Farming for 1.5°

Independent inquiry on farming and climate change in Scotland

From here to 2045

NOURISH SCOTLAND

NFU Scotland

Thirty Percy

Polden·Puckham Charitable Foundation

ef Esmée Fairbairn FOUNDATION

INTRODUCTION

Farming for 1.5 was established as an independent inquiry in 2019 by NFU Scotland and Nourish Scotland. The intention was to develop a consensus roadmap for farming in Scotland in the context of the climate and nature emergencies, and the Scottish Government's commitment to net zero by 2045.

This can only be achieved if agriculture can become part of the solution, not part of the problem. This means farmers, scientists and environmentalists working together to achieve the changes needed while maintaining food production and sustainable livelihoods for food producers.

The independence of the inquiry enabled all panel members to contribute views freely and develop their thinking collectively, without any pre-determined constraints or no go areas.

Our thanks go to all the panel members who have contributed throughout the inquiry, as well as to all those who have provided the evidence to inform the panel's discussions and underpin their conclusions.

Martin Kennedy	Pete Ritchie
NFUS President	Director, Nourish Scotland

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THE PANEL

Co-chairs

Nigel Miller is a graduate of the Royal Dick School of Veterinary Studies. He worked in the Highlands in a mixed farm animal practice before returning home to the family farm partnership in the Scottish Borders. His current farming operation in partnership with his sons carries 170 breeding cows and 800 breeding ewes; winter and spring barley and has diversified into wood processing. Nigel is a past chair of FWAG Scotland and the NFUS Livestock Committee and held the position of NFU Scotland President over the period of the last CAP Reform. He has been a board member of SRUC and SAC Commercial and today is a board member of the Moredun Research Institute and Chair of Livestock Health Scotland.

Mike Robinson is the Chief Executive of the Royal Scottish Geographical Society (RSGS) based in Perth. He has worked in the Scottish charity and environment sector for the last 25 years, initially with RSPB as Head of Marketing, and later with the Royal Botanic Gardens in Edinburgh as Director of Development. In a voluntary capacity Mike has held more than 40 board/advisory roles, mostly for environment and human rights bodies, including as previous Chair of Stop Climate Chaos Scotland (SCCS). He also chaired the Scottish Parliament's short life working group on annual targets, sits on the advisory groups for Air Passenger Duty & ScotRail, and the board of Transform Scotland. He is a member of the Arctic Strategy Forum & Perth City Development Board and is heavily involved in promoting climate change solutions. He holds two Honorary Fellowships and awards for his services to the environment.

Panel members

Andrew Barbour runs a livestock enterprise with his wife and family in Highland Perthshire. He also has experience in forestry, deer management and aquaculture. He was recently Acting Chair of the Deer Working Group.

Russell Brown farms in partnership with his wife Hilary and their two sons Robbie and Stephen. They farm over 1000 ha of arable land in Fife and Perthshire. Russell has been the Chairman of NFUS potato working group. At present he is the Chairman of the Scottish Potato Co-op, a group of 16 potato growers who have set up the co-op to market 70,000 tonnes of fresh potatoes.

Robert Fleming farms near Glenluce in South-West Scotland. The farming enterprise comprises 240 ha of grassland on the coast, stocked with suckler cows, 500-800 growing cattle, 300 finishing cattle and Roussin sheep. Robert utilises a paddock grazing system, with the focus on home grown forage. He was a former member of the Scottish Cattle Industry Group (SCIG) for QMS, was the host farmer for Agrii's first Forage iFarm and is a 2015 Nuffield Scholar. The title of his Nuffield study was 'Efficiency Gains Through Improved Beef Genetics'.

Sheila George is the Food and Environment Policy Officer at WWF Scotland. With a PhD on disease dynamics of bovine TB, she has worked in the NGO sector on landscape-scale conservation delivery, nature-based solutions, land use and environment policy.

Deborah J. Long is Chief Officer at Scottish Environment LINK, the umbrella organisation for Scotland's environmental charities. LINK aims to conserve, protect and restore wildlife and nature; to enable access to nature and landscapes, and to defend environmental rights. Prior to this, for 14 years she was director of Plantlife in Scotland, a small NGO conserving native plants, fungi and habitats. She also ran a Europe-wide project on sustainable food growing.

Dave Reay is Executive Director at the Edinburgh Centre for Carbon Innovation, Professor of Carbon Management at the University of Edinburgh and Director of Policy at ClimateXChange. Dave has authored over 100 articles and 5 books on climate change and is an advisor for the Scottish Government on rural policy and climate change. His latest project involves managing his farm on the West Coast of Scotland to sequester a lifetime's carbon emissions.

Pete Ritchie is Executive Director of Nourish Scotland, which he co-founded in 2013. He also runs Whitmuir Organics with his wife and is a trustee of the Food Ethics Council. Pete is a first-generation farmer and was previously founder and director of Scottish Human Services.

Geoff Simm is Director of the Global Academy of Agriculture and Food Security at the University of Edinburgh. This is one of five Global Academies that aim to galvanize interdisciplinary teaching, research and translation on key global challenges. Geoff's research is in sustainable farm animal breeding and sustainable agri-food systems. He is a Fellow of the Royal Agricultural Societies and a Fellow of the Royal Society of Biology.

Sarah Skerratt is the Director of Programmes at the Royal Society of Edinburgh. Previously she was Professor of Rural Society and Policy Director of Policy Engagement at Scotland's Rural College (SRUC). For 30+ years, Sarah has researched rural community resilience, empowerment and disempowerment; poverty; leadership; and broadband. She has recently focused on rural mental health, working with the national charity Support in Mind Scotland.

John Smith and his wife Ruth run a herd of pedigree Holsteins rearing replacements and some dairy beef on a predominant grass-based system on the Kintyre peninsula. A past chair of Scottish Association of Young Farmers Clubs he recently spent 7 years on NFUS board of directors chairing the legal and technical committee for 5 years and Milk committee for 2 years.

Steven Thomson is a Senior Agricultural Economist at SRUC with over 25 years of experience in agricultural and rural policy analysis and has been involved in assessing agricultural change, particularly in reference to the Common Agricultural Policy (CAP), for a number of years.

Secretariat

Keesje Avis Senior Policy Officer Nourish Scotland.

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Evidence contributors

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Toby Anstruther, Balcaskie Estate (farm visit)
Vera Eory, SRUC
Yvette de Haas, Wageningen University

Case studies

We interviewed 15 farmers about their approach to tackling climate change on their farms. The interviews are available on the website.

We've taken some quotes from those interviews to illustrate key points in the text.

The panel would like to put on record its appreciation of all those experts from farming, policy, NGO and scientific communities who have shared their insights and knowledge with us. We have all been on a learning journey together, and this report is the better for it.

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EXECUTIVE SUMMARY

Doing the same thing next year as we did last year is no longer an option for farmers in Scotland.

The Scottish Government's commitment to net zero by 2045 requires a cut in on-farm greenhouse gas emissions from a baseline of 7.5MtCO_2e in 2018 to 5.3 MtCO_2e by 2032. This is against the background of no fall in emissions for the last ten years. At the same time, farmers must at least maintain per capita food production, and make a living.

It's not just government policy: retailers and processors are committed to cutting their supply chain emissions while meeting their customers' expectations. Behind them stand the banks and investors which increasingly see the nature and climate emergencies as a major risk.

At the same time, The Scottish Government's Statement of Intent for Biodiversity, published in December 2020, underlines the government intention to take action at large to benefit nature and tackle habitat fragmentation. This is a challenge across all terrestrial and marine habitats, and one that needs to be met within the next 10 years, the UN Decade of Ecosystem Restoration.

So, change is inevitable; and farmers need to be in the driving seat, not at the back of the bus.

This report proposes a pathway to 2032 and then to 2045 which supports farmers to deliver the transition. We suggest targets for each of the three key greenhouse gases:

For carbon dioxide we see some efficiency savings in the next ten years, while we prepare for fully decarbonising farm machinery in the 2030s.

For methane we see a reduction of 25% by 2032 through a combination of better animal health, improved genetics, early adoption of feed additives and better management of manures. By 2045 a reduction of 50% on current levels is possible through low methane breeding and widespread adoption of feed additives.

For nitrous oxide we see a reduction of 25% by 2032 through a combination of more efficient use of bagged nitrogen, manures and slurries, an increase in the use of legumes and the reduction of nitrogen use in the large areas of land being farmed for nature.

Nutrient budgeting, yield mapping, crop monitoring, controlled release fertilisers and variable rate application all contribute to nitrogen use efficiency. Further uptake of these measures result in a cumulative reduction of 50% in nitrous oxide emissions by 2045.

In combination, this means a 55% reduction in emissions by 2045. Our proposals also provide for continuing grassland and arable soil carbon sequestration through best practice management, and significant on-farm sequestration in woodlands and wetlands.

For biodiversity, while Government targets are not yet clear, progress towards the vision of Scotland's Environment Strategy (2020) will require managing more land for nature. The direction of travel indicated in the Government statement on biodiversity that 30% of land should be managed for nature will be significant for farmed landscapes.

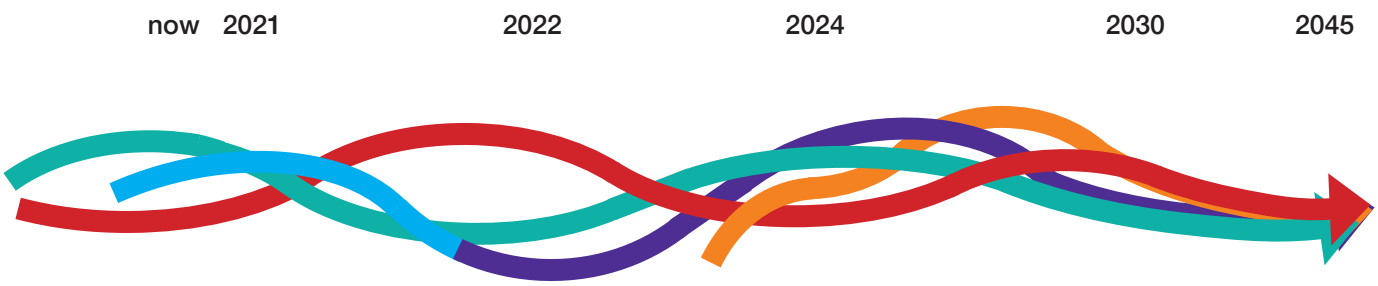
We have not set out detailed proposals or payment rates for a new farm support mechanism. Phases 2 and 3 below are a form of strong conditionality. Phase 2 – universal greening – is about specific practices to reduce emissions, while Phase 3 – greenhouse gas reduction contracts – is a whole farm approach where businesses choose a change plan which is compatible with a low carbon business model for their holding. At a system level these changes are underpinned by national support for nature-friendly farming, agroforestry and land use planning to get the right trees in the right places.

Our interim report recommended the establishment of a Transformation Steering Group. Scottish Government has committed to establishing an Implementation Board, so we have used that terminology in our recommendations.

The panel agreed a number of principles:

- Nature and climate must be tackled together.
- Everyone has to do something, and there has to be something in it for everyone.
- We need to reduce total emissions from agriculture while maintaining food production per capita, not just reduce the intensity of emissions.
- A high-level, transparent, science-informed climate and nature literate transformation group should be established to co-ordinate activities and policies, drawing from expertise across several fields of expertise in a similar way to the Farming 1.5C enquiry panel.
- Speeding up best practice adoption and innovation requires an informed, explicit, co-ordinated and responsive approach; it won't happen by itself. The advisory service is key, and needs to be rebooted and aligned to the goal.
- There should be targets for individual gases.
- Land use change should be planned rather than left to the market; and should be an inclusive transparent process guided by best available science.

