one of my daily tasks of moving stock, I started to notice the increased diversity in my permanent pasture, fresh cow pats disappearing so fast it feels like overnight and numbers of grey partridge increasing year on year. And, probably for me, the one that stood out the most was water infiltration. I do farm in the, let's call it 'rain assured' Eden valley! But after heavy rain events when bodies of water would once sit, they weren't there anymore. I am still amazed at the speed with which all of this happened as 10 years isn't really a long time in farming terms.

So, I began to wonder, how should I be rewarded for producing these public goods? What is their true value? And when we think about land and particularly rental values, why is this not considered?

Building a grazing system that can add natural capital, produce nutrient dense food and that can effectively be replicated elsewhere, should landowners not be queuing up at my door paying me for my services? An interesting thought when you think about the current situation we have, with high rents on short-term Farm Business Tenancies (FTBs). This benefits neither party, squeezing farmers' already tight margins, with no incentive to reinvest in infrastructure, never mind thinking about the longer-term environmental wealth of the land.

CHAPTER 3: MY STUDY TOUR

As my scholarship was affected by the Covid 19 pandemic, my travel schedule didn't follow the usual timeframe. After initially setting out on my travels in February 2020, it wasn't until January 2023 that I had the opportunity to fully continue with my studies.

Where/when	Reason
Papua New Guinea February 2020 – 10 days Queensland, Australia March 2020 - 3 weeks	Visit New Brittan palm oil, to see cattle integration with palm production. To understand how holistic management is effective in a brittle climate. Attend Resource Consulting Services (RCS) two-day next steps business programme. Visit a number of farmers who have been through the RCS program spanning the last 25 years and use holistic management.
South America January 2023 – 5 weeks Argentina Chile Uruguay	To find out if it really is production at any cost. Ser Beef – Largest family-owned feed lot in Argentina. Central Valley – Chile's breadbasket, producing wine, fruit and veg. Soriano region – To visit 2,000 Ha managed under techno grazing.
UK	To find out if we are on the right path and is good work being rewarded? Andrew Barbour – Agroforestry pioneer in Perthshire. Alex Brewster – Regenerative farmer in Perthshire. Groundswell – Two-day regenerative farming conference.
Northern Ireland January 2025 – 1 week	The look at how the level of government support differs in the devolved nations. Agri-Food and Biosciences Institute - Longest running agroforestry trail in Europe

CHAPTER 4: WHAT IS NATURAL CAPITAL?

The challenges facing UK farmers

Natural capital refers to the world's stock of natural resources, encompassing geology, soils, air, water, and all living organisms. These assets form the foundation upon which human societies and economies are built, providing essential goods and services that sustain life and drive economic activity. For instance, forests supply timber, rivers offer freshwater, and fertile soils yield crops. Beyond these tangible products, natural capital delivers vital services such as climate regulation, water purification, and pollination, which are crucial for maintaining ecological balance and supporting human health. The concept of natural capital extends the traditional economic notion of capital to include the goods and services provided by the natural environment, emphasizing the need to manage these resources sustainably. Overexploitation or degradation of natural capital can lead to a decline in the availability of these essential resources and services, posing risks to human well-being and economic stability. Therefore, recognizing and valuing natural capital is fundamental for informed decision-making and sustainable development. Collectively, the benefits derived from natural capital are known as ecosystem services.

The UK farming industry is currently navigating a complex landscape of challenges that impact its sustainability and productivity. Key issues include:

Biodiversity Loss: Biodiversity loss in the UK is driven by multiple factors beyond intensive agricultural practices. Urbanisation leads to habitat destruction and fragmentation, reducing natural spaces for wildlife. Pollution, including chemical runoff, air contaminants, and light pollution, adversely affects various species. Climate change alters habitats and disrupts ecological balances, further threatening biodiversity. Additionally, the introduction of invasive non-native species can outcompete and displace native flora and fauna. These combined pressures not only disrupt ecosystems but also impair essential services such as pollination and soil fertility.

Policy and Regulatory Changes: The UK agricultural sector is undergoing significant policy and regulatory transformations, introducing uncertainties for farmers. The government has phased out the Basic Payment Scheme (BPS), a primary income support for many farmers, and replaced it with Environmental Land Management (ELM) schemes. ELM focuses on rewarding environmental stewardship and sustainable practices, aiming to balance food production with ecological conservation. While these initiatives promote sustainability, they also present financial uncertainties as farmers adapt to new funding models and compliance requirements.

Additionally, the agricultural sector faces challenges related to regulatory compliance, often referred to as ‘red tape’. Farmers must navigate complex regulations concerning environmental standards, animal welfare, and food safety. While these regulations are essential for maintaining high standards, they can impose administrative burdens and increase operational costs, particularly for smaller farms.

Collectively, these policy shifts and regulatory requirements cause uncertainty for farmers trying to adapt their systems. Making planning financial to align with evolving governmental policy very difficult.

Land Use Change Through External Investment: There is a growing trend of external investors acquiring agricultural land for non-farming purposes, such as renewable energy projects, housing developments, biodiversity net gain (BNG), carbon offsetting and nutrient neutrality (NN). For instance, government plans indicate that over 10% of England's farmland could be converted to solar panels, forests, and nature reserves by 2050 to meet net-zero goals. While these changes support environmental objectives, they may reduce the land available for livestock production, affecting domestic food production.

Economic Pressures: Farmers are facing increasing economic challenges. Recent research indicates that farm input costs have risen by an average of 44% since 2019, with significant increases in expenses for fertilisers, fuel, animal feed, and machinery. Additionally, recent changes to the inheritance tax rules could impose further financial burdens on farming enterprises, going as far as potentially making succession to future generations out of reach for some businesses.

Market Volatility: The farming industry is highly susceptible to fluctuations in both domestic and international markets. Factors such as changing consumer preferences, trade agreements, and global supply chain disruptions can lead to unpredictable pricing and demand for agricultural products. This volatility makes it challenging for farmers to plan and invest confidently in their operations.

Addressing these challenges requires a multifaceted approach, including the adoption of sustainable farming practices, proactive engagement with policy developments, financial planning to mitigate economic risks, and strategic land management to balance production with environmental stewardship.

The financial pressures that come with these challenges make it difficult for farmers to adopt sustainable farming practices even with a shift in mindset.

As the saying goes, "If a farmer is in the red, he can't be in the green."

Case Study 1. New Brittan Palm Oil - Papua New Guinea

Figure 2: John Smith farm manager of Ramu Beef NBPOL overlooking a maize crop. Photo: author's own.

Setting out on my first Nuffield journey, I was eager to get off the beaten track and explore places less travelled even by the hardiest of scholars. I was fortunate to be invited to spend a week in Papua New Guinea (PNG) with New Britain Palm Oil Limited (NBPOL), a pioneer in sustainable palm oil production. In 2008, NBPOL became one of the first companies globally to achieve Roundtable on Sustainable Palm Oil (RSPO) certification.

