Farming with Nature: increasing biodiversity in agricultural land

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Executive Summary

Climate change is having a significant effect on the global environment, and it is felt most keenly by those whose livelihoods depend upon it: farmers. Over the last decade, agriculture has been cited as being a significant cause of climate change. While conventional agriculture certainly has contributed, farmers have an opportunity that few other businesses or individuals have: it is crucial to consider the role of farming in combating biodiversity loss and climate change, and how this can be amplified.

Evidence shows that farmers can optimise their operations using ecological theory and systems thinking, but adoption of these practices depends on their financial stability and values. Without sufficient income, farms cannot invest in environmentally-friendly practices. While profitability is key in all regions, in areas without external financial support, farmer values and market drivers will have a bigger influence and impact on the extent of change.

Collaborative programs offer the best opportunities for transformative change. Successful initiatives such as Marlborough Downs Space for Nature and the Farming for the Future program in Australia highlight that biodiversity can boost production and profits. The Boerenatuur farmers collective in the Netherlands has had the greatest influence and success in promoting biodiversity-friendly farming through education, support, and incremental financial incentives. Consequently, farmers have seen enhanced farm and business value and access to alternative markets, whilst providing ecosystem services that continue to benefit the entire community.

Keywords: Biodiversity, Natural Capital, Systems Thinking, Sustainable Agriculture, Farm Profit

Table of Contents

Foreword

As a farmer, an ecologist and a father, I am deeply interested in nurturing life. Whether that be growing good, nutritious food to feed my family and others, realising a life as part of something bigger, or leaving the world in a better state and passing on what I have learnt to my children. This is a life with purpose and meaning.

We often hear that we are the current stewards of the land and that we aim to hand it on to future generations in a better or stronger state, however it is not a straightforward path for many of us. We have to navigate the economics of a business, societal pressures and a constantly changing and often unpredictable environment. As humans, despite wanting to be, we are not perfect, and seeing our reflection can often be challenging. We need to be open to change.

Like ecology, my Nuffield experience has been about diversity. It has fed my curiosity and allowed me to explore through intuition. The first two chapters of my report highlight the science-based theory around ecological literacy and biodiversity, specifically in relation to agriculture. The latter chapters, and possibly more interesting component of the report, are directly related to my farm visits, meetings and conversations I have had along the way. Overall, this report is a brief collection of thoughts from my experiences travelling around the world, meeting with farmers and others with varied interests in agriculture. However, I do acknowledge that my experience has been biased towards high-income countries that have inherently advanced agricultural systems. Other farming systems are of great interest but they'll have to wait for another time.

My report is focused around promoting biodiversity. Biodiversity is a vital and holistic part of nature (and natural capital for cultivated systems), as these two are part of each other and both describe life on Earth. Sometimes the terminology in my report may blur a little from "biodiversity" to "nature" and "natural capital", as a broader, all-encompassing term. This is not meant to confuse, but to highlight the intertwined way that if you are promoting biodiversity in agriculture, you are working with nature and all the support systems it brings and requires.

My report is not a prescriptive silver bullet describing how to work with nature or increase biodiversity and, by extension, natural capital. It has probably left me with more questions than when I started. Observing what others have done, what they are doing and what they are planning has given me new ideas and pathways to improve our farm. I have not solely focused on the values of production for financial gain, as for some farmers, that is not their end goal, but I have commented on their values and the 'why' of their farms. This is not intended to underestimate any farm or farmer visited, as they are all financially successful and are happy with the progress of their farming enterprise.

These observations of what people do and what they value, on-farm, are the foundations of my report, and give me a greater sense of confidence to go forward with humility and purpose.

As Sarah Singla, agronomist, crop farmer and French Nuffield scholar told me, "we are dust, and when I leave, I want to add earth to the earth".

Table 1. Travel itinerary

Travel date	Location	Visits/contacts
March 7th – 10th , 2023	Vancouver Island, British Columbia, Canada	Pre-Contemporary Scholars Conference
March 11th – 17th, 2023	Vancouver, British Columbia, Canada	Nuffield International Contemporary Scholars Conference
May 22nd- June 23, 2023	Singapore Northern Australia Delaware, USA Netherlands Norway	Nuffield Global Focal Programme
Sept 21st-23rd, 2023	Canberra, ACT	Farming for the Future workshop National Farmers Federation Australian Parliament House Australian National University
May 3rd- 4th, 2024	Carrick, Tasmania	AGFEST
June 13th, 2024	Coal Valley, Tasmania	Managing Dry Times workshop, University of Tasmania
June 16th- 21st, 2024	United Kingdom	Yarrow and Norton, Oxfordshire Horton House Farm, Wiltshire CB Cooper Partnership, Wiltshire Darts Farms, Devon Wastenage Farms, Devon
June 21st - 25th, 2024	Netherlands	Linda Kopczinski, Overijssel Niew Slagmatt Boernatuur

June 26th – July 29th 2024	France	La Ferme du P'tit Ban Houe, Grand Est Ferme Duo d'Lait, Saône-Et-Loire La Ferme de le Carruge, Rhône Mons Fromager Affineur, Loire Chererie d'Arbois, Jura La Ferme De Germigney, Jura Ferme de Plateau, Provence Sarah Singla, Agronomist, Aveyron Les Bergers du Larzac, Aveyron-Hérault Ferme de le Vezou, Aveyron Chevrerie du Coteau, Pyrénées-Atlantiques La Ferme Auzkia, Pyrénées-Atlantiques La Ferme Ithurrieta, Pyrénées-Atlantiques Sylvian Cournet, Cerfrance Gascogne Occitane, Haut Garone - Pyrénées-Atlantiques La Petalerie, Bordeaux Le Doyenne, Île-de-France
July 29th- 31st, 2024	Netherlands	Xander Beks, I4Nature

Acknowledgments

I am grateful for so much.

Firstly, I would like to thank Nuffield Australia, and my sponsors The JM Roberts Charitable Trust and the Tasmanian Institute of Agriculture, for their generous investment in my scholarship. My Nuffield experience has been one that has allowed me to have an incredible learning experience while travelling and looking at farms. It has fed my curiosity, and probably left me with more questions. It is an experience that I will cherish always and look forward to continuing.

The people, the people, the people. Thank you. In so many different ways my Nuffield experience has encouraged humility. To those who encouraged me to apply (through each of my four attempts), all the farmers and other people who have opened their doors and given their time and experience, generously shared food and insights, and above all, their humanity, thank you.

A great number of people have made it possible for me to leave our farm, our customers who choose to support us and our current and past staff (Timah, Roz, Erin, Jan, Mitch and Ilana), and our community, who are always willing to lend a hand and support when needed.

And finally, my family. Thank you to my parents, John and Agnes, and Mair for your continuous and ongoing support. And to Kate and our children, Hamish and Zoe, their kindness, support and generosity for letting me have time away, doing what needed to be done, and being great travel buddies. You are my ultimate inspiration.

Thank you!

Abbreviations

AASF	Australian Agricultural Sustainability Framework
AGW	A Greener World (third-party farm certification scheme)
AOP	Area of Protected Origin
CAP	Common Agricultural Policy
CBD	Convention on Biological Diversity
COVID-19	Coronavirus disease
EBIT	Earnings Before Interest and Taxes
EFAs	Ecological focus areas
EU	European Union
ESG	Environmental Sustainability Goals
FAO	United Nations Food and Agriculture Organisation
ha	Hectares
MLA	Meat and Livestock Australia
NFF	National Farmers Federation
NPK	Nitrogen, phosphorus, and potassium fertiliser
PDO	Product of Designated Origin
RA	Regenerative Agriculture
UK	United Kingdom
UN	United Nations
SDG	Sustainable Development Goals

Objectives

To understand why biodiversity is important for farms and ways to increase biodiversity in agriculture, in particular:

- ecological literacy for farmers - understanding systems thinking, not following recipes,
- how ecosystems function - what are the key principles,
- how promoting biodiversity, farming with nature, can help farmers build resilience and profitable enterprises,
- barriers to adoption and/or change - pathways towards profitable, resilient biodiverse farms.

