

FOREWORD

This profile report is about food **and** security – about the impact that food scarcity has on peace and stability; on infrastructure and society.

It is about the ecological crises we face, and how a focus on the restoration and regeneration of one of the Earth's most essential organs – its soil – can achieve so much to reverse the decline in nature, to mitigate the impacts of extreme weather, and to underpin food and societal security for everyone.

This report profiles the critical importance of soil health through the writings of 22 experts – military minds, NGO leaders, scientists and practical farmers.

Together, we aim to alert policy-makers and civil society to the security threats posed by declining soil health, and to the remarkable opportunity that soil regeneration provides.

Global security is maintained by taking steps to mitigate future threats. Now, in addition to traditional state-on-state or intra-state threats, we face non-traditional threats, the most important of which can be characterised as 'ecological breakdown'. The extreme weather events associated with global warming, coupled with the loss of biodiversity and soil structure, could have devastating impacts on harvests around the world. While access to food is a recognised accelerant of instability, it is soil biodiversity in particular that is critical in minimising and mitigating this risk.

The right to affordable nutrition underpins peace and civil stability, but ecological breakdown is already affecting food production. If we see a two degree rise in global temperatures, which now seems increasingly likely, we could experience extreme disruption in global food supplies. When food is scarce, prices rise, inequality increases and simmering resentments can turn rapidly into conflict and even war. Healthy soil and a balanced ecosystem are critical for food sovereignty and a peaceful society.

We urge governments to take the security risks associated with soil degradation and ecological breakdown extremely seriously.

We offer agroecology as a low risk and low cost solution that can mitigate the security threats connected with poor soil health. With COP26 in sight, agroecology and regenerative farming can produce great food locally and at scale, while greatly accelerating carbon drawdown, regenerating biodiversity, and managing precipitation to provide greater drought resilience and better flood protection.

I hope that you will find this collection of articles inspiring and informative – and that you will support us as we work to restore soil health and transform food production, in order to build peace and maintain global security.



ffinlo Costain
Founder, Food & Global Security Network
<https://www.foodandsecurity.net/>

PUBLISHING NOTE

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Our advisors are Rear Admiral Neil Morisetti, Dr Ashleigh Bright, Reginaldo Haslett-Marroquin, Clare Hill, Roland Bonney and ffinlo Costain,

Farmwel is a think tank working for sustainable agricultural land use and food production. Our priorities are to mitigate global warming, integrate agriculture with biodiversity, and ensure that good, nutritious food is available for all. We have given evidence to Parliamentary committees and helped UK Government develop farm animal welfare and sustainability metrics. We have advised on global warming mitigation pathways and have highlighted the importance of the revised metric, GWP*, which accurately assesses the warming impact of methane. Farmwel and FAI also produce the popular Farm Gate podcast: <https://www.faifarms.com/podcasts/>

FAI are a global team of farmers, veterinarians, scientists and strategists with first-hand experience of food production and its challenges. We have people and offices in the UK, US, Brazil, Germany, Norway and New Zealand. Through strategic partnerships with leading food brands and organisations we implement better farming practices and improvements in commercial supply chains. FAI are thought leaders in agriculture's opportunity to tackle the two most pressing issues facing humanity: biodiversity loss and climate change. Our regenerative agriculture work encompasses transition both at farm level and strategically through supply chains. www.faifarms.com

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EXECUTIVE SUMMARY

We face two concurrent crises in nature: climate change and the loss of biodiversity. Both threaten the availability of food and water, endangering global supply chains. Human access to affordable nutrition and potable water are critical in maintaining peace and security. Global warming, biodiversity loss, food and water – they are connected, above all else, by soil health.

