SPOTLIGHT
Savills Research

UK Rural - June 2020

Rural Land and Carbon

savills

Climate change action • Carbon sequestration and accounting • Achieving net zero

2019
recorded the highest level of CO_2 in human history

11%
of total UK emissions are from agriculture

30%
fall in GHG emissions since 2008 (in the UK)

What is the climate emergency?

Public demand for action on climate change has never been higher. Governments and corporations around the world have bowed to pressure and are taking action

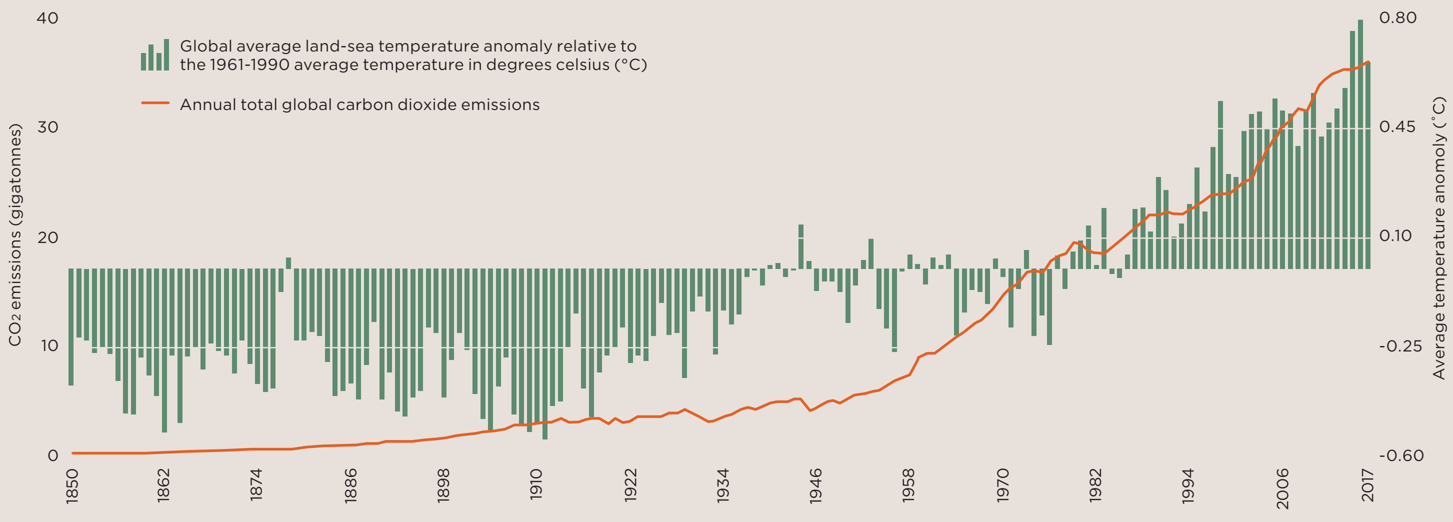
Climate campaigners have not been placated by the simple declaration of a climate emergency. The declaration was little more than an overdue acknowledgement of well-established science; that climate change is occurring and human activities are the main cause.

Climate change and global warming are terms often used interchangeably, leading to the dismissal of global warming as part of a natural cycle. It is true the Earth has seen its climate continuously change through a cycle of ice ages and warmer interglacial periods over hundreds of millennia.

However, global average temperatures have increased by 1.1°C in the past 200 years alone, and the speed of the recent change is causing exceptional pressures on the natural systems that sustain human existence. This period of heating coincides with an unprecedented increase in human-influenced greenhouse gas (GHG) concentrations in the atmosphere. Ice cores tell us concentrations of carbon dioxide in the atmosphere have not been this high at any point in the past 800,000 years.

In galactic terms, the greenhouse effect makes Earth the "Goldilocks planet": not too hot, not too cold. GHGs absorb infrared radiation emitted from the Earth's surface, trapping that heat in the atmosphere. The more GHG accumulating in the atmosphere, the more heat is trapped and the more we interfere with the Earth's multi-millennia carbon cycle. Recovering our system resilience from the negative implications of climate change is going to take huge effort and investment, and rural land use is both hero and villain in this new era. This report highlights some of the challenges and opportunities ahead.