Introduction

Life on earth is over 700 million years old and has gone through many changes. Currently, climate change and the decline in biodiversity are two of the greatest threats to life on Planet Earth. These threats are already having impacts on agricultural systems and reducing food and fibre production, in the face of an increasing human population. In order to reduce the risks of climate change and enhance biodiversity, it is essential that farmers are be able to find win-win outcomes that supports the environment and ecosystems but also empowers them to evolve their farm businesses to build resilience and improve profitability.

Why is Biodiversity important?

Biodiversity is the foundation of healthy functioning ecosystems, which in turn support human life and activities (Fig. 1). It refers to the variety and variability of life forms on Earth, encompassing ecosystems, species, and genetic diversity within species. It is crucial for maintaining ecosystem resilience, stability, and productivity (Hooper et al., 2005; Sala et al., 2000). In simple terms it should be considered as the number or diversity of species present (species richness) and their abundance (species abundance).

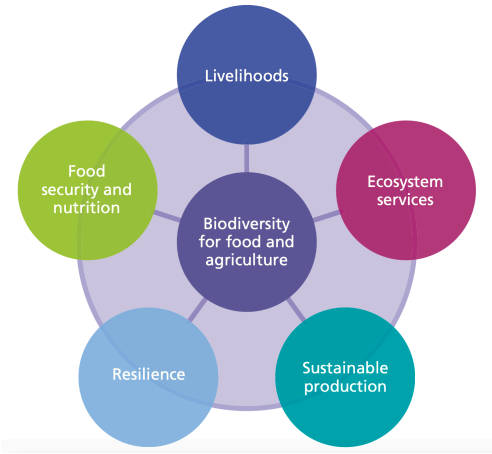

Figure 1. The importance of Biodiversity for human wellbeing is at the core of food and agriculture, and is indispensable to food security, sustainable development and the supply of many vital ecosystem services. (source: FAO 2019)

Biodiversity and Agriculture

On farms, the greatest richness and abundance of species (biodiversity) are typically found in the soil. Soil ecosystems are incredibly diverse, hosting a vast array of microorganisms, fungi, insects, helminths and other invertebrates. These organisms play crucial roles in nutrient cycling, organic matter decomposition and soil structure maintenance, directly influencing soil health and fertility. Healthy soils support robust plant growth and resilience, making them foundational to sustainable farming

practices. The diversity within soil ecosystems often exceeds that of above-ground ecosystems, underscoring the importance of maintaining soil health through practices such as cover cropping, reduced tillage, and organic amendments (Bardgett & van der Putten, 2014).

In addition to soils, agroforestry systems and field margins are areas on farms where biodiversity tends to be high. Agroforestry integrates trees with crops and/or livestock, creating a multi-layered habitat that supports a wide variety of species. Trees provide habitat for birds, insects, and other wildlife, while also offering shade and contributing to nutrient cycling. Field margins, hedgerows, and buffer strips similarly serve as refuges and corridors for wildlife, fostering beneficial insects like pollinators and natural pest predators. These areas not only enhance biodiversity but also provide ecological services that benefit the entire farm ecosystem, such as improved pest control and pollination (Jose, 2009).

Forested areas on or near farms also contribute significantly to biodiversity. Forests provide complex habitats that support a wide range of plant and animal species, many of which are not found in other agricultural landscapes. The structural complexity and variety of microhabitats in forests promote high levels of species richness and abundance. Forest ecosystems contribute to overall landscape connectivity, allowing species to move and interact across different habitats, which is essential for maintaining genetic diversity and ecosystem resilience. Integrating forest patches within agricultural landscapes or practicing agroforestry can thus enhance biodiversity conservation and provide multiple ecological benefits (Harvey et al., 2008).

Biodiversity Declines

The decline of biodiversity has coincided with the degradation of soil health and productivity in agriculture that has happened over centuries, starting with historical practices like extensive land use and inadequate soil conservation pre-Industrial Revolution (Tilman et al., 2002). The onset of industrialisation in the late 19th century introduced mechanisation, with synthetic fertilizers, and pesticides being developed early in the 20th century (Smil, 2001). These processes initially boosted yields but have led to long-term issues such as soil compaction, nutrient depletion and chemical dependency and reduced biodiversity (Pimentel et al., 1992). Throughout the 20th century and into the present, intensive agricultural practices have exacerbated soil erosion, reduced organic matter in soil, and exacerbated diminishing biodiversity, further intensified by climate change effects such as erratic weather patterns and new seasonal temperature variability (IPCC, 2014).

Over recent decades, farmers have improved soil management practices aimed at restoring soil fertility and resilience in agricultural systems (Garnett et al., 2013). Farmers have been globally recognised for managing human and natural capital to improve food security, nutrition and rural development through a number of farming systems. They are often seen as constant innovators and researchers who contribute to developing sustainable agriculture and more resilient rural livelihoods for communities (Altieri, 1999).

Biodiversity and Sustainable Farming Systems

Sustainable farming systems, or what could loosely be called “Regenerative Agriculture” (RA), include conservation agriculture, certified Organic and Biodynamic farming, and Agroecology. Each system has prioritised biodiversity conservation through distinct approaches (Kremen & Miles, 2012). Though each system has different approaches, they have holistic approaches that use ecological principles. Each system seeks to optimise the interactions between plants, animals, humans and the environment (Reganold & Wachter, 2016). Broadly they have integrated land management, allowed improvement in water and soil quality, promoted diversity and nutrient cycling, and synergistically increased efficiency and resilience.

Specifically, organic farming excludes synthetic chemicals, fostering diverse habitats and populations of beneficial organisms like pollinators and natural predators (Pretty, 2008). Biodynamic farming integrates spiritual principles and lunar cycles with ecological practices, promoting soil health and diverse ecosystems through holistic management and diverse crop rotations (Reganold & Wachter, 2016). Agroecology applies ecological principles to agriculture, enhancing biodiversity with diversified cropping systems, natural pest control, and habitat preservation (Gliessman, 2014). Conservation agriculture (including no-till principles) minimises soil disturbance and preserves permanent soil cover, fostering biodiversity by protecting habitats and supporting soil health, which in turn sustains diverse plant and animal species essential for ecosystem resilience and agricultural sustainability (Hobbs, 2007).

The transition for farmers from conventional systems to these alternatives, however, is not necessarily straight forward. The journey is often fraught and can have inherent risks, despite the opportunities and benefits. Change is often driven by extreme or life changing events and decisions (Massey, personal communication, 2023). However, as climate change and the risks associated with farming increase, more farmers are looking to other ways of farming profitably and efficiently. As transitioning from conventional agriculture becomes more mainstream, understanding how nature and ecosystems work, ecological literacy and integrating an increasing role for biodiversity (or natural capital) into farming systems are generating greater interest (Fig. 2).