NBPOL's operations are extensive, spanning over six sites in PNG and the Solomon Islands, managing a total land area exceeding 146,000 hectares. This includes more than 90,000 hectares dedicated to oil palm production, 5,600 hectares for sugar cane, and 9,500 hectares allocated to cattle pastures. The company also operates two abattoirs and a renowned seed research and a production unit.

During my visit, my time was spilt between the two cow-calf cattle operations on the mainland at Ramu beef and on the island of West New Brittan. All the cattle are rotational grazed and finished in a feedlot before being processing through the abattoirs. NBPOL supplies over 30% of PNG's total beef consumption. The region's tropical climate, coupled with highly productive, free-draining volcanic soils and annual rainfall ranging between 2.5 to 4 metres, creates optimal conditions for cropping maize and managing improved and native grasslands.

Figure 3: Cattle grazing in a half stand Palm Oil plantation at NBPOL, West New Brittan site. Photo: author's own.

The main reason to visit NBPOL was to meet farm manager Jeff Mcinnerney to see the cattle grazing in one of very few commercially run half stand palm oil plantations in the world. A pretty radical concept in the yield-based, every gramme counts, data-driven world of palm production. It was planted 30 years ago as an experimental trial and partly to help gain some good publicity at a time when the production systems of palm oil were starting to come under increased pressure ethically and environmentally. This model has never been expanded on since the initial trial, which seems like a missed opportunity as the beef from the West New Brittan operation is one of the islands main sources of protein for the workforce that make up 80% of its population.

Figure 4: Jeff Mcinnerney at NBPOL's boundary overlooking the native forest and grasslands. Photo: author's own.

Relating all this back to beef farming in the northwest of England and my original study questions seemed a long way apart in this climate. A huge amount of data had been collected, fertiliser applied and the grasses directly under the palms had been chemically controlled to maintain the palms. But in between all of this was a very healthily diverse sward, full of thriving native grasses that could be found in abundance on the other side of the boundary fence in some of West New Brittan's native bush.

I was fascinated by PNG and the operation that NBPOL was running despite all the negative press around palm oil production I had been fed as a wealthy westerner. I began to wonder, if it's done responsibly and managed suitability, is this production system in this climate all that bad?

It was a big wake-up call to learn that all the palm oil produced at NBPOL makes its way directly into processing plants in the Northwest of England. It was at that point that I realised I had come to the perfect place to start my study tour. Although very shortly afterwards I released that this visit had also filled my head with lots of other bigger-picture questions about global trade, multinational corporations, ethically produced food and population growth. As it turned out, this would become a bit of a theme of my travels.

Case study 2. Resource Consulting Services – Queensland, Australia

Figure 5: Farmers... heroes of the future. Photo: author's own.

My next stop was Resource Consulting Services (RCS) in Queensland. RCS is a leading agricultural advisory firm in Australia, specialising in regenerative agriculture, grazing management, and business consulting. Established in 1985, RCS has helped farmers and land managers improve productivity, profitability, and environmental sustainability. The company provides training, workshops, and one-on-one consultancy to support holistic farm management, soil health, and natural capital monitoring. Through programmes like Grazing for Profit and ExecutiveLink, RCS equips producers with the tools to optimise land use while enhancing ecosystem services. With a strong focus on evidence-based practices, RCS are one of the main groups leading the way to a sustainable agricultural transformation across Australia.

Figure 6: Dr Terry McCosker, co-founder of RCS. Photo: Resource Consulting Services.

I was invited to attend one of RCS next steps business programme meetings. The six-month coaching programme offers farming businesses and individuals the support, skills and confidence needed to help implement regenerative farming principles. Terry McCosker, co-founder of RCS in 1985, is a true pioneer of Australian agriculture helping to bridge the gap between traditional and regenerative farming. With over 50 years of experience in research, teaching, and advisory roles, he's shaped the way farmers approach ecosystem health, financial sustainability, and family well-being. A trailblazer in soil carbon and carbon farming, Terry has dedicated his career to making agriculture more sustainable, profitable, and resilient for future generations.

After spending a few days with the RCS team and farmers from over 40 different businesses, I can honestly say I've never been in a room with so many people who have such a positive outlook on agriculture. The energy, passion, commitment, and willingness to share knowledge are a true reflection of the fantastic work RCS has been doing over the past four decades.

Giving Terry's dedicated his whole career to monitoring and improving soil health, and with the growing opportunity's that are opening for regenerative agriculture in Australian to finically benefit from payments for ecosystem services. He seemed like the perfect man to set me well on the way to find some answers to my original study questions. Having explained my study topic and what I was setting out to learn along the way, the question was simple 'what is it I need to monitor to achieve these goals?' The answer I received was even simpler 'soil carbon, that's it'. Now this was a bit of a shock to the system. Surely, I thought this can't be my whole report written in those four little words? Obviously, there is much more to it than this, processes that need to happen not just in farming systems but in the mindset change of the farmers who are operating those systems. This is where RCS come in, offering first hand advice, mentoring, peer to peer networks and business support. As Terry went on to reiterate, to achieve these goals it begins with the five key principles of regenerative agriculture. Keep the soil covered, minimise soil disturbance, maximise plant diversity, keep a living root in the soil and integrate livestock. All of this encourages ecosystem function which in turn creates resilient and profitable businesses.

This is perhaps no more apparent than in countries with an arid climate such as Australia, as I went on to find out visiting various farms that had been through the RCS grazing for profit workshops over the last 25 years.