The panel proposes five overlapping phases which all need to start now:



Phase 1: Underpinning actions

Phase 2: A farmer's mitigation menu

Phase 3: System change to low emission production

Phase 4: Whole farm system change

Phase 5: Land use change

Approach	Examples	Timeline
Phase 1: Underpinning actions	Theory of change Improved baseline data New contract for advisory services Plan for better data capture and use Develop universal calculator Stronger links to research	Immediate start, updated baseline in place by end 2022
Phase 2: A farmer's mitigation menu	Nutrient budgeting and use of controlled release fertilisers Slurry injection Legumes/ intercropping Manure management Livestock health Feed management Genetic improvement of ruminants	To be part of Universal Greening requirements from 2022
Phase 3: System change to low emission production	Choice of approaches 'precision' or 'nature value' - to ensure all sectors and farm types can contribute through a low carbon pathway.	Pilot projects start as soon as possible to inform design. Contracts to be required as part of post 2024 policy
Phase 4: Whole farm system change	Increase diverse approaches to support biodiversity and multifunctional landscapes Agroforestry Organics, agroecology, regenerative farming	Pilot projects start now under both agricultural and forestry schemes to inform post 2024 agricultural and future forestry policy
Phase 5: Land use change	Right trees in right places – planned approach to land use change, encourage integration of farming and forestry Restoring peatlands and wetlands	Implement public interest test now to control investor-led afforestation In 2022 revisit forestry strategy to develop science-based approach to land use planning

List of recommendations

1 The Implementation Board's approach must be grounded in an explicit theory of change, which they refine and develop over time.

2 The Board should institute a scheme for continuing professional development for farmers. The new contract for advisory services should involve a re-focusing of the service on working with farmers to tackle the climate and nature emergencies; and an emphasis on reaching the full diversity of farmers through flexible and inclusive 'one to few' approaches. This enhancement of CPD and refocussing of advisory services should be reflected in formal training provision for new entrants too.

3 The Board should ask SEFARI and RPID to work with existing generic initiatives such as the Digital Transformation Service and the Data Lab, relevant AgtriTech Innovation Centres and Region and City Deals, and agree a plan for improving the use of data at farm, region and national level to support and monitor the sector's transition to low-carbon farming.

4 As part of the Green Recovery[1] priorities under "boosting youth employment opportunities in nature and land-based jobs", Scottish Government should fund a programme of training and employing young people to undertake soil carbon testing and mapping of on-farm natural capital.

5 The Board should invite costed proposals from existing providers for developing a 'universal' farm-level calculator with greater functionality. The data from the universal calculator would be in the public domain, and there would be an independent board including farmers and scientists to oversee further development. This recommendation should be integrated with Recommendation 3.

6 The Board should establish a farmers' advisory panel to act as a reference group for the Strategic Research Programme. Scottish Government should continue to invest in the Rural Innovation Support Scheme.

7 Scottish Government should introduce the mitigation menu as soon as possible, to replace the existing greening scheme with the expectation that all farms sign up to the baseline requirements and a number of options.

8 From 2024, Scottish Government should introduce emissions reduction contracts across all farm types underpinned by a management plan that fits their system and its future development, with a limited number of management interventions.

9 Scottish Government, farmers and research institutes should work together to accelerate advances in ruminant livestock selection and breeding; include reducing methane emissions in breeding goals, and encourage uptake of best practice.

10 Scottish Government should set a target of 6,000 hectares a year for agroforestry creation, and create a ring-fenced budget for agroforestry with a dedicated 10-year programme to drive it.

11 There should be a public interest test applied if more than 50% of a holding is planned to be afforested.

12 Forestry applications over 20 hectares should be required to specify the net carbon sequestration they will achieve over the next 50/100 years, and demonstrate biodiversity net gain.

13 Land use change should as far as possible be planned to optimise economic environmental and social outcomes rather than be purely market-driven.

14 Regional land use planning groups should be supported by large-scale modelling as described in the Research Strategy for Environment, Natural Resources and Agriculture so they can make informed decisions and recommendations.

15 The carbon in Scotland's soils should not be traded until further notice.

The transformation requires unparalleled investment, led by government and supported by the whole supply chain; in advice, in research, development, innovation and translation to practice, in kit and in data – but most of all in people.

Some farmers in Scotland are already delivering on best practice and experimenting in these new areas. What will make our net zero and biodiversity targets achievable is leaving no-one behind – making it easier for everyone to adopt best practice and for more farmers to innovate. This is a social and cultural challenge as well as a technical one.

Tackling the nature and climate emergencies is not just about farming better. It's about redefining the role of farmers, with delivering for nature and climate on an equal footing with producing food. Stewardship has to be seen as a core professional and business value.

1 SETTING THE CONTEXT

The challenge

Scotland is committed to producing net zero greenhouse gas emissions by 2045 – less than a generation in the life of a family farm.

At that point Scotland must be offsetting any residual emissions in the economy by locking up additional carbon every year – whether in trees, in soil, in the sea, or using any of the emerging technologies.

Scottish agriculture has a high carbon footprint because of its focus on livestock production – which in turn is because most of its land is not suitable for growing crops commercially. While most of the lamb and much of the beef we produce is exported rather than consumed here, the inventory and therefore our national targets are based on production rather than consumption.

The current emissions from Scottish agriculture are around 7.5Mt of CO_2 equivalent per year – around 20% of the Scottish total. For illustration – to offset these emissions would take around 1.25m hectares of established Sitka spruce on typical land – slightly more than the whole of the Scottish Borders plus Dumfries and Galloway.

The more agricultural emissions can be reduced, the more options we have for offsetting residual emissions, both from agriculture and from the wider Scottish economy.

At the same time, Scotland's biodiversity, including in our farmed landscapes is in continuing decline (State of Nature Scotland 2019 report). Scotland has significant potential for High Nature Value Farming, which tends to be concentrated in upland and marginal farming, often the least economically viable areas in an agricultural sense but some of our most environmentally rich regions. While these places and communities face some of the greatest economic constraints in earning a viable living from the land, there is both an environmental and socio-economic rationale for supporting some of these areas to continue delivering environmental public goods and sustaining vibrant rural communities.

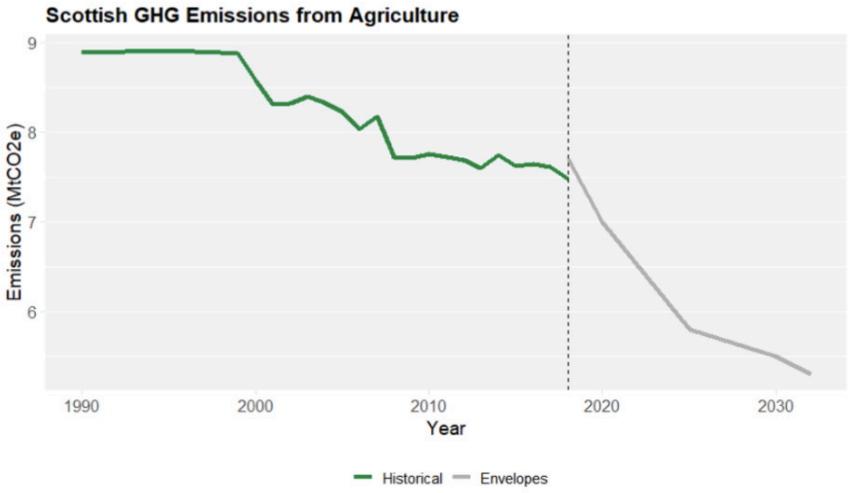
The other constraint is to maintain overall food production – though the balance of what we produce may change in response to policies and markets, for example producing more cereals, legumes, fruit and vegetables for human consumption.

We have not looked in this report at dietary change. Reducing meat consumption in high-consuming countries makes meeting the 1.5 degree global target much more achievable, as well as having benefits for restoring nature.

However, we focus in this report on reducing emissions from the current level of production as this is more within the control of Scotland's agricultural sector.

Scotland is well-placed to use its grass – along with by-products from food and drink processing - to produce milk and meat from cows and sheep. This is a 'low opportunity cost livestock' approach.[2] However, we can and must cut emissions from all our production systems.

The current Scottish Government climate change plan tasks agriculture with reducing emissions to 5.3Mt CO_2e by 2032, with much of that reduction coming in the first five years. We suggest that larger reductions would come in the second five years as adoption of new approaches starts to impact on emissions. Further work is needed both to refine the national inventory for agricultural emissions and to improve bottom-up estimates with farm level greenhouse gas calculators.



While this is still a lower percentage cut than required of some other sectors, it represents a complete departure from the static picture of the last 10 years, and remains a challenging task. The proposals in this report are designed to deliver that reduction.

Just as importantly, the sector must be geared up by 2032 for further reductions in emissions in the following decade. The research, development, innovation and capacity-building to make this next step change achievable must begin now.

Sources and sinks of greenhouse gases from agriculture

The current greenhouse gas emissions from Scottish agriculture are estimated at 7.5 Mt CO_2-equivalent[3] which are balanced between methane (4.2 Mt), nitrous oxide (2.2Mt) and carbon dioxide (1.1Mt)

Most methane emissions come from the digestive systems of cows, sheep and deer; and most nitrous oxide emissions from the interaction between reactive nitrogen and soil. Some nitrous oxide emissions and methane come from the way we store and handle animal manure and slurry.

There are emerging opportunities to reduce methane emissions from sheep and especially cattle. (Controlling deer populations will also help.)

After forty years of experimentation, feed additives which inhibit methane production in the rumen are coming on stream, with the potential of reducing emissions by 30% or more – although initially uptake will be mainly in the dairy sector where the feed additives are easier to deliver at the right dose.

At the same time, advances in genomics are making it possible to identify and breed from cattle and sheep which are naturally low methane producers. If researched and developed further, and taken up widely as part of a national or co-ordinated international breeding programme, this

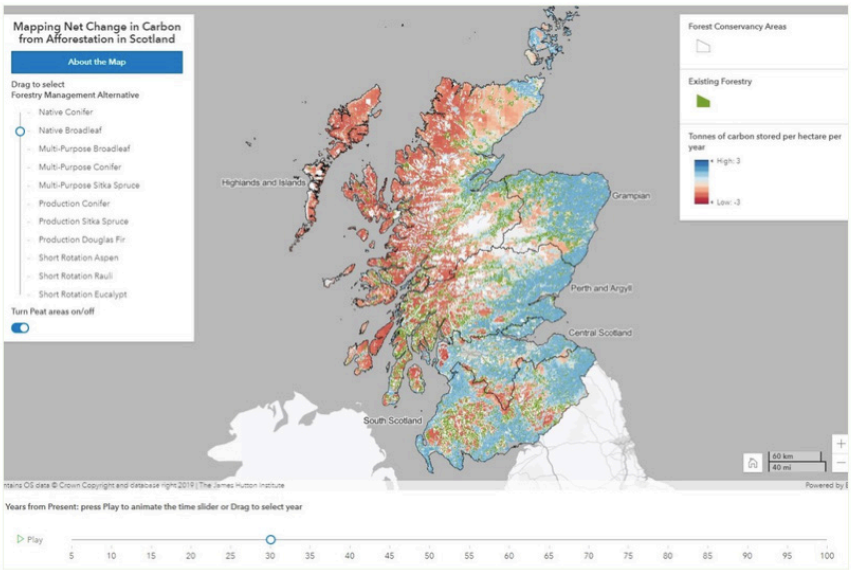
technology could reduce methane emissions by a further 30% or more over the next 10-20 years. Scotland is well placed through its research base and experience in genetic evaluation to take a lead on this development.

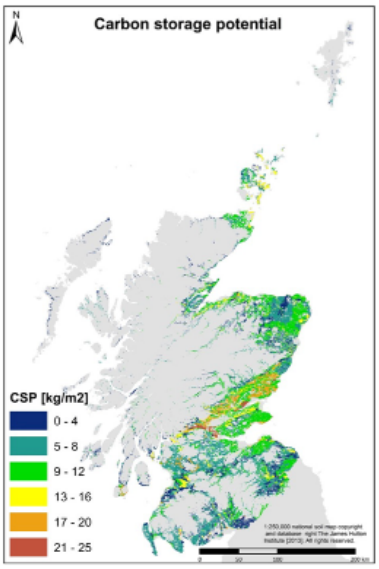
There is a big opportunity to recycle nitrogen more effectively on farm and to rely more on biological nitrogen fixation through legumes. 55% of manufactured nitrogen in Scotland is used on grassland. Only half of the nitrogen applied to crops and grassland in Scotland ends up in the crop, with the rest leaching into the water or escaping into the atmosphere.