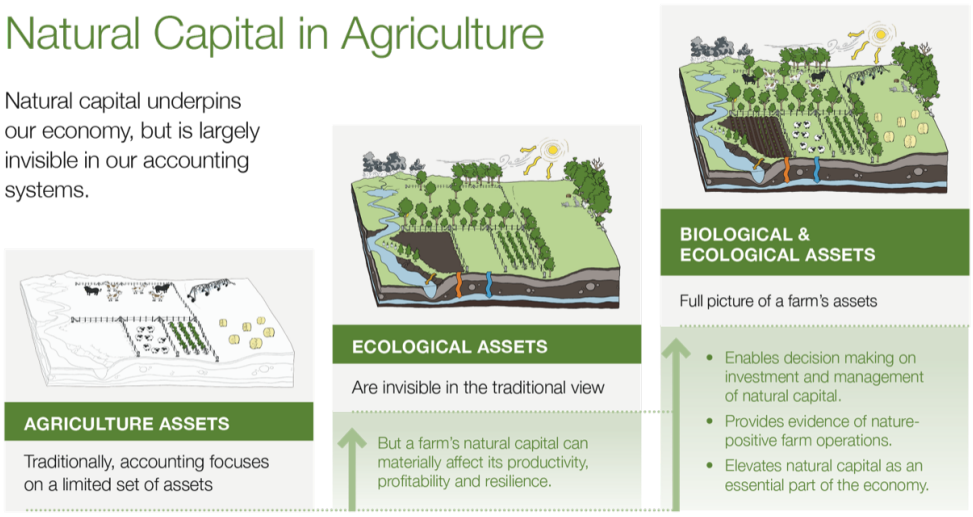

Figure 2. A conventional versus holistic accounting view, including the benefits ecological functions and biodiversity (natural capital). (source. MLA, 2024)

Ecological Literacy: promoting ecological services for Agriculture

Ecological literacy is vital for transforming agricultural practices towards sustainability. By understanding and applying ecological principles, farmers can develop systems that are productive, resilient, and environmentally friendly. This holistic approach not only benefits the environment but also enhances food security and farmer livelihoods, contributing to a sustainable future for agriculture.

Ecological literacy in the context of agriculture refers to the comprehensive understanding of ecological principles and their application in farming. This concept is essential for addressing the complex interactions between agricultural activities and the broader environment. Ecological literacy involves knowledge of energy flow, nutrient cycling, ecosystem dynamics, and the interdependence of organisms, all of which are critical for developing sustainable agricultural systems (Capra, 2002).

Systems thinking

One of the core components of ecological literacy is systems thinking. This approach allows farmers to view their farms as integrated systems where changes in one component can affect the entire system. For instance, practices such as crop rotation, intercropping and agroforestry are based on understanding the ecological interactions between different plant species and how these can enhance soil fertility, reduce pests and improve yields (Altieri, 2002). Systems thinking helps farmers design agricultural practices that are not only productive but also sustainable.

Ecological Services for Agriculture

Ecological literacy emphasises the importance of biodiversity and soil health. Diverse plant species in agricultural systems can enhance ecosystem services such as pollination, pest control, and nutrient cycling (Kremen & Miles, 2012). For example, incorporating legumes into crop rotations can improve soil nitrogen levels, reducing the need for synthetic fertilisers. Understanding soil health is also critical, as healthy soils support robust plant growth, store carbon, and improve water retention, which are vital for resilience against climate change (Lal, 2004).

Ecological literacy enables farmers to adopt sustainable practices that enhance resilience to environmental stressors. Practices such as conservation tillage, cover cropping and other methods to reduce soil erosion, improve water infiltration and enhance biodiversity (Montgomery, 2007). These practices contribute to the farm's ability to withstand extreme weather events and reduce dependency on chemical inputs leading to more resilient agricultural systems (Reganold et al., 2011).

Beyond technical knowledge, ecological literacy involves ethical and social dimensions. It fosters a sense of stewardship and responsibility towards the environment, encouraging farmers to adopt practices that preserve natural resources for future generations. Ecological literacy also promotes social sustainability by encouraging community-based approaches and local knowledge sharing (Pretty,

2008). For example, community-supported agriculture (CSA) programs can strengthen local food systems and foster connections between farmers and consumers.

To enhance ecological literacy among farmers, education and policy support are crucial. Education programs that integrate ecological principles into agricultural training can empower farmers with the knowledge and skills needed for sustainable farming. Policies that incentivise sustainable practices, provide funding for research, and support extension services can facilitate the adoption of ecological literacy in agriculture (Tilman et al., 2002).

Promoting ecological landscape functions

Ecological landscape functions are critical for sustaining agricultural productivity and ecosystem health, and are all intertwined with biodiversity (Kremen and Merenlender, 2020). Understanding and leveraging key ecological landscape functions can greatly enhance agricultural productivity and sustainability. One of the primary functions is soil health, which is maintained through processes such as nutrient cycling, organic matter decomposition and microbial activity. Healthy soils are the foundation of productive farming, providing essential nutrients for crops, improving water retention and reducing the need for chemical fertilizers. Incorporating practices like cover cropping and composting can enhance soil biodiversity and fertility, fostering robust crop growth (Bardgett & van der Putten, 2014).

Water regulation is another critical function supported by well-managed landscapes. Ecosystems naturally capture, store and slowly release water, which is crucial for optimal plant growth, especially during dry spells. Practices such as agroforestry, maintaining riparian buffers and implementing contour ploughing can improve water infiltration and reduce runoff, helping to maintain consistent water supply and prevent soil erosion. This is particularly important in the face of climate change which is causing more erratic weather patterns and increasing the frequency of both droughts and floods (Foley et al., 2005).

Biodiversity within agricultural landscapes offers significant benefits including natural pest control and pollination services. Diverse plant and animal species support a resilient ecosystem, reducing the reliance on chemical pesticides and enhancing crop yields. For instance, maintaining hedgerows and field margins provides habitats for beneficial insects and birds that prey on crop pests. Additionally, promoting diverse cropping systems and planting native flowering plants can support endemic pollinators and beneficial insects, which are vital for the production of many crops (Kremen & Miles, 2012). This biodiversity not only supports immediate agricultural needs but also contributes to the long-term sustainability of the farming ecosystem.

Farmers can also benefit from the synergies between different ecological functions. Practices that enhance soil health often improve water regulation and support biodiversity. For example, cover crops add organic matter to the soil, improve its structure, increase water infiltration and provide habitat for beneficial organisms. Similarly, agroforestry systems integrate trees with crops and livestock, enhancing soil fertility, improving water management and creating habitats for diverse species. By understanding and harnessing these synergies, farmers can develop more resilient and productive agricultural systems that are better equipped to withstand environmental challenges (Gurr et al., 2016).

Biodiversity for resilient and profitable enterprises – no silver bullets

Theory is good, but in reality, all farms are different. From the physical factors that make up a farm (e.g., soils, topography, rainfall) to the economic and social factors that guide what is farmed and grown. These all influence what can be grown or produced, who wants to buy it and at what price. In turn, this influences the role of biodiversity on farms as, until recently, it was treated as an externality on farm balance sheets and not seen to have had any intrinsic value. In recent decades this has begun to change with value being recognised, initially with Organic and Biodynamic production systems, through to the recent rise of Regenerative Agriculture (RA). These production systems have had a focus on nutritional quality and receiving a premium for the produce, whereas other sustainably focused farming systems have focused on quality and the leverage of on-farm efficiencies to reduce costs. The following case studies highlight ways in which innovative and traditional farmers are working to promote biodiversity.

Dairy and Livestock - Horton House Farm, UK

Jonny and Rachel Rider run a mixed enterprise in Wiltshire, UK. They have cow and goat dairies and run cattle, sheep, goats and pigs for meat, and chickens for egg production, all in rotation, across 1100 hectares of Crown Tenancy.

In total, they graze 1200-1500 cows and around 300 goats. Sheep, pigs and laying hens are secondary livestock that are valued within their rotational or “holistic” grazing system and provide additional income streams. Rotational grazing and integrated land management has increased pasture diversity and soil organic matter, providing a resilient farming platform for three generations. The farm is currently receiving premium values for their produce through short supply chains into the domestic UK market.

The 350-400 cow dairy unit is the primary enterprise on the farm, aiming to sell around 1.1 million litres of milk per year. The dairy uses an intensive rotational grazing system, moving the cows 5-6 times per day, once-a day milking with milk sold at a premium for dairy processing. These cows are primarily grazed on herbal leys, multi-species pastures comprising of predominantly legumes, grasses, forbs and brassicas close to the dairy, with some additional haylage provided in colder months. The haylage is cut on farm from some of the surrounding leased land. After grazing, the pasture is rested for 40 days in summer and 60 days in winter, allowing for pasture recovery and nutrient recycling. All these practices are focused on promoting soil health and biodiversity. Furthermore, the pasture is divided up by trees (Fig 3.). These are planted as parallel hedges/fence lines around 50m apart. They consist of fruit trees interplanted with Italian Elders. The latter are nitrogen fixers which enhances nitrogen capture and storage across the pasture.