Overview

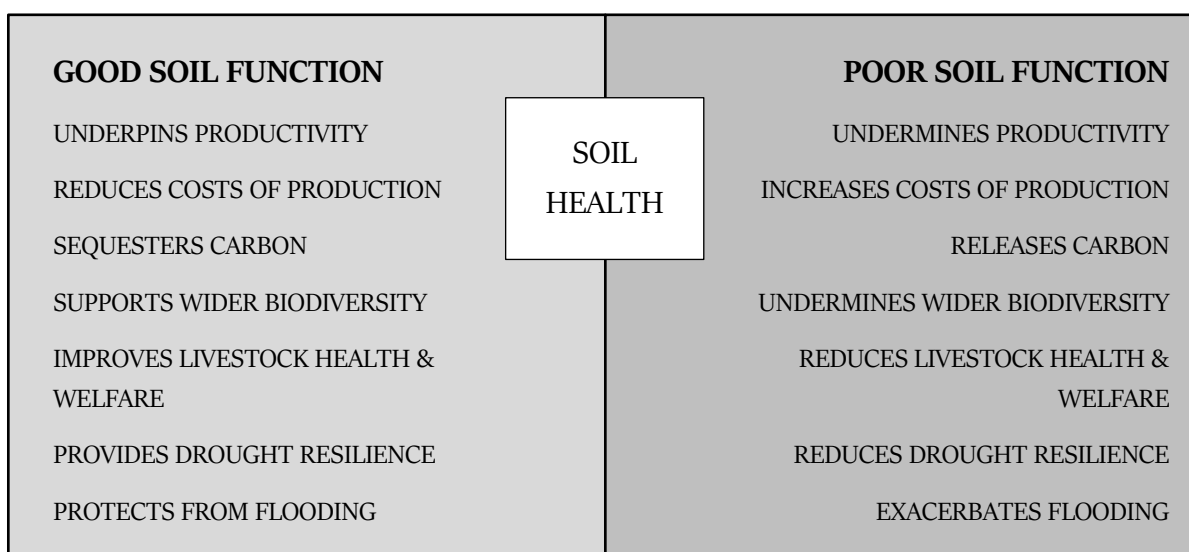
Soil health and productivity is under threat. In a warming world, excellent soil health helps to ensure access to good quality nutrition while protecting communities from the impacts of extreme weather. By contrast, poor soil health undermines access to nutrition and threatens national resilience to increased drought and flooding.

The rights to affordable nutrition and a secure home underpin peace and civil stability. The impacts of climate disruption and biodiversity loss are already affecting global production and the availability of staple ingredients, which in turn is forcing migration, and leading to trapped populations. These impacts are set to increase as

temperatures continue to rise and while biodiversity remains in a state of crisis. This will strain global supply chains and international trading relationships, leading to greater national protectionism, prices rise, and supply chain instability.

Soil health should therefore be considered a security priority.

Governments and food businesses should take action to restore soil biodiversity in order to maintain peace and security. Action must centre on practical strategies to regenerate soil health, including farm level behaviour change, and steps to improve nutritional knowledge and diversity for citizens.



Uncharted territory

We are moving into uncharted territory in terms of both climate and biodiversity breakdown. There is an urgent need to consider key impacts on society, with fair, continuous access to good nutrition being one of the most critical.

In the USA, the Centre for Climate & Security (now part of the Council for Strategic Risks), investigated the link between climate and conflict. Their recent World Climate & Security report places water and food availability as the top climate-related accelerant of instability.

The availability or scarcity of staple ingredients can mean the difference between a civilised society and civil conflict. Interruptions in food supply may lead to nutritional insecurity, emphasising inequality, and acting alongside other social undercurrents to build resentment and increase the threat of civil unrest. At the more extreme end, this could lead to individuals or communities defending food supplies from other citizens.

Healthy soils, rich in biodiversity, directly underpin access to high quality affordable nutrition. Periods of extended international disruption, linked to extreme or cascading weather events, will undermine the global supply of staple ingredients, increase prices, and act as accelerants to migration, nationalism and protectionism. The health of a nation's soil, and its capacity to provide nutrition for citizens, is highly likely become fundamental to its future success or failure.

Underscoring this basic truth, **Reginaldo Haslett-Marroquin**, president of the Regenerative Agriculture Alliance, writes in this report about how as a child growing up in war-torn Guatemala he became aware of the importance of soil regeneration.

Soil health also directly impacts a society's resilience to extreme weather events, such as drought and flooding. Good soil management helps to ensure safe, continuous access to fresh water, and reduces the likelihood of population

displacement due to the flooding of homes and population centres.

Food and security

The old approach to food security, based around volume, supply and calorific intake, must rapidly change. The post-Second World War drive to produce food abundantly and cheaply for citizens has led directly to a dangerous reliance on large company investment, government subsidies and the widespread use of petrochemicals. While this approach has been successful when assessed against its own objectives, it has had devastating impacts on the environment, rural resilience, and animal health and welfare. As **Vicki Hird** from UK Sustain writes, 'food' security is no longer enough, we now need 'nutritional' and 'soil' security.