Most CO_2 emissions in agriculture come from mobile machinery, where there are significant opportunities for reducing fuel use and decarbonising farm machinery as well as heating, cooling, drying and lighting systems.

In the short term, reducing tillage saves both diesel and wear and tear on machinery, and is likely to benefit most soils.

At the same time, more carbon can be locked up on farms, below ground in soils and above ground in trees, hedges and scrub.





Map (above) reproduced from https://woodlandexpansion.hutton.ac.uk which provides interactive maps showing the carbon sequestration potential of planting different species on different soils across Scotland. In this scenario of planting native broad leaf trees the blue areas show positive sequestration potential while on the red areas planting trees would result in a net loss of carbon. So getting the right tree in the right place is essential.

The map[4] (above right) shows the significant potential for locking up soil carbon in arable and grassland soils. While improvements in soil carbon stocks are possible they take a long time.

Our overall approach

In this report we set out ambitious but achievable ways to reduce emissions by 24% in the period from now to 2032. The goal is to reduce emissions by producing the same output per capita with fewer emissions, not to produce more with the same emissions.

We do not consider in detail ways to increase biodiversity in the farmed landscape but recognise this remains an urgent challenge for Scottish land managers and society as a whole to tackle.

After 2032, a combination of further uptake of measures along with adoption of innovations which are currently at an early stage can reduce emissions much further. By its nature, agriculture will always create some biogenic emissions: but it is possible to cut them sharply from current levels while at the same time increasing on-farm carbon sequestration, on-farm biodiversity and maintaining production.

Many of the practice changes needed to reduce emissions are well-known: better management of fertilisers, manures and grassland; improved animal health and reproduction, better genetics; feed additives that reduce methane emissions; intercropping, cover crops, legumes and reduced tillage; reducing energy use and generating energy on farm; agroforestry and organic systems.

Our recommendations in general align with many of the recent farmer-led group reports, specifically:

Maintain, rather than increase production.

Climate and nature must go together.

Leave no-one behind.

Reform the advisory service and introduce CPD.

Develop a single farm-level GHG calculator with greater functionality.

Improve soil carbon baseline information.

Support agroforestry and on-farm sequestration.

Increase uptake of mitigation measures.

Low methane breeding.

New technologies (esp post 2032).

In one specific area (trading of soil carbon credits), we side more with the Highland Upland and Crofting Group in recommending caution rather than the enthusiastic approach of the Arable Climate Change Group.

For more detail on how the recommendations align, see Appendix 1.

In terms of the 'Efficiency-Substitution-Redesign' framework[5] farmers can make significant progress by improving efficiency within current farm business models and by substitution – for example of slurry injection for splash plates, biological nitrogen fixation for bagged fertiliser, optimizing suckler cow size, and so on. In the medium term, the challenge is to redesign farming as a circular rather than a linear process, optimising rather than maximising yields while restoring natural capital.

In chapter 4, we provide more details on some of the specific mitigation measures which can be adopted, and more will emerge as a result of research and technical developments. However, there are two key messages which run through this report:

First, it is possible to reduce emissions from agriculture significantly and restore biodiversity while maintaining production.

Second, this will not happen if we keep using the same approaches as we have used in the past. A step change is needed in the way we use knowledge, funding and leadership. The depth and pace of change will require a team approach – not just all farmers but also suppliers, customers, investors, advisors, civil society, researchers and policymakers. For farmers in particular it means rethinking what being a farmer means – moving climate and nature from being on the sidelines of business decisions for many to being part of the core business purpose.

"It (regenerative farming) really changed my way of thinking about the whole thing and it is not only cost saving. Which is originally what I why I went down this road. It ticks so many other boxes, eco-service benefits of improving soil health. Whether it be clean water or carbon sequestration or biodiversity and so on, it does tick all the boxes and that's what's so beautiful about the whole thing. I don't know if I really like the word regenerative, but it's taken off" Doug Christie

"We cannot solve our problems with the same thinking we used when we created them" Albert Einstein

Photo by Amber Kipp on Unsplash

2 KEY PRINCIPLES AGREED BY THE PANEL

Nature and climate must be tackled together

Climate change is simply the most visible and high profile consequence of our broader assault on natural systems over the last 250 years. In addition, the profound loss of natural capital has reduced the planet's capacity to regulate and regenerate.

Agriculture is a biological process. Emissions of methane, nitrous oxide, soil carbon are primarily caused by the activities of micro-organisms too small to see. The health of plants – like our health – is regulated by an invisible microbiome.

> "We do not see the bacterial mass residing beneath our feet, without which life as we know it would not exist. The activities they are engaged in are undertaken in silence to the human ear. These three features of Nature – mobility, invisibility and silence – are of profound significance to the economics of biodiversity" Dasgupta Review

Our efforts to tackle climate change in agriculture must be rooted in a broader effort to respect, work with and restore nature. The State of Nature Scotland (2019) report showed that agricultural productivity, linked to the intensification of land management is increasing and mirrored by the decline in farmland nature, although some farmers have adopted wildlife friendly farming techniques.

We can make some progress in reducing emissions by greater efficiency within the current model: but moving agriculture to being part of the solution rather than part of the problem for both nature and climate means moving to a 'regenerative' mindset. In this mindset, the role of farmers is not just to produce food, but to enhance the diversity and resilience of the natural world on which we all depend.

> "Fully aware of the damage done by fertilisers to habitats, particularly the enrichment of freshwaters. Seeing that problem right in front of me in the loch here made me look more into the issues surrounding nitrogen and phosphorus. There was enough information around to show that a more extensive system could be run without the damaging effect of nitrogen in particular. The more intensive model in place here at the time had real health and welfare issues, with pollution as just one of the consequences. It was obvious to me that redesigning the system was essential in order to stay in business - to keep both our stock and environment healthy" Andrew Barbour

Everyone has to do something, and there has to be something in it for everyone. Tenant farmers specifically need to be included in a just transition. We received evidence (see Appendix 2) from the Scottish Tenant Farmers Association detailing the many challenges faced by tenant farmers seeking to make the long-term changes and investments needed to reduce emissions and restore nature.

We recognised also that reducing emissions is only one part of the picture for farmers. They also need to be able to sell their produce, and lack of processing capacity for example in the dairy sector makes this a challenge. The sectoral farmer-led groups also made this point that low carbon business models are dependent on low carbon supply chains and markets.

We need to reduce total emissions from agriculture while maintaining food production per capita, not just reduce the intensity of emissions. We must produce at least the same national output per capita in terms of protein, calories and micronutrients for people while reducing the negative impact of that production. Panel members felt strongly that in the context of a still-growing global population that Scotland should at least maintain its modest contribution to the global food supply. We should not reduce our own emissions by 'offshoring' them and increasing food or feed imports from other countries where in some cases the environmental impact of production would be higher.

Higher uptake of some of the efficiency measures recommended in this and other reports (e.g. higher calving rate, shorter calving intervals, earlier age at first calf) will increase overall production and emissions if the number of breeding cows remains the same. Instead, output can be maintained from a smaller number of breeding animals and this has been a trend for many years in the pig and dairy industry. Smaller suckler cows produce fewer greenhouse gas emissions but can achieve similar outputs in terms of beef production.

> "If I can grow more from my better land, then I can then sideline some of my poorer land to do something else, whether that's for rewilding, or whether like my five-year old said this morning 'Wouldn't it be nice to have a nice pond with some trees round about it?" Robert Fleming

A high-level, transparent, science-informed transformation group should be established to co-ordinate activities and policies. This was a recommendation of our interim report and we were pleased to see the announcement by Scottish Government of an 'Implementation Board' to be set up in the near future. We encourage the Government to ensure the membership has diverse expertise and backgrounds. The Board will also need an ongoing process of engagement and consultation with wider stakeholders - including the food and feed supply chain – and a continuing input of research and information from SEFARI and others.

Speeding up best practice adoption and innovation requires an informed, explicit, co-ordinated and responsive approach; it won't happen by itself. The advisory service is key, and needs to be rebooted and aligned to the goal. The speed at which farmers adopt new climate and nature friendly practices is key to achieving the emissions reduction goal. DEFRA's Farm Practices Survey show how patchy that adoption has been over the last few years, though some recent evidence suggests that a change of mindset may be gathering pace.

The demands of retailers and processors will be a significant influence on farmer practices. However, the transition to new practices will be a challenge to many – in terms of new skills, new day to day routines, new hardware and software. Just as importantly, change means loss – of ease, of habit, of competence, of security, even of identity. The emotional work of change for a small business, especially one rooted in generations of doing things a certain way, should not be underestimated.

Advisors – along with the 'one to few' groups we describe in this report – have a key role in accompanying farmers through these changes, providing support and encouragement as well as information.

There should be targets for individual gases, including an immediate cap on biogenic methane and a target to reduce this by 50% by 2045. The current targets expressed in CO_2 equivalents are unhelpful when it comes to targeting on farm actions. While some actions (improved manure management for example) can reduce both methane and nitrous oxide emissions, more actions have a specific impact on one of the three key gases. Separating out targets and actions both at farm and national level creates a clearer roadmap.

The panel had an evidence session with John Lynch specifically on the global warming potential of methane, and the different views on how this should be measured.[6] The GWP* metric is designed to reflect the fact that methane cycles relatively quickly in the atmosphere and so should be treated differently from CO_2 and N_2O which persist for centuries in the atmosphere.

Steady methane emissions therefore do not lead to additional global warming, though any existing methane emissions still of course contribute to already-elevated global temperatures and so must be addressed as part of climate action in Scotland and worldwide.

The panel sees the logic of the argument for using GWP* rather than GWP^{100} - particularly in the way GWP* accounts for the impact of a decline in methane production (as envisaged in our transformation pathway). Using GWP^{100} accounting results in an underestimate of the benefits of reducing methane emissions.

We think GWP*provides a fairer account of the contribution of methane to global warming, and would be keen to see the Marginal Abatement Cost Curves recalculated using this metric. The next Climate Change Plan update should also use GWP* in its modelling of emissions pathways.

Far from giving a free pass, this provides a strong argument for reducing methane emissions, which could contribute to an immediate slowing of warming and significant air quality benefits too, and should therefore be prioritised. Ongoing methane emissions carry a significant opportunity cost and the higher methane emissions are, the more pressure there is to eliminate all other greenhouse gases entirely.

Given that global methane emissions are on the rise again after a period of stability, efforts should be pursued to reduce emissions from all major sources, including fossil fuel extraction, gas leaks, and ruminant livestock production.[7]

Two innovations – effective feed additives and low methane breeding strategies – offer to break the link between methane emissions and current levels of production of meat and milk from ruminants.

There is a future for sustainable high welfare, low opportunity cost ruminant livestock systems using grass and by products to produce human edible protein. However, this is an argument for maintaining, not increasing, national production – and for doing so while enhancing biodiversity and soil carbon sequestration.

Land use change should be planned rather than left to the market; and should be an inclusive transparent process guided by best available science. The combination of carbon markets, generous planting grants, favourable tax treatment and predictable returns are making commercial forestry a highly attractive investment proposition in Scotland. We are seeing whole farms taken out of production to be converted to plantations. By area, 60% of current forestry grant applications in one Conservancy are from external investors rather than farmers.[8]

While increasing woodland cover in Scotland is desirable and necessary, the Panel remains concerned that the current focus on achieving planting targets through a developer-led approach is likely to produce less than optimal land use outcomes in terms of biodiversity, new entrant opportunities and rural communities.

We welcome the development of the Rural Land Use Partnerships as we see this as the best mechanism for building consensus on how to balance public benefits with private gain in the way we use our land. We recommend that those Partnerships have access to high quality data and modelling tools to underpin their work.

However, while these Partnerships are finding their feet, we should ensure that the expansion of commercial forestry is consistent both with the Scottish Government's biodiversity statement of intent and with the principles of Just Transition.

