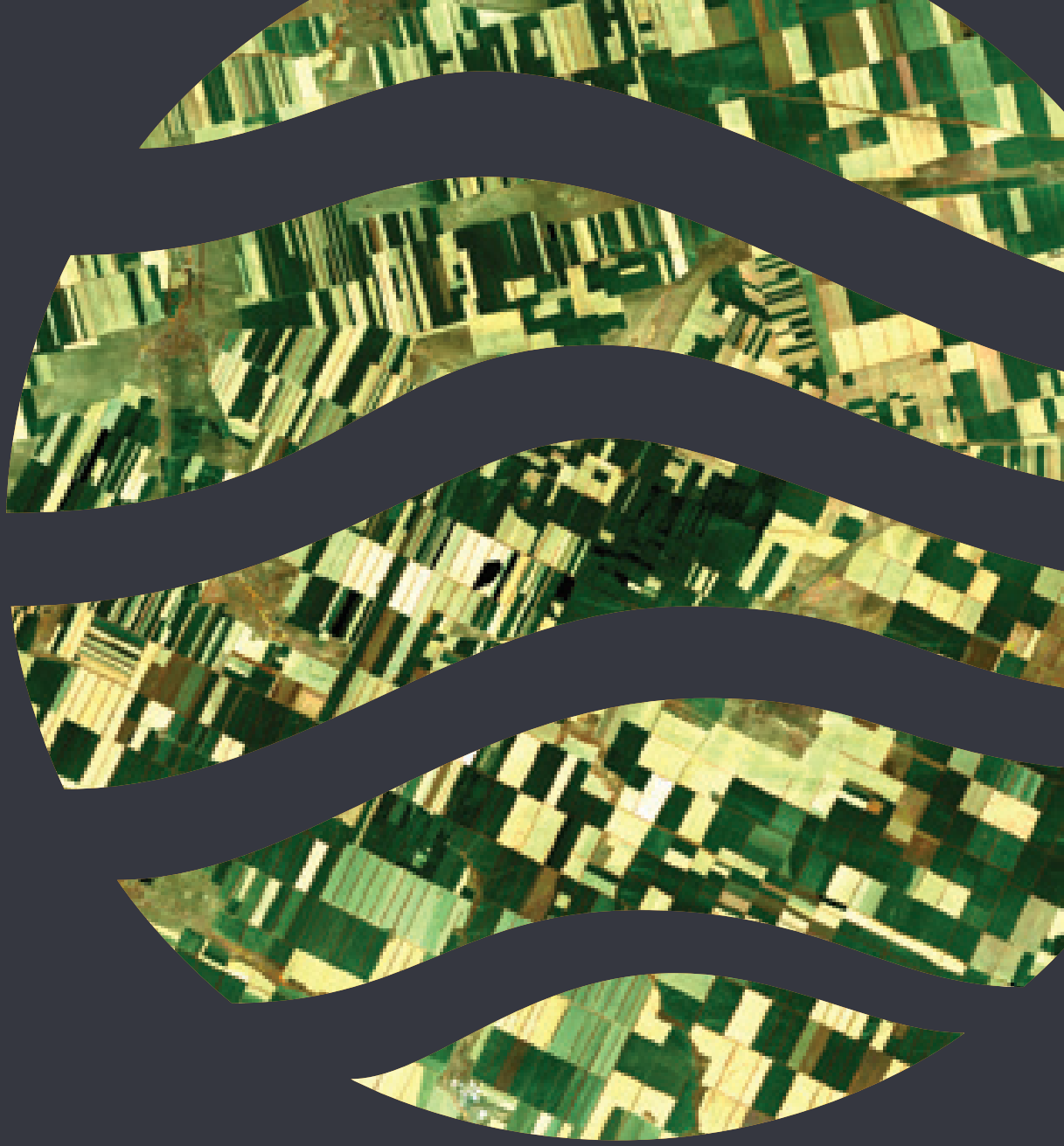
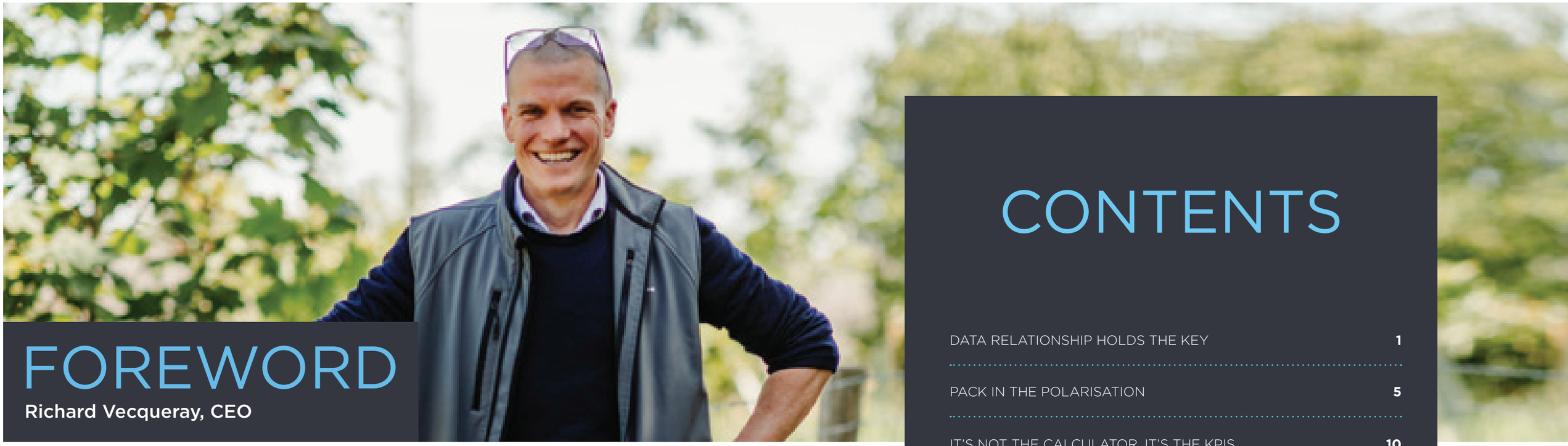


HORIZON 2025

An Outlook for the Agrifood Sector

MAP OF AG



FOREWORD

Richard Vecqueray, CEO

Take Control with Tech

Another year. Another set of challenges. Such is the nature of farming. Global agricultural systems continue to face increasing pressures from climate change. Around the world there are yet more extreme weather events and as I write in early December, here in the UK we have already witnessed our second named storm of the winter season.

Rising temperatures, water scarcity, and weather events of increased intensity are critical issues for food production. Greenhouse gases from agriculture remain under an intense spotlight, with livestock contributing over half of farm gate emissions.

The global population facing hunger is over 730 million, with Asia bearing the largest number and Africa having the highest prevalence. At the same time, obesity rates climb in high-income regions, indicating a widening nutrition gap. Efforts to improve food security are being coupled with a shift towards more sustainable production methods.

Meanwhile, technological advancements such as Precision Agriculture tools continue to gain traction as farmers seek to optimise productivity amid rising costs and environmental concerns. Major machinery manufacturers are pivoting towards data-driven solutions to maintain relevance.

Global agricultural value is at an all-time high, yet the workforce in agriculture is declining, adding further pressure to the need for technology to mitigate labour shortages.

The presidential election in the US will see yet more upheaval in global trade as president-elect Trump seeks to assert his MAGA policies.

And of course, political insecurity and conflict around the world is as bad as I can recall in my lifetime.

It's far from an exhaustive list but it's easy to see that we cannot expect a return to more settled and predictable times over the coming 12 months.

Which means we have to look at what we can do for ourselves. As the ancient Greek philosopher Epictetus said: "Some things are up to us and some things are not".

This year's *Horizon* is full of examples of actions and ideas we, as an industry, can adopt to shape our collective future, by leaning on technology and data. We are at last witnessing a huge shift from the promises of digitisation to the realisation of its benefits.

So, as you make your plans for 2025, it's worth thinking about how smart technology can support what you do in your businesses. It won't provide all the answers but it will allow you to optimise better the decisions that are within your gift.

In other words, concentrate on the things you can control, and let the tech support you.