Figure 3. A recently grazed Horton House Farm multi-species herbal ley paddock, with 15-20 species identified. Also in the image are the fruit and Italian Elder tree paddock dividers. (source: author)

Excess cattle from the dairy herd are raised and finished as 100% grassfed beef. These cattle are grazed away from the dairy platform on the Marlborough Downs (Fig. 4) lease from the National Trust with specific conditions to protect and promote native biodiversity. On these native pastures and meadows, limited rotational grazing is possible with stock being moved once a day with 40 – 60 day recoveries. This practice has shown to be effective in increasing flora and fauna species richness and abundance in the pasture. Wildflowers, butterflies and birds, and the germination of wild orchids that were rarely previously seen have been observed in the recovering landscape.

The goat dairy is a recent addition to the enterprise, commenced during the COVID-19 lockdowns. The goat herd is 100% grass fed. Initially after kidding in June-July, the kids remain with their mothers for 90 days. Subsequently, the kids are turned off farm for meat and the does are milked throughout the autumn and winter when milk demand in the UK is at its highest.

Their enterprise is certified by A Greener World (AWG) as 100% Grass Fed and Animal Welfare Approved, and subscription to this certification guides a number of the farm's practices. Though not considered an organic certification, they are held to practical standards that in some way go beyond traditional organic certifications. Each AWG certification programme is designed to promote positive and measurable effects on the environment, animals and society to encourage sustainable farming practices.

Figure 4. Jonny Rider from Horton House Farm moving cattle as part of their daily rotational grazing system on the Marlborough Downs. These native pastures are under restoration and have around 30-40 species within the forage. On the left of the image is the previous day's forage area with the cows sited in the fresh forage area. (source: author)

Dairy and Cropping - Wastenage Farms, UK

Peter and Di Wastenage run an integrated mixed dairy and cropping farm in Devon, UK. Currently they run around 2700 dairy cows across 8 or 9 dairy units in the County. The dairy herd is rotationally grazed on multi-species herbal leys with additional feed grown on either leased, owned or under-trial land in conjunction with neighbouring farms. They also have a share-farmed goat dairy, milking around 600 goats. The farm operated for many years under organic certification, but the Wastenages are now working toward a farming model that will enhance environmental sustainability and reaching optimum outputs without organic certification.

Under the farm's organic management, milk production was sold at a premium price, compensating for a reduced output with no inputs to the pasture. At that time, this was considered a prosperous return and the Wastenages' gained integrated approach accolades as UK Farmers of the Year in 2015.

However, limitations in Organic Certified practices have motivated innovation towards greater on-farm sustainability goals: putting soil and plant health first. This innovation aims to maintain or increase production at the same level of forage while vastly reducing nitrogen use and phosphate leaching compared to conventional dairy farming systems. Furthermore, it aims to increase organic matter in soil by enhancing their multi-species herbal leys and crop rotations. Overall it is hoped this will increase

profitability of the dairy while increasing soil organic carbon (SOC) and improving biodiversity (including for pollinators and beneficial habitats).

Current changes in practice incorporate a 6-year rotation of cover crops (fodder beet, crimson clover, rye, corn, vetch and oats) and herbal leys (mixes of grasses, red and white clovers, plantains, chicory, sheep's burnet and others), targeted foliar application of inputs and terminating crops through grazing or cutting. So far, results have been promising. By concentrating on foliar applications of what is needed after plant testing, the most common input applications have been humates, bio-stimulants, boron and molybdenum, not NPK, which has produced around three to four times the amount of dry matter compared to application rates of conventional dairies. Milk production is similar to that of a conventional dairy, around 6800 litres per cow per season, despite using only 25% of the nitrogen fertiliser comparatively. This is seen as big step towards optimising farm outputs.

Figure 5. Peter Wastenage in a first-year soil restoration trial paddock on a neighbouring farm. (source: author)

To meet the feed requirements for their dairy platforms and reach the nutritional and environmental standards they aspire to, the Wastenages are having to work with other farmers to help them change their farming systems, incorporating their innovations to improve soil health and biodiversity (Fig. 5). Peter explained that this was not an easy process as often they are seen as "cranks". To offset these attitudes, they are gathering data on their techniques and soil improvements while all the time maintaining their optimised outputs, to be provide evidence to support their actions.

Cropping and Livestock - Le Ferme De Germigney, France

Emmanuel Ogier and his family have been crop and livestock farmers for three generations, growing from 30ha of owned land to approximately 300ha. During the 1990's the market value of cattle in France crashed due to the Bovine Spongiform Encephalopathy (BSE) outbreak in the UK and the Ogiers reduced their herd from around 150 to 50. This had a drastic effect on farm income and the Ogiers changed their main focus to cropping. Initially this was wheat and other cereals, but soon wheat prices and yield also started to decline. In 2005 Emmanuel was looking for innovations and found cold-pressed oils. This process retains all the nutrients and vitamins, creating a pure, high-quality oil. In 2006 they started producing their own brand of cold-pressed sunflower and canola oils, selling direct to consumers through local farmers markets and then into health-food stores. They have since expanded to include chamomile oil. They continued to grow-on a small beef herd, sold locally as meat.

In 2015, customers were expressing an interest in whether the oil was organically produced. This led to the observation that an opportunity for further value-adding was available. At this time Emmanuel became unwell, which he suspected was due to the agricultural chemicals he was applying to the crops. This was the final push that he needed to convert the farm to organic production.

Figure 6. Emmanuel Ogier with his premium range of cold-pressed oils at the Le Ferme De Germigney visitor center. (source: author)

Going forward, the farm has been committed to organic production and harnessing biodiversity in the agricultural systems to counter the usual agricultural problems, such

as pests. Innovations have focused on improving soil health and biodiversity, such as extending their crop rotations over seven years, using multi-species cover crops, incorporating alfalfa to increase soil nitrogen (in two successive years) and suppressing the germination of unwanted weed species (cover crop mixes include vetch/ryes, radish/oats or phacelia/buckwheat). In recent years Emmanuel has been actively planting hedgerows and flower strips, either at the margins of the fields or as interrow strips. These increase habitat for pollinators and beneficial insects to help rebalance their farming ecosystem. The importance of this is highlighted by the depredation of canola crops in the Jura region of France by the Altise beetle, which has effectively stopped production of canola in the region. Through the inclusion of the hedge and flower strips and the promotion of habitat for beneficial native parasitic wasps, beetle numbers are controlled and canola harvest yields remain higher than under conventional practices, in addition to the provision of higher quality oils. These premium oils continue to be sold across France at selected outlets, but also directly from the farm visitor centre (Fig. 6) that is used in combination as an education centre for sustainable farming.

Horticulture and Cropping - Bio Brass, Netherlands

Bio Brass is an innovative integrated Certified Organic vegetable producer in Flevoland, Netherlands. Bio Brass was founded by a Netherlands Nuffield Scholar, Gerjan Snippe, in collaboration with two other neighbouring farmers who wanted to improve their organic crop rotations, harness efficiencies of scale and shorten their supply chain to increase their share of the market value of their crops.

Their innovations have been to use organic principles, to find balance by listening to nature and forming closed loops which have improved soil health and nutrient cycling. The biodiversity of the soil was overlooked in the past, but this systems attention on soil biodiversity has led to an extensive crop rotation over 7 years. This cycle consecutively utilises:

- two years of legumes and grasses;
- a green manure crop;
- broccoli or cauliflower;
- onions;
- either a sweet corn or barley crop, or a wheat crop in conjunction with a green manure crop;
- and finishes with either a potato, carrot or parsnip crop.