3. THE TRANSFORMATION PATHWAY

Phase 1: Underpinning actions

Approach	Examples	Timeline
Phase 1: Underpinning actions	Theory of change Improved baseline data New contract for advisory services Plan for better data capture and use Develop universal calculator Stronger links to research	Immediate start, updated baseline in place by end 2022

Theory of change

The scale of the task at hand demands an ambitious team approach across the industry and across government.

Engendering wide-reaching change is not simple, nor should it rely on common sense. We must think as much about how to make change, as about what needs to change.

We know that the first 25-30% of emissions reduction can come from improved efficiency – delivering the same output in terms of crops, milk and meat from fewer animals with fewer inputs.

For example, as shown by Thomson et al[9] (using Beef Efficiency Scheme data and Agrecalc) adopting best practice in a suckler herd reduces emissions by a third compared to the current Scottish average.

Over 80%[10] of Scotland's terrestrial area is under some form of agriculture, which therefore has the potential to significantly impact on biodiversity across large swathes of the country. While attribution of the causes of biodiversity loss is very difficult, there is no doubt that in recent decades agricultural practices have had the biggest single impact upon nature.[11] This is having a long term negative impact on Scotland's environment and has the potential to damage agricultural yields.

However, many farmers [54% from DEFRA survey[12]] do not believe that tackling climate change will improve business profitability. There is still a widespread belief that being 'green' takes you into the red and has to wait for better times. This mindset has to change for the sector as a whole to move forward.

> "We're sitting waiting to see what the policymakers are going to do. Most people are not going to move on if it's going to cost them money to reduce their carbon output. I think there's a lot of people in the same situation as us, sitting, waiting to see what the direction should be" Russell Brown

There is a huge range of efficiency across all sectors, especially beef and sheep. While recognising that the larger businesses produce the bulk of the output, are responsible for the bulk of the emissions, and in many ways have more capacity for change, the panel recommends an inclusive approach, engaging producers of all sizes.

Changing practices requires producers to be 'allowed, willing and able'. 'Allowed' may include support from a landlord or other family members to do something new. 'Willing' may be to do with seeing the financial benefits: but it is often as much to do with reputation, tradition, confidence, risk of failure, and heart. 'Able' is about skills and knowledge, but it is also about availability of labour; physical and mental health, kit and cash flow.

> "So there's a farmer, there's a farmer's son and there's a farmer's father. And you're never quite sure who's still controlling the business. ..and it is not an uncommon situation where the grandson is not in tune with the granddad" Derek Robeson

An approach which sets out to 'leave no-one behind' is more likely to retain a diverse structure of farm businesses, including part-time farmers. It also requires a smarter and more responsive approach to advice and support. The top performers will keep improving anyway, and will pay for advice when needed. The challenge is to move the whole industry forward: while keeping the focus on reducing total emissions not just emissions intensity.

For some producers the most profitable strategy is to reduce both stocking and inputs and our proposals include this pathway (see Phase 3).

Farmers are not homogeneous and make decisions for many different reasons. We know from decades of research on adoption of innovation that - unsurprisingly - early adopters are likely to be younger, with more formal education and more connections off the farm.

We also know that there is a lag between people hearing about an innovation and giving it a go – and that while people hear about innovations through the media, or a sales representative or a government advisor, their decision to try it out most often comes because of a neighbour or peer.

> "So talking to people who've done it was really invaluable. Likewise with friends and colleagues who've tried to navigate things like the forestry grants scheme, the various woodland carbon code, … My main bit of advice is use that vast experience we've got in Scotland. And the easy way into that is pay your NFUS subscription and they will put you in touch with people who have done it" Dave Reay

> "...make time to go and see other people's farms. And almost everybody will say yes, if you ring them up, can I come round to spend a few hours walking around with you? And it's just really useful to do that...whenever we have gone out and have a look at what other people are doing, that's been really helpful" Toby Anstruther

In a panel evidence session Dr Amanda Lucas described the assumption of policymakers that "as long as it saves money and you provide support, farmers will take it up". This is based on the belief that humans make decisions individually, are self-interested and are rational. However, humans are social learners – we like to conform, we are more other-centred than self-centred and our decision making is constrained rather than rational.[13]

> "I've probably gone against the consensus, more traditional ways of doing things a bit, and it's been quite hard actually questioning or continuously trying to go my own way with people shaking their heads or saying 'it's not going to work" Doug Christie

Opinion formers can be more effective in influencing uptake in others if they are provided with guidance and are working as part of a broader change strategy.[14] Many of these 'influencers' will not be in traditional industry leadership roles but will be well-networked, including through social media.

The creation of 'Climate Change Champions' and sophisticated demonstration sites can create barriers for many in the farming community if they feel they cannot identify with the production approach or the level of investment required. The requirement for whole system change needs to go beyond talking to the already converted. For this to succeed we need to 'protect' the innovators, underwriting or guaranteeing losses in order to allow them the freedom to experiment and iron out new practices, and invest in promoting them and the actions that are effective.

> "And it's about community, isn't it? You can't change stuff on your own, you need community behind you. And peer support is really, really important in that" Nikki Yoxall

There must also be channels for knowledge to go in to policy makers and scientists, rather than just out to farmers. Providing evidence to the Farming for 1.5°C Panel Dr Dominic Duckett wrote "for change to occur knowledge is best co-constructed rather than communicated…. knowledge reform ought not to be a top down process. Institutions usually think they should target farmers while farmers think they should target institutions, especially government."[15]

We recognise that the supply chain will have a powerful role in driving practice change, as evidenced by the recent requirement from milk processors for dairy farmers to change their management of bull calves.

Government regulation also has an important role in accelerating change. We recommend for example that Scottish Government follow the Northern Ireland Government in regulating application methods for slurry (see Phase 2).

Recommendation 1

Our approach must be grounded in an explicit theory of change which we refine and develop over time

Advisory services

The transformation needed is knowledge-intensive. Taking a whole-life approach, the training of new and future farmers must overtly align with the requirements of the net zero transition, while ensuring long-term resilience of food production in Scotland, and helping to meet national biodiversity goals. Educational provision for new farmers right across Scotland needs to enable them to implement innovations in technology and practice, as well as maximise the benefits of emerging markets for low carbon produce and to understand emerging requirements for net zero-aligned auditing, reporting and decision-making.

Universal and consistent learning for all farmers, old and new, is fundamental in helping the develop an understanding of climate change and its solutions (e.g. the Climate Solutions course developed by RSGS). Formal education providers for new farmers in Scotland must therefore embed such green skills and knowledge into their provision, dynamically enhancing learning to align with the fast-changing nature of rural land use and financial support systems, and highlighting the positive green career pathways available in Scottish agriculture.

Farming is one of the few professions where there is no formal requirement for continuing professional development, yet existing farmers represent a crucial community through which climate and nature goals can be achieved, and where the technologies and practices required to deliver on these goals are often new and emerging. CPD for farmers must be relevant, accessible, flexible, and timely.

Farmers in receipt of public support should be expected to undertake a proportionate level of CPD. Such capacity building can be supported by formal education pathways, such as college and university modular courses, as well as via industry and government-led provision. Ideally it would combine these, to ensure timely and context-appropriate knowledge and capacity building that aligns with changing rural support systems, technical and practical innovations, and a consistently high standard of delivery.

This learning should in turn be supplemented by an effective advisory service. The current advisory service is not adequate to the task of supporting the industry transformation needed and must be redesigned and resourced commensurately.

Its purpose should be clearly and visibly re-focused on helping the sector tackle the climate and nature emergencies, and its success should be judged not on its outputs but on the outcomes in terms of reduced emissions, increased resilience, and enhanced biodiversity.

Additional training and CPD for advisors will therefore be needed that overtly aligns with the net zero transition for the agriculture and land use sectors in Scotland. In particular, this training and CPD needs to build the capacity of advisors to support farmers in meeting emerging climate and nature conditionalities on support, and to guide them in the use, reporting and decision making that arises from carbon auditing and low carbon farming tools.

> "...farming, forestry, conservation is fundamentally linked, but if you want woodland advice, you tend to go to a forester who doesn't know that much about farming, probably, or conservation. You want agriculture advice you go to an agriculture advisor. How do you get someone that oversees that whole picture?" Derek Robeson

The publicly-funded advisory service is not agnostic; advisors must be policy-proficient advocates and be prepared to challenge farmers who argue that nothing more can or needs to be done to tackle climate change or nature decline.

Their close integration with Regional Land Use Partnerships (RLUPs) would be a key element of this advocate role, both in terms of giving voice to the needs of farmers in a particular region, and in providing consistent advice and support within that region that reflects national priorities and allows sustained integration with other land users, local government and public bodies.

Serving everyone means using a diversity of approaches, including for example ways to address the needs of women farmers, part-time farmers, crofters, organic farmers, market gardeners and so on.

As the primary customers, farmers should be involved in shaping and reviewing the service on a periodic basis, perhaps through a governance group or evaluation events and not simply through questionnaires and feedback forms.

SEFARI and the advisory service should work closely together so that advisors and through them farmers have digestible access to current research findings; and so advisors and farmers can also suggest, shape and participate in new research activity.

> "There are guys like xx at SRUC who has an in depth inspirational knowledge over a wide range of issues .. however the experience of farm systems on the ground isn't strong; although they have the solutions for the big challenges like managing soil carbon, or reducing methane emissions within their grasp, translating it into action on farm is slow. There is a link needed to make implementation on the ground possible. There has to be a sort of two way learning, where he supports people learning and they enjoy learning the ideas that they think might push the boundaries, because in the end it's going to be farmer's ingenuity and investment and hard work, which actually makes things change and every farm will be different and every person will be different" Nigel Miller

A significant part of the delivery budget should be used for 'one to few' learning groups which run over a period of years to allow trust to be built, success to be shared and mistakes to be learned from in a safe environment.

All farmers should be expected and encouraged to join at least one group. Membership of such a group would form part of the farmer's CPD.

Skilled facilitation is essential for these groups; the facilitator does not need to know more than all the participants but does need to be able to create a culture of shared learning and mutual support. Facilitators can invite topic specialists in as needed.

While some facilitators may be staff members of the advisory service, the facilitator team could also include farmers, vets, staff from rural payments, feed merchants and others.

> "I still don't understand soil science, but I've got really good advisers that back me up and the results are out in the field for everyone to see. That's what I could show a farmer, I could talk to a farmer what we've got from where we started, and it's just the steps in between" Robert Fleming

These part-discussion, part-change support groups, would act as a bridge to expert advice, to new ideas and to pilot projects which inform the group members and the wider network. Whether topic-based or place-based, these groups should be inclusive and meet and communicate in ways which ensure part-time or one-person enterprises are not excluded. The groups may have a social aspect, which will support trusting relationships and the easier exchange of knowledge.[16]

Irish research has shown that "dairy farmers with agricultural education or who participate in farmer discussion groups are more likely to adopt the mitigation practice of extended grazing" highlighting the "urgent requirement for a stronger link between research and knowledge transfer to encourage practice change and the adoption of mitigation measures."[17]

> "We were involved with the 'Planning to Succeed', and that was a great group, and our group is still running. It allowed 15 farmers to get together that had all the same integrity and honesty – they were willing to share things, share secrets about the business and be honest with one another - that's a great thing. Getting out of your comfort zone as well is a tremendous thing" Jim Shanks

The Panel recommends that the group practices should avoid the creation of centres of excellence or activity hubs within the group, instead focusing on a community model that works with and for all within the community.

The inspiration for this type of knowledge transfer and support network comes from a RISS funded farmer group on Arran, supported by a SAC consultant. Their collaborative rather than competitive approach is expanding on data and processes from the Beef Efficiency Scheme and the Farming for a Better Climate Initiative, with the ambition to involve other local wider actors in the community such as Taste of Arran and Arran Eco Savvy. They are also looking at the link between farm businesses, processors and retailers.

Recommendation 2

A scheme for continuing professional development for farmers should be instituted**.** The new contract for advisory services should involve a re-focusing of the service on working with farmers to tackle the climate and nature emergencies; and an emphasis on reaching the full diversity of farmers through flexible and inclusive 'one to few' approaches. This enhancement of CPD and refocusing of advisory services should be reflected in formal training provision for new entrants too.