Richard Vecqueray
CEO, Map of Ag

CONTENTS

DATA RELATIONSHIP HOLDS THE KEY

The agrifood supply chain around the world has an increasing need for access to farm data to evidence sustainable food production. **Rob Burgess** investigates what's been happening in the UK.

Significant developments in recent years in institutional reporting frameworks centred on sustainability such as the Task Force on Climate-Related Financial Disclosures, the Taskforce on Nature-Related Financial Disclosures, and the Science-Based Targets initiative (see page 4) are driving something of a sea change in the need for accurate farm production data.

Measurement of the sustainability credentials of the agrifood sector's farm supply base (in the case of food retailers and processors) or understanding financed emissions (in the case of banks) is in some cases no longer optional, and even where it is voluntary, is becoming an inescapable focus for these major corporations.

"The financial regulators need to know that the banks and financial institutions understand the risks that climate change poses to their future business operations," says Carolien Samson, Head of Sustainable Banking at Oxbury Bank. "The initial focus has been around how extreme weather events and changes in weather patterns could lead to financial losses for institutions. But this has evolved into how changes in a combination of technology, consumer behaviour and market demand affect the value of certain businesses in the future."

Mandatory reporting against the TCFD framework is relatively new and it's early days in terms of getting access to farm data, Shidrati Ali, Associate Director for Environmental Sustainability at Lloyds Bank, explains. "To calculate our financed emissions, we need to know what the client emissions are. At the moment we are just using sector averages but this is not an accurate reflection. Industry wide there is a push towards better quality data to understand and accurately reflect the emissions we are financing and be accountable for that."

The challenge, she explains, is developing something scalable that can move the dial from using sector averages to individual farm insights. "We are baselining some 850 of our largest clients to start understanding where they are not only in terms of emissions but also other dimensions such as nature." But it's only a small part of the bank's agriculture portfolio so in the meantime the bank is working towards using proxies in terms of client financials which, she says, is a "step forward from sector averages."

But at a time when farmers are really feeling under the cosh, is this focus on data a help or hindrance?
Agriculture contributes a significant portion of the indirect (Scope 3) emissions for many food companies. The use of feed, fertiliser and fuel represents in the region of 80% of those farm-based emissions, so it's relatively easy to see that more efficient use of these expensive inputs not only benefits the environment but also the farmer's bottom line.

Much of the work we have been doing with data at Map of Ag in the past couple of years has been heavily driven by these three Fs. Working with a number of retailers in the UK including Morrisons, we have been developing insights that not only help with sustainability reporting, but which also develop a partnership between farmer and supply chain that focuses on improved and long-term sustainable food production.

"Getting access to the data relies on having good relationships with the farmers we source from, from a trust point of view," says Sophie Throup, Technical & Sustainability Manager at Morrisons. "We also have to consider the value back to farmers."

To support Morrisons, Map of Ag has been using farm surveys to capture the core detail, but wherever possible, minimising the ask of farmers by connecting to farm databases, or making use of other data sources. "We set off from the beginning to ask as few questions of farmers and use as much of the data we already had in manufacturing as possible," Sophie says. The combined data she adds has been "used to develop key performance indicator benchmarking so farms can see where they fall, against a red, amber and green coding and decide how to turn these measures into action plans". Insights such as these can be used in other ways too.

Take nitrogen use efficiency as an example. Synthetic nitrogen fertilisers have a significant global warming

"Getting access to the data relies on having good relationships with the farmers we source from, from a trust point of view.

Sophie Throup

MYTON FOOD GROUP

impact both from their manufacture and from their 'field' emissions in the form of nitrous oxide, and to a lesser extent ammonia and methane.

At Map of Ag we have developed a dashboard that shows how efficiently the farm is using nitrogen and allows scenarios to be modelled in a 'what if?' sort of way. Reducing fertiliser use is a triple win: for global warming, farm profitability and water pollution.

Morrisons, Sophie says, believes supporting its farmers with the interpretation of the data is vital in the relationship with its suppliers. "We pay for all the carbon footprinting on the farms and we provide free farm advice through Map of Ag's consultants." The company has also, more recently, started giving farmers free access to soil carbon mapping through Downforce Technology's satellite imagery-based solution.

Working with farmers in this data-driven way is a journey which is in its infancy, says HSBC's Interim Head of Agriculture, Grace O'Dwyer. "It's generating a huge amount of interest, especially where innovation and collaboration are producing real results. Producing food more sustainably will be a defining feature of agriculture in the coming years."

So if this data focus is going to become the new norm for farmers, where does it begin and where might it end? Just having access to a farm map is a great starting point, Carolien says. "It's incredibly useful as it enables us to derive a lot of other information such as flood risk of the farm. And the farm's baseline emissions number is really helpful for farmers to evidence change over time."

Shidrati agrees, although she says in the absence of a carbon baseline, even a small amount of data can be a great help. "If farms are not doing carbon accounting, then one of the things we would need would be what type of farm they are in terms of cropping and livestock and their yields. From there we can calculate emissions related to those more accurately than just proxies and averages."

And while carbon is the major focus, understanding the farms through a nature lens is just around the corner. "In two or three years, we'll need to report for TNFD," Shidrati confirms. "That's even more complex than carbon as we don't yet know the metrics we will be using."

Sophie hopes there will also be some consolidation to maximise the use of the farm's baseline data. "I hope in five years there will be one report you can reuse across different customers."

It all points to a growing importance the agrifood chain is placing on its relationships with farmers. "In the future, I suspect as an industry we will be discussing a suite of metrics across carbon, biodiversity and water to understand what will have the biggest impact on sustainability," Grace concludes.

Institutional reporting: what does it all mean?

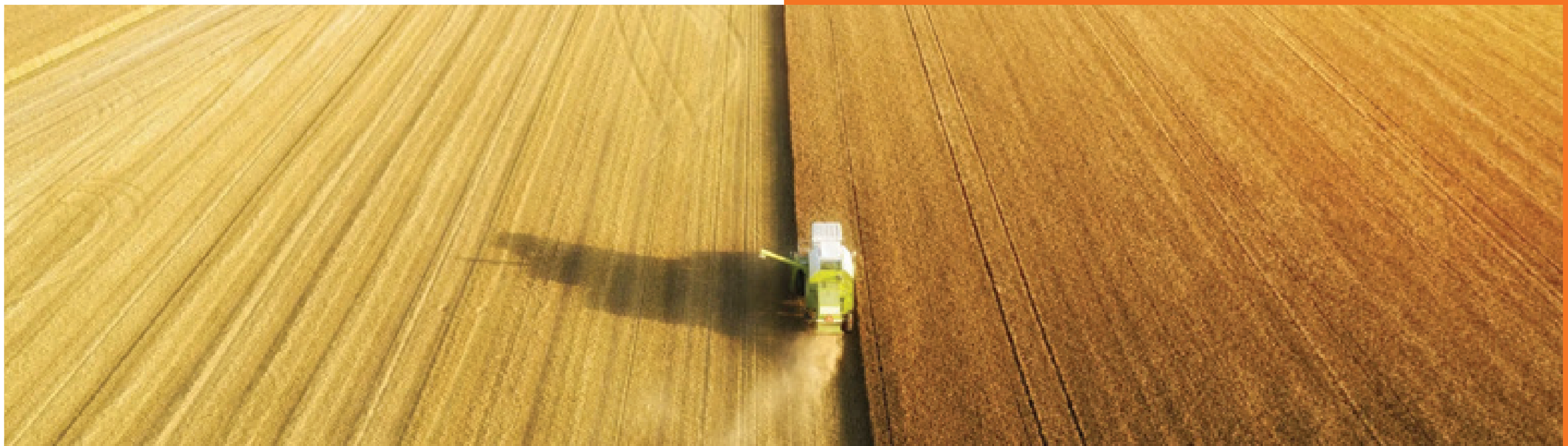
Taskforce on Climate-Related Financial Disclosures focuses on mandated reporting for large companies in the UK and many other countries, including those in the agrifood sector. Organisations have to measure and report on indirect emissions (Scope 3), which includes emissions from the agricultural supply chain. TCFD, which is for example incorporated into the EU's **Corporate Sustainability Reporting Directive**, encourages assessment of physical and transition risks associated with climate change. This necessitates data on farming practices, crop resilience, and emissions to evaluate and mitigate risks effectively.