The perceived duty to maximise carbon emissions reduction presents a new threat. As with the drive for cheap food, it is dangerous to over-simplify land use challenges and opportunities. A strong focus on emissions reduction creates additional imbalance in already teetering ecosystems. Pressure to increase forestry, biofuel production and rewilding is further restricting the availability of land for food production. This is contributing to the collapse of smaller farm businesses and an even greater consolidation, commodification and intensification of farm systems.

The separation of land use for different activities is inefficient and leads to increased external costs. For example, intensive forestry can greatly reduce biodiversity and exacerbate flood risk. Rewilding can reduce employment and undermine rural economies. Meanwhile the resulting further intensification of livestock agriculture requires industrial-scale land use to produce cereal and proteins such as soy, leading to high chemical and water use and additional land use change, all of which lock us into additional biodiversity loss and increased global temperatures linked to long term 'stock' greenhouse gases.

Dr Ashleigh Bright calls for a renewed focus on holistic solutions and metrics which account for the multitude of benefits that crops and livestock provide in the long term.

Holistic management is a more efficient approach to agricultural land use, designed to deliver multiple ‘public good’ outcomes together. This can be achieved partly through a shift in focus, from emissions reduction to warming mitigation, which recognises the ‘flow’ effect of short term greenhouse gases such as ruminant methane. By using accurate global warming metrics we can show the positive impacts of agroecological farm systems, which can produce high quality nutrition affordably and at scale, while regenerating soil health and biodiversity, delivering warming mitigation and adaptation, improving the potential for good animal health and welfare, and supporting a diverse and vibrant rural economy where profits are recycled around countryside communities.

This transition will also require behavioural change at citizen level. While the cost of meals must remain affordable for all, the price of some ingredients will need to rise. Governments and food businesses should become less cautious in directing people to reduce the carbon intensity of their diets. This will require advice and incentives to replace high impact diets with extensively and agroecologically produced meat, dairy and cereal products, as well as seasonally and nationally produced fruits, vegetables and pulses.

The historian **Edmund Simons**, from the Royal Agricultural University, writes that past civilisations have faced ecological and food system collapse many times before. He asks whether this time, as our global civilisation faces the greatest of ecological crises, we will take the steps necessary to avoid our own demise.

To achieve this, we will need a new definition of food security, based on Colin Tudge’s principle of ‘good food for everyone forever’, rather than on ‘cheap food for everyone today’.

Soil must become a global security priority

Global security is maintained by taking steps to mitigate future threats. As **Rear Admiral Neil Morisetti** says, ‘traditional’ threats are ‘either state on state or intra state, frequently with a military component.’ However, we also face ‘non-traditional’ threats, the most important of which can be characterised as ‘ecological breakdown’.

In their article for this report, the **Council for Strategic Risks** writes that, ‘Global ecological disruption is arguably the 21st Century’s most underappreciated security threat. Human societies are producing rapid, novel, and foundational changes across multiple Earth systems with concomitant—and sometimes severe—consequences for people, societies and security worldwide.’

Over the last decade, work has been undertaken globally to understand the security threats associated with climate change. As **Jimmy Woodrow** from the Pasture-Fed Livestock Association reminds us in his article, the US intelligence community currently anticipates a mix of direct and indirect threats associated with global warming, including ‘risks to the economy, heightened political volatility, human displacement, and new venues for geopolitical competition that will play out during the next decade and beyond.’

But climate change is not an ecological threat in isolation. Despite this, the Council for Strategic Risks notes that the parallel threat from biodiversity loss has ‘seemingly made no waves within the security community.’ They write that, ‘Recognition of these issues is growing, but there is currently little indication that the scale of the threat is broadly understood or that mitigating policy actions are likely to follow without a change in course.’

We have chosen to focus on soil health in this report because it is at the nexus of ecological breakdown.

Its health is already greatly diminished, and without it all life on Earth is severely threatened.

But much as soil health is at risk from climate change and biodiversity loss; from extractive agriculture and ‘more-for-less’ food systems – soil also provides clear and achievable pathways out of crisis.

Healthy soil in regeneratively-managed, agroecological production systems can store carbon, restore biodiversity, manage water, produce abundant food, provide the multitude of jobs that keep rural economies viable, and ensure greater resilience and security for societies around the world.

In his article, **Johnnie Balfour** tells us that the fortunes of his 1350 hectare farm, and the people who depend upon it, were transformed by the implementation of holistic management and the adoption of regenerative agricultural principles.