Investing in better data

Throughout our evidence sessions, there was a repeated request for better data collection and better management and use of current data, both at farm level and at system/national level.

The Committee on Climate Change found "driving effective use of data including developing Key Performance Indicators enabling better measurement of performance across the sector" as a key driver of productivity.[18] Equally the Agricultural Productivity Working Group[19] identified "Harnessing the power of data and inspiring farming businesses to measure performance" as their number one recommendation to overcoming low productivity.

Although data is essential to improvement and profitability at farm level, farmers vary hugely in what they capture and use. While some can tell you each cow's lifetime production, calving interval, feed and medicines intake at the press of a button, others rely more on memory and judgement when taking decisions about culling and breeding.

Data on biodiversity and the natural environment is harder to gather and aggregate – yet if we want to measure progress we need ways to measure this on farm and at landscape level.

People only seek, create and use data which helps them achieve their goals. For some farmers this is seen more in terms of compliance – what do I have to record and submit – and is not seen as a support to decision-making, to making or saving money, to a better quality of life, or to being seen as a good farmer and team member.

> "Three years ago I started recording fuel use for every operation I did, and I found out that I was spending more money per hectare on an extensive, mainly permanent grass system on my cattle. I was using more fuel for my livestock side than I was my cereals, which is not taking account of the drying costs, so I thought something's wrong here and that's why I've gone down a sort of mob grazing or whatever you like to call it to try to keep the cattle outside all year round. For example, first two years, I was using 60 litres a hectare of fuel associated with the cattle. Now I'm at 45, but there's a long way to go. I reckon I could reduce that to 10 or 15 without any problem, but it takes time getting these grasses more adapted to grazing throughout the winter with long rest periods and short duration grazing periods. Another wake up call was seeing I was using more fuel for drying the crops (generator and burner fuel usage) than I was for growing the crop (stubble to stubble)" Doug Christie

Feedback is an important element in motivation, and is currently lacking for farmers who submit data. Whether we do fitness training, send bulk emails, use twitter or have a smart meter we have become used to seeing at a glance how well we are doing – compared to last month, or to the industry average. For example, getting feedback from BCMS on age at first calving, calving index, days to slaughter or carcase quality and how that's changing over time could motivate farmers to become more interested in their own performance. SAOS are currently developing some of these capabilities in their pilot work to change the database provider from BCMS to ScotEID.

Sensors, accelerometers, GPS and connectivity have hugely increased the availability and accessibility of data in recent years. Research institutes, government departments and NDPBs also maintain a range of datasets. However, to monitor progress on tackling the climate and

nature emergencies – and to inform the next iteration of the national greenhouse gas inventory – we need to make better use of the data we have and also gather new data.[20]

The Beef Efficiency Scheme is a valuable contribution to creating a sense of a 'national herd' and provides useful experience to build on.

> "There are multiple businesses on the island that were participants in the beef efficiency scheme and they will have done multiple carbon audits and they all been able to track their improvement over the years. …When you have cumulative audits, you can look and see, oh, well, that's the year I did that. And that's the impact that it had. There's that built in a kind of knowledge exchange with yourself and that's really good" Alex Pirie

Developing an overall data strategy is beyond the remit and expertise of the panel,. We make some recommendations below on farm-level footprinting and on gathering baseline data.

Recommendation 3

The transformation steering group should ask SEFARI and RPID to work with existing generic initiatives such as the Digital Transformation Service and the Data Lab , relevant AgtriTech Innovation Centres and Region and City Deals, and agree a plan for improving the use of data at farm, region and national level to support and monitor the sector's transition to low-carbon and nature-positive farming.

This must specifically include genomic data to support breeding for lower methane emissions in cattle and sheep.

Improving soil and land use baselines

Soil management is at the heart of tackling the climate and nature emergencies. Scotland hosts some of the world's premier soil science research (and next year's World Congress on Soil Science). This knowledge could be better used in policy, advice and on-farm practice.

We comment in Section 5 on the issue of soil carbon trading. However, maintaining and enhancing soil carbon has benefits for the farm as well as the planet. Being able to measure that reliably at farm and national level helps with developing the next inventory – and also makes it possible to measure the effectiveness of different management strategies on different soils so that advice to farmers can be refined.

Gathering validated data on current soil status at field level across Scotland would provide a valuable baseline for measuring progress – not just on soil carbon but also on compaction and nutrient status.

At the same time, this exercise could map other natural features on farm which are currently not all mapped, such as hedges, scrub, wetlands and tree pasture. This would both update land use data and inform management advice at farm and landscape level.

This would build on the work on the 'Soil Survey of Scotland' carried out between 1947 and 1981 by the Macaulay Institute.

Recommendation 4

As part of the Green Recovery[21] priorities under "boosting youth employment opportunities in nature and land-based jobs", Scottish Government should fund a programme of training and employing young people to undertake soil carbon testing and mapping of on-farm natural capital.

Farm level greenhouse gas calculators

Estimating net emissions at farm level provides a useful management tool for farmers and advisors, and over the last few years dozens of different 'carbon calculators' have been developed. These provide an estimate of greenhouse gas emissions per kg of product.

For farmers, it makes a lot of sense to look at the farm as a whole and to recognise sequestration in trees and soil as well as renewable energy production as part of the farm's overall impact – even if these end up in different places in the national inventory.

The three most commonly used in Scotland are Agrecalc, Farm Carbon Toolkit and Cool Farm Tool. They operate in slightly different ways – for example in how they estimate carbon sequestration in woodland and soil, how they handle the emissions embedded in bought-in feed, how they include biodiversity.

There is not yet an industry standard – and that makes benchmarking and measuring progress more difficult. Also, if the data provided by farmers is not validated, it will be much less useful for any bottom-up aggregation.

> "I mean, there's something ridiculous, like over 50 different carbon measuring kits or methods out there – which one should we be using, which is the one that is going to provide comparable results" Denise Walton

Widespread adoption of one package could also help with gathering more detailed collective data on farm practices than the current DEFRA farm practices survey. It is essential that aggregate data is in the public domain rather than proprietary to the software provider.

The existing tools are not currently linked into other farm software packages or databases like IACS , BCMS – or abattoir data: these linkages would increase the ease of use and accuracy of the tools, for example pre-filling land data or allocating the emissions from a store animal across two farms depending on the age of movement.

> "It would be great to get to the stage, and I'm sure it will come, whereby we've got a system and an IT system that we can put our inputs in, and we have a multi species database that has recorded everything that's on farm, and we would be able to do an annual carbon audit just by putting our inputs in. We're not at that stage yet, but that's what we should be striving to achieve" Martin Kennedy

Finally, the tools could be more interactive and encourage users to explore scenarios – what if I cut back on nitrogen? Or put in some more woodland?

Like an EPC on a house, farm-level calculators will tend only to provide generic advice on how to improve performance – and are more useful if followed up by bespoke advice or with a conversation in a 'one to few' learning session.

> "Using Agrecalc on the beef efficiency scheme, I got a piece of paper saying what I could be doing to improve my carbon footprint and it started off: 'You need to change your light bulbs in your sheds'. Come on now… that is going to do diddly squat" Doug Christie

Recommendation 5

The Board should invite costed proposals from existing providers for developing a 'universal' farm-level calculator with greater functionality. The data from the universal calculator would be in the public domain, and there would be an independent board including farmers and scientists to oversee further development. This recommendation should be integrated with Recommendation 3.

Aligning research and innovation support

Achieving the needed transformation in Scottish agriculture will require more than widescale adoption of tried and tested mitigation and efficiency measures. Research and innovation are vital to create new pathways to sustainability.

Scotland enjoys a great depth and breadth of research both on agriculture and on climate change. Centres which bring that knowledge together such as SEFARI and ClimateXChange have a valuable role.

The Rural Innovation Support Service has generated a great variety of small-scale farmer-led projects to answer challenges identified by farmers themselves, from growing hemp to scaling up cow with calf dairies, from using shellfish compost to control Potato Cyst Nematode to using woodchip for bedding. These projects have supported farmers to test ideas and try out new things that can make a difference to their businesses. In many cases these are low cost and low tech innovations that provide benefits without adding unnecessary costs.

However, the nature and climate emergencies call for a greater shared effort to find new solutions and to test and upscale innovations.

The current draft strategy for Environment, Natural Resources and Agriculture Research contains many useful proposals:

- Build a body of evidence, expertise and knowledge to inform development and implementation of livestock improvement policies that mitigate climate change and enhance biodiversity.
- Develop approaches to influence farmer behaviour and effect change on the ground with respect to soils, land management, air quality, flood prevention and climate change.
- Understanding the impact of land use change and land management: on emissions and carbon sequestration; on risk and resilience and; on our ability to respond and adapt to climate change.
- Produce science-based and quantified estimates of the mitigation potential of new and existing measures to reduce emissions from agricultural GHG's.
- Model the GHG emissions from the beef, sheep and dairy sectors, and develop a single projection model to project GHG emissions under a range of Scottish farming/land scenarios (including grasslands and moorlands), to include changes in land use, agriculture and forestry under different business and emissions scenarios.
- Understand the role and estimate monetary/non-monetary value of soils and peatlands in delivering net GHG reductions and other key ecosystem services.

However, these proposals are spread across several themes and topics, and there is not a clear and visible focus in the strategy on reducing greenhouse gas emissions from agriculture.

Many of the topics of interest to farmers – regenerative agriculture, soil carbon, mob grazing, feed additives, low methane breeding, agroforestry and so on – are absent from the strategy. Organic farming – which is going to attract a ring-fenced one third of the Horizon Europe budget for agriculture, forestry and rural areas research – is also missing.

"What I really feel is lacking in support is in simple advice on farming holistic or regenerative agriculture. When you try and translate it back to your own particular circumstances. There are all sorts of issues. And there is no help anywhere to figure out how to overcome some of those things. There is no research going on, no meetings going on where this sort of stuff is shared. … The thing that's really lacking is solid technical advice for the actual practitioners. I mean, you really have to be a pioneer. It's not easy" Malcolm Hay

Closer links are needed between research, innovation and the questions farmers are looking to answer. Farmers have always been researchers, experimenters and innovators – and this creative activity should work alongside, inform and learn from the rigorous knowledge developed and held in our science institutes.[22]

> "It's a learning process, trying to make sure that, you know, the research that has been done, you know, it's been well verified and properly cross-examined because I think there will be lots of stuff being said maybe today, and in five years time, it may not necessarily be the best information. … So it's really the start of a new journey for many people. And I wouldn't necessarily rush out to the first person's advice on it. We need to just follow it through and go with it. And, you know, just be careful that we don't just rush off in one direction" John Smith

Recommendation 6

The Board should establish a farmers' advisory panel to act as a reference group for the Strategic Research Programme. Scottish Government should continue to invest in the Rural Innovation Support Scheme.

Phase 2: A farmer's mitigation menu

Approach	Examples	Timeline
Phase 2: A farmer's mitigation menu	Nutrient budgeting and use of controlled release fertilisers Slurry injection Legumes/ intercropping Manure management Livestock health Feed management Genetic improvement of ruminants	To be part of Universal Greening requirements from 2022

This phase looks at what can be achieved in the short term by using existing payment and regulation mechanisms to encourage wider uptake of well-known mitigation measures.

The panel has benefited from WWF Scotland's report "Delivering on Net Zero: Scottish Agriculture[23]" This draws on earlier SRUC work to review 37 different measures which collectively could reduce emissions from Scottish agriculture.

Similar mitigation menu systems, largely based on MACCs, have also been developed by Teagasc[24] in the Republic of Ireland. The Irish approach aims to reduce net farming emissions by 30%, while WWF's report suggests emissions reductions of around 40% are possible based on realistic estimates of take-up by 2045.

Some of these options will have an immediate financial benefit for the farmer – for example, improving animal health.

The WWF report found "Improved animal health and breeding, with increased fertility, growth rates and yields, and reduced morbidity/mortality could reduce total livestock numbers needed to deliver the same output and deliver 366 kt emission reductions with 40-50% uptake."[25]

Other practices which could make a significant dent on emissions and benefit biodiversity – such as better grazing management, including legumes in the rotation, managing field margins and field cover, Integrated Pest Management, converting to organic or developing agroforestry – will often have an upfront cost.