Through the development of this rotation, the only input required is phosphate, and new crop additions are being considered to try and further offset these inputs such as the incorporation of blackberries or the inclusion of livestock (manure). The greatest outcome is the increased biodiversity that has enabled healthy soil microbiomes to thrive and thus reduced the farms' operating costs while providing continuous premium, high-quality, year-round produce.

Furthermore, the improved soil biodiversity plays a major role in their marketing and sales strategy. A key part of Bio Brass's strategy is to create a connection with their consumers so that people can understand the difference between organic and

conventional production. To do this, an AU$60,000 visitor centre was built to offer locally grown produce and farm-fresh meals where customers can see how the produce is grown and its ecological footprint.

Small Scale Farms - Beef, Goat and Sheep Dairies - France

Although large scale farms are able to harness greater efficiencies of scale, small farmers may find it easier to find efficiencies through working with nature. Small organic dairies in France are especially well placed to work with nature and encourage biodiversity due to the support of traditional ways of farming (e.g., AOP and PDO).

These small dairies are often found in areas where it is difficult to use larger machinery and therefore seasonal natural pastures and silvopasture foraging areas are managed through “holistic” rotational grazing (Fig.7). As these resources are limited farmers are acutely aware of over-grazing and browsing and work carefully to match their stocking rates and rotations accordingly. This is more of a symbiotic relationship with nature, that supports biodiversity through increased nutrient cycling and promoting soil health.

Good examples of these enterprises are:

- Carmen Bateson and Christophe Prodanu, Cheverie d’Arbois, located in Arbois within the Jura Region, milking 16 goats, using 2ha of owned land and accessing another 5ha.
- David Labu and Franck Tremblay, Ferme de Plateau, located in regional Provence, milking 160 sheep, on 3ha of owned land and accessing the local forests for foraging.
- Gerard and Linda Gauthier, La Ferme du Currage, at Ouroux in Auvergne-Rhône-Aples region, milking 80 goats on 46ha of owned land.
- Peio and Nelia Setoain, La Ferme Auzkia, fourth generation farmers in the Aldudes Valley of the Pyrénées-Atlantique, running 30 blondes d’Aquitaine cattle on about 20 ha.

These farms leverage their traditional artisan craft, value-adding to their produce at source, making exceptional cheeses and produce that are recognised locally and in the broader domestic market as some of the best organic meats and cheeses. Further incomes are derived from people’s interest in seeing how the farms operate in traditional ways, with some offering meals and accommodation, or offering their produce for sale directly at the farm gate.

Figure 7. Traditional multi-species herb and forage pastures in the in Auvergne-Rhône-Aples region of France. Note the presence of tree stands throughout the landscape and connectivity through hedgerows. (source: author)

Barriers to promoting biodiversity

The main barriers to promoting biodiversity in agriculture and farming with nature, can be separated artificially into three strands; economic, intellectual and emotional. However, in reality, these strands are intertwined.

One of the biggest fears that farmers face is financial ruin. The long hours of work, increasing debt and interest rates, reliance on banks and the increased expenses associated with living rurally (for example, boarding school fees, higher fuel costs) mean that farmers are often making a living at the edge of viable businesses, depending on asset wealth to ensure the family's economic future.

Many farmers are concerned that moving an operation towards one more aligned with natural ecosystems will result in significant financial losses that will never be recoverable. As Sarah Singla says, when she farms, "one third is for the farmer, one third for the community, and nature takes the last one third". Emmaunel Ogier subscribes to an 80-20 principle. To see a decrease in income of 20-30% is certainly frightening, and downright unpalatable for many.

Financial fears aside, many farmers have been educated through tertiary institutions in conventional practices – where crops are terminated, soils are ploughed, disced, tilled, tilled again and then sown. They have also invested heavily in the machinery to perform these tasks as efficiently as possible. For those who have inherited generational farms, they are also encumbered with the narratives handed down through the generations: "this is the way we farm our land". To farm differently from such convention requires great courage, and good communication with family members, who still may not be accepting of different techniques. There is also needs to be some level of acceptance from landowners. These institutions, such as the National Trust in the UK, are hesitant to allow farmers to change the way in which they use leased land. Often, the landowners have restrictive conservation covenants to protect natural places and historic buildings to retain the character of the landscape. However, they can have perverse outcomes that restrict adaptation to innovative practices. A number of the farmers visited in the UK mentioned various limitations, such as over-sowing for multispecies pastures or high intensity rotational grazing until research validates these approaches for the specific environments. For many, at all scales, there is simply a lack of knowledge of how farming with nature can be efficient and profitable, and indeed how it can ultimately benefit the greater good.

Humans are tribal animals, and we rely on our tribes for safety and assistance, particularly in times of need. This is more pronounced in rural areas and for farmers compared to urban dwellers. The communities in which farmers live and work can be small and the opinions of those within the community matter greatly. From an evolutionary perspective, to be different is dangerous. To move away from conventional farming and embrace a softer approach to the land will attract significant commentary in some communities. The fear of failure and shame can be overwhelming and can limit or delay any attempt to integrate nature into farming practices for many farmers.

Reasons for change

Mark Twain has been attributed with saying *"Change is hard*". While this is true, change in the face of uncertainty is even harder.

At the end of the day, if there is no perceived need to, no-one will willingly change. Many of the stories in books about RA, on podcasts, and in conversations with farmers, like Charles Massy or Emmanuel Ogier, describe how farmers have changed their operations because they simply have had to. Interestingly, these reasons tend to fall into the same three categories identified as barriers: economic, intellectual and emotional.

Farmers tend to be very connected to their land and livestock. All the farmers observed absolutely want to ensure that the land is left in a better condition than when they acquired it (through purchase or succession), to ensure that the farm can continue to prosper for generations to come. The greatest farmers are the keenest observers, and the keen observation of their land is associated with memory (own or shared) and emotion. For many, the emotion associated with the change in the function of the landscape over the last several decades, associated with changing climate has led to concern for the future of both their farm, livelihood and the long-term well-being of their community and children.

Emmanuel Ogier shared his story of significant depression when he realised that he was killing life in order to make food for other lives. While this is indeed nature, the manner in which he was exterminating all life on his farm through the use of pesticides and herbicides was an anathema for his soul. He realised that he had to change the way he farmed for his own mental and physical health.

Spirituality and connection to nature were certainly themes that emerged in some discussions with the farmers interviewed for this project, which was remarkable to witness and very generous of those who felt comfortable and at ease enough to share. By being connected to nature and the nature of all things, it was evident that these farmers' mental well-being was excellent.

All of the farmers met through the Nuffield Scholarship program who are farming with nature have increased their knowledge through self-education. It is clear that they are life-long learners who have chosen to embrace an open mindset in order to address their needs. They have read books, attended conferences and have been encouraged by their state's Departments of Agriculture to attend workshops. For example, in France, all farmers have access to a professional development allowance. Others seem to have been guided by their intuition and put into practice "safe-to-fail experiments" on their own farms, observing outcomes. Of note, the majority of farmers have not had access to mentors or supports, particularly in the early phases of their journey towards ecological farming. This is certainly an opportunity that could be developed should various government departments or not-for-profit organisations think it worthwhile to pursue, to help tip the scales in favour of the uptake of ecological farming.

There are multiple economic opportunities to take up practices that incorporate farming with nature. In the UK and Europe, the EU and/or the country in which the farmer resides provide financial remuneration for various activities. These policies do have an effect on driving behavioural change, as farmers can incorporate the financial rebates into their business plans and map their farming activities accordingly. Other examples include "locking up land" for ecosystem services, with a small financial benefit provided

by the government for doing so (an Australian example of this is an Environmental Conservation Covenant).