Global CO_2 emissions and average temperature anomaly from 1850 to 2017



Source Global Carbon Project, Hadley Centre, Savills Research, NOAA

CLIMATE CHANGE ACTION: A TIMELINE

1824 French physicist Joseph Fourier first describes the Earth's natural "Greenhouse Effect"

1850 284ppm, close to the average level of the past one million years

1896 Swedish chemist Svante Arrhenius concludes that industrial coal burning will enhance the natural greenhouse effect

1911 300ppm, concentrations have never been this high in the past 800,000 years

1975 The term Global Warming first appears in a scientific paper by US scientists

1988 Intergovernmental Panel on Climate Change (IPCC) formed to collate and assess evidence on climate change

1992 The United Nations Framework Convention on Climate Change (UNFCCC) is established

1997 The Kyoto Protocol is adopted by UNFCCC (developed nations pledge to reduce emissions by average of 5% by the period 2008–2012)

2005 EU trading emissions scheme launches

2008 The Climate Change Act is created in the UK (first domestic long-term legislation on climate change, long term emissions target = 80% reduction of 1990 levels by 2050)

2008 Committee of Climate Change is established in the UK (independent advisory body responsible for recommending 5-year carbon budgets)

2013 400ppm, last seen around 3 million years ago, long before Homo sapiens existed

2015 The Paris Agreement is adopted by UNFCCC

2017 The UK sets out its Clean Growth Strategy

2018 25 Year Environment Plan produced in the UK

2019 UK sets out new Clean Air Strategy and a Green Finance Strategy

2019 UK adopts a legally binding target to reach net zero emissions by 2050

2019 415.7ppm, the highest level ever recorded in human history

2020 The new Environment Bill and new Agricultural Bill progress through the UK parliament

2020 UN Conference of Parties 26 (due to be hosted in Glasgow) is postponed due to coronavirus

Bold = concentration of carbon dioxide recorded in the atmosphere in parts per million (ppm)

“Recent climatic events – floods, wildfires, storms – and their growing frequency have ignited public concern, leading to global protests, school strikes and demonstrations”

The recent shift in action towards climate change

Increasing policy action and public concern puts the pressure on rural emissions

Multiple interrelated factors are driving the current increase in climate action. The landmark Paris Agreement (2015) is an international concord which aims to keep global temperature rise this century to below 2°C above pre-industrial levels and to pursue efforts to limit the increase even further to 1.5°C. To this date, 189 parties have ratified the agreement.

At a national level, the UK became the first country to commit to a legally binding net zero emissions target. England and Northern Ireland are committed to achieving net zero emissions by 2050, Scotland by 2045 and in Wales the goal is a 95% reduction in emissions by 2050. These targets are legislated within the UK Climate Change Act, which sets the nation’s annual carbon budgets.

Since the Climate Change Act was passed in 2008, the UK has demonstrated that it is possible to decouple emissions growth and economic growth (although the impacts of coronavirus lockdown have challenged this convention). Since 2008, GHG emissions have fallen by 30%, while the economy has grown by 13%. Per capita emissions in the UK are now close to the global average at 7-8 tonnes of carbon dioxide equivalent (tCO2e) per person, having been over 50% above in 2008. Even though UK emissions have decreased through measures targeting the low hanging fruit in industry and energy, agriculture has been left behind in its strategy to reach net zero.

Within the UK there has been a host of strategies developed to support decarbonisation. The Green Finance Strategy will require all financial companies and large asset owners to disclose their climate-related financial risk in their annual reporting from 2022. The strategy will enhance carbon disclosure, but also require an understanding of climate impact on their existing business models and supply chains. Food supply chains and agricultural businesses within them will undoubtedly fall under the scrutiny of this high-level legislation, as well as being required to supply carbon disclosure for larger businesses further along the chain looking to comply with their own net zero targets.

While the UK’s new overarching net zero target could result in a more joined up, cross-sector approach between DEFRA and BEIS, climate policy and agriculture are both devolved matters, creating scope for piecemeal policy making at a time when coordinated action is critical.