Agroforestry (assuming 10% of land excluding rough grazing by 2045) and organic conversion (assuming 40% by 2045) offer the most significant emissions reduction in the menu (between them about 40% of the total reduction).

However, both these involve change at whole farm level and we pick these up in section 3.4.

An ambitious mitigation menu can contribute to significant reductions in emissions in the period from now to 2032. This depends on high uptake which in turn will require a combination of advice, support, market signals and loans or grants to cover capital investments.

The uptake of best practice, efficiency interventions and mitigation measures has been at best patchy. A recent report entitled "Boosting Productivity Growth in Scottish Agriculture"[26], found that when compared with comparator high-income countries, Scotland performs as a middle ranking country. This reveals potential for improvement, particularly regarding technology uptake and better farm planning. However, in terms of "economic efficiency" the report found a "diversity of performance" across farm types "with low or negative annual rates of change identified in most sectors".

Reducing nitrogen waste and improving animal health are both important 'early wins' for reducing emissions.

Mitigation example - reducing nitrogen waste

Estimates of losses of reactive nitrogen in Scotland to water (132 kt N yr-1), air (80 kt N yr-1) and terrestrial systems (90 kt N through atmospheric deposition) are substantial, and predominantly due to agricultural activities.[27] This reflects a nitrogen use efficiency of around 50% - in other words, half the nitrogen we apply to crops and grassland is wasted.

Significant savings are possible through the implementation of best practice in manure management, precision spreading, controlled release fertilisers, increasing the use of nitrogen fixation in rotations and breeding plants for nitrogen use efficiency. With the heavy climate impact of nitrous oxide, even small cuts in emissions will have a significant and long-term impact on climate change.[28]

WWF[29] reports that 55% of nitrogen fertilisers used in Scotland are on grassland, with dairy farms being very dependent on their use. Better use of clover and other grassland legumes along with effective manure management can reduce or eliminate the need for bagged nitrogen on grassland. Conversely, using bagged nitrogen inhibits clover.

Introducing peas or beans into a cereal rotation cuts nitrogen use over the rotation, while intercropping – for example peas with barley – also reduces the need to add nitrogen.

There is a current call to extend Nitrate Vulnerable Zones (NVZs) across Scotland (and the rest of the UK) to counter excessive nitrogen use. However, the Nitrates Directive's two main objectives to reduce water pollution "caused or induced by nitrates from agricultural sources" and to prevent further nitrate pollution, have not managed to markedly reduce the wastage of fertiliser in Scotland. Across the EU, between 2010 and 2015 there were no further decreases of losses of nitrogen losses from agricultural land[30] despite the implementation of the Nitrates Directive. This is a blunt tool in terms of providing solutions to tackle the climate and nature emergencies.

A new approach to tackle nitrogen should be created for ***all*** Scottish farmers, learning from SEPA's experience working with farmers and informed by the Scottish Nitrogen Balance Sheet and farm-scale assessments of N-use and efficiency. The aims should be to:

- cut waste in the system, achieving a halving N wastage nationally by 2030
- make better use of biological nitrogen fixation
- reduce emissions from manufacturing N (N fertilisers have a high carbon footprint in the production phase, so reduced use will cut emissions in the field and at the factory too)
- protect vulnerable ecosystems (reactive N pollution - such as via ammonia deposition or eutrophication of water courses - is a major threat to natural ecosystems).

"With the help of an SRDP grant, we were able to build a slurry store and install a slurry separator. We've got two products there in solids and liquids, and we're able to target them better on farm. It's reduced my nitrogen purchasing and my Ps and Ks by about 65%, so it's been huge" Robert Fleming

Mitigation example - animal health

The panel is finalising a more detailed paper on this issue.

A good baseline of animal health on farm provides the foundation for other efforts to reduce emissions, such as precision nutrition, feed additives etc. Conversely, poor animal health raises increases the greenhouse gas intensity of production – more animals and more feed and more other inputs are needed for a given level of production. Reducing disease allows the same level of output to be achieved with fewer animals.

Philip Skuce[31] shows how common diseases of cattle and sheep impact on greenhouse gas emissions per kg, for example by causing premature deaths or culling and by increasing the amount of food infected animals need to put on weight. He picks out 3 diseases and estimates the reduction in emissions intensity achievable if these were managed. UKCCC suggests BVD, mastitis, and internal parasites as potential management targets.

Some key diseases with a range of impacts are difficult to quantify; for example the core clinical disease caused by BVD including the birth of PI calves has been quantified but the virus effect as an immuno-suppressant, which may be more important, has not been captured in some calculations.

Even with this range of unknowns the headline numbers associated with several wide spread diseases would suggest that by selecting cost effective disease control targets emission reductions of over 5% should be achievable in the medium term.

Most interventions to reduce or treat disease more than pay for themselves.[32]

The Moredun Research Institute in conjunction with SEFARI partners is planning a further workshop to identify disease control options as part of a GHG reduction strategy. That work may move us towards specific disease control/management recommendations for the ruminant sector and is likely to report in the second half of 2021.

"Green Direct Payments" (commonly known as Greening) are an existing mechanism and therefore administratively simple to adapt. Whether this is described as 'greening' or as 'enhanced conditionality' it is important to introduce a baseline scheme which requires all farmers to undertake good practice measures to tackle climate and support biodiversity. Some of these measures will involve a financial cost to farmers while others require an investment of time or a change in practice.

The Universal Greening mitigation menu system should:

1 Be mandatory and include options that fit a range of systems, while supporting business efficiency or have a positive cost-benefit so as to support buy-in and generate culture change at farm level. This is to provide a ramp into positive climate change management. Practically this would mean an end to the current exemption for mainly grassland farms.

2 Include "an escalator" to ratchet up the number of climate change and biodiversity options implemented over time on each holding, to build positive climate change impact at the same time as building skills and understanding.

3 Be designed to allow a self-audit system to avoid the risks of non-compliance.

Marketing standards and/or branding have the potential to incentivise and add momentum to the change process.

The proposed mitigation menu set out below is a way to include all holdings in taking some steps to reduce emissions. We recommend that this – or a similar set of requirements – is adopted for the 2022 funding round.

Political, advisory and community support is integral to optimising buy-in at farm level.

Mitigation menu

Baseline requirements: all farms to undertake soil analysis (including soil carbon) on 5-year cycle and designate 10% of their area to support biodiversity (for example, no fertiliser or manure spread, no pesticides used, managed grazing, agroforestry).

Then farms could choose say 3 initially from the following list, with more options developed and required over time:

1 Yield mapping and variable rate spreading of fertiliser on cropped land
2 Precision operations technology - GPS/Autosteer
3 Precision animal nutrition system
4 Nutrient budget for all enclosed land
5 Slurry spread with injection or trailing shoe
6 Slurry processed through AD plant
7 Slurry/manure exchanged with another farmer
8 Slurry stores covered
9 Application of organic manure/slurry/compost on at least25% of cropping area
10 Spring cultivation

11 Cover or catch crops to protect soils and build carbon and/or nutrients

12 Intercropping – e.g. peas and barley

13 Clover inclusion – in all pasture/grass reseeds

14 Grass/clover reseeds without ploughing

15 Crop rotation include 20% grain legumes

16 Herd/flock health plan developed with vet and actions identified

17 Herd or Flock Sires – balanced breeding goals – index top 25%

This first strand is an important step. Depending on the level of uptake, these measures could mean a reduction in emissions of around 10%.

A greater targeted reduction of greenhouse gases at farm level, coupled with land use change, is also required to transform agriculture in a net-zero economy.

Recommendation 7

A mitigation menu should be introduced as soon as possible, to replace the existing greening scheme with the expectation that all farms sign up to the baseline requirements and a number of options

Phase 3: System change to low emission production

Approach	Examples	Timeline
Phase 3: System change to low emission production	Choice of approaches 'precision' or 'nature value' - to ensure all sectors and farm types can contribute through a low carbon pathway.	Pilot projects start as soon as possible to inform design. Contracts to be required as part of post 2024 policy

This third phase builds on phases 1 and 2, assumes best practice is in place and relies on the existence of a farm-level baseline.

The greenhouse gas contracts focus on new interventions in land management and/or cropping requirements and introduce sequestration and biodiversity thresholds.

Addressing individual gases allows the impact and persistence of each gas to be factored into a reduction strategy with targeted management measures that are quantified and audited at holding level and understood by the farmers and his/her team. This achievable end point then compounds to a national reduction.

The reduction contracts should offer two options to allow producers to adopt a management plan that fits their system and its future development, with a limited number of management interventions.

Options:

Approach A covering precision farming, would have a support premium to compensate for costs and controls.

Approach B includes 'multifunctional' farming delivering sequestration, biodiversity priorities and low emission production, and would have an enhanced support premium to reward multifunctional management and constraints on production.

Approach A example - early adoption of low methane breeding
See Geoff Simms article for more detail

Cows and sheep produce methane as part of a digestive system which allows them to turn human-inedible grass and by-products into milk, beef and lamb. This digestive system contains a huge diversity of micro-organisms.

Because methane is a much more powerful greenhouse gas than CO_2 this accounts for around 3.7Mt of emissions – about half of the total agricultural emissions in Scotland.[33]

Within the rumen, the micro-organisms which break down the grass produce a surplus of hydrogen gas in the process. Methane-producing bacteria use this as their energy source.

Some individual cows and sheep have a population of micro-organisms which produce much less methane than others because they produce less surplus hydrogen for the methane-producing bugs to use. We have only looked at a small sample of individuals and there may be even greater differences out in the Scottish herd.

We know this because SRUC researchers can put animals in respirometers and measure the methane emissions accurately. This is not a difference between breeds but between individual animals. Researchers have now found a reliable and practical way to analyse a sample of rumen microbes from live cattle to predict that animal's methane performance.

Much of this difference is passed on to calves (and lambs), opening up the possibility of breeding low methane animals. This is already starting to happen with sheep breeding in New Zealand and with cattle breeding in the Netherlands.

This is not editing or altering the genes of cattle and sheep, just intelligent selection and breeding, by accurately selecting animals naturally carrying a population of rumen microbes which results in less methane emissions.

Clearly, breeding for low methane has to be balanced with other breeding goals such as ease of calving, milk production, fertility and so on. If adopted at scale, such a breeding programme could in theory reduce emissions from the Scottish herd at a rate of 2 to 6% a year, leading to a cumulative reduction of 20 to 60% in 10 years.[34]

Currently, only a minority of beef and a smaller minority of sheep farmers in Scotland use the Estimated Breeding Values and indices based on these when choosing breeding stock. This approach is not universal among dairy farmers either, although in practice farmers using AI will be choosing highly competitive bulls by default.[35]

So there are high cultural barriers to rapid adoption.

There are advantages to a breeding strategy compared to (and complementing) the use of feed additives which is the other promising option on the table:

a. The improvements are cumulative and 'locked-in' – they don't rely on farmer behaviour (apart from choosing the right sires)

b. There is no ongoing cost associated

c. There are technical difficulties of administering food additives safely in a grazing/ extensive context

d. Most feed additives to reduce efficiently methane production are preventing the final step of methane metabolism but do not prevent the cause of methane production – the surplus of hydrogen, which is then partly emitted into the atmosphere. Hydrogen has also an indirect global warming potential but is less potent than methane.

Approach B example – less is more

Recent research by Chris Clark[36] and others demonstrates that on many upland farms after a certain point the variable costs of buying in feed and fertiliser rise faster than the income from additional production.

Reducing stocking levels to the point where external inputs are not needed and the farm relies on 'nature's bounty' of free grass can make the farm less productive but more profitable and resilient.

This is particularly relevant in a context where unconditional basic payments are being reduced and more funding is available for nature restoration and carbon sequestration.

Some of the proposed interventions are still in development and their impact is still being quantified. Anti-methanogens for example, are currently being assessed and are not licensed - a vital development that needs to proceed quickly. New science will emerge; as knowledge progresses interventions and implementation of reduction contracts may evolve or change. Systems must be in place to respond to development and new science.