Regenerative farming key principles

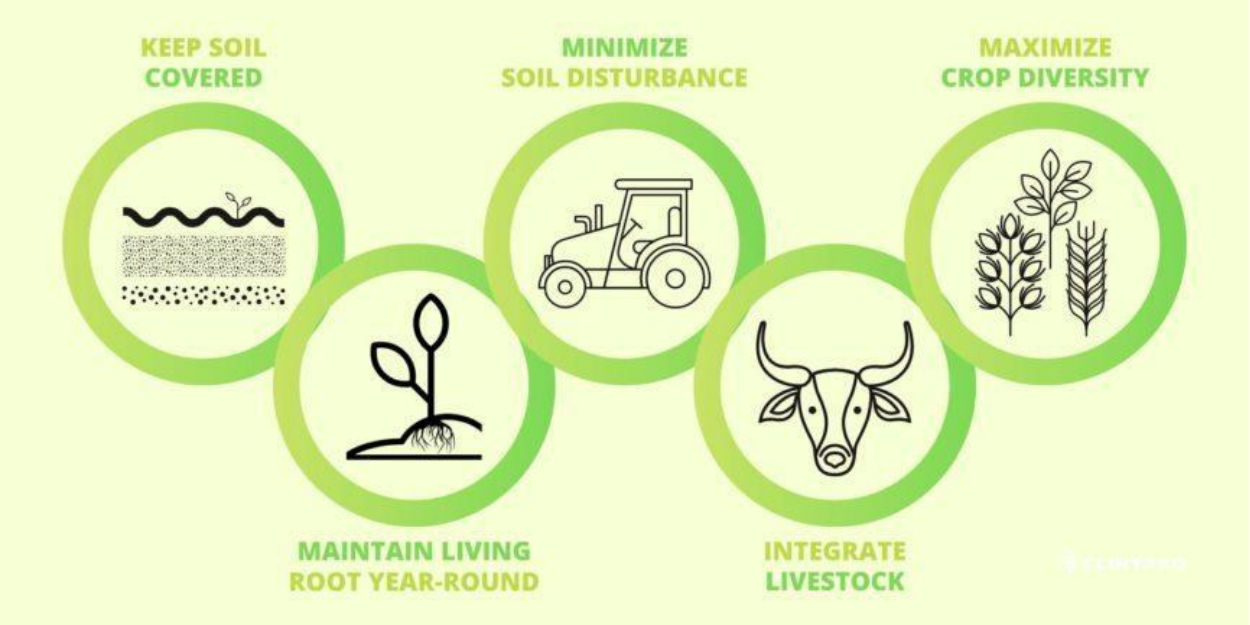

Figure 7: Graphic from Cool Farm Tool: https://app.coolfarmtool.org/

Regenerative farming is all about working with nature to rebuild soil health, boost biodiversity, and improve ecosystems while producing nutrient dense food and fibre. Going beyond just sustaining the land by actively restoring it using natural processes. Focusing on healthy soils, better water cycles, and reducing the need for synthetic inputs, regenerative farming helps create stronger, more resilient farms. The goal is simple: leave the land in better shape for future generations while maintaining a productive and profitable system today.

Keep the Soil Covered

Bare soil loses moisture quickly and is prone to erosion. Keeping it covered with plants, mulch, or crop residues helps retain water, protect against extreme weather, and support soil life. A well-covered field improves fertility and resilience.

Minimise Soil Disturbance

Excessive tillage disrupts soil structure and microbial life. By reducing tillage or switching to no-till methods, farmers can improve soil health, water retention, and carbon storage.

Maximise Plant Diversity

A mix of crops, diverse pastures, and cover plants helps improve soil biology, break disease cycles, and build resilience. Diversity above ground leads to diversity below ground, which is key for a thriving farm ecosystem.

Keep Living Roots in the Soil

Keeping plants in the ground year-round feeds soil microbes, improves water infiltration, and builds organic matter. The more roots in the soil, the better its structure and fertility.

Integrate Livestock

Well-managed grazing mimics natural systems, helping cycle nutrients, stimulate plant growth, and improve soil biology. Livestock play a crucial role in regenerating land when using planned grazing systems.

"It's not the cow, it's the how."

Case study 3. ALC Brahmans – Gundaroo Station, Australia

Figure 8: Louise and Alf Collins at Gundaroo Station. Photo: ALC Brahmans.

Traveling down a dirt track across a couple of washed-out gullies from a recent rain event that had sent the sand flies into overdrive I arrived at Alf and Louise Collins' Gundaroo Station. He is a self-confessed maverick, breeding high fertility, low cost of production Brahman cattle and selling bulls and semen to cattle producers globally.

Figure 9: A three-day old cow pat on Gundaroo Station. Photo: author's own.

While touring around with Alf it very quickly became apparent that he had a very good understanding of the animals and the environment he was farming. Observing pasture for productive native grasses and stopping on numerus occasions to look at recent cow pats. One of which was the third day in a row he had stopped at this particular one and it was safe to say he was extremally pleased with the overtime his dung beetles had been putting in recently! But what really stood out for me was the cattle; with over 60 years of selecting for the same genetic traits, these animals are perfectly suited in their environment.

The cattle are mated on the 1st October in the dry season while lactating; this is to identify the most well adapted females through their ability to conceive whilst lactating, in very dry grazing and to hold that pregnancy, calve un-assisted, raise a sound calf and to re-breed within the low-cost management regime. Having spent a couple

of days with Alf, it's not surprising his cattle genetics are so sought after, running a zero tolerance for cattle that do not earn every year. Any non-earning cattle are converted into dollars, no exceptions made.

As I depart and wave goodbye, he shouts *'Fertility is the key driver to profit, don't forget that bit Jimmy!'*

Case study 4. The Gibsons – Coonabar, Australia

Figure 10: Murray and Wendy Gibson at Coonabar Station. Photo: Meat & Livestock Australia.

Approaching Coonabar Station in central Queensland it is obvious that a very different approach to land management has been undertaken here. The lush green grass and tree cover is a stark contrast to that of the neighbouring dry arid countryside. This is all due to Murray and Wendy Gibson's forward-thinking mindset from day one after taking over the ranch in 1988. The whole area was covered entirely in thick virgin-standing scrub, and while watching their neighbours' clear, fell, slash and burn tactics, they had different ideas. Building that native scrub into their farming system has allowed them to retain soil moisture, increasing plant diversity and creating shade for animals. Now 30 years down the line their 6,781 hectares of land is thriving.

Originally the ranch was split into two large paddocks; well-planned rotational grazing infrastructure was put into place, and this has now evolved to 104 paddocks in total. Meaning that over this period the carrying capacity has gone from 600 LSU (Large Stock Units) up to 3,000 LSU.

Bucking the trend with his high-risk approach put a lot of pressure on the business in the early days. Murray admitted it was challenging to commit to changes, as so many conflicting opinions existed. However, since then, gradual improvements and highly flexible management strategies have maximised their agroecosystem and business profitability.

Figure 11: Some of the Gibson's paddocks with the native scrub alleyways. Photo: author's own.

I think of all my Nuffield visits this was the one that left the biggest impression on me. To see what had been achieved over 30 years by applying a holistic approach and how the environmental was thriving alongside it was amazing.

They run a fully trading stock system and coupled with the extend grazing season the ranch allows stocking rates to match pasture growth and the ability to buy and sell ahead of volatile market prices, creating a very resilient and profitable business. Alongside the impressive beef production system, opportunities are now beginning to open for the Gibsons who are working to generate income for from their natural capital. For example, they have one of the first farms in the country which aims to become accredited for biodiversity credits. At the time it was early doors in the process so it was difficult to put a value on what the level of financial reward would look like.

Mind Set change

After returning from Australia in a hurry, right when the world had been turned upside down by the Covid-19 pandemic, I had plenty of time to reflect on everything I had learned. Although I had so much to contemplate, I realised that my biggest takeaway from my travels was the mindset of the farmers I met, especially those involved in the RCS program. They had a different way of looking at things: resilient, forward-thinking, proactive, and overwhelmingly positive. This is something that I could relate to through my own experiences of a shift in mindset and a change in farming system. But seeing a large network of highly motivated environmentally-focused farmers, in a brittle climate and all with a

common goal of leaving the land in a better state than when they found it, really brought it home that mindset shift is key to how we observe what is happening ecologically on our farms.