189

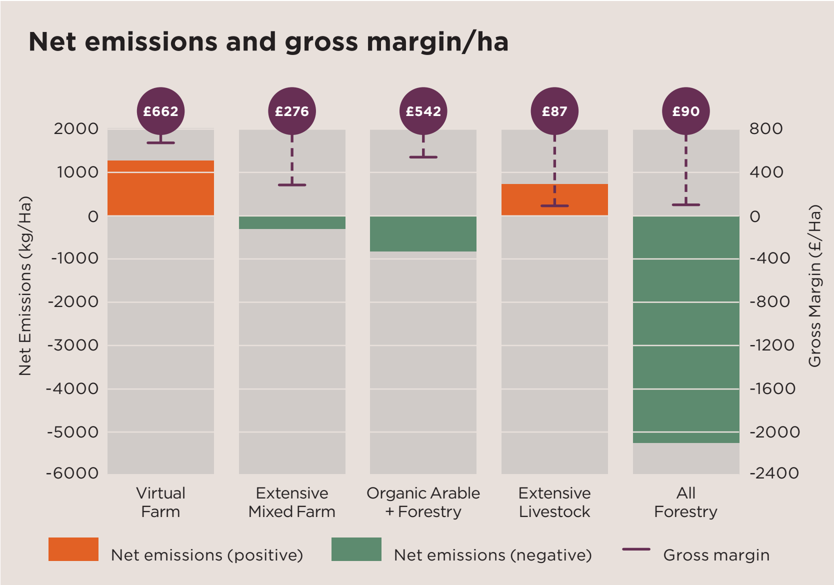
parties have ratified the landmark Paris Agreement (2015)

In the UK agricultural emissions have only decreased by 16% since 1990 making agriculture an increasingly large part of the problem. In 1990, agriculture was a mere 7% of total emissions. As of 2018, it makes up 11% of the total and little is being done to limit the increase. Given that the UK is on course to miss its fourth and fifth carbon budgets, it is highly likely that new legislation will appear in the next few years to enable the UK to reach its 2050 net zero target, and this could coincide with the agricultural transition period.

Recent climatic events – floods, wildfires, storms – and their growing frequency have ignited public concern, leading to global protests, school strikes and demonstrations. This has not abated through Covid-19 lockdown. Young influencers, such as student climate activist Greta Thunberg, continue to serve as a catalyst for change. Businesses have started to react but there is an urgent need to catch up, and UK agriculture will undoubtedly be impacted by future climate legislation.

However, the threat to agriculture is more than simple regulation. In order to retain public support, the agricultural sector will have to step up to the climate change challenge.

> "The crucial factor remains the impact on gross margins as a result of a net zero land use policy. Enterprises have to be economically viable and are essential in providing food"



Source Savills Research

Balancing act

How to cut carbon through land use changes

Agriculture occupies a relatively unique position as both a source of greenhouse gas emissions, but also a sink.

In order to explore the impact of net zero on farming systems, we used the Savills Virtual Farm and the Farm Carbon Cutting Toolkit online calculator to estimate the carbon balance of different management and land use scenarios.

We also calculated the impact of these scenarios on the financial viability of the Virtual Farm.

THE SAVILLS VIRTUAL FARM

The Virtual Farm is a top 25% arable producer located in the East Midlands. The farm covers 830 hectares of clay soils, of which 809 hectares are arable cropped. The crops on our virtual farm include feed wheat, winter oilseed rape, spring beans, winter oats, spring barley and fallow.

THE SCENARIOS

In all scenarios, hedgerows were allowed to grow larger, but no other mitigating factors (e.g. min till) were adopted other than those specified. Where forestry is involved, to allow comparison with annual cropping a discounted cash flow model was used to calculate an average annual output for the timber crop. Sequestration rates vary for a range of tree species, but we have assumed Sitka Spruce is planted because it is a common commercial tree crop. There is no value included for the sale of sequestered carbon, noting that this is a developing market. Where there was a lack of clarity in data, we underestimated figures, and noted that including soil organic matter content in the calculator presented several complexities. Income from BPS was not included in our financial modelling, and figures are based on 2019 market prices.