The most beneficial economic incentive, however, remains the increase in profitability that all the farmers interviewed for this project have experienced. From both academic and practical agronomic perspectives, Sarah Singla and Sylvian Cournet have observed and promoted farming with nature to reduce external inputs, such as pesticides, herbicides, synthetic fertilisers and increasingly large machinery. With a slight decrease in income, but massively reduced expenditure, profitability increases immediately. The long-term gains also have a ratchet effect on profitability: farming with nature inevitably leads to increased biodiversity in the soil which increases SOC and then leads to increased crop yields. Even when considered in the terms of another economic pathway, carbon farming, where increasing biodiversity is a side benefit, (at the time of writing) Professor Matthew Harrison has described a six-times greater benefit from the inclusion of natural capital for farm profitability in Australia. For example, in pastured systems, increased SOC leads to drought resilience due to better water infiltration and storage in soil, as well as increasing livestock capacity per hectare.

There are other opportunities that can also be leveraged, such as carbon or biodiversity credits through credentialed programs. More easily accessible to all farmers are premium pricing and marketing opportunities, either through branding or through credentialed programs that certify Biodiversity or “Farming with Nature” principles, in the same way that Organic Certification has successfully infiltrated the population. Mons Affineurs is one of France’s premier cheesemongers who buy cheeses directly from farmers and mature them in their specialised cheese caves to supply French and international markets. Although there are economic differentiations in their cheeses, those cheeses with unique flavours and textures, related to AOP traditional organic farming practices are in greatest demand and command the highest prices. The value of these cheeses through short supply chains and good personal and business relationships ensures maximum return to the farm gate and supports biodiverse-friendly farming (Fig. 8).

Figure 8. The cover of the Mons cheese catalogue highlighting the importance of biodiversity for dairy farming and processing and marketing. (source: author)

Also, and not yet fully realised, are opportunities for corporates and financial institutions. An example may be that a corporate business pays a farmer a bursary each year for a number of years, to regenerate or rewild an area of their farm – and in return, they have brand association (if branded), or community approval (and thus increased business from those who choose to "shop ethically"). Financial institutions have another opportunity to appease shareholders and their customer base by incentivising farmers to work with nature through reduced interest rate loans. Rabobank in the Netherlands is currently piloting an interest rate scheme for Dutch dairy farmers, where reducing interest rates are linked to their progress along a journey of sustainable practices. While these opportunities are currently in their infancy and will require structured measures and some kind of accreditation framework, they certainly seem like a market opportunity that benefits farmers, the corporate institution and the public they serve.

Transitioning to farming practices that incorporate nature is like an old-fashioned set of scales. When the benefits of change outweigh the barriers, behaviour will change. There is a need to now increase farmers' awareness of the benefits to themselves, their farms, their families and the community.

Pathways for profitable, resilient biodiverse farms

Over the past few decades there have been numerous high-level policies in place globally, regionally and in Australia to promote biodiversity in agriculture. However, their success has been limited at best.

Globally, several key policies aim to integrate biodiversity into agricultural practices. In 2015 the United Nations (UN) adopted Sustainable Development Goal (SDG) 15 to encourage sustainable use of terrestrial ecosystems, halting biodiversity loss and underscoring the importance of integrating biodiversity into agricultural practices to sustain ecosystem services vital for human well-being. Further to that, the Convention on Biological Diversity (CBD) is one of the most significant international agreements that promotes sustainable agricultural practices that conserve and enhance biodiversity (CBD, 2010). The Aichi Biodiversity Targets, established under the CBD, specifically include targets for the sustainable management of agriculture, aquaculture, and forestry to ensure biodiversity conservation. Additionally, the Food and Agriculture Organization (FAO) supports biodiversity-friendly agriculture through initiatives like the Globally Important Agricultural Heritage Systems (GIAHS), which recognise and promote traditional agricultural practices that maintain biodiversity (FAO, 2021).

Regionally, the European Union (EU) has been proactive in incorporating biodiversity into its agricultural policies. The Common Agricultural Policy (CAP) includes "greening" measures (Green Direct Payments and Agri-Environment Climate Measures) that require farmers to adopt environmentally friendly practices such as crop diversification, maintaining permanent grassland and creating ecological focus areas (EFAs). The EU Biodiversity Policy for 2030 further reinforces these efforts, the Farm to Fork Strategy, setting ambitious goals to restore biodiversity across Europe including significant increases in organic farming and the restoration of degraded ecosystems (European Commission, 2020). In some countries this had led to rapid agricultural development promoting change. Ireland's new Food Vision 2030 strategy is a bold pathway (Irish Department of Agriculture, Food and the Marine, 2021) delivering significant benefits for the Irish agri-food sector, Irish society and the environment. In demonstrating the highest standards of sustainability (economic, environmental and social) Ireland is setting itself up for future competitive advantages.

In the Australian context several policies and programs aim to promote biodiversity in agriculture. The National Landcare Program supports projects that enhance sustainable land management practices and biodiversity conservation. The Environmental Stewardship Program provides financial incentives to farmers to manage their land in ways that protect and enhance biodiversity. Furthermore, the Biodiversity Conservation Trust offers funding for conservation activities on private land, aiming to integrate biodiversity conservation with agricultural productivity. Currently the Australian Agricultural Sustainability Framework (AASF) is being developed as a joint initiative led by the National Farmers Federation (NFF) and supported by the Australian Government. The AASF has set out unify sustainability objectives across agricultural sectors. It is hoped that the AASF will foster farmers to reach sustainability goals and strengthen local and broader supply chains.

However, despite these initiatives and policies, including some direct payments and devolved grants, they have often failed to achieve their objectives due to several key challenges.

These challenges include:

- fragmented and inconsistent policies,
- complex and bureaucratic processes,
- lack of enforcement and compliance,
- insufficient financial incentives,
- market pressures and economic constraints, including labour,
- inadequate knowledge and training, and
- climate change and environmental degradation.

At the farm, the greatest challenges to adoption by farmers are mostly economic and environmental. Although policy issues probably cause the greatest concern and ire, they do not directly provide farm income and therefore limit the influence on how people farm.

Economic pressures are the greatest issue; without a farm income, farmers cannot farm in any way, let alone in a manner that promotes biodiversity and nature. Traditionally farmers tend to prioritise short-term productivity gains over long-term sustainability, undermining the adoption of biodiversity-enhancing practices as a result. This, coupled with inadequate knowledge and training, makes adaptation difficult. Adoption is further hampered by extreme weather events, soil degradation and changing climate envelopes, making it even more difficult for biodiversity-friendly practices to take root for long-term benefits. Addressing these issues requires a multi-faceted approach that includes better tailored financial incentives from Government and the private sector, integrated policy and monitoring streamlined processes and improved education and training. By tackling these challenges, the agricultural sector can move towards more sustainable and resilient practices that support both biodiversity and productivity.

Farming for the Future program

One comprehensive step towards addressing the challenge of biodiversity loss, climate change and agricultural productivity is the Australian Farming for the Future program (MLA, 2024). This is a pioneering pilot initiative that brings together farmers, researchers and educators and other stakeholders, aiming to provide national-scale evidence that connects biodiverse farming, high quality food and fibre production and farm profitability. This program envisions a profound transformation of the Australian agricultural sector, focusing on integrating natural capital management into farm operations to boost resilience and profitability.

The program is designed to promote sustainable agriculture through a collaborative and multi-faceted approach. By integrating national coordination, regional implementation, multi-stakeholder governance and robust support mechanisms, the program supports farmers to adopt practices that enhance the sustainability and resilience of the agricultural sector. This structure not only benefits individual farmers but also contributes to broader environmental and economic goals.

The program’s fundamental philosophy is that natural capital’s financial contribution to farming can surpass the economic gains from alternative income streams such as carbon credits and biodiversity markets. By enhancing producers' understanding of

how natural capital impacts their core production processes, Farming for the Future aims to drive widespread adoption of improved land management practices. The ultimate goal is to help the sector evolve into a more resilient, profitable, and sustainable industry for all, rather than a select few who can capitalise on the carbon and biodiversity credit markets.