For years, traditional farming has been all about maximising and control - controlling weeds, pests, and yields through chemical inputs, heavy machinery, and rigid systems. But farmers that have stepped away from that mindset, instead of constantly fighting against nature, are learning to observe key indicators, adapt, work with and optimise their systems to benefit environmental outcomes.

A big part of this transformation comes from simply paying more attention. Instead of seeing weeds as the enemy, regenerative farmers ask what those weeds are telling them about soil health. Instead of relying on synthetic fertilisers, they focus on building healthy, living soils that naturally provide the nutrients crops and pastures need. They watch how water moves across their land, how their livestock interact with plants, and how biodiversity returns when they reduce chemical inputs.

Making this shift isn't easy. Many farmers have spent years being told that success is measured by high yields and that achieving those yields requires high inputs. Moving to a system that prioritises soil health, biodiversity, and long-term resilience requires a leap of faith. But what I have noticed is that once farmers make the leap, they never wanted to go back. It is making farming more enjoyable, less stressful, and ultimately more profitable.

What's most inspiring is that this change in mindset doesn't just benefit the land - it benefits the farmers themselves. Farming with nature, rather than against it, creates a sense of connection and purpose. It replaces the constant pressure to control everything with a deeper understanding of how ecosystems function. It turns farming into a dynamic, evolving process where observation and learning are just as important as action.

Regenerative farming isn't just about better soil or healthier livestock. It's about seeing farming differently adapting, observing key indicators, and working with nature rather than forcing it into submission. And that's a mindset shift that will change agriculture for the better.

"If you can build a muscle, you can build a mindset". - Jay Shetty

Case study 5. SER BEEF – San Luis, Argentina

Visiting SER BEEF in San Luis, Argentina, gave me the perfect opportunity to step away from the regenerative outlook to look at a high input beef production system. Running 80,000 head of cattle at any one time, the Italian-owned company has the largest independently owned feed lot in Argentina. The

operation is a very well managed system and has turned low productivity land into highly efficient, irrigated farmland. The scale is truly impressive, especially with the government- funded irrigation infrastructure that allows up to 7,500 hectares to be farmed with irrigation.

Figure 12: SER BEEF cattle, Argentina. Photo: author's own.

What really stood out was how SER BEEF has evolved over the years. Originally focused on extensively grazing breeding cattle, they saw an opportunity in the 2000s to expand their beef production by building one of Argentina's largest service-oriented feedlots. With all cattle contract finished for customers, they can take in cattle at different stages, feed them efficiently, and prepare them for both domestic and export markets. Their facilities are designed to handle all types of cattle, from smaller animals for local consumption to the larger 450-500kg cattle required for international trade.

The infrastructure supporting this operation is on another level. Thanks to extensive government investment in hydraulic systems, SER BEEF can maximise productivity by utilising large-scale irrigation. This ensures reliable crop production for cattle feed, creating a steady supply of high-quality nutrition that keeps the feedlot running efficiently. It's a great example of how smart

infrastructure and technology can transform poor quality land into a large scale and highly productive business.

During a meeting with SER BEEF's head agronomist analysing some of their extensive soil carbon data collection, it was fascinating to see how over the last 20 years their data has shown a huge increase in soil carbon levels on the irrigated pasture. A nearly 3% raise over that period, at first glance could seem like a major win and for soil health and carbon sequestration. However, when reflecting on the numbers, it became clear that the increase is heavily influenced by the large amount of nutrients brought onto the farm through feed and other inputs. This raises an important question about how we quantify and record data for key ecological indicators.

As we move towards financial rewards for ecosystem services, we need to be very careful about relying solely on data without understanding the full context. If incentives are purely based on numbers without considering external inputs, it could create unintended consequences and fail to truly measure regenerative progress. This is something we need to be mindful of when structuring payment schemes and evaluating environmental impact.

The visit to SER BEEF was a fascinating look into large-scale beef production and highlighted the potential complexities of measuring ecosystem benefits. While their operation is undoubtedly impressive, it highlights the need for a well-rounded approach when assessing environmental gains and structuring financial incentives.

Case study 6. Central Valley, Chile

Due to Central Valley's Mediterranean climate it makes it an ideal place for producing fruit, vegetables, and wine. But with little rainfall over the summer months, farmers rely heavily on irrigation, using water from the snowmelt high up in the Andes. Most of the gravity-fed irrigation systems were built over 120 years ago. These have been designed to move water efficiently through canals and ditches and have stood the test of time and continue to be the backbone of farming in the region. Despite the challenges of water scarcity, farmers here have a strong culture of responsible water use, ensuring that every drop is used wisely.

Managing soil health in these conditions is challenging, a challenge that agronomist and consultant Roberto Contardo is helping farmers to navigate. I spent the day with Roberto visiting a kiwi, cherry, and vineyard operation, where his role involves making regular visits, twice a month, to assess soil conditions and provide management advice. One of the key parts of his work is digging a one-meter square pit at each farm to examine the soil profile and see how it's responding to different management practices. This hands-on approach allows him to identify issues early and recommend changes before problems get out of hand.

Figure 13: Roberto Contardo with the management team observing the condition of the soil. Photo: author's own.

One of the biggest concerns in these systems from a soil health perspective is the heavy reliance on chemical inputs. Other than the trees themselves, there are often no living roots in the soil, which means there's little biological activity happening underground. Combined with the constant need for large amounts of irrigation, this has led to widespread soil compaction. Without structure and organic matter to retain moisture, the soil becomes harder to manage, requiring even more water and inputs to keep production levels up.

What stood out most was how valuable regular discussions with farm staff are in tackling these challenges. Rather than just telling farmers what to do, Roberto works closely with them, ensuring that everyone from farm managers to field workers understands why certain changes are needed. This kind of knowledge exchange is crucial in shifting management practices toward more sustainable approaches.

By bringing the whole team together and making soil health a regular talking point, farmers can ensure that everyone involved in running the system is on the same page and long-term goals are achieved. Whether it's experimenting with cover crops, reducing tillage, or adjusting irrigation strategies, small, consistent

changes can make a big difference. The key takeaway from this visit was clear - improving soil health is about ongoing observation, discussion, and adaptation whatever the farming system.

Land use and management control challenges

Farmers today are facing a growing number of challenges when it comes to land use. One of the biggest issues is the increasing competition for farmland, driven by external investment in renewables, housing developments, Biodiversity Net Gain (BNG), Nutrient Neutrality (NN), rewilding, carbon capture, and tree planting. As a result, land prices are rising, making it incredibly difficult for family farms to plan for the next generation, but now the financial barriers to acquiring more land are higher than ever. This situation has been exacerbated by the government's recent changes to Agricultural Property Relief (APR), which adds further uncertainty to the future of family farming.