Carbon modelling scenarios and their land uses

Name	Description	Arable area (ha)	Livestock area (ha)	Woodland area (ha)
Baseline	Virtual Farm	809	0	0
Scenario 1	Extensive Mixed farm	339	200	270
Scenario 2	Organic arable farm and forestry	539	0	270
Scenario 3	Extensive livestock farm	0	750	59
Scenario 4	All forestry	0	0	809

VIRTUAL FARM: MANAGEMENT RESPONSES TO REDUCE CO2e EMISSIONS

The results of the carbon modelling will be used to alter management practices on the Virtual Farm, but given that all the scenarios have a negative impact on financial viability, none are being considered for adoption in the short term. Management will focus on measures to reduce arable crop production CO2e emissions below the current baseline. These include:

- Using nitrogen fertiliser products produced with lower carbon footprints.
- Selecting nutrient sources and crop genetics with higher potential nitrogen use efficiencies.
- Using fertiliser treated with nitrification/urease inhibitors, or coated fertilisers.
- Further adoption of precision farming techniques for efficient input and machinery use.
- Cutting emissions by reducing machinery idling time and fitting low energy building lighting.
- Exploring the feasibility of switching from conventional crop establishment techniques to direct or strip drilling, cutting fuel use and oxidation of soil organic matter.

Ultimately, with sequestration on farm currently offsetting just 5.7% of the Virtual Farm's emissions, emissions reduction in isolation will not lead to the farm achieving net zero. This suggests a degree of land use change or offsetting elsewhere will be required.

THE IMPACT OF SOIL ORGANIC MATTER

Across the whole 809 cropped hectares, a policy of increasing soil organic matter content from 2.00% to 2.01% would sequester 568 tonnes of CO2 per year. Research from Defra suggests that full arable reversion could increase soil carbon levels by 0.1% per year, but we substantially underestimated this in our modelling. However, inclusion of livestock has a large negative impact on emissions, and the subsequent treatment of methane and soil organic matter in calculations are central to understanding carbon impact. Taking these uncertainties and limitations into account means that overall forestry has the largest predictable impact on carbon balance.

98%
sequestration is achieved by afforestation of whole farm

1,335
tonnes of CO_2e = emissions from the Virtual Farm

2,600%
more carbon sequestered through scenario 2 than on the Virtual Farm

Carbon modelling scenarios: economics and emissions

Name	Gross Margin Total (£)	£/ha	Emissions (CO_2e (t/year))	Sequestration (CO_2e (t/year))	Net emissions (CO_2e (t/year))	Carbon Balance (tCO_2e/ha/annum)
Baseline	535,000	662	1,335	77	**1,256**	**1.6**
Scenario 1	223,000	276	776	1,072	**-292**	**-0.4**
Scenario 2	439,000	542	1,240	2,056	**-816**	**-1.0**
Scenario 3	71,000	87	2,056	679	**1,376**	**0.9**
Scenario 4	73,000	90	117	5,354	**-5,238**	**-6.5**

BASELINE SCENARIO: CURRENT ARABLE ROTATION

The Virtual Farm currently emits 1,335 tonnes of CO_2e per year from fuel, fertilisers and inputs. It offsets just 5.7% of these emissions by sequestering 77 tonnes of CO_2e per year in its field margins, woodland and hedges. There is very little sequestration, and most of it (74%) comes from the hedgerows. It is the most profitable model.

86%
decrease in gross margin occurs in Scenario 4 that sequesters the most carbon

SCENARIO 1: EXTENSIVE MIXED FARM

- Wheat, oil seed rape and winter oats
- 270 head of beef cattle
- 5–15 year old Sitka Spruce

Introducing rotational grazing almost halves the emissions of the Virtual Farm and enables the farm to be carbon positive. Fertilisers and sprays contribute 52% of emissions, whereas livestock accounts for 28% of total emissions.

85% of the sequestration comes from the woodland, 9% from the soil organic matter of the grassland, and the rest is from hedgerows and field margins. Overall, the scenario retains 41% of the land in arable cropping and reduces net emissions by 40%, with the Virtual Farm's gross margin reducing by 58%.

SCENARIO 2: ORGANIC ARABLE FARM AND FORESTRY

- Organic wheat, barley and field beans
- 5–15 year old Sitka Spruce

Organic arable and forestry sequesters 2,600% more carbon than the Virtual Farm and has a substantial positive carbon balance. Organic fertilisers still lead to induced emissions from the soil and 57% of the farm's emissions are linked to the use of organic fertilisers.

Although the emissions in this scenario are not reduced substantially, the increase in sequestration generates an overall negative balance. Over 80% of the sequestration is from the woodland, the rest comes from hedgerows and field margins.