Taskforce on Nature-Related Financial Disclosures launched in 2023 and broadens the scope beyond climate to include nature-related risks, such as impacts on soil health, water quality, and biodiversity. Organisations need farm-level natural capital data to assess dependencies such as reliance on healthy soils, and impacts, for example fertiliser use affecting water. Many organisations are preemptively adopting TNFD guidelines to align with expected regulatory requirements and demonstrate leadership in the area of 'environmental, social, and governance' (ESG). The CSRD's biodiversity-related disclosures align closely with TNFD.

Science-Based Targets Initiative has developed sector-specific guidelines, including for food, land, and agriculture (FLAG), which require detailed data on emissions, land use, and farming inputs. Over 4,000 companies world-wide are participating in SBTi, and many have pledged net-zero targets, necessitating robust tracking and reductions in emissions across their supply chains, particularly in agriculture. Data on practices such as regenerative agriculture or afforestation is vital for companies claiming offsets or insetting in their carbon strategies.

Partnership for Carbon Accounting Financials helps financial institutions measure and disclose GHG emissions associated with their lending and investment portfolios, including agriculture-related loans. Banks and lenders request farm-level data on emissions, land use, and energy consumption to calculate financed emissions. There is growing adoption among financial institutions globally.

Internationally, other frameworks exist including **Carbon Disclosure Project** supply chain programme, the **Accountability Framework Initiative** focusing on ethics, **Global Reporting Initiative** standards based around labour, local community impacts and environmental stewardship, **Sustainable Agriculture Initiative** metrics for soil health, carbon sequestration and ecosystem services, and **UN Sustainable Development Goals** which includes sustainable agriculture goals.



PACK IN THE POLARISATION

Transitioning to regenerative agriculture carries risk, says Cumbrian dairy farmer **Joe Lyall**. But we should stop viewing sustainable food production in a binary way.

As both a proud dairy farmer from Cumbria and a student of Environmental Science at the University of Manchester, it is easy to see why I feel somewhat torn over the current state of our food system in the UK.

Professors and academics tell me how ruminants affect the natural carbon cycle, contribute to the decline in biodiversity, and graze on what could be prime wildlife habitat, but at the same time I know from lived experience that my family's business produces nutritious milk and meat from healthy cows.

These are not, of course, mutually exclusive facts. I am deeply unconvinced by each side of an increasingly polarised food debate between agro-industrialists calling for food security and intensive production on one side, and ecomodernists proposing alternative foods and abandoning the land on the other.

It's clear, though, that continuing to farm the way we do is not an option.

Report after report outlines not only the ecological and environmental harms and self-harm that post-war agriculture has wrought on the British countryside, but also on its people. In the past 45 years the agricultural workforce has declined by nearly a third, while high land prices and inflexible tenancies have seen the average age of farmers creep towards 60.

I live in this agro-industrialist model of farming and can see that it is leaving the land and its community ailing; but I find some of the proposed alternatives just as unviable and unattractive.

Instead of working to appease either position, I believe we should reject them and the divisions they stoke with an aim of striking a measured balance, embracing agricultural practices that work within natural systems while still producing a healthy quantity of valuable and nutritious food.

“We should embrace agricultural practices that work within natural systems while still producing a healthy quantity of valuable and nutritious food.

Regenerative agriculture is the farming model that, for me, has the potential to achieve that balance, pushing back against the wholly extractive agro-industrial model we are currently stuck in, while still respecting the heritage of land management. In a way, it works to heal the divide I, and I'm sure others, feel between being a farmer who cares deeply for the land, and a naturalist and academic who knows the damage that our current food system is doing to the environment.

Regenerative agriculture is not a strict model of farming. It is inherently dynamic and context-driven, allowing it to be adapted to each farm and farmer; as such it has accrued a range of definitions and explanations.

To me, the approach involves producing the food, fibre and produce we need using principles and methods that work with and restore the natural systems that have been badly degraded by current approaches. It is fundamentally based around sustainable cycles; not disrupting the functioning of soil, water and biological systems by carrying out the agro-industrialist's intensive farming practices, such as artificial fertiliser and pesticide applications, nor by funnelling energy and resources into the similarly industrialised vision of processed bacterial protein.

What I find some definitions miss, however, is the necessity of a sound business model for regenerative farming to succeed.

We live and work in a capitalist world where food is a private good. And farmers and landowners who are pivoting their intensive, production-oriented businesses towards more natural systems must still be able to financially support themselves, their families and communities.

Some find a conflict here between food production and nature restoration, consequently finding that regenerative agriculture, in attempting to reconcile them, must fail. While gross profit and yield may decrease during an intensive-to-regen transition, a business's net profit, and therefore overall profitability, can increase as the three core inputs - bought-in feed, artificial fertiliser and fuel - are reduced.

Nonetheless, the wider food system is stacked against those farmers wishing to start such a transition. Supermarkets (and by proxy us as consumers) expect food to be on the shelves, so shifting to a farming model with lower yields may jeopardise the minimum supply contracts farmers are often signed up to.

Similarly, feed and fertiliser suppliers offer farmers long-term contracts in which prices are often lower than on-the-spot market. Although this keeps costs down and mitigates volatility (which allowed our farm to weather disruptions such as the tripling of fertiliser price in on-the-spot markets as a result of the war in Ukraine), this system can keep farmers locked into their current model for months and sometimes years in advance, which in turn delays their ability to transition away from these inputs.

On top of these external pressures, the often smothering status quo from tight-knit farming families and communities can contribute to our present debilitating situation. Breaking from 'the ways things are done' is a daunting task for any farmer. I know from arguments with my own family that just agreeing to tinker around the edges can feel like a Herculean effort, so getting the necessary consensus to alter how a whole business operates is an even greater challenge.

But what of those that have begun to break with the status quo?

My home county of Cumbria is host to many incredible farmers working a diverse range of systems, with some further down their regenerative journeys than others. Compare my family farm, situated on the banks of the River Petteril in the Eden Valley of North Cumbria, with Strickley Farm, headed by James Robinson, in the Lune Valley of South Cumbria.

At almost identical elevations, with similar annual rainfalls and soil types, our contexts are not that different, and yet we pursue diverging business strategies.

My family farm focuses on increasing production: we are paid per litre of milk, so it seems only natural to pursue higher yielding cows to maximise our returns.

To do so, we use artificial fertilisers that deliver higher grass production for summer grazing and winter silage, grow pesticide-treated maize and barley crops in annually ploughed fields, and buy in feed from Canada and Indonesia to support high milk yields. This intensive management system is profitable and ensures we can comfortably support family, staff and cows.

Meanwhile, Strickley farms organically and regeneratively; this means no artificial fertilisers or pesticides, with the only nutrients the soils receive coming from that returned by the cows in their slurry and manure.

Pests are managed with ecology in mind - for example, without pesticides, green dock beetle populations that graze on dock plants have skyrocketed, providing natural pest management.

What Strickley gains in terms of lower input costs, it loses in terms of production: its cows do not produce the volume of milk ours do. Both farms are profitable, and support families and farm workers. Both supply nutritious milk, cheese and meat to citizens, produced from healthy cows. But what separates the two is their overarching aims, and how these affect our local environments.

My family farm is production oriented and so we seek to maximise our output, whereas Strickley is pursuing its farm's maximum sustainable output – the point where a farm business will be at its most profitable and nature will be optimised.

While our farming model is profitable, productive and can be sustained as long as the supplies of bought-in feeds, artificial fertilisers and pesticides continue, it does not focus on restoring or optimising natural systems in the regenerative manner Strickley does.

I should make clear that our farm is not a 'biodiversity desert', as intensive farms are often presented. We have worked with our local Rivers Trust and water company to fence off watercourses from the cows, construct new ponds and reduce farmyard runoff, all of which has contributed to a significant drop in nutrient levels in the River Petteril, improving the habitat for the resident trout, herons and damselflies.

However, much of this work is carried out adjacent to or in parallel to the overall farming operation - land is set aside for nature and cut off from the cows and the ploughs, drawing a clear line between the two.

We find our choice of agricultural models intersecting with another apparent dichotomy: the land-sparing versus land-sharing debate. This debate pits a model of intensively managed, productive grassland and crop fields, clearly separated from unproductive areas designated for nature, against a more fluid and blurred understanding of where 'farm' ends and 'nature' begins, incorporating the two into a shared vision.