Broader context

The climate disruption witnessed around the globe in 2021 has been remarkable. The Center for Disaster Philanthropy records that 45,350 wildfires in the USA have burned more than 6.4 million acres, while data from the Russian Forestry Agency shows 45m acres on fire in Russia. Zhengzhou, in China’s Henan province, received 24.2 inches of rain (a year’s worth) in just four days in July. A swathe of land collapsed in catastrophic flooding in Germany’s Rhein-Erft-Kreis district, while unprecedented levels of rain also fell in over Belgium, France, Luxembourg, the Netherlands and Switzerland. In Australia, in New South Wales, extreme flooding followed a record-breaking bushfire season that had swept the region the previous year. In February a polar vortex brought freezing weather to Texas, Arkansas, Louisiana, Mississippi and Alabama. Meanwhile, drought continues to contribute to the humanitarian crisis in Ethiopia, while Northern India has been hit by severe cyclones. In July, Reuters reported that, Aon, a London-based insurer, had estimated that global natural disaster-insured losses would reach \$42bn (£31bn) for the first six-months of the year.

This catalogue of disruption should come as no surprise. The IPCC Sixth Assessment report, released in August, concludes that it is ‘unequivocal’ that human beings have caused ‘widespread and rapid’ changes to Earth’s oceans, ice and land surface. Many of these changes are irreversible and abrupt changes and tipping points, such as rapid permafrost melt and forest dieback, ‘cannot be ruled out’.

As **Sue Pritchard** from the Food, Farming and Countryside Commission notes, ‘The IPCC Sixth Assessment report makes it clear we are failing to grasp how serious this crisis really is. Not only will we fail to meet the 1.5 degree target in the Paris Agreement, but, in their most likely scenario, we will exceed 2 degrees of global warming and could reach 3.5 degrees by 2080.’

While increased global ambition on global warming is welcome, the biodiversity crisis is just as serious. In May 2019 the UN reported that, ‘Nature is declining globally at rates unprecedented in human history – and the rate of species extinctions is accelerating, with grave impacts on people around the world now likely.’ A report by the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES) noted that three-quarters of the land-based environment and about 66% of the marine environment have been significantly altered by human actions.

In 2017, shortly before the IPBES report was published, a German study showed a ‘more than 75 per cent decline over 27 years in total flying insect biomass.’ The decline in insect populations is emblematic of the reduction in biodiversity more broadly, and even more worryingly this study was carried out in a protected area. Of equal concern, in 2020, WWF reported statistics that showed ‘the population sizes of mammals, birds, fish, amphibians and reptiles have seen an alarming average drop of 68% since 1970.’

Biodiversity loss is also a root cause of the current pandemic.

Zoonotic viruses such as Covid-19 are directly linked to humanity's on-going assault on the natural world.

History is littered with examples of zoonotic disease transmission from livestock (Ebola, Marburg, Hendra, Nipah, Sars CoV1, Sars CoV2 etc.) as our production systems have intensified and our encroachment into wildlife habitats has increased, permitting more opportunities for cross-species transmission.

As **Laura Higham** says in her article, 'The evidence shows that healthy wildlife populations help protect us from infectious disease. When we interfere with biodiversity and wildlife habitats, we threaten species that each serves a vital role in the ecosystem.'

Soil biodiversity

While access to food and water is a recognised accelerant of instability, it is soil biodiversity in particular that is critical in minimising and mitigating these risks. Healthy soil is both protection from, and an indicator of, the impacts of the twin crises we face in nature.

Regenerative soil management and agroecological farm systems are critical if we are to successfully mitigate global warming. (The components of regenerative land management are described later in this report by **Caroline Grindrod** from Roots of Nature.) Soil can act as a powerful carbon sink, locking in carbon for many generations to come. In regenerative agroforestry systems, where trees are integrated with crops and livestock, levels of carbon sequestration can surpass draw-down rates associated with traditional broadleaf woodland. Conversely, intensively managed soil leads to erosion, compaction, poor water filtration and the loss of soil organic matter, while degradation from ploughing, the use of toxic agri-chemicals and over-grazing all contribute to higher carbon dioxide emissions.