SCENARIO 3: EXTENSIVE LIVESTOCK ENTERPRISE

- 500 head of beef cattle (housed outdoors)
- 1,800 head of sheep (housed outdoors)
- 5–15 year old Sitka Spruce

Under this scenario the arable enterprise is replaced with an extensive livestock enterprise. The Farm becomes a net emitter, with 80% of emissions from livestock. The grassland results in a big increase in sequestration though, with 56% from the soil organic matter of the grassland, 32% from the woodland and the final 12% from hedgerows. The principal sources of emissions are livestock (80%) and fertilisers (10%). The farm's gross margin has decreased by 87% compared to the baseline.

SCENARIO 4: ALL FORESTRY

- Whole farm planted with 5–15 year Sitka Spruce

This scenario sequesters the most carbon, but the farm's gross margin has decreased by 86% compared to the baseline. Woodland accounts for 95% of sequestration, the final 5% is from hedgerows. This scenario could also have the most significant impact upon the farm's capital value because forestry is effectively a permanent land use change. Emissions from this model are split evenly between fuel and the aggregate materials needed to enable forestry operations. This model has almost one tenth of the emissions of the Virtual Farm and it becomes a substantial net sink of carbon, absorbing 6,800% more than the baseline.

What the results say...

The results of this modelling exercise highlight that for an arable farm a large proportion of emissions are due to the energy intensive processes used to manufacture artificial fertilisers. Regardless of whether they are organic or inorganic, the application of nitrogen to land promotes biological processes that lead to an increase in nitrous oxide and ammonia emissions.

The crucial factor remains the impact on gross margins as a result of a net zero land use policy. Enterprises on land have to be economically viable and are essential in providing food. A balance between crop production and forestry could allow a farm to achieve net zero, however a considerable area of the farm would require converting to forestry, which could affect the viability of the remaining production enterprise, and this may not be a suitable land use for the area. A system of offsetting carbon on another piece of land may be more viable.

The Virtual Farm, with the highest level of emissions, has the greatest financial viability. At the other end of the spectrum, afforestation of the whole farm provides 98% sequestration yet decreases the gross margin by 86% (alongside reducing the capital value of the land). Despite the sequestration possibility of rural land, land managers are unlikely to make large scale land use change decisions until carbon itself is valued as a counter-balance to productive agriculture. The question is, therefore, how the private carbon marketplace and future agri-environmental policy will develop to incentivise net zero farming, or whether farmers will be forced through regulation to adopt these practices in spite of the market reality.

10%
of the UK's land area are peat bogs

50-58%
of soil organic matter is organic carbon

12
years to remove a molecule of methane by natural processes

The five Ws of carbon accounting

With agriculture facing increasing scrutiny over emissions, farmers and land managers should look to measure just how much carbon their holdings produce

Without action and with the continued decline of emissions in other sectors agriculture will become responsible for a larger proportion of the UK's emissions. Since 1990, agricultural emissions have decreased, however as a proportion of UK emissions, agriculture has increased from 7% to 11%. The sector needs to do more, and the first step is knowing exactly where emissions are coming from through carbon accounting.

WHY

When it comes to net zero, the importance of measuring carbon cannot be understated. Carbon accounting is critical to managing carbon, which will soon be of fundamental importance to the operation of agriculture in the UK.

- *Future agriculture policy*: public money for public goods may provide investment for climate change mitigation, but the likelihood of a rising compliance baseline is high. Being aware of your own emissions ahead of time and planning accordingly will put your business ahead of the curve.
- *Productivity and profitability* are strongly correlated with emissions. While some practices will require significant upfront capital, measures that reduce emissions often simultaneously facilitate increases in efficiency and output, leaving the holding better off in the long term.
- *Marketing benefits* will emerge from successful reductions in emissions but not just from an improved image with consumers. Many processors and brands already realise this and require some form of carbon account from producers.

WHO

The number of free carbon calculators available means anyone can pursue carbon accounting. Any farmer can input the data themselves and obtain results. Given the extensive list of inputs, this may be an arduous task, particularly on large holdings. The challenge is what to do with the results and this is where expert help will be invaluable. Identifying areas where GHG emissions are higher than expected can be carbon and cost efficient.