Equally, the importance of rare and native breeds across all farming sectors must be recognised, and diversity protected.

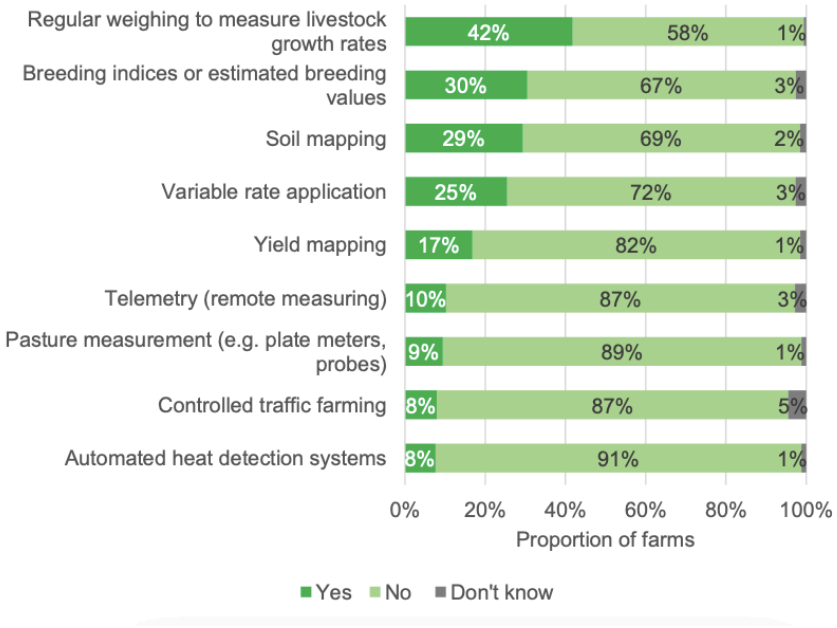
These greenhouse gas reduction contracts would be similar administratively to the land management contracts, running over five years and allowing farmers to pick from a range of options. Capital and revenue support would be available.

However, they would include a strong emphasis on measurement of results and collation of data. Farmers would have support from the advisory service in implementing these contracts.

Approach A: Precision farming options	**Approach B: Nature value options**
Required: 10% of land managed for biodiversity	Required: 30% of land area to sequester or store carbon; 30% of land to underpin biodiversity (these can be overlapping – see below)
Examples	**Examples**
Adopt currently available EBVs and indexes and once available equivalent tools to select directly for lower methane.	Adopt currently available EBVs and indexes and once available equivalent tools to select directly for lower methane. (Rare breed exemption)
Include approved anti-methanogens over the feeding period. Innovative techniques are likely to provide alternative methods of administration.	Reduce breeding livestock units by 10% Reduce mature weight of cows
Maximise value of manures and slurries – storage, separation, application, AD	Covered FYM storage
High ambition suite of measures to prevent livestock disease	High ambition suite of measures to prevent livestock disease
Use of high sugar grasses	Extended hedgerows and shelter belts
Adoption of soil fertility/carbon building techniques through the application of manures, compost, or green manures or grazing of break crops	Adoption of soil fertility/carbon building techniques through the application of manures, compost, or green manures or grazing of break crops
Require a nitrogen-fixing crop such as peas, beans or lentils at least one year in 5	
Application ceilings for nitrate and urea application: use of controlled rate fertiliser	Minimise/eliminate use of bought-in nitrogen
Variable rate precision spreading based on mapping or crop monitoring	
Adopt crop genetics and plant population targets that optimise uptake and utilisation of nitrogen fertiliser	
Intercropping	Increase diversity of grass and forb species in pasture

While many precision farming techniques have been available for some time, adoption is still limited as shown in this recent DEFRA Farm Practices Survey.[37] It will be important to get timely feedback on the rate of adoption of these techniques in Scotland, through improved farm survey data as well as monitoring of the greenhouse gas reduction contracts.

Figure 2.1 Precision farming techniques used on farms (where this technique is relevant)



Managing land for nature value and for sequestration

In December 2020[38], the Scottish Government published a statement of intent to manage 30% of land for nature by 2030. Given that over 80% of our terrestrial area is under some form of agricultural management[39], providing this 'nature value' pathway for Scotland's farmers post 2024 will make a substantial contribution to achieving that target. The panel has not specified the minimum requirements of 'managing for nature' but we would expect it to include no application of nitrogen fertiliser or pesticides and other measures on habitat diversity and species management. However, it is important for this to be seen not as an issue of minimum compliance but rather a positive decision to maintain and enhance nature on the farm – creating a greater diversity of habitats and of species (both plant and animal).

In terms of sequestration, the panel is keen to encourage a range of options - woodland, silvopasture, hedges, open woodland pasture, open scrub pasture, wetland, peatland, moorland, thin peat, acid grassland. The enhanced mapping proposed as part of Phase 1 should result in these assets being better captured at farm level. The Panel has some concern that the sequestration values of some soils under agricultural use and in particular land managed by low intensity grazing, including scrub, are not sufficiently understood nor quantified and are largely excluded from the carbon accounting equation.

Clearly, these options will provide different rates of carbon sequestration – and different soils and climates will affect for example the rate of growth for trees and shrubs. Standard values (referenced against for example production Sitka spruce over a 50 year cycle) would be one

way to assess the sequestration contribution from a particular land use. Farm woodlands should include 50% native species, and natural regeneration should be encouraged alongside planting.

On some farms, there will be a significant overlap between the 30% of land managed for nature and the 30% managed for sequestration, while on other farms those land parcels would be largely separate. These land designations should be able to be captured and aggregated within the existing land parcel mapping software.

Recommendation 8

From 2024, introduce emissions reduction contracts on a mandatory basis across all farm types underpinned by a management plan that fits their system and its future development, with a limited number of management interventions.

Recommendation 9

Scottish Government, farmers and research institutes should work together to accelerate advances in ruminant livestock selection and breeding; include reducing methane emissions in breeding goals, and encourage uptake of best practice.

Phase 4: Whole farm system change

Approach	Examples	Timeline
Phase 4: Whole farm system change	Increase diverse approaches to support biodiversity and multifunctional landscapes Agroforestry Organics, agroecology, regenerative farming	Pilot projects start now under both agricultural and forestry schemes to inform post 2024 agricultural and future forestry policy

The options outlined above will reduce greenhouse gas emissions, but Scottish farmers and landowners will need to go further still. Current business models tend to support increasing inputs and outputs; while fixed costs, including loan repayments, encourage businesses to run faster, even if this reduces productivity while increasing production.

Changing the farm system - for example changing the core enterprise by converting to organic or introducing agroforestry at scale - can require many years before a new equilibrium is found. The endpoint is a farming system that is more profitable and sustainable while generating fewer emissions, but businesses may need considerable support in the form of grants and loans during the period of change.

The Potential for Agroforestry

See the panel's more detailed report on agroforestry.

This report uses the widely used definition of agroforestry as the growing of woody perennials on the same piece of ground as an agricultural crop, either livestock or crops.[40] The Panel recognises that all woodland types, including hedgerows, can play a role in delivering both carbon sequestration and biodiversity gains on a farm, but agroforestry has the potential to deliver on these goals without significantly reducing and even increasing[41] the productive potential of a farm. Internationally, agroforestry is recognised as a sustainable climate-smart agriculture option that can help deliver on many Sustainable Development Goals and contribute to countries' Nationally Determined Contributions to be submitted to the Paris Agreement.

Agroforestry can enhance agricultural production depending on planting methods, time scale used and species choice. There are associated reductions in nitrate leaching due to deep root structures[42] while Agroforestry Ammonia Abatement[43] uses both the dispersive effect of a barrier and the uptake of ammonia into the tree canopy to mitigate emissions for example from pig, poultry and dairy units. These contribute to improved water and air quality, while the maintenance of an understory of herbage further supports biodiversity and improves soil structure.[44] Agroforestry can benefit livestock productivity as it can protect better quality pasture, improve animal health by providing a diversity in diet (tree fodder), and give protection from adverse weather.

Both sheep and cattle have been observed to choose to go under trees when calving or lambing. This behavioural choice results in lower stress thus more fertile, less prone to disease, and has better rumen production.[45]

> "Older farmers I remember when we first went organic, like the father of one of the older guys on our farm said, "oh, yeah, but of course, the sheep prefer the grass under the hedges because it's got its different species and it doesn't have the fertilizer on it". We never really thought about that"
> Toby Anstruther

The presence of trees also stops ploughing, an additional mean of protecting soil carbon. In silvoarable systems, shelter belts and alley cropping can reduce soil erosion as well as wind damage to crops and farm buildings. Agroforestry can also provide a tool for landscape restoration as it can 'enhance physical, chemical and biological soil characteristics, thereby increasing soil fertility, controlling erosion and improving water availability'.[46]

The limited experience of agroforestry in Scotland, usually using wide spaced trees, has led to the perception that agroforestry in general will not yield quality timber products, and are instead restricted to firewood. However, the Panel holds that suitable agroforestry species can be planted and grown in ways that deliver good quality timber for a range of markets while helping to diversify the types of trees grown in Scotland, with resultant benefits to increasing resilience in Scotland's woodland resource, landscape and rural businesses. For example, if done at scale, birch would have a wide range of uses and thus markets as is seen in Scandinavian countries.

As such, the Panel sees the development of agroforestry as central to future agricultural and forestry policy; as an important integration tool to be used in delivering biodiversity gains and greater carbon sequestration on farms whilst protecting agricultural productive potential. This is despite the limited experience of agroforestry in Scotland. WWF's "Delivering on Net Zero" report suggests a potential of a 570 kt reduction in emissions with uptake by 30% of farmers, assuming 10% of farmland is used for trees. The Panel echoes this call for take-up.

In the 8 years since the Woodland Expansion Advisory Group report recommended "better integration between woodland creation and farming" and in the 6 years since agroforestry has been in the Scottish Rural Development Plan, there has been no significant progress on agroforestry in Scotland. The current Scottish Forestry Strategy[47] does not mention agroforestry at any point.

Scottish Forestry recently wrote "As part of the Forestry Grant Scheme Stability and Simplicity review it has been recognised that the agroforestry option is not delivering and it will be reviewed – but this is unlikely to be before 2021".[48] This is despite a growing interest in the topic with 50 people signed up to the Rural Innovation Support Service funded Scottish Agroforestry group that started in May this year.[49]

According to the literature[50] barriers include farmer perception, landscape aesthetic appeal, and a lack of key policy incentives. Panel experience adds to this list a lack of knowledge on silviculture in the farming community, the perception that trees bring problems to livestock (such as flystrike), a resistance to agroforestry in the forestry sector, until recently the lack of a 'champion' in the NGO sector, inertia and risk averse culture in the Government Forestry Department, much reduced capacity in the 'forestry' academic community (only the University of the Highlands and Islands offers a degree course in forestry), lack of engagement in

the agricultural academic community and the lack of obvious drivers to force uptake or development of agroforestry (e.g. the lack of a sequestration element to agricultural emissions calculations). There are also particular current and historical land ownership and tenancy issues,[51] which in turn has led to a lack of understanding or commitment to agroforestry.

Yet, agroforestry remains one of the most effective ways to achieve Scotland's climate goals in both mitigation and adaptation[52] across a range of soil types, while improving agricultural and biodiversity resilience and providing a diversity of products. Including 50% native species in farm woodlands, with support for natural regeneration as well as planting contributes to both climate and biodiversity targets.

The Panel recommends creating a ring-fenced budget for agroforestry within the agricultural budget, with a dedicated long-term programme to drive it and a target of 6,000 hectares a year.

This programme must allow for innovative designs and take into account the cultural, tenancy and climatic variances that are particular to Scotland. Silvopastoral planting models must be informed by those who understand the needs and habits of livestock. Integrating Scottish agriculture and forestry knowledge and understanding will further assist the largescale establishment of a variety of agroforestry models.

Agroforestry should be considered for pilot schemes starting in 2022 with a variety of planting styles, with the joint support and advice of RPID, Scottish Forestry, the Woodland Trust, RSPB and Soil Association. It is important that plantings result in biodiversity net gain and maintain habitats for example for waders.