Good soil management also restores the building blocks of biodiversity and is integral to successful climate adaptation. Biodiverse soils, rich in nutrients and micro-fauna, retain water in the soil carbon sponge and help to ensure water availability, land resilience, and continued food production even in times of drought. By contrast, compaction and poor soil biodiversity negatively impact the soil carbon sponge, leading to rapid water loss, flooding, and reduced resilience to long dry periods. **Graeme Willis** from CPRE details the importance of soil biology later in this report.

As we face up to the twin crises of global warming and biodiversity loss, farmers are our first responders. The choices they make will establish a narrative of human success or failure as we move towards the middle of the century. Degraded soils must be regenerated; retrofitted with abundant biodiversity, so that carbon and water can be harnessed, stored and released efficiently and effectively.

Soil habitats

Martin Lines from the Nature Friendly Farming Network reminds us many people still see soil as little more than dirt; a functional day-to-day reality. We walk on it, we build on it, and we plough into it. Like the ocean, our eyes skate across the surface with little understanding of the vibrancy of life beneath.

But for farmers like **Nikki Yoxall**, soil is an exciting, thriving and highly complex ecosystem; the bedrock of human society. It provides the living basis for all nature, combining minerals, organic matter, water, air, and living organisms including fungi, nematodes, arthropods and earthworms. Soil types and habitats vary enormously, but a single teaspoon of healthy soil will typically be home to 10,000 different species, with more individual organisms than there are people on planet Earth.

In his article, **Øistein Thorsen** reminds us of David R. Montgomery's description of our planet as 'an

oasis in space rendered hospitable by a thin skin of soil that, once lost, rebuilds only over geologic time.’ In the eighty or so years since the start of the Green Revolution, agriculture has treated this vital organ, which takes centuries and millennia to form, as an infinite and expendable resource. We have stripped away our soil’s natural goodness; we have purged the life that once flourished inside it.

Crucially, farming alone is not to blame.

Society more broadly has delighted in cheaper and more plentiful food. Governments have supported production systems that seek to simplify Earth’s systems while subsidising the production and use of synthetic agri-chemicals that strip essential virtue from complex soil environments. Agriculture has been caught in an ever-decreasing circle – its base material has become unhealthy and depleted, and its prescribed medicine has masked the symptoms while depleting soil habitats ever further.

The good news is that cures are available. Soil health and organic matter can be regenerated relatively quickly. These regenerative processes provide pathways to large-scale carbon storage, biodiversity restoration, greater resilience to extreme weather events, and a potentially fairer global distribution of more diverse and higher quality nutrition for humans around the world. But government policy and investment from public and private sources will be needed to mobilise and support agroecological transition at scale.

And there is an active choice to be made by political leaders and by society, as **Chantal Clément** and **Nick Jacobs** from IPES Food explain. Will we choose to allow powerful actors to appropriate and control the Earth’s productive resources, or will we work together to build the foundations for new, more sustainable and regenerative food systems?

Soil benefits

Carbon – Soil is one of our planet’s great carbon sinks and sources. A data visualisation, presented by a US Government soil scientist in the recent Netflix film, *Kiss The Ground*, shows enormous plumes of CO₂ rising into the atmosphere during the springtime ploughing season, and the reverse process occurring during the summertime as plants grow and absorb carbon.

By reducing soil disturbance and improving the cycling of organic matter – for example through Adaptive Multi-Paddock grazing of ruminants or by integrating more livestock within agroecological arable rotations – we are able to accumulate rather than deplete these carbon stores. Assessments vary, but there is common agreement that the regeneration of soil health around the world could deliver a third of the carbon drawdown necessary to mitigate climate change, with no adverse impact on biodiversity. As **Patrick Holden** reminds us, after the ocean, the soil is Earth’s largest carbon store.

An indicative study in the USA shows sequestration rates in AMP systems of an additional 9t/C/ha/yr, down to 1m depth, compared to conventional grazing systems. Although direct comparison between soil and trees is extremely tricky and should be heavily caveated, we can put this into some kind of context by noting that the UK Forestry Commission expects sequestration rates of around 1.6tC/ha/yr from trees growing in standard broadleaf woodland (unmanaged sycamore ash/alder/birch).

This is not to suggest that soil is a better solution than trees, but to show that both have good carbon storage potential, and to make the point that regeneratively-managed pasture should be considered a hugely important carbon asset. Any choices about the right mix of soil management and tree planting should be land appropriate. Our view is that most farmland should include trees, hedges and ponds, ideally integrated within the farm system, to enhance carbon sequestration, as well as biodiversity and hydrology.