One might assume my farm fits the land-sparing model better, whereas Strickley, with its multitude species of grass, herb and flower in its meadows and pastures and hedgerows crowded with all manner of birds, sits more comfortably in the land-sharing model. Yet despite my attempts to categorise each farm, the binary of sparing or sharing is a false one. Unproductive areas at Strickley have been fenced off, as the land-sparers recommend, while the remaining land is managed in line with nature, following the land sharers' mission, creating the mosaic of habitats that are often some of the most beneficial ecosystems on the planet. Our farm has areas of low input, species-rich pasture on which we graze the milking herd - although not at Strickley's scale.

It is reasonable, then, to assume that this regenerative agricultural approach makes Strickley better than my family farm, and I believe there is some truth in that assessment. From a wildlife perspective, Strickley's biodiverse meadows, pastures and hedgerows allow nature to thrive without the disruptions associated with modern agriculture.

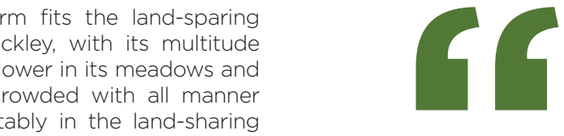
Additionally, as regenerative systems are much less exposed to international feed and fertiliser markets, Strickley can weather the impacts such as the war in Ukraine, the Houthi shipping attacks in the Red Sea and the anthropogenically induced climate extremes that can risk the viability of high-input farms like my own.

The limitations to production levels still stand though, so farming at Strickley means the cows cannot produce the volume of milk that ours can. This is not an issue on a farm level, as it is net and not gross profit that determines profitability, but how we deal with this yield drop associated with a regenerative transition remains the major perceived stumbling block for making this system work at a national scale in countries such as the UK.

The standard bearers of agro-industrialism might state that we 'can't eat butterflies': that the widespread adoption of regenerative agriculture will lead to empty supermarket shelves, leaving the country dependent on overseas food imports produced to lower standards, and that our only option is to continue maximising food production using intensive agricultural methods.

Meanwhile, however, over a quarter of the UK population is obese, while nearly a fifth is experiencing food insecurity - and the overlap between these two groups is substantial since the inability to afford healthy nutritious food forces citizens onto high-calorie processed diets.

Yet more than a quarter of all purchased food in the UK ends up being wasted. There is as much a problem with how we consume and use food as there is with how we produce it.



Imagine if a managed national transition towards regenerative farming were to occur. Is it ridiculous to suggest our eating habits may change as a result?

Imagine if a managed national transition towards a lower yielding, regenerative farming model, like that practised at Strickley, were to occur. Is it ridiculous to suggest that our eating habits may change as a result?

If it were only the farm, the food supplier and the shop that were dependent on making profit, rather than every feed and fertiliser company in the whole agro-industrialist supply chain, or the vague corporations managing the labs in an ecomodernist model, could food be cheaper under a regenerative model? Add in the improvements to natural cycles and functioning ecosystems a regenerative model can produce, and I think there is a real hope that such a transition could genuinely alter our relationship with food, from production through to consumption, for the better.

This dream scenario aside, I do not for a second believe a regenerative transition is easy, nor is it a silver bullet. Tapping into natural systems is complex and fraught with risk, the majority of which falls on the farmer themselves who must financially and emotionally weather the pressures this change can bring.

While my family will look to adopt more regenerative practices on the farm in the future, we can only do so with the confidence that it is the right direction for the business. Higher net profit in regenerative systems sounds brilliant, but a drop in gross profit could limit the funds available to invest in new equipment or necessary maintenance that would aid in the transition and so will have to be accounted for.

Despite these challenges, the key to achieving this transition is learning from those who have walked the path before, like the Robinsons at Strickley, without getting entangled in whether to share or spare land, or to focus on purely producing food over restoring nature, and instead to work to build a system that works for us, for the cows and for the land we manage.

Science needed to support regenerative transition

by Professor Mario Caccamo

With a growing momentum towards regenerative agriculture it is important to remember the successes in food production of the past five decades, says NIAB CEO Mario Caccamo.

"In that time we have seen the global population double to over eight billion. And while it is unacceptable that 10% will go to bed hungry, we should not forget that the number would have been three times that but for the Green Revolution spearheaded by Norman Borlaug and others. We have reduced hunger and extended life expectancy at a remarkable pace."

But as we face the challenges of climate change and the requirement to grow crops that are healthier, environmentally friendlier and profitable, the question Prof Caccamo says we should ask is: can we sustainably intensify the way we produce food?

"One of the strengths of regenerative farming is its lack of prescription, and flexibility, provided its guiding principles are observed," he explains. "These guiding principles are founded on well-established farming practices, many of which have been studied by NIAB as part of our applied agronomy research programmes for many years, for example in terms of longer, more diverse rotations, use of cover crops, minimum and no till cultivation systems, and improvement of soil health.

"Many progressive NIAB members I have spoken to about their experiences with introducing regenerative farming practices on a commercial basis are adamant that they need that flexibility, and all the tools in the toolbox such as glyphosate to control weeds, or novel genetics to increase productivity while reducing dependence on chemical pesticides and fertilisers."

But while the success of regenerative farming may lie in its flexibility, and the diverse range of ways in which its guiding principles can be delivered, there remains a lack of commercial-scale data to inform best practice – in other words a lack of independent science which will incentivise farmers to adopt soil restoration production practices, allow the industry to demonstrate its sustainability credentials to value chain partners, and to communicate with consumers the benefits that come from a more science-based approach to agricultural production."There is a need to provide the science which can scale up and underpin the credibility of regenerative farming systems, based on a recognition that practices focused on increasing soil organic matter, avoiding erosion, and reducing disturbance to the soil are entirely compatible with sustainable intensification and precision agriculture," Prof Caccamo says.

That's why NIAB has set out with a major research effort focused on delivering that science, building on its independence and research leadership in soil science, variety testing, rotational agronomy, precision agronomy, cover cropping, data science and water use efficiency.

NIAB's objective is not only to be the go-to place for independent advice, but also to develop the metrics by which the sustainability of regenerative agriculture practices – in terms of resource use and environmental impact – can be benchmarked and monitored over time.

"This outcomes-focused approach to data collection and assimilation will be essential," Prof Caccamo says, "not only to understand and drive best practice at farm level, but also to provide information to customers and ultimately consumers about the comparative sustainability impact of each unit of food produced, whether that is a loaf of bread, a punnet of strawberries, or a bag of potatoes."

NIAB also plans to integrate regen ag objectives into its genetics and pre-breeding activities, for example by improving the performance and viability of N-fixing pulse cropping options, investigating novel crop opportunities, and even exploring the potential for cover crops to become an additional source of revenue within the rotation, as is already happening in the United States with the development of gene edited Covercress™ as a source of high value oil and animal feed.

"We are confident that a progressive, science-based approach to regen ag, embracing innovation and harnessing the power of large-scale data, offers the potential for high-yielding, profitable crop production to go hand in hand with reducing agriculture's environmental and climate impacts," Prof Caccamo concludes.

Obsessively chasing the farm's carbon footprint number is missing the point, argues **Hugh Martineau**.

Do you know the carbon footprint of your farm? And if so, what does it tell you? The short answer will be: If it's just the output number, not a lot.

True, your retailer or processor may be fixated on the number, because calculating their Scope 3 emissions is an important part of their corporate reporting (see page 4). They have a genuine need to know.

But for a farmer, how does the number, spat out of one of the calculator tools, actually help?

For some time now I have been arguing that obsessing about the carbon calculation is putting the emphasis in the wrong place. At the end of the day, it's simply a number at a point in time. But it provides little information to the farmer about how to make changes in the management of the farm to the benefit of the business, or how those changes might impact the farm's emissions.

There is a lot of noise around about what the calculators are and how they work. And, indeed, what the future of this looks like. So let me start with some of the basics.

A carbon calculator uses data - of varying resolution and accuracy - to calculate the impact the farm is having on climate change. Some are designed around a whole-farm approach, while others focus on a roll-up of the individual enterprises.