These effects have already been felt in the uplands, as marginal land gives businesses and investors the biggest opportunities in carbon and biodiversity credits schemes. What was once considered poor quality land for food production is now seen as a valuable asset for environmental schemes, pushing prices even higher. While these initiatives have positive environmental goals, they often come at the cost of farming operations. Many family farms, particularly those in upland regions, find themselves unable to compete in the land market, leaving them without options for expansion or long-term stability. The risk is that farming communities, which have shaped the landscape for generations, will be priced out, leading to a decline in rural livelihoods and food production.

For tenant farmers, the challenges are even more complex when considering natural capital values and ecosystem services. A major issue is the question of management control and ownership of these new assets. If opportunities arise to generate income from natural capital, such as selling carbon credits or engaging in biodiversity projects, will landlords step in and claim a share? This is a pressing concern, particularly for tenant farmers on short-term agreements and grazing licenses. Even if a farmer is highly motivated to invest in natural capital and build long-term sustainability, the reality is that short leases do not provide the security needed to reap the rewards of these efforts. Without guarantees that they will benefit from their work, many farmers are hesitant to engage in these schemes, creating a significant hurdle to achieving environmental progress.

Longer-term tenancy agreements could offer a potential solution, allowing both landlords and tenants to collaborate on environmental initiatives in a way that benefits both parties. However, in the current landscape of short-term agreements and high land values, these cooperative arrangements remain difficult to establish. If this issue is not addressed, tenant farmers could be locked out of emerging income streams, putting their businesses at risk while also limiting the overall success of environmental policies.

Ultimately, the increasing competition for land, the rise of external investment, and the complexities of natural capital ownership present serious threats to the future of family and tenant farming. If policymakers and stakeholders do not find a way to balance these competing interests, the rural landscape may undergo a dramatic shift, one where farming businesses are pushed aside for corporate greenwashing exercises. While sustainability and conservation are important goals, they must be pursued in a way that ensures farming families and tenant farmers can continue to produce food and earn a living, rather than being squeezed out of the very land they have worked for generations.

CHAPTER 5: BIODIVERSITY

Figure 14: AI generated image.

Biodiversity should be at the heart of a resilient and productive farming system. It's the variety of life in all its forms; plants, animals, insects, fungi, and microorganisms all working together to create a balanced and thriving ecosystem. A biodiverse farm isn't just good for nature; it's good for productivity, soil health, water management, and farm profitability. Farmers and land managers are in a unique position to harness the power of biodiversity, shaping landscapes that are both productive and rich in life.

Why is biodiversity important?

A thriving farm is about much more than growing crops or raising livestock, it's about creating an environment where all elements of the ecosystem work in harmony. Biodiversity underpins key natural processes that make this possible:

Nutrient Cycling

Microorganisms, plants, and animals work together to break down organic matter, making essential nutrients available to plants and improving soil fertility.

Healthy Soils

A variety of plant life encourages soil microbes and fungi that improve soil structure, enhance nutrient absorption, and boost resilience against erosion.

Water Retention

Diverse plant root systems increase the soil's ability to hold water, reducing runoff, leaching of nutrients and ensuring better moisture availability during dry periods.

Pollination and Pest Control

A biodiverse farm supports pollinators like bees and butterflies, as well as predatory insects and birds that help manage pests naturally.

Resilience to Climate Extremes

Diverse landscapes are better equipped to withstand droughts, floods, and other climate challenges, providing a buffer against unpredictable weather.

The benefits of a biodiverse farm

Embracing biodiversity brings both environmental and economic advantages. The land becomes more productive, resilient, and allows wildlife to thrive. While farmers gain long-term sustainability there is also the potential future financial rewards for providing ecosystem services.

Increased Productivity – Healthy soils, strong plants, and natural pollination all contribute to better yields and farm output.

Better Livestock Performance - A diverse pasture diet, increased shade and shelter leads to healthier animals with improved growth rates and fertility.

Long-term Sustainability - Working with nature rather than against it ensures the farm remains productive for future generations.

Rewards for providing ecosystem services - As governments and businesses recognise the value of biodiversity, farmers may have opportunities to benefit from incentive programs, such as (BNG) biodiversity net gain.

Farmers and land managers: the stewards of biodiversity

Farmers and land managers are at the forefront of biodiversity conservation. Their daily decisions, how they graze animals, what they plant, how they manage water, directly shape the land's health and resilience. By encouraging biodiversity, they create farming systems that are not only productive but also rich in life, self-sustaining, and capable of supporting future generations.

As well as looking at biodiversity ecologically, it is also key that farming businesses consider it from a social and economic point of view. As alongside improving soil health, producing nutrient-dense food, increasing resilience, and potentially unlocking new revenue streams through ecotourism and biodiversity-based incentives. Whether through planting trees, diversifying pastures, or simply observing how nature responds to different management practices, every step toward a more biodiverse farm is a step toward a healthier, more resilient future.

By embracing biodiversity, farmers are not just growing food. They are creating landscapes that will sustain life for both humans and nature for years to come.

"Farming isn't something that can be taught. Each plant tells its own story that has to be read repeatedly." Kelsey Timmerman

CHAPTER 5: THE SOIL FOOD WEB

The soil food web is like a bustling, underground village, full of life working together to keep the land healthy and productive. This hidden world is home to countless organisms' bacteria, fungi, protists, archaea, and tiny soil animals, all playing a crucial role in breaking down organic matter, cycling nutrients, and supporting plant growth. Ruminant grazing animals like cows are essential players, helping to drive these natural processes.

When cows graze, they aren't just eating grass; they're harvesting solar energy stored in plants and turning it into manure, a rich source of nutrients that feeds soil microbes. Their hooves disturb the ground, helping seeds contact the soil and allowing air and water to penetrate. This creates the perfect conditions for dung beetles and worms to thrive, breaking down organic matter and taking nutrients down into the soil to start the cycle over again. Without the integration of grazing animals, this natural cycling of nutrients would slow down, leaving soil less fertile and less productive over time.

Cows also stimulate plant growth through grazing. When they graze plants, it encourages roots to shed old material and push deeper into the soil, improving soil structure and increasing carbon storage. Meanwhile, the fungi and bacteria in the soil form partnerships with plant roots, delivering nutrients in exchange for sugars produced by the plant. This exchange wouldn't happen as efficiently without the regular pulse of nutrients provided by grazing animals.

Beyond soil health, cows also play a role in maintaining diverse plant life. Their selective grazing patterns allow different plant species to thrive, supporting a wide range of insects, birds, and wildlife. In well-managed grazing systems, this biodiversity leads to healthier ecosystems, more resilient landscapes, and a stronger connection between soil, plants, and animals.