To ensure rapid drawdown, **Thomas Gent** proposes on-farm carbon accounting and payments.

Hydrology – The capacity of healthy soil to hold and slowly release water is critical. **Walter Jehne**, the Australian soil microbiologist and climate scientist, notes in his article that the soil carbon sponge has an exceptional capacity to ‘infiltrate, retain and make available water to extend the longevity of green plant growth, its transpiration and its natural physical cooling or ‘air conditioning’ of the climate.’

By contrast, degraded soils cannot hold water, and compacted soils cannot absorb water. In both instances, farmers are unable to utilise precipitation effectively. Run-off washes vital minerals and other nutrients away, and over a larger land area this poorly managed water can become a substantial flood problem further downstream. Poor quality soil on farms can lead directly to the flooding of homes and businesses and the devastation this causes to people's lives.

Farmers who understand and work to improve the natural hydrology of their land can benefit greatly in times of drought. In regions of Australia that have seen decades of low rainfall, much of the land can be brown and arid for much of the year – and yet regeneratively managed farms in the same region remain green and productive for all seasons. When it does rain, the water is held in the land, and then released optimally as plants grow.

Functioning hydrology, linked with good levels of soil organic carbon, result in little or no soil erosion even during heavy storms, and ensure that water and nutrients are accessible for food production throughout the year.

Healthy, functioning soil, alongside low impact land interventions such as leaky dams, provide a low cost alternative to expensive concrete flood prevention infrastructure. In some places this natural approach can all but eliminate flood risk.

Biodiversity – Soil is also critical for biodiversity restoration. Soil, with its micro world of fungi, arthropods, bacteria, nematodes and earthworms is the basis for all life above ground. Soil provides the

foundation of the food web, supporting the life on which all other species depend. While much attention has been placed on the protection and restoration of individual species that people love to see, such as the skylark, it is the soil, ultimately, that supports the habitat on which the skylark depends. All conservation efforts must place soil health at the very baseline of their strategy.

In this report **Clare Hill** describes the explosion of biodiversity at FAI Farms in Oxfordshire since the team began its transition to regenerative grazing.

Oceans – Although we do not touch on the oceans in this report, it is important to note the strong interconnectivity between agricultural land use and the health of lakes, rivers, estuaries, coastlines and the ocean itself. Pollution from the land and destructive practices in rivers and at sea have led to a dramatic decline in water-based ecosystems, and in the life and food systems that once thrived around us. Pollution from farms can negatively impact water quality, but regenerative practices that cycle nutrients and reduce run-off can have a positive effect. Regenerative food production is also possible at sea.

In summary – Healthy soil sequesters and locks in carbon, which is imperative if we are to constrain temperature rises and mitigate climate change.

Healthy soil is the foundation of life on earth, and is essential if we are to restore biodiversity.

Healthy soil provides protection against drought, and against flooding.

Healthy soil can produce high quality nutrition and support the livelihoods of billions of people around the world.

In short – healthy soils are essential for life on Earth.

Cop 26 and beyond

As we look not only towards COP26, but to future policy-building to mitigate global warming, it is critical that our efforts to rapidly combat climate

change do not further damage and destroy the health and functionality of our soil habitats.

The benefits of mass tree-planting to sequester carbon, for example, must be balanced against the impacts on soil health, biodiversity, functioning hydrology and the capacity for people to grow nutritious land-appropriate food.

Humanity faces an enormous and interconnected ecological crisis. Our solutions must seek to rebalance nature as a whole. We must question and sometimes resist well-intentioned actions focussed on single ecological outcomes, because these could tip humanity further into the arms of ecological and societal peril.

To achieve this we must use the latest science, even when it is inconvenient and does not fit the prevailing political narrative. For example, as **Ffinlo Costain** writes later in this report, current carbon

assessments, particularly of livestock systems, are inaccurate due to a structural misunderstanding of the role of ruminant methane. The science has been corrected and accepted by the IPCC in AR6, but we must rapidly embed this knowledge into our assessments of the global warming impacts of land use, to better inform decision-making.

Land is finite, and we rebalance ecological systems most successfully when we plan and deliver for multiple outcomes from all land, rather than sparing, or zoning, different sections of land for different functions.

Nature is diverse and interconnected, and so our responses to ecological threats and opportunities must be diverse and interconnected too.

As the farmer, **George Young**, says at the end of this report, 'Soil is everything.'