Alongside these pilot schemes, there should be a short desk study to look at the carbon values of different agroforestry planting models on different soil types. This would complement the recent modelling work by James Hutton Institute and Forestry Research.[53]

Recommendation 10

Scottish Government should set a target of 6,000 hectares a year for agroforestry creation, and create a ring-fenced budget for agroforestry with a dedicated long term advisory, funding and research programme to drive it.

Extensive farming systems

The WWF report suggests that a 40% uptake of organic farming in Scotland could deliver 730 kt CO_2e reductions due to a combination of a lack of synthetic nitrogen fertiliser use, a 10% reduction in livestock numbers and the conversion of 20% of tillage land to rotational grassland.

Of all the actions examined, this had the highest potential for carbon savings as well as air, water and biodiversity benefits associated with lower inorganic input use. Scottish examples echo these trends[54] with close links to local communities, a growing diverse market both locally and further afield and higher returns due to lower input costs. In 2020 UK sales of organic produce grew by more than 12%.[55]

However, the percentage of certified organic farmland in Scotland is now only 1.6%[56] of total agricultural land with a decreasing trend since 2011 in both land area and number of farmers. This is in stark contrast to the European Commission target of 25% of total farmland in organic management by 2030.[57]

There is currently no policy in place for supporting organic conversion in Scotland post 2020, despite the co-benefits to farmer incomes in the growing UK, EU and global markets.

There are other also other forms of agroecological and/or regenerative farming already being practised in Scotland, such as high nature value farming, Pasture for Life, biodynamics and others. These all have lower synthetic nitrogen use, often incorporate rotations in their practices and rely on extensive livestock systems. They all have a role to play in reaching net zero and should be supported.

This may require the creation of a new category of production where limits on the use of nitrate fertilisers and other inputs would apply with a focus on the quality production of food, fibre, sustainable wood, and breeding stock as well as managing defined percentages of the holding for both sequestration and biodiversity. This system would have a range of marketable outputs, make a significant contribution to public goods and subject to light touch audit.

Phase 5: Land use change

Approach	Examples	Timeline
Phase 5: Land use change	Right trees in right places – planned approach to land use change, encourage integration of farming and forestry Restoring peatlands and wetlands	Implement public interest test now to control investor-led afforestation In 2022 revisit forestry strategy to develop science-based approach to land use planning

The changes in farming practice outlined in the previous three sections will result in significant land use change.

The greenhouse gas reduction contract option B proposes 30% of the holding being used for sequestration and 30% for biodiversity. If this was taken up on 30% of holdings it would result in say an additional 300,000 hectares of farm woodland, much of it designed to co-deliver on biodiversity.

Legumes in the rotation would have a significant visual impact on the landscape, as would wide uptake of agroforestry.

Currently, however, land use change is mainly understood in terms of commercial afforestation and peatland restoration, with ambitious targets for both. Other key habitat restoration approaches, including grasslands and uplands, must be considered in order to meet expected global biodiversity targets.

The current system for afforestation is very much developer-led, with land owners approaching Forestry Scotland with proposals for approval and grant assistance. The current scheme is attractive to investors, with a combination of planting grants, maintenance of basic payments and favourable tax treatment of the timber crop.

While this approach may achieve the planting target, it may have other negative results. The Panel has heard accounts of tenancies not being renewed and landowners choosing instead to afforest whole farms.

> More consideration is required of the effects of tree planting targets on the tenanted sector. Current fiscal and subsidy support make commercial afforestation an attractive option for landlords who take land out of the tenanted sector for planting and deny new blood the traditional upland route into farming. Scottish Tenant Farmers Association, evidence submission.

There is no guidance on cumulative landscape impact from multiple forestry projects within a catchment area, and limited local influence over decisions, unlike for example applications for quarrying or wind farms which can be similarly contentious.

New tree and woodland cover must avoid being double counted as carbon mitigation - both as a carbon sink at the farm level, and again in the overall forestry cover in the carbon inventory.

New tree and woodland cover deployed on farms and crofts as part of a climate change mitigation plan must take account of the long-term storage of carbon and opt for species and uses that optimise this - and be sensitive to other priorities such as biodiversity, landscape, climate adaptation and community benefit.

Some tree-planting schemes may result in a net loss of biodiversity as there is currently no requirement to undertake a biodiversity assessment of the site. Currently there is no requirement on forestry schemes to demonstrate 'biodiversity net gain'.

Some planting may take place on soils which although not deep peat end up losing more organic matter than is replaced by the growing trees for decades.[58]

For area-based targets to be effective in ensuring GHG emissions abatement outcomes they need to include explicit supporting assumptions on the minimum anticipated extent or rate of carbon sequestration delivered across the area of new woodlands. Otherwise a combination of land manager preferences, budgetary limitations, and the unintended consequences of other land use or agricultural policies can lead to the afforestation of less productive land, on soils with higher organic matter contents, that in the worst cases results in net emissions of carbon for decades.[61]

Recommendation 11

There should be a public interest test applied if more than 30% of a holding is planned to be afforested.

Recommendation 12

Forestry applications over 20 hectares should be required to specify the net carbon sequestration they will achieve, and demonstrate biodiversity net gain.

Regional land use planning

Regional land use planning provides a vehicle to bring stakeholders together to discuss future land use scenarios and options.

It is a form of 'polycentric governance' which would co-exist and interact with decision-making by individual private and public land managers, with national government targets and drivers for land use, and with the views of local communities and land users.

Regional land use planning is a requirement of the 2019 Climate Change Act and five areas of Scotland have been designated as pilot areas. However, it will be some time before partnerships are fully operational.

Recommendation 13

Land use change should as far as possible be planned to optimise economic environmental and social outcomes rather than be purely market-driven.

Recommendation 14

Regional land use planning groups should be supported by large-scale modelling as described in the Research Strategy for Environment, Natural Resources and Agriculture so they can make informed decisions and recommendations.

4 IMPLEMENTING AND FINANCING THE TRANSITION

Our panel recommended in November 2020 in its interim report the establishment of a 'transformation steering group'. We are pleased to see Government is now setting up an Integrated Implementation Board to drive things forward.

This Board has many challenges, with early action needed for example on pilots, on a replacement for greening, on agri-environment schemes including organics, on commissioning a redesigned advisory service, on improving the use of data and on the new research strategy.

However, given the need for medium-term and long-term thinking and planning as well as short-term actions, it makes sense to make appointments to the Board on a 4-5 year timescale, through to the introduction of a new farm support scheme.

Pilot schemes

The purpose of pilot schemes is to encourage and test adoption of new or rarely-undertaken practices to explore how well they work in practice across a range of farm types. This would allow the more effective ones to be included in a national scheme of support/encouragement/regulation.

Pilot schemes would be useful for a number of practices which could be adopted more widely, including:

- Growing beans for human consumption in a cereal rotation.
- Establishing silvopastoral or silvoarable agroforestry schemes.
- Methane-reducing feed additives.
- Slurry separation.
- Controlled release fertiliser.
- Intercropping.
- Cover crops and undersowing.
- Ambitious livestock health improvement measures.
- Scrappage scheme for broadcast slurry spreaders.

Financing the change

While some management changes will see an early financial payback for farmers as well as a reduction in emissions, some will take longer to pay for themselves. There are also additional costs of transition in terms of enhanced advice, data gathering and research.

Agriculture currently enjoys substantial public funding of around £600m per year. There is significant scope for refocusing that budget, both by capping large payments and implementing conditionality through the mitigation menu and the greenhouse gas reduction contracts.

However, this does not mean that all the costs of transition can be met from within the existing funding envelope. As with decarbonising other sectors of the economy such as transport and heating, upfront investments by Government may be needed to accelerate change. Again, as with transport and heating there may be scope for a public-private investment partnership.

The panel has identified some specific transition costs:

- Baseline work/mapping of soil carbon and on-farm natural features.
- Enhanced advisory service and CPD.
- Grants and loans to businesses to implement measures in their greenhouse gas reduction contracts, including feed additives, slurry and manure handling etc. The Agricultural Transformation Fund and Beef Efficiency Scheme have already generated some learning on how to support uptake of new approaches.
- Agroforestry at scale.
- Other habitat enhancement measures on farm proposed as part of the nature value option.
- Expansion of organic conversion.

The costs of change can be met from various sources:

- The farmer themselves, either because they see the benefit or to comply with changing regulation.
- The government, because the public value of the change outweighs the cost.
- The end customer who is willing to pay a premium for 'green' produce.
- Businesses which benefit directly, like water companies which save money having to clean up their water supply.
- Processors and retailers who are willing to invest in 'greening' their supply chains.
- Investors who can make a profit (e.g. by buying and afforesting land) or who want to invest in carbon reduction schemes.
- Businesses which want to offset their residual emissions by buying soil carbon.

> "Supermarkets are jumping onto the bandwagon as well, or water companies are paying farmers down South for putting cover crops in, which is great, really good and I think that's possibly where the funding should come from in the future rather than from the government, because I think the government going forward will have a lot more important ways of spending their money, whether it be the National Health Service or whatever it is, or providing decent food into schools and into the public sector than paying farmers on a per area basis, if farmers are going to be subsidised it should be on a 'public money for public good' basis" Doug Christie

Just transition is an important consideration. Government investment may be needed to ensure that the more marginal cash-poor farms can make the transition to more sustainable production and more secure income. However, there is a danger of Government being the only investor in

change, with the benefits of change going to the supply chain and outside investors. A planned approach to joint public-private investment in the transition should be explored.

Given the soil carbon market's stage of maturity, the panel doubts the wisdom of farmers in Scotland selling soil carbon sequestration to outside investors. There are risks of farmers reducing the value of their land and making it harder to sell if they have already sold their soil carbon rights. Also, selling those rights outwith Scottish agriculture means the credit does not appear either on the farm account (so the farm can't claim for example to be 'carbon positive') or on the national account.

The panel proposes a moratorium on trading in soil carbon in Scotland until a fair and credible scheme is in place. The presumption should be that any soil carbon sequestration benefits should be retained within Scottish agriculture's envelope.

Recommendation 15

The carbon in Scotland's soils should not be traded until further notice

Conclusion

The work of this panel – and of the many farmer-led groups meeting over the last year – has demonstrated that there is an essential and viable role for farming in a net zero, nature rich Scotland.

The change may look as if it's about technology, or kit, or just about saving money. But fundamentally it's a change of mindset, about farming for the future.

Farming in Scotland has the opportunity to lead the way in aligning practice, policy, research and advice with an ambitious net-zero target and restoring nature. Let's grasp that opportunity.

"I think the problem is mindset. And actually, we can farm profitably by farming for the climate and with biodiversity"
Denise Walton

APPENDIX 1

How this report aligns with/builds on/ differs from other recent publications

HUCG Hill, Upland and Crofting Group https://www.gov.scot/publications/hill-upland-and-crofting-group-initial-findings-report/

SBCS Scottish Beef Climate Scheme https://www.gov.scot/publications/suckler-beef-climate-scheme-final-report-2/pages/2/

DCCG Dairy Climate Change Group https://www.gov.scot/publications/dairy-sector-climate-change-group-report/

ACCG Arable climate change group https://www.sasa.gov.uk/document-library/arable-climate-change-group-report

JTC Just Transition Commission report https://www.gov.scot/publications/transition-commission-national-mission-fairer-greener-scotland/

UKCCC Land use policies for a net-zero UK https://www.theccc.org.uk/publication/land-use-policies-for-a-net-zero-uk/

This report	Other recent reports
Maintain, not increase national production	Any performance-based efficiency outcomes must be based on production optimisation and not maximisation so as not to encourage environmentally unsustainable management practices and increased use of inputs simply to increase outputs HUCG
	Areas across the farm that could be released as a result of efficiency gains through this scheme in order to create or restore habitats to enhance the biodiversity potential of the farm through management supported by other agri-environment, woodland, or peatland restoration schemes SBCS
Climate and nature must go together	A focus on meeting climate targets should not come at a cost to management which specifically targets biodiversity. Many opportunities to benefit one also deliver outcomes for the other, but beyond that, care must be taken to carefully balance trade