WHAT

The list of what must be measured initially appears quite extensive, but a majority will already be monitored on a well-managed holding. It goes without saying that the more care and attention that is paid to input data, the more accurate and useful output data will be. From this number, a strategy can be developed. For most calculators, the following information needs to be available:

- *Livestock age and numbers*
- *Annual fuel type and quantity*
- *Utilities type and quantity*
- *Assets (buildings, machinery and materials)*
- *Tonnage of crops harvested*
- *Fertilisers (chemical and organic)*
- *Land area and type*
- *Agro-chemicals*
- *Imported livestock feed*
- *Waste and disposal method*
- *Distribution and refrigeration*
- *Soil organic matter*
- *Perennial biomass features*

WHERE

Defining the scope of the account is vital. It may look at a product or the whole holding, and may or may not include emissions from let properties or purchases. A whole holding approach captures all emissions on a farm to give a tCO_2e per hectare measurement, which can be used for benchmarking to track the holding's progress over time and highlight areas where emissions can be reduced, or sequestration increased. The Farm Carbon Cutting Toolkit is one example of a whole holding calculator.

This approach is not appropriate if the measurement is to be used further along the supply chain. For this, a product footprint is more appropriate. Only data relevant to the product is measured, meaning fewer inputs, but any carbon sequestered on the farm is also omitted. Retailers can incorporate this figure in a final measure of the carbon emitted delivering the product to the shelf, which is of increasing interest to consumers. The Cool Farm Tool can be used to calculate a product's carbon footprint.

Precisely where to stop measuring is often misunderstood and can lead to "double counting". For example, if a holding were to sequester carbon through a tree planting initiative and sell the carbon credits, it cannot include that carbon in its own carbon account. Instead, the price paid for those carbon credits can be reinvested for compounding gains. Furthermore, benchmarking is ordinarily limited to emissions that occur within the farm gate but being aware of those occurring beyond may still affect business decisions, such as carbon embodied in fertiliser.

WHEN

A carbon account should be conducted annually at the same time each year. Crucially, the process should continue on a long term basis as many changes made will be relatively small and not immediately noticeable. Indeed, extenuating circumstances outside of a land manager's control may entirely outweigh changes made and result in an increase in GHG emissions. But the journey to net zero is not a short one and significant benefits will be realised over time.

> "The 2020 Agriculture Bill commits to providing financial assistance to farmers for protecting and improving soil quality"

Quantifying carbon

Development of robust methods to measure what's underfoot

The land use sector has been firmly in the spotlight for its emissions impact, but tree growth, peatland restoration and well-managed soils are key for carbon sequestration. Measuring and verifying the quantity of carbon within a farm is essential both to identify where costly inputs are being wasted, and to ensure that nature-based solutions to increasing carbon storage receive due investment.

Determining the exact amount of greenhouse gasses that are emitted or sequestered is close to impossible. Instead, proxies and standards are used to regulate the industry and deliver final figures of carbon dioxide equivalent (CO2e). It is by no means an exact science, but the methods are now robust enough for land managers to deploy them in the field.

SOIL

The most accurate way to measure carbon sequestration rates is through regular analysis of the change in soil organic carbon (SOC) content over time. Measuring changes requires a soil sampling strategy that captures the natural variation in soil carbon across the field, as well as a measure of SOC concentration and bulk density of the soil sample. Soil sample tests are usually conducted in laboratories, but costs are reducing as technology improves.

Farmers can also conduct proxy tests on farm to monitor soil health. These tests do not provide a figure for carbon sequestration, however they are helpful in tracking soil improvement.

SOC delivers multiple agronomic benefits as well as carbon balance advantages, but the potential for farmers to be paid for storing carbon in soil remains remote. The 2020 Agriculture Bill commits to providing financial assistance to farmers for protecting and improving soil quality. However, the UK currently lacks an industry standard for converting soil carbon sequestration improvement into "verified" and hence tradeable carbon credits.

There are systems for verifying and then selling soil carbon sequestration in Canada, America and Australia. With the importance of SOC becoming ever more obvious, research continues to explore simpler, cheaper and more accurate ways of quantifying the carbon beneath our feet and incentivising land managers to deliver more of it.