Broadly, these calculators are driven by emissions factors (factors we apply to activities to understand the emissions of climate pollutants such as methane and nitrous oxide) which are then converted into

carbon dioxide equivalents (CO2e) using a global warming potential (GWP) conversion factor which accounts for their relative potency.

Calculators vary in terms of their methodologies - primarily the sources of data (emissions factors) they use - ranging from IPCC (Intergovernmental Panel on Climate Change) Tier I (low resolution) data that, for example, treats all cows as the same, through Tiers II and III which are in effect increasing levels of granularity of the activity data from the farm, where for instance you might be able to calculate enteric fermentation based on the specific energy intake of every animal in a herd.

With each calculator using different methodologies it's hardly surprising none of them gives the same number, something that was the subject of a DEFRA harmonisation report this time last year.

But when I stand in front of farmers, I don't focus on the numbers too much. It's like the weight of a pig: good to know but it tells you little about productivity, efficiency or profitability, or the context of the farm. Where I get much more engagement is when we start to talk about the key performance indicators (KPIs) that can improve the farm's results and, as a by-product, lower the emissions footprint.

And this is because without making any changes on the farm, the carbon footprint will change from year to year anyway by simple virtue of the fact we are dealing with biological systems hugely impacted by the weather. But no farm can control the weather, so why obsess about the number?

There's a myth that just measuring GHG emissions will change your emissions over time. Instead, what farmers really need to know is how to collect and scrutinise the right data to measure the right KPIs to make the right management changes. In other words, the carbon calculation might be interesting but that act of undertaking an emissions assessment, in itself, doesn't improve the business, or the emissions it produces.

So what should the farm focus on? Every business will be different, but there are some basics which apply to all.

A farm's emissions are driven by the management of resources: livestock, land, feed, fuel and fertiliser. So it's best to focus on things that drive efficient use of those such as lifetime productivity, fertility of animals or nutrients usage (both feed and fertiliser).

These are all areas where a farm can make choices, and increasingly better choices with the right data. For example, calculating nitrogen use efficiency (the balance between nitrogen input and nitrogen offtake in the end product) allows the farmer to start to look at the management practices they can influence to improve efficiency. It's why at Map of Ag we developed a scenario tool that allows farmers to assess the potential impact of management changes. Ultimately better use of nutrients will improve profitability and, consequentially, lower the GHG emissions of the farm.

A lot of time and effort is being expended by different actors in the supply chain to gather data to calculate emissions footprints. But for the most part, none of it is being gathered with any consistency in approach, which is problematic when trying to compare apples with apples. Nor does it offer help or context to the farmer.

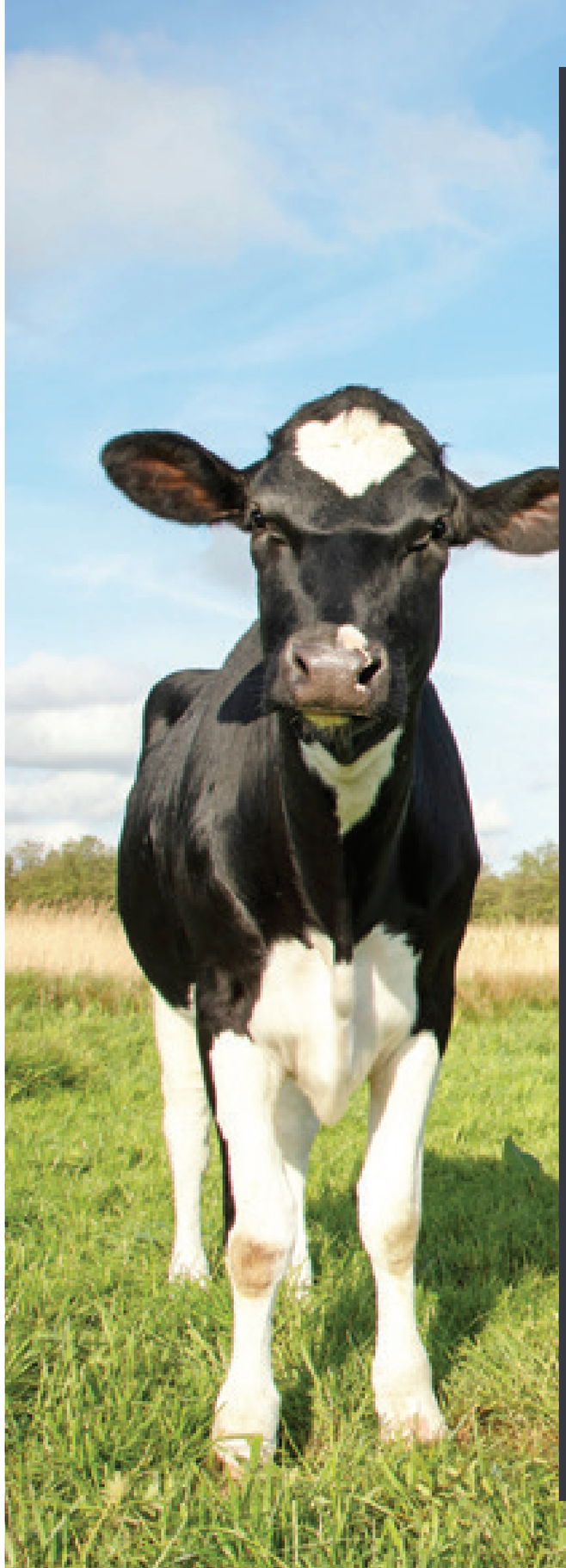
While there is much talk about harmonising the carbon calculators, which I think is positive, I would much rather the effort goes into a unified set of standards and practices around gathering, sorting and using farm data that is focused on KPIs that matter.

There are huge opportunities here in terms of a more centralised and automated approach that is focused on accuracy and consistency. In five years we should want to be in a position where we have stopped talking about which calculator to use and be able to measure the KPIs that matter, because we have focused on the data flows that prioritise consistency, accuracy and, importantly, scalability of collection.

We already have the standards for the calculators to follow. We are retrofitting IPCC frameworks that were designed for national inventory reporting and trying to work them at farm scale. None of them is perfect but there is some merit in having a unified approach which will only improve over time.

So when you are next asked to do a carbon calculation - and you will be - don't just settle for the number. Ask how the supporting data can be used to measure consequential KPIs to the farm and know that nine times out of 10, any beneficial changes you make to the business will help with your footprint.

Sure, measure your baseline to know where you are starting from, but then focus on the things you can control.



Understanding the **jargon**

Carbon Calculator - is a modelling tool used to estimate the greenhouse gas (GHG) emissions and carbon sequestration potential associated with agricultural activities. It helps farmers, policymakers, and organisations assess their GHG impact at a specific point in time.

Intergovernmental Panel on Climate Change (IPCC) - United Nations body that provides scientific assessments on climate change, its impacts, and potential solutions. It provides frameworks for assessing, among other things, emissions factors for agriculture.

Greenhouse Gas Inventories - these are comprehensive reports produced to measure and document the emissions and removals of greenhouse gases within a specific country, region, sector, or organisation over a set period. These inventories are crucial for understanding the sources of GHG emissions, tracking trends, and informing strategies to mitigate climate change.

Emissions Factors - are the amount of emissions created from the activities of the farm and tend to be categorised in tiers, from I to III which broadly reflect an increasing resolution (granularity) of understanding of the activities of the farm.

Activity Data - data relating to the activities that generate emissions. The better the activity data, the better the estimates of emissions as higher tier emissions factors can be used.

Global Warming Potential - GWP quantifies how much energy a specific gas will absorb and re-radiate in the atmosphere compared to CO_2 over a defined timeframe, commonly 100 years (GWP100). Carbon dioxide serves as the baseline with a GWP value of 1. Short-lived gases (e.g. methane, CO2e ~28-34) may have a higher GWP over 20 years than over 100 years because their impact is concentrated in a shorter timeframe. Nitrous oxide has a CO2e of ~265-298.

AR6 - Assessment Report Six, completed in 2021, is the most recent review of the GWP numbers for greenhouse gases. It's helpful for carbon calculators to say which AR they are aligned to.

REMOTE CONTROL?