So, while the tiny organisms in the soil do the heavy lifting when it comes to breaking down organic matter and cycling nutrients, cows and other ruminant grazing animals are the ones keeping the whole system in motion. They are the bridge between the grasslands and the underground world, ensuring that nutrients continue to flow, plants continue to grow, and the land remains healthy and productive

Trees: the future of resilient farming

One of the biggest takeaways from my travels during my scholarship has been the vital role that trees play in the future of livestock and cropping systems. Whether I was standing in a sun-drenched paddock in Australia, walking through Chile's dairy heartland in Orsono, watching cattle graze under nitrogen-fixing

Acacia trees in Uruguay, or visiting farms in the UK who are enterprise stacking by growing trees for timber and fruit crops. One thing is clear, integrating trees into farming landscapes isn't just a nice idea: it's essential for building resilience.

Agroforestry and silvopasture are proving to be game changers. By incorporating trees into our farming systems, we can increase biodiversity, improve water retention, provide shade and shelter for livestock, enhance animal welfare, purify the air, and ultimately build more robust and sustainable businesses. The industrial revolution and the sharp population growth that followed has driven a race-to-the-bottom production-based farming model at any cost regardless of outcomes. This way of thinking has seen the mass removal of hedgerows and treating trees as if they are just big obstacles for large, hydrocarbon-powered machinery.

For decades, environmental schemes have encouraged tree planting, but often at the expense of food production. Farmers have been paid to take land out of use to plant trees, as if the two can't exist together. That way of thinking is outdated. Trees and farming aren't rivals; they should be working together. The future isn't about choosing between trees or livestock; it's about integrating them to build healthier soils, increase biodiversity, improve water cycles, and make farms more profitable in the long run. It's time to stop seeing trees as a problem and start recognizing them as one of farms biggest assets.

Learning from farmers around the world

Australia was the real turning point for me. It became very apparent than when I visited the Gibsons ranch in Queensland, seeing lush green native pastures thriving under the ancient acacia trees and creating shade from the intense heat, ultimately helped drive animal welfare and performance. These trees weren't just there for aesthetics; they reduced heat stress and provided browsing to balance the diet and additional fodder in dry periods. In this instance they didn't even need to plant any new trees, they designed a way of integrating their livestock grazing system around trees that had survived in those arid conditions for hundreds of years. Realising that trees are an investment in the long-term sustainability and key to the future of their operation.

Uruguay provided another fascinating perspective, where silvopasture is widely embraced, with cattle grazing under native tree cover. Farmers I spoke to highlighted using native trees in their grazing systems to significantly improve soil health. Tree roots worked deep underground, breaking up compacted soils and increasing organic matter, which in turn enhanced the land's ability to absorb and retain water.

Figure 15: Dr. Martín Jaurena, a scientist at Uruguay's National Agricultural Research Institute (INIA). Photo: author's own.

A key figure in advancing this approach is Dr. Martín Jaurena, a scientist at Uruguay's National Agricultural Research Institute (INIA). His research focuses on the nitrogen-fixing potential of trees and their role in improving pasture productivity. By planting around 30 trees per hectare, early findings suggest that dry matter growth could increase by as much as 20%. This is a game-changer for livestock farmers looking to maximise productivity while also improving soil structure and water retention. Trees not only pull nitrogen from the air and make it available to the soil, but they also create a microclimate that reduces evaporation, keeping pastures greener for longer in dry conditions. Dr. Jaurena's work is helping to prove that trees in grazing systems are not just an environmental win but a highly practical tool for boosting farm output and long-term resilience.

Figure 16: Rodrigo Olave from the AFBI research site in Loughgall, Northern Ireland. Photo: author's own.

Visiting the AFBI research site in Loughgall, Northern Ireland, to meet Rodrigo Olave and learn more about the long-term agroforestry experiment was fascinating. As this project, which started back in 1989, is one of the longest-running agroforestry trials in the UK, and it was brilliant to see a fully grown stand of high-value timber now reaching maturity. This trail really drives home the point that agroforestry is a long-term investment. In the designing of systems like this, the end product of a valuable timber crop is just as important as the livestock that graze in the trees themselves. Data shows that these well-maintained systems have been able to extend the grazing system in some instances by up to three months depending on soil types.

Rodrigo took me through some of the data gathered over the years, particularly on moisture retention and pasture growth under tree cover. The numbers tell a compelling story, tree roots improve water infiltration, reducing runoff and helping the soil hold onto moisture for longer. This is particularly valuable in a place like Northern Ireland, where rainfall can be unpredictable, and summers are becoming drier. The experiment is also shedding light on how dry matter production changes depending on tree density. While it's clear that too much canopy cover can reduce pasture growth, a well-managed system with widely

spaced trees can actually enhance productivity, offering shade for livestock while still allowing plenty of light for grasses to flourish.

With Northern Ireland's tree cover sitting at just 6%, the lowest in Europe. It's exciting to see research like this demonstrating the benefits of integrating trees into farming landscapes. Seeing the results firsthand reinforced just how much potential agroforestry has in creating more resilient, productive farms while delivering valuable ecosystem services.

Figure 17: Andrew Barbour's maturing silvopasture system. Photo: author's own.

Andrew Barbour, Fincastle farm, Scotland – visiting Andrew's farm showed how his wood pasture system brings together productivity, sustainability, and animal welfare. The mix of trees and grasslands creates a resilient, multi-functional landscape offering shelter from wind, rain, and sun while encouraging early grass growth, which boosts overall farm productivity. Andrew began integrating trees into his farming system 25 years ago now, after realising that the farm had become an unhappy place for livestock, the environment and the family themselves. Fincastle is a very different place these days, due to the thoughtful layout, with alley systems and smaller wooded blocks, grazing areas balanced

with productive woodland, supporting timber growth alongside livestock. The farm has transitioned to a more productive sheep breed, achieving higher outputs from a very low input system. Cattle naturally make use of the trees for shade and browsing, but the system remains flexible, allowing for rotational grazing, timber harvests, and ongoing planting to expand and improve the setup every year.

CHAPTER 6: THE CASE FOR AGROFORESTRY AND SILVOPASTURE

What's exciting about these integrated systems is how they work with nature, rather than against it. Trees bring a whole host of benefits to livestock and cropping farms, and they can play a huge role in making businesses more resilient in the face of climate change and market pressures.

Livestock welfare is one of the most immediate and obvious advantages. Animals suffer in extreme weather, whether from heat stress in hot climates or exposure to wind and rain in cooler ones. Trees provide natural shelter and shade, reducing stress and improving overall wellbeing. Studies have shown that cattle with access to shade gain weight more efficiently and produce better-quality meat and milk.

Beyond animal welfare, trees also play a key role in improving soil health. Their deep roots help break up compacted soils, allowing water and nutrients to reach deeper layers. Falling leaves and organic matter from tree roots increase soil carbon, improving fertility and water retention. In areas prone to drought, this ability to hold onto moisture can make all the difference between a productive and a struggling farm.