Farming for the Future is focused on several key objectives:

- **Documenting Evidence**: Establishing a national-scale evidence base that demonstrates the relationship between on-farm natural capital and business performance in Australian agriculture.
- **Integrating Natural Capital**: Embedding natural capital into mainstream farm valuation and management practices. This involves equipping producers with data, tools and support to measure and manage their natural capital effectively.
- **Identifying Benefit Pathways**: Understanding and quantifying how natural capital benefits farm businesses and identifying pathways through which these benefits are realised.
- **Developing Tools**: Designing, building and testing a benchmarking module to assist farm decision-making by providing insights on optimising natural capital management.
- **Activating Support Systems**: Engaging supply chains, financial services and government organisations to support the measurement, management, and investment in natural capital as a production factor.
- **Encouraging Systems Change**: Building networks across industry, government, philanthropy and academia to accelerate the adoption of natural capital management and enhance sector resilience and profitability.

The Livestock Pilot Program of Farming for the Future has concentrated its research on livestock operations across New South Wales, Victoria, Tasmania and Western Australia. Data was collected from 130 livestock businesses, representing various natural capital types and enterprise sizes.

The program utilised remote sensing technology, field surveys and interviews to gather high-quality data on natural capital, financial performance and production. Statistical analyses and benchmarking were employed to quantify relationships between natural capital and farm performance and to identify beneficial management actions. Additionally, the program engaged with landholders, farm advisors and industry stakeholders to develop and refine tools for natural capital management.

The Livestock Pilot Program has yielded significant insights:

- **Financial Motivation**: Private financial benefits were identified as the primary incentive for producers to invest in natural capital improvements.
- **Productivity and Efficiency**: Analysis of 113 livestock farms revealed a positive correlation between natural capital and production efficiency. This suggests a “double dividend” effect where higher natural capital contributes to improved productivity and reduced costs.

- **Benefit Pathways**: Different benefit pathways were identified, including increased productivity and reduced input costs. Farms with high natural capital also reported lower costs for inputs like energy, fodder, health and labour.
- **Financial Performance**: High natural capital was associated with higher financial performance metrics such as gross margin and earnings before interest and taxes (EBIT). For instance, optimised natural capital led to a median increase in EBIT ranging from $20 to $175 per hectare per year across different regions.
- **Resilience**: Farms with high natural capital demonstrated greater resilience to climate and market shocks. This resilience is attributed to enhanced water retention in soils and lower-cost natural capital inputs that are less susceptible to international market fluctuations.
- **Farm Type Insights**: Analysis of different farm types showed that most could benefit from improving natural capital, though the specifics varied by farm type and region. Evidence of a “trade-off zone” was observed for certain natural capital elements, suggesting potential roles for market incentives in specific circumstances.

Farming for the Future provides crucial resources for producers, including measurement protocols, evidence bases and tools to enhance natural capital management. These resources enable farmers to report on natural capital improvements and leverage market opportunities. The initiative also engages farm advisors and industry partners to promote widespread adoption of beneficial practices.

By delivering farm-scale natural capital and benchmarking reports, the program helps producers explore how natural capital management can enhance their business performance on a case-by-case basis. The insights gained are expected to drive large-scale industry adoption, potentially increasing the proportion of farms adopting improved practices by 38% beyond baseline forecasts.

Looking ahead, Farming for the Future plans to expand its research scope to include around 270 new farms and two additional focus regions by 2026. This expansion will enhance the statistical confidence of the findings and provide deeper insights into natural capital-farm business relationships.

The program aims to include 1,500 livestock, cropping and mixed farms across all Australian states and territories in its research. This broader dataset will help develop a comprehensive understanding of the benefits of natural capital management across different operation types and locations, contributing to a more financially prosperous, climate-resilient and environmentally sustainable agricultural sector in Australia.

Strengthening the network of collaborators and partners will be crucial for achieving these goals, ensuring the continued evolution of Australian agriculture towards enhanced sustainability and resilience.

Boerenatuur

In the Netherlands Boerenatuur, directly translated as “Farm Nature”, is a forward-thinking collective approach for farmers that are looking to embrace biodiversity into

their agricultural practices. Through structured support, financial incentives and education, farmers are encouraged to adopt sustainable methods that benefit both their operations and the environment. This initiative is not only vital for the sustainability of individual farms but also for the broader goals of conserving biodiversity and promoting ecological balance in agricultural landscapes. This holistic approach aims to make farms more resilient and environmentally friendly.

Boerenatuur operates under a collaborative framework involving multiple stakeholders, including government agencies, agricultural organisations and environmental groups. It is governed by a central body that coordinates efforts and provides guidelines, with regional branches implementing localised programs. The initiative relies on a mix of public funding, subsidies and private investments to support its activities. Farmers receive direct support from agricultural experts and participate in training and educational programs to adopt biodiversity-friendly practices. This decentralised yet coordinated approach ensures that Boerenatuur's goals are effectively integrated into diverse agricultural landscapes across the Netherlands.

To reach the Boerenatuur goals the network provides farmers with tailored support and are encouraged to make a number of practice changes:

1. **Habitat creation**: Farmers are encouraged to create and maintain habitats for a variety of species. This might include planting hedgerows, creating wetlands, or maintaining grass margins along fields. These habitats support pollinators, birds and other beneficial organisms.
2. **Agroecological practices**: The initiative promotes practices such as crop rotation, reduced use of chemical inputs and organic farming. These practices help improve soil health and reduce the negative impact on surrounding ecosystems. Precision agriculture techniques are also encouraged to optimise resource use and minimise environmental impact.
3. **Financial and education support**: Boerenatuur offers financial incentives to farmers who adopt biodiversity-friendly practices. This can include payments to offset production loss for ecosystem services, grants, or access to specialised markets where sustainably produced goods command higher prices. Additionally, educational programs and training sessions are provided to equip farmers with the knowledge and skills necessary to implement and maintain these practices effectively.
4. **Resource management for impact reduction**: Efficient management of water and nutrients is emphasised. Techniques such as precision agriculture and water conservation help reduce waste and minimise environmental impact.

Though each of the practice changes and support would provide some benefit to the farmers, the synergism this program offers ensures that the benefits are far greater and are leading to win-win outcomes at all scales.

1. **Improved Soil Health**: By adopting practices that promote biodiversity, farmers often see improvements in soil health. Healthier soils have led to better crop yields and reduced the need for artificial fertilizers.
2. **Pest and Disease Management**: Diverse ecosystems have helped to control pests and diseases naturally. For example, certain insects and birds are

returning as natural predators to harmful pests and thus reducing the need for chemical pesticides.

3. **Enhanced Farm Resilience**: Biodiversity can make farms more resilient to environmental changes and extreme weather events. Diverse systems are better equipped to handle stress and recover from disturbances.
4. **Economic Incentives**: In some cases, farmers have financial benefits for implementing biodiversity-friendly practices, such as reimbursements for land or production loss. Additionally, there's growing consumer demand for sustainably produced goods, which has led to better market access.
5. **Positive Public Image**: Adopting sustainable practices has improved some farms' reputations and strengthened their brands. Consumers are increasingly interested in the environmental impact of their food and farms that promote biodiversity can attract environmentally-conscious customers.

Overall, Boerenatuur has produced a positive opportunity for Dutch farmers and the environment. By integrating biodiversity into their operations and taking a collective approach, farmers are improving their land's health and productivity while contributing to broader conservation goals at regional scales. The initial success of this program has been recognised nationally and has now been strengthened with an increase in funding from the Dutch Government.

Marlborough Downs Space for Nature

The Marlborough Downs are in Wiltshire, UK is a region known for its chalk grasslands and diverse wildlife. In 2011, the local farmers were concerned about biodiversity loss and the impact that it was having on their farms, both ecologically and aesthetically. They formed the Marlborough Downs Space for Nature in 2012. This initiative is a farmer-led project, funded by UK Government and European Commission's LIFE Programme. These grants were aimed at promoting environmental stewardship and sustainable agriculture. Additionally, farmers invested their own resources and time, with additional support from private donors, corporate sponsors and charitable organisations. Here, the farmers are working collaboratively on conservation efforts across the Downs that are still continuing today.