Satellite and other remote-sensed data analysis is becoming a central part of data-driven agriculture. But there's a lot to get your head around. **Andrew Cooke** explains the technology and its application to farming

I'm pretty bullish about the potential for satellite and other remote-sensed data provided we pay careful attention to the appropriate and consistent use of the data. The insights from these systems can add real value to farmers and growers. It can help them manage and control their operations with greater precision than ever before.

However, disconnecting remote sensing from land managers and their advisors – or from on-the-ground farm-scale data – could be a recipe for assumptions, inaccuracy, and (at best) averaging.

So if you are contemplating using remote sensing, think about how its combination with on-farm data and careful review could improve your outcomes. In the meantime, here's some helpful explanation of the technology...

What types of remote sensing technologies are available (e.g., satellite, drones, aerial imagery), and how do they differ in cost and data precision?

Satellite images provide a broad overview, are regularly updated, and are relatively affordable. However, they may lack the high resolution that drones can offer. Common satellite services for agriculture include Sentinel-2 (free but moderate resolution) and commercial satellites such as PlanetScope (higher resolution but paid).

Drones offer high-resolution, close-range images, allowing for detailed crop and soil analysis. However, they require upfront investment or hiring services and may be limited by weather or flight regulation (and this impacts frequency with which they can be applied). Aircraft-based imagery offers a middle ground, with wider coverage than drones and better detail than most satellites. It's very expensive to do, but typically reasonably cost-effective to buy as it's already been paid for by an agency and is being resold. Passes are infrequent, only every few years except in parts of the US where planes are flying areas every fortnight for certain crops.

How often are satellite or drone images updated, and is this frequency suitable for monitoring farm activities, crop growth or detecting changes?

Satellites such as Sentinel-2 provide images every five days, while commercial satellites can offer daily or near-daily images. This frequency is typically sufficient for monitoring crop stages or seasonal changes. Drones offer on-demand imagery, ideal for specific tasks such as pest or disease detection, although the weather may impact usability. Commercial satellites charge a minimum price per square kilometre which means buying regular passes can become very expensive. The exception to this is imagery delivered through a sector-specific aggregator.

What are the limitations of remote sensing (e.g. in cloudy or low-light conditions), and how can these be mitigated?

Cloud cover and low light are limitations. Satellite providers such as Sentinel use radar imagery that works regardless of weather or light, making it useful in cloudy conditions. Drones also face issues in cloudy weather, but multispectral cameras with near-infrared capabilities can help detect crop health despite lower visibility.

I generally recommend that people intending to use remote sensing data consider cloud, sun angle (time of day and time of year), camera angle (whether the camera is directly over the area or off to the side), and reference alignment with other data. These all have a higher impact on quality and utility than pixel size, for instance.

How can remote sensing data be used to monitor soil health and detect variations in soil moisture, nutrient levels, or compaction?

Remote sensing can detect soil moisture variations using thermal and multispectral imagery, which helps farmers manage irrigation. Soil organic matter and compaction may require further analysis but can be indicated by vegetation health and growth patterns over time, which satellites and drones can monitor.

What role does remote sensing play in tracking crop health, pest infestations, or disease outbreaks, and how early can these issues be detected?
Remote sensing can detect early crop stress indicators using NDVI (Normalised Difference Vegetation Index) or other indices. Infrared and multispectral data can highlight issues such as pest infestations or nutrient deficiencies before they are visible to the naked eye, giving farmers time to intervene early. The ability of indicators to pick up problems varies by crop species.

How can remote sensing be integrated with precision agriculture to optimise irrigation, fertiliser use, and pest management?

By overlaying remote sensing data on field maps, farmers can identify variability across fields and adjust resources accordingly. Precision agriculture uses data to apply water, fertiliser, or pesticides only where needed, reducing waste and costs, through technologies such as variable rate application.

What are the key opportunities from remote sensing in the livestock sector?

Opportunities can include monitoring pasture conditions, vegetation health and fertility, biomass availability, overgrazing and predictive grazing scheduling. GPS collars can allow livestock movements and grazing patterns to be tracked, even making use of solutions such as virtual fencing to move stock in line with feed availability. Water availability, heat stress detection, predator activity and environmental compliance are also being used in the livestock sector.

Map of Ag is introducing a simple and lightweight map visualisation tool within FarmMetrics.

Can remote sensing help identify areas of land that are most vulnerable to erosion, flooding, or drought; and why would this be beneficial?

Elevation models and historical data on soil moisture and rainfall can highlight erosion-prone areas. Vegetation and soil moisture indices and thermal imagery also identify areas at risk of drought. Combined with local weather data, clever modelling can be used to help plan mitigation strategies.

What kind of geospatial maps can be generated from remote sensing data, and how can they be used for farm planning (e.g. field layouts, cropping plans, grazing schedules)?

Farmers and agronomists can generate yield maps, vegetation index maps, and soil moisture maps, which assist in visualising resource needs across fields. These maps enable targeted actions, such as applying more nutrients to low-yield areas or adjusting planting densities.

How accurate is the data from these technologies, and what level of precision is suitable for various farming tasks?

Satellites and drones generally offer GPS accuracy within a few metres, while high-precision RTK (Real-Time Kinematic) GPS used with drones or tractors can be accurate to within a centimetre. The precision needed varies: crop mapping to support vehicle or robot movements may need high accuracy, while general field monitoring and insights require less precision.

What software or platform types are available for integrating and analysing remote sensing data, and are there options specific to agricultural applications?

Platforms such as Trimble and John Deere Operations Center are tailored for agriculture, providing tools for data integration and field management. Open-source tools such as QGIS or Google Earth also allow for data analysis but require more technical expertise. Here at Map of Ag our Data Platform connects and tidies up data so it is readily usable for important geospatial analytics.

How can remote sensing data be combined with other on-farm data, such as weather stations or IoT devices, for more comprehensive analysis?

Combining remote sensing with IoT data (soil moisture sensors, weather stations etc) offers a full picture of field conditions. Platforms are being developed to integrate various data sources, enabling advanced analytics and real-time insights for better farm decisions.

What are the upfront and ongoing costs of using remote sensing and geospatial mapping services, and is there a clear return on investment for different farm sizes?

Costs can vary hugely. Basic satellite data may be acquired for free (apart from processing time costs), but higher-resolution data or drone services cost more. Drones, for example, may require an upfront £1,000–£3,000 investment (possibly more) and software and data access subscriptions, but the savings from precision agriculture practices can pay off in reduced input costs and improved yields. Farmers are naturally sceptical about the benefits, and manufacturers and software providers need to focus on the tangible outcomes of the tech.

How can remote sensing assist with environmental compliance and environmental benefits?

Remote sensing can be used to monitor compliance. For example, the requirement for green covers on arable land to achieve climate smart commitments, or by assessing environmental impacts such as runoff. Clever algorithms are starting to be able to do these things at significant scale (for example changes in soil organic carbon year to year, important for carbon insetting/offsetting). Measurement of above-ground woody biomass is important for calculating carbon sequestration and it's even possible to use the data to calculate other metrics such as biodiversity connectivity.

What emerging trends in remote sensing or geospatial technology might be relevant to agriculture, and how might these improve farm management in the future?

Advances include artificial intelligence (AI)-driven predictive analytics, hyperspectral imaging for detailed soil or crop composition analysis, and autonomous drones for routine monitoring. Machine learning is also becoming crucial to being able to derive key productivity and environmental metrics at scale, without the need for physical on-the-ground measurement.

Can you suggest a few examples of farms in the UK, NZ or Au that have successfully integrated remote sensing and seen tangible benefits?

New Zealand dairy information company LIC provides a pasture measurement service for its farming shareholders. Remote sensing satellite data is aggregated to paddock scale to provide regular predictions of the amount of pasture feed on hand, and biological models provided by Map of Ag and the national climate research organisation, NIWA, are used to fill gaps when cloud obscures the satellite images. Farmers use pasture cover data to make grazing decisions and plan future feed purchases.

Australia's CiboLabs provides a similar service, Australian Feedback Monitor, in conjunction with Meat and Livestock Australia.