Biodiversity also thrives when trees are part of the landscape. On my travels, I saw firsthand how tree-rich farms supported more wildlife, from birds and insects to beneficial predators that help control pests naturally. Pollinators, in particular, benefit from increased tree cover, which in turn supports higher crop yields and better pasture growth.

Rethinking environmental policy

The new agroforestry policy in the UK is a promising step towards integrating more trees into farming systems. After years of discussion about the benefits of agroforestry, it's great to see the new policy is now finally being rolled out this year. The payment structure looks encouraging, with financial support varying depending on tree density and design, allowing for a range of approaches that suit different farms. Whether it's silvopasture, alley cropping, or shelterbelts, there's flexibility for farmers to adopt a system that works for their land and business.

One of the biggest challenges with any new scheme is making it practical and accessible. If the rollout is done well, this policy could help farmers design tree-based systems that enhance biodiversity, improve soil health, and boost resilience to extreme weather, all while maintaining or even increasing productivity. Hopefully, the process is straightforward and avoids the overly complicated red

tape that farmers have been faced with in some previous environmental schemes.

It will be interesting to see how this new policy works alongside the existing Countryside Stewardship and Sustainable Farming Incentive (SFI) schemes. If the environmental schemes can be easily integrated with each other, then this will provide farmers with more opportunities to benefit from not just agroforestry, but payments for ecosystem services and biodiversity gain. Time will tell how effective it is, but for now, it's a good starting point that acknowledges the key role trees can play in the future of farming. With the right implementation, it could be a game changer for UK agriculture.

CHAPTER 7: DISCUSSION

One of the biggest lessons from my journey has been the importance of shifting our mindset. This isn't just about adopting new technology or reinventing the wheel, it's about going back to what previous generations of farmers did naturally: observing the land, understanding its signals, and using that knowledge to guide decisions.

For too long, we've been locked into a production-driven mindset, focusing almost entirely on yield-based KPIs. But the reality is, environmental indicators, things like soil health, water retention, biodiversity, and overall land resilience, are just as, if not more, important. These simple, low-cost observations can tell us so much about how our land is responding to daily management. And, over time, they give us a clearer picture of its long-term health and sustainability.

This isn't about rejecting progress; it's about blending old wisdom with modern knowledge. We have more data, better tools, and greater opportunities than ever before to make informed decisions. But at the core of it all, we need to relearn the observational skills that generations before us relied on. Farming isn't just about maximising production, it's about optimising and working with the land, not against it.

By shifting our mindset and embracing a more holistic, long-term approach, we can build an adaptive and resilient future, one that benefits not only our farms and businesses but the environment and communities around us.

For too long, agriculture has viewed nature as something to be controlled or managed in isolation from production. But the reality is that nature and farming are intrinsically linked. Trees, soil microbes, pollinators, and livestock all play a role in nutrient cycling, water retention, and productivity. Once we recognise that nature isn't an obstacle to farming but rather its foundation, the way we approach land management changes entirely.

Understanding and monitoring natural capital on farms

Farmers are in a unique position to monitor and enhance natural capital, but for any monitoring system to be useful, it must be practical, cost-effective, and easily integrated into daily farm routines. Obviously, scientific measurements and technology will always be key and required to quantify data for credit schemes. But the most powerful monitoring tool remains farmer observations. The ability to read the land, its soil health, water retention, biodiversity and plant resilience has always been a core skill of good farmers. Strengthening this observational approach allows farmers to assess the health of their farm ecosystem in real time.

Some simple ways farmers can monitor natural capital include:

Soil health indicators: A simple spade and a keen eye can tell you a lot about your soil's health. Digging a hole and taking the time to observe key factors like soil structure, compaction, earthworm activity, and root development can give you real insights into how well your soil is functioning. Start by looking at the soil structure, does it break apart easily, or is it compacted and tough? Well-structured soil should be crumbly and full of pores for air and water movement.

Earthworms are key indicators of a healthy soil, the more the merrier as they help with aeration, organic matter breakdown, and nutrient cycling. Counting how many you find in a spade full of soil can be a simple but effective indicator of soil life; these numbers can vary with different soil conditions and temperature. So, digging 3/4 holes in each paddock and taking the average will give you a more accurate picture of overall earth worm activity.

Pay attention to root development, too. Are roots deep and branching out freely, or are they struggling to push through compacted layers? Poor root growth could signal soil compaction, which limits water infiltration and nutrient uptake. You can also feel the soil texture; does it have a nice, rich, earthy smell? That's a good sign of microbial activity and organic matter presence.

These simple, low-cost observations provide valuable insights into your soil's overall health. Regularly assessing these factors can help you understand how your management practices are affecting soil function and guide better decision-making for long term resilience.

Water infiltration tests: A water infiltration test is a quick and easy way to see how well your soil absorbs water, which can tell you a lot about compaction levels and organic matter content. Better infiltration means your soil can handle heavy rainfall without waterlogging and hold onto moisture longer during dry periods, making it more drought resilient.

To do the test, grab a metal or plastic tube roughly 150mm in diameter. Push it about 5cm into the soil, making sure it sits snugly to prevent water from leaking out the sides. Pour in a measured amount of water, about an 25mm or so and start timing. Watch how long it takes for the water to soak in completely. If it disappears quickly, your soil has good structure and drainage. If it pools on the surface for a long time, it could be a sign of compaction or low organic matter.

For an even better assessment, try testing different areas of your field like compacted pathways, well-managed pastures, or recently tilled land to compare results. Regularly checking infiltration rates over time can help track improvements in soil health and the land's water carrying capacity.

Biodiversity counts: Keeping track of biodiversity on your farm doesn't have to be complicated or time-consuming. Simple observations of plants, insects, and birds can give you a great idea of how healthy your land is and how well your ecosystem is functioning.

The best starting point is to observe what is growing in the hedgerows and on the roadside verges; these are a great snapshot of what the natural seed bank would look like without human interference. Look at the variety of plants that are growing there including different grasses, wildflowers, herbs and broadleaf species. If we can move away from monoculture ryegrass pastures to more diverse swards and grazing on longer rotations allowing plants to seed, we will ultimately build more resilient farming systems.

Birds are a great indicator of biodiversity, one simple and easy way to monitor numbers is to take part in the Big Farmland Bird Count, run by the Game & Wildlife Conservation Trust. This fantastic initiative encourages farmers and landowners across the country to record bird numbers over a set period each year. The data collected helps monitor bird populations and the different species found on farmland nationwide.

Taking part in regular bird counts can give you valuable insights into how your land management practices directly affect wildlife. Over time, you'll be able to spot trends, see improvements, and make more informed decisions to support biodiversity on your farm.

Dung beetles: key Indicators of a healthy ecosystem

Dung beetles play a vital role in maintaining a well-functioning ecosystem, and their activity can tell us a lot about soil health, pasture quality, and even animal digestion. These insects help break down manure, recycling nutrients back into the soil, improving its structure, and reducing parasite loads for livestock. The faster dung beetles break down cow pats, the healthier and more active the ecosystem is.