The primary objectives of the Marlborough Downs Space for Nature initiative are:

- **Enhancing Biodiversity**: To create, restore and manage habitats that support a wide range of wildlife, including birds, insects, mammals and plants.
- **Sustainable Farming**: To integrate conservation practices into agricultural operations, ensuring that farming remains productive while also being environmentally friendly.
- **Community Engagement**: To involve the local community in conservation efforts, raising awareness and fostering a sense of stewardship for the natural environment.
- **Research and Education**: To support research into effective conservation practices and to provide educational opportunities for farmers and the wider community.

The Marlborough Downs Space for Nature initiative is structured around a cooperative model with local farmers as the primary drivers. Farmer collaboration has been paramount, where a group of local farmers collectively plan and implement conservation activities, sharing knowledge, resources and expertise to achieve common goals. A steering committee, consisting of representatives from the farming community and partner organisations, oversees the project setting strategic directions and ensuring objectives are met. Additionally, environmental NGOs, government agencies and research institutions are involved for access technical support and additional resources. The initiative also includes the general public in the collaborative journey to a better place for wildlife, farmers, local communities and visitors.

The initiative has achieved several notable outcomes, particularly in promoting biodiversity in agriculture:

- **Habitat Creation and Restoration**: Significant areas of chalk grassland, hedgerows, ponds and wildflower meadows have been created or restored. These habitats support a wide range of species, including butterflies, birds and pollinators.
- **Species Recovery**: The initiative has contributed to the recovery of several species, such as the corn bunting and the brown hare, by providing suitable habitats and implementing targeted conservation measures.
- **Sustainable Farming Practices**: Farmers have adopted more sustainable practices such as reduced pesticide use, crop rotation and the establishment of field margins. These practices benefit both biodiversity and farm productivity.
- **Community Involvement**: The project has engaged the local community through events, educational programs and volunteer opportunities, fostering a greater appreciation for the natural environment.
- **Research and Monitoring**: Continuous monitoring and research have been integral to the project, helping to track the impact of conservation efforts and adapt strategies as needed.

The Marlborough Downs Space for Nature initiative is a successful example of how farmers can lead conservation efforts to promote biodiversity within agricultural landscapes. Through collaboration, funding from diverse sources and a strong commitment to sustainability, the initiative has created a model for integrating biodiversity into farming practices while enhancing the natural environment.

Conclusions

There has never been a more important time to consider how farming can be part of the solution to biodiversity loss and climate change.

There is clear evidence, in both theory and practice, that farmers can optimise their farming operations using systems thinking, based on ecological theory and working with biodiversity.

Farmers can take small or large steps on this journey. What is vital to promote change is tipping the balance in favour of the adoption of these practices. Here, the values of farmers, as individuals or collectives, and the make-up of their farming landscape, will influence the desire and capacity for adaptation, but underscoring this are the farms' financial positions. If a farm business cannot generate enough income to thrive then there will not be enough 'fat in the system' to be able to put some aside for nature.

Where there are little or no external support payments for farm production and/or ecosystem services, farm profitability is the most important factor that allows farmers to integrate environmentally-friendly actions on their farms. Farmers' values (economic, environmental and emotional) also directly influence the size of the steps taken in changing practices. However, subsidies for production (not linked to environmental policy) can reduce the appetite for change, as the farmer does not need to do anything different in order to receive their subsidy.

Farmers can make the changes alone as the pioneers in this space have done, but greater change can be affected through collaborative programs. The Marlborough Downs Space for Nature initiative has shown that farmers with a desire to restore and promote farming with biodiversity can do so with start-up financial assistance, with benefits for food production and also the greater good.

Whilst still in the pilot phase, the Farming for the Future program in Australia has broken new ground, clearly showing that farms with greater natural capital who are inherently more biodiverse can have a "double dividend". They have increased their production and decreased their costs with an overall increase in profit. Delivery of these results is now in the hands of the outreach collaborators. This pathway has also cultivated discussions around mainstream market opportunities and financial incentives, but these are yet to germinate.

The greatest change to biodiversity-friendly farming has been driven by the Boerenatuur collective approach in the Netherlands. This has provided education, support to reduce uncertainty around practice change and financial incentives to nurture the transition to farming with nature. In this model the financial incentives are considered as small reimbursements to offset potential decreases in income incurred through the loss of productive farmland, or to cover costs, such as fencing materials or contractors. Furthermore, these are provided incrementally so farmers can maintain autonomy to make small or large changes to their operation, and benefit accordingly. The farmers also gain from having greater perceived value at their farm gate, social licence and access to alternative financial markets and arrangements.

Tipping the scales of sustainability where benefits outweigh barriers is the key to developing greater biodiversity on farmland. This can only be done by removing the economic and emotional barriers that drive uncertainty. Though individual farmers can be profitable working with nature, for greater benefits we need change across regions

and the global agricultural sector. For this to occur, we need strong farmer-driven support systems including research, education and extension that promote profitable farming. Ultimately for transformative change to environmentally-friendly sustainable food and fibre production systems, financial incentives aid tipping the balance costs of production shared across the supply chains, promoting equity for the ecosystem services that we all rely upon.

Recommendations

There are no silver bullets, and there are no simple recipes that any farmer can follow. To successfully nurture farmers to increase biodiversity on their farms and to integrate nature into their farm systems, the following recommendations should be adhered to:

- For individual farmers to make environmentally conscious decisions in the face of uncertainty:
  - Find your “why”, this will help guide you.
  - Find the best resources and people you trust to help you.
  - Talk to, and more importantly, listen to people that know more than you, recognising that peer-to-peer learning can give you the best insights.
  - Be discerning to whom you listen to and what advice you take on board.
  - Don’t be afraid of change, failure or the unknown. They are all learning opportunities.
  - Make “safe-to-fail” changes, don’t take chances or make changes that are so big that there is little or no economic recovery possible.

- Increasing biodiversity on farms should start from the ground-up with five key elements:
  - Maximising crop, pasture and landscape diversity
  - Minimising disturbance to the soil
  - Maintaining living roots, year round
  - Keeping the soil covered
  - Integrating livestock into system where possible

  Translating these elements into practices is farm dependant, but inclusion of practices such as such as multi-species pastures, cover cropping, rotational cropping, rotational grazing with sheep and cattle and incorporating crop residues into soil before drilling will allow synergies that increase biodiversity, promote soil health and nutrient cycling.

- Funding and support for ongoing learning and professional development for all farmers, with continuity and relationship building over time, to develop trust and enable medium and long-term results to be shared widely.

- Continued research and extension into innovative ideas and the benefits of integrating biodiversity and natural capital into all forms of agriculture, from trusted-extension providers including long-term and safe-to-fail trials, rather than limited consultancy-driven workshops.

- Develop regional approaches to integrating biodiversity into farming to improve connectivity and reduce the impacts of environmental change on the wider landscape.

- Formation of regionally farmer-driven collectives to provide education, data-sharing, operational assessment, support and market access opportunities, based on the successful Farming for the Future program and Boernatuur.

- Development of policy and funding initiatives to assist farmers to maintain and enhance the ecosystem services that they provide from both land set aside for nature but also from agricultural land, potentially utilising the existing Australian Landcare and State-based Natural Resource Management Organisations.

- Explore the potential for marketing campaigns and label verification systems for biodiverse farms.

- Continued and enhanced support of the AASF, or alternative initiatives, to promote sustainable agricultural practices through supply chains for improved market access and outcomes.

- Development of independent corporate and financial incentives for increasing and maintaining biodiversity and natural capital stocks and ecosystem services provided by farms.

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