WOODLAND

The Woodland Carbon Code (WCC) is a UK assurance scheme for woodland carbon. The WCC has developed a standardised calculator to calculate the amount of carbon sequestered through new woodland planting. The factors that influence this are tree species and age, yield class of the timber, spacing of the trees, management regime (regularity of thinning), area of woodland and age at timber felling. These figures then project the amount of carbon that will be sequestered as the woodland grows. Each tonne of projected carbon sequestration is called a Pending Issuance Unit (PIU), which, once the project is registered under the WCC, can be sold to companies or individuals wishing to purchase woodland carbon credits. PIUs are a guarantee of future sequestration, and once they are verified they are converted to Woodland Carbon Units. These full carbon credits can then be retired or reported through sale.

PEATLAND

The Peatland Code is a certification standard for UK projects wishing to quantify and market the carbon sequestration of peatland restoration. The code sets out best practice requirements alongside a standard method (involving aerial and field assessment) for calculating baseline and future sequestration. As with the WCC, independent validation and verification of the project ensures that buyers can be confident in purchasing peatland carbon units.

FOCUS ON METHANE

For agriculture, the emission of methane is a key issue. The way we quantify these emissions and convert them to carbon dioxide equivalents will have significant consequences, and so it remains a hotly debated topic.

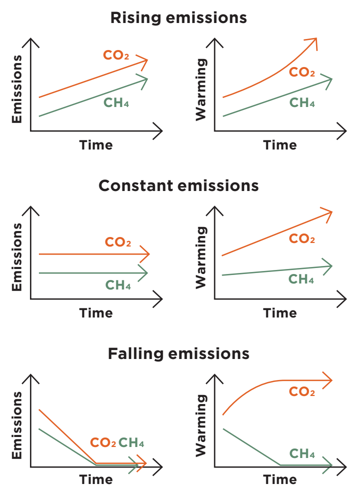
If you emit a molecule of carbon dioxide, that molecule will remain in the atmosphere until it is sequestered. It will continue to cause global warming for decades. Even if no further carbon dioxide is emitted, temperatures would remain at an elevated level.

If you emit a molecule of methane, natural processes will remove that molecule after around 12 years. After that, the methane molecule can no longer contribute to climate change. If it is not replaced, temperatures would fall back to what they were before, assuming all else is the same.

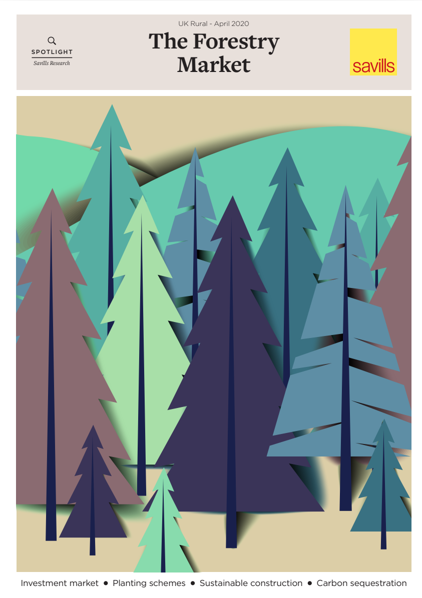
Conventional metrics of climate impact do not take this into account. Instead, they show falling methane emissions as equivalent to an amount of carbon dioxide that would continue to cause global warming. But the differences between carbon dioxide and methane mean that decreasing emissions would ultimately lead to lower global temperatures.

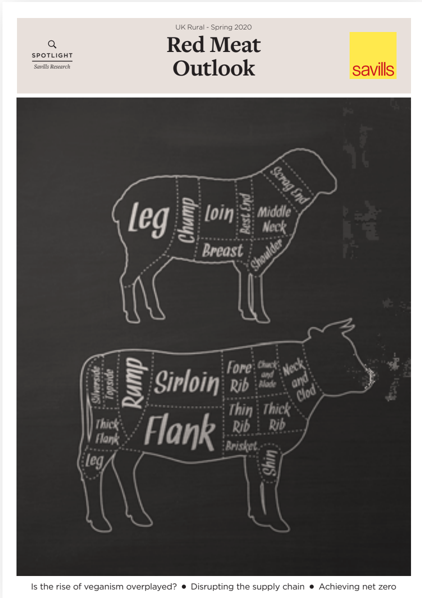
A new way of measuring global warming potential takes methane's short lifetime into account by focusing on changes in the rate of emissions. This better reflects the climate impact of methane.

Global Warming Potential CO2 vs CH4



Source University of Oxford





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