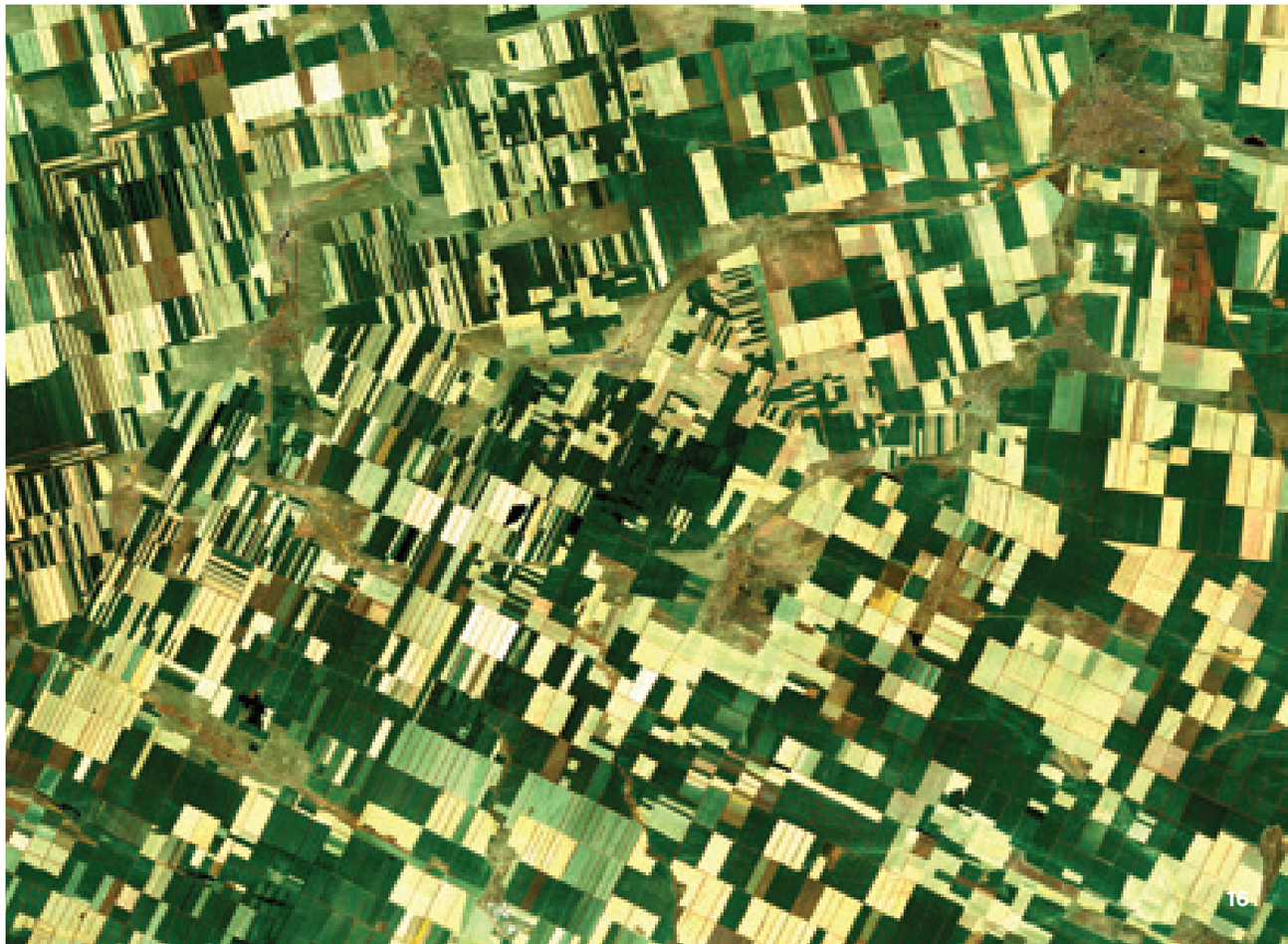
In the UK, Map of Ag and its satellite partners analyse fields of wheat and oilseed rape to provide supporting evidence of regenerative or climate smart farming practices that are rewarded by supply chain customers.

FarmMetrics

For several years Map of Ag has provided FarmMetrics, a white-label tool that its supply chain customers can deploy to their farmers. A range of primary farm management data connected through Map of Ag's data platform can be displayed in FarmMetrics so that farmers can review, correct, and fill gaps.

Now, Map of Ag is introducing a simple and lightweight map visualisation tool within FarmMetrics. Farmers and growers can connect field maps from the Rural Payments Agency or their own farm software, adjust and correct as necessary, and then review or capture agricultural practice information that their supply chain needs.

The spatial view makes it easier for farmers to visualise and report on field-level records, and supports additional evidence of climate smart practices delivered through satellite data analysis.



FARMING THE NEXT AI FRONTIER

Artificial Intelligence has become increasingly ubiquitous in our lives, says **Forbes Elworthy**. But where might it play in agriculture?

Think you don't engage with artificial intelligence? Think again.

Much of what you and I do every day is driven by AI. Social media feeds use it. Google search uses it. Washing machines that can recognise part loads and optimise water consumption use it, as do many other 'smart' kitchen devices.

Driverless cars are just around the corner (literally) and chess grandmasters have been under threat for some time. It doesn't take long for what seemed novel "AI" to become simply a device or tool. We stop looking too closely under the hood, because it seems to be yet another autonomous tool that just works.
So, what about farming? How far has AI penetrated mainstream agriculture?

Many farmers now have a plethora of professional apps on their smartphone. These allow them to order supplies, monitor stock, place fertiliser, pay bills, measure soil moisture, measure grain dryness, check weather, market produce, schedule tasks for staff and so on.

Beyond smartphones, other devices on farms and orchards also process information autonomously, for example modern tractors, seeders, sprayers and harvesters are now packed with sensors and algorithms to help optimise outcomes.

Therefore, just like the rest of us, farmers already interact with AI.

But what impact is this AI having on agriculture? Farming is in many ways highly suited to AI. It is a large industry with a high potential for measurement and with it a big opportunity for data-driven solutions. But currently a lot of data goes uncollected. And very little of it is processed into valuable insights.

It's a bit like the chicken and the egg: AI tools need data sets which are large enough to 'learn', but will not be of much use until enough (good) data is available. But that egg is starting to hatch. Agriculture is moving from being data lean to data abundant.

Every farm season is unique, as are most farm production systems. This lack of standardisation (from a high-country sheep farm to an orchard) makes many farms or the tasks within these farms less suitable for simple modelling: meaning something smarter is needed.

So where might AI take farming and the agrifood industry next? What is AI currently good at?

Artificial Intelligence tools tend to be good at text compilation (from auto-complete, to large language models), solving complex puzzles, supervising robots, mining data, and creating new information tools.

How relevant are these for the future of agriculture and food?

Farming is an input:output system. It is already pretty lean having become increasingly mechanised in past decades and, with the exception of horticulture, has had a decreasing reliance on labour.

As such, mainstream farming has become a series of capital rather than labour intensive systems. Artificial intelligence will help the main input:output ratios of agriculture become more efficient, however these gains may not be much faster than in the rest of society, with the exception likely to be fruit and veg operations where the potential for robots, seemingly "five or 10 years off" for at least a decade, is closer than ever.

So where might AI really find its farming foothold?

My father died in 2004 and shortly afterwards I found myself re-learning farming. With so much ahead of me I planned simply to stay on the farm and get on with it. Just me, Bridgie, the kids and our staff.

However, something unexpected happened. From that first week, helpers started calling me and showing up at the farm. And to this day they have not stopped doing this. So what is going on?

It turns out that a farm is not really 'run' by a farmer. Instead, he or she is a generalist assembler. No farmer has the skills to be their own agronomist, vet, seed specialist, machinery engineer, geneticist,

Farmers should ensure that all counter parties with whom they share data acknowledge, from inception, that farm data is the property of the farm, not the party who is offered access to it.

or accountant. Instead, we outsource this expertise from a revolving door of farm service professionals, on a piece-work basis.

Farmers and their salaried staff also don't do some of the farm's physical tasks. Almost every week, one or two expert contractors arrive to carry out sowing, spraying, harvesting, scanning, crutching, shearing, insemination (the original AI!) and many more tasks.

What I had not learned from ag college, nor from my time as a shepherd, is just how many of these people there are out there helping farms. I estimate there are seven to 10 of these professionals per farm. So, in most developed agri-economies, there are 200,000 of these good people. Most of them are white collar and therefore well trained and open to using screens and data.