Farmers should pay attention to how quickly dung beetles are processing manure. If cow pats sit untouched for long periods, it could indicate a lack of beetle activity, which might be due to poor soil conditions, overuse of certain livestock treatments, or low biodiversity. On the other hand, quick breakdown means nutrients are cycling efficiently, benefiting both the pasture and the animals grazing on it.

Observing cow pats themselves can also provide valuable insights. Well-digested manure with a fibrous but broken-down texture suggests good rumen function, while overly loose or undigested pats may indicate dietary imbalances or poor

gut efficiency. By simply observing how dung beetles and manure interact, farmers can gain a better understanding of not just their soil health and biodiversity but of livestock health and nutrition.

Observing livestock behaviour for signs of a healthy ecosystem

Livestock behaviour can tell you a lot about the health of your farm's ecosystem. Simply taking the time to observe not just how their livestock graze but what they're choosing to eat and when. Animals have the ability to balance their own diets if given the right options. You might notice them browsing on hedgerows, nibbling certain herbs, or favouring specific patches of pasture. This is their way of selecting what their bodies require, whether it's extra minerals, fibre, or medicinal plants.

The best time to observe this behaviour is right after moving them into a new pasture. Watch where they go first and what plants they seek out. Over time, these observations can help guide pasture management decisions, encouraging more plant diversity and a healthier grazing system that works in harmony with the animals. By letting livestock show us what they need, we can create more resilient and productive farms.

By incorporating these simple, low cost, consistent observations, farmers can gain a better understanding of their natural capital and identify management practices that enhance rather than deplete it.

Embracing technology to quantify natural capital

Technology is playing a crucial role in measuring and valuing natural capital for credit schemes. As financial rewards for biodiversity net gain and other ecosystem services grow, tools like remote sensing will become more widely used to track environmental changes.

However, farmers themselves are in the best position to establish a baseline for their natural capital assets and track improvements over time. With smartphones acting as powerful data collection tools, farmers can easily record changes in soil health, biodiversity, and landscape quality. Having this data opens up opportunities to work directly with the private sector, creating new income streams or attracting investment for nature-enhancing projects.

By cutting out unnecessary middlemen, direct marketing of natural capital credits could mean more financial returns for farmers while giving investors a clearer insight into how their contributions is making a real impact. Instead of just ticking a box, these investments could drive genuine improvements and benefit both farmers and the environment.

Apps like Vidacycle's Soilmentor are a great tool for farmers to establish a baseline and track changes in natural capital over time. While there is an annual

fee, the app designed by farmers, for farmers, offers a wealth of knowledge and connects users to a large network of pioneering practitioners from around the world. It's an easy and effective way to monitor key ecological indicators, helping farmers make more informed decisions and see real progress on their land.

Mapping services like Fera's LAND360 are powerful tools that combine data and science to accurately map, measure, and analyse existing land habitats while modelling biodiversity potential. It provides farmers and landowners with valuable insights to make informed land-use decisions. By assessing natural capital, including soil health, carbon storage, and biodiversity, LAND360 helps identify opportunities to enhance ecosystems, improve resilience, and even unlock financial incentives for conservation efforts. Understanding the true value of your land allows for better long-term planning, ensuring both environmental, social and economic benefits for the future - technology provides a great starting point.

The true value of natural capital and ecosystem services

When you look at the bigger financial picture for England, the numbers around natural capital are huge. In 2020, the Office for National Statistics estimated the total asset value of natural capital at £1.4 trillion**,** making up 78% of the UK's total. The annual value of ecosystem services alone was £35.7 billion, covering everything from recreation and tourism (£12.4 billion) to health benefits (£5.5 billion).

This may seem a very literal way of looking at it, but given farmers are in a such a unique position to tap into these opportunities, whether through renewable energy, which has seen a huge increase in value in recent years, or through tourism, conservation, or biodiversity initiatives. With farmland decreasing by 7% and urban areas expanding by 37% since 1990, the value for ecosystem services in well-managed rural landscapes is only going to increase.

The challenge is that natural capital covers so many different services, everything from clean air and carbon storage to soil health and recreation, so putting an exact price tag on it is nearly impossible. But one thing is clear, farmers and landowners are at the heart of it all, with a huge opportunity to benefit financially while also protecting and enhancing the environment for generations to come.

CHAPTER 8: RECOMMENDATIONS

Make natural capital monitoring a daily habit

Farmers don't need expensive technology to monitor their land effectively. Regular observations of soil health, biodiversity, and livestock behaviour can provide invaluable insights into farm resilience.

Explore emerging markets for ecosystem services

As markets for ecosystem services develop, farmers should stay informed and be proactive in finding opportunities to generate income from nature positive practices.

Policies fit for purpose

Future farming policies must be practical, adaptable, and rewarding. Working alongside existing schemes to support farmers in balancing productivity with environmental benefits.

Recognise the long-term value of natural capitol

Investing in soil health, water retention, and biodiversity isn't just an environmental action, it's a business strategy for long-term farm resilience and profitability. Make nature a stakeholder in the business!

Integrate trees into farming systems where possible

They improve soil health, boost biodiversity, and support long-term land productivity as well as helping prevent soil erosion, improve water retention, and provide shelter for livestock and wildlife. Over time, they can also enhance carbon storage and create additional income opportunities through timber, fruit, or ecosystem service payments.

Final thoughts

I know that throughout this report I've touched on some topics that might not seem directly linked to the original questions I set out to answer. But through my studies, the incredible people I've met, and my own farming experiences, I've ended up looking at things through a much wider lens.

It's made me more aware of the challenges and hurdles both the industry and individual businesses face. But since starting this scholarship, there is more data, technology, and incentives emerging to give farmers real opportunities to tap into new income streams from ecosystem services.

Personally, I think it's an exciting time for the industry. There are so many opportunities ahead for farmers to produce nutrient-dense food, support biodiversity, and build resilient, profitable businesses, all while making the most of nature's value.

"A good farmer is nothing more nor less than a handy man with a sense of humus." E.B. White

CHAPTER 9: AFTER MY STUDY TOUR

Now I am back in the Eden valley and reflecting on my travels. It is only then that you fully appreciate what the scholarship means. Like I said at the very start, it might sound selfish but as I was once told, you do a scholarship for yourself, and it's true. So, alongside the changes I have made to the business over the last decade or so, the knowledge I have taken from like-minded, highly motivated and positive people I have met along the way has been invaluable in helping build a diverse and dynamic family business. Obviously, there are always challenges to overcome - that's farming! But I feel very excited about taking my business forward in the future, building resilience, providing a quality of life for my family and creating opportunities for the next generation to thrive.

CHAPTER 10: ACKNOWLEDGEMENT AND THANKS

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