Might this army of helpers be made more efficient and effective by AI tools? For example, with the right algorithms encapsulated in web tools, might each vet be able to look after 50 farms rather than the present 30? Might a field suffering from a disease receive more prompt diagnosis and treatment via agronomists getting alerts directly from sensors, rather than having to walk the field?

It seems possible the very things that AI is good at may be what is needed by these professionals. Consider vets, agronomists and farm advisors using text compilation to write first draft reports? Or AI parsing of symptoms to help solve the puzzles of diseases?

There's more. Robots could accompany contractors to farms, making them more effective. Big data sets could be mined by users to generate insights. And new information tools could be invented to further help farms.

My main conclusion from six months pondering AI and agriculture is that the farm service industries offer a ripe environment for it, to help farmers make better production and sustainability decisions.

But there is one last issue that is too important not to mention: farmer control of data.

It is no accident that the dominant tech companies are making the biggest AI advances. Firms such as Google (i.e. Alphabet) and Facebook (i.e. Meta) have large private data sets of information on people like you and me on which to train their AI. It would be a pity if a similar grand larceny were to happen to farming.

Farmers should ensure that all counter parties with whom they share data acknowledge, from inception, that farm data is the property of the farm, not the party who is offered access to it.

Fortunately, farm data standards such as the Australian NFF Farm Data Code, the UK's Farm Data Principles, and Farm Data Code of Practice in NZ have been set up to address this. Firms who sign up to these standards commit that farmers and only farmers should be able to permission their data to AI and other projects.

Farmers should make sure organisations who get measurements from their farms commit to these standards.

WHAT VALUE DOES YOUR FARM DATA HAVE?

Given sometimes over-inflated expectations about the monetisation of an individual farm's data, **Andrew Cooke** and **Richard Vecqueray** explore where the real value lies

It wasn't long ago that everyone was talking about farm data as the "new oil" for farmers. Of course, data is oiling the wheels of food production as we move forwards, but viewing it simply through the "Can I sell my data for money?" lens is rather missing the point - and the opportunity.

Instead, we thought it would be useful to look at some of the key areas where a farm's data has value... and why.

Let's start with market research. Around the globe, research agencies interview farmer panels on myriad subjects to inform the wider supply chain around trends and provide other analyses. Farmers are indeed often incentivised (sometimes paid) for that information but in many ways it's more a recognition of their time than anything.

There is a potential value here, and it's more than just the monetary incentive. Why not ask: "What's in it for me?". Could the agency share some high-level findings or even provide some benchmark information for your farm based on the aggregate dataset. It could be subject to confidentiality or embargo, but nonetheless potentially useful.

A second and growing area is where farmers are being rewarded for practice change and necessarily needing to provide the supporting evidence. Many corporates in the supply chain have environmental (and social and governance, collectively ESG) agendas to deliver, and proving that their suppliers are doing the right thing is an important part of that. Sometimes, the business might be adding value to their product. In other cases they need to have the data for mandatory (and voluntary) reporting. Either way, they need the engagement of farmers.

Businesses such as Cargill, Arla and Fonterra are needing to measure practice change. Fonterra in New Zealand, for example, has a staged programme.

Initial premiums over the base milk price reward farmers for data collection and meeting baseline ESG achievements. Higher tier premiums reflect milk quality practices and will increasingly reward achievement of outcomes required by key customers, such as reductions in greenhouse gas emissions (though this is different from paying for the insets - see below).

The banking sector is also becoming increasingly active in this area, some offering preferential loan terms in return for evidence of ESG-related commitments from the farm.

Then there is the area of carbon credits. A year or two back everyone was getting terribly excited about selling carbon credits to businesses outside agriculture to offset their emissions. Some have described this as the great "Wild West" of carbon trading. And it is true it is fraught with difficulties.

But there are businesses, for example, Denmark-based Agreena that are focused on using carbon credits to support the transition to regenerative agriculture. Farmers can track and validate their regenerative practices, generating carbon credits that can be sold to companies seeking to offset their emissions.

Agreena employs technologies, including satellite imaging, to monitor and verify these practices. Additionally, the company says it offers financial solutions such as blockchain-based traceability and smart contracts for seamless transactions between farmers and corporate buyers.

Other businesses, such as Zulu Ecosystems, are focused on above-ground woodland and peatland restoration that are backed by government-supported codes in the UK - the Woodland Carbon Code and Peatland Code.

According to its head of natural capital, Alastair Grizzell, landowners can plant trees or restore peatland and sell carbon credits either as Pending Issuance Units (in other words selling now based on an estimate of the future carbon sequestered), or Woodland Carbon Units sold once the carbon sequestered is verified every five years.

Zulu takes a very data-driven approach to assessing project viability since they can run for 100 years in the case of woodland, and 40 years for peatland. And they tend to be deployed on land that is deemed (by data analysis) ineffective for ongoing food production.
More recently, insetting has become a focus, partly because farmers have rightly been concerned about getting the timing and price wrong when it comes to selling offsets. Quite simply, if you've sold an offset, you've just made the challenge of getting your farm closer to net zero harder. And if you've taken that risk, did you get sufficient reward?

In NZ, meat processor Silver Fern Farms has a Net Carbon Zero By Nature beef brand. Acknowledging that 96% of the emissions from a kilogram of Angus beef comes from the farm, Silver Fern is certifying its beef (independently approved by certification organisation Toitū Envirocare) as 'Net Carbon Zero' where the emissions associated with its production are balanced with the equivalent carbon sequestration occurring within the lifecycle of that product. In other words, insetting.

The company says that 14 of the 17 farms in the pilot have a "clear path" to carbon neutral and the programme contracts and purchases the carbon from the participating farmers. The access to the necessary data to prove this not only rewards farmers for their strong environmental management practices, it also highlights the benefits of grass-fed beef from New Zealand, the company says.

Across the 'ditch' in Australia, supermarket giant Coles is doing something similar with its Coles Finest Certified Carbon Neutral range. Here the company is working collaboratively with farmers to achieve better sustainability outcomes. Using data from the farm, all its products in the range are independently certified to the Australian Government's Climate Active Carbon Neutral Standard for Products & Services.

The supermarket is working with a select group of Australian farmers who are committed to reducing their carbon footprint through focusing on herd efficiency, maximising growth rates and investing in emission reduction strategies including the planting of trees, renewable energy, feed management strategies and biodiversity improvements.

In the UK, policy framework Biodiversity Net Gain (BNG), while probably a relatively small and finite market, is paying farmers through BNG credits for engaging in biodiversity projects to allow property developers to demonstrate at least a 10% improvement in biodiversity value, which must be maintained for 30 years.

The value is measured using DEFRA's biodiversity metric, which evaluates the distinctiveness, quality, and size before and after development of habitats. Necessarily, farm data is required to monitor these.

Other examples include the UK's Landscape Enterprise Networks (LENs) which focus on collaborative solutions to environmental challenges by bringing together businesses, landowners, NGOs, and other stakeholders to co-fund and implement projects that benefit biodiversity, mitigate climate impacts, and enhance local natural resources. LENs projects are designed to address shared goals, such as improving water quality, reducing flood risks, and fostering regenerative agriculture.

Farmers are rewarded for their participation but have to provide data on farm management practices, soil types and vegetation, biodiversity status, environmental performance metrics and field boundaries and features.

Finally, there is of course possibly the biggest benefit of all: meaningful data-driven insights about the performance of the farm. The adoption of precision agriculture tools such as variable-rate spreading, and yield and soil mapping are revolutionising our understanding of the performance of the farm and supporting tactical and strategic decisions that improve returns. Smart wearables in livestock are doing similar things.

Collecting good data is helping businesses understand farm performance at sub-field or individual animal level allowing farmers to optimise productivity and balance that with other sustainability-based payments or rewards on parts of the farm that are less profitable.

Across the board it's possible to see that a farm's data truly has real value.

And while that might not always be direct compensation for providing data to a third party, it is extremely rare that the collection and analysis of good data will fail to improve the business in some way.

So next time you're mulling things over in the tractor cab, ask yourself where and how you could maximise the value of the data on your farm. You might be surprised.

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CONTACT US

Working with clients across the world, Map of Ag operates in the UK, New Zealand and Australia.
We'd love to hear from you. If you wish to get in touch please email info@mapof.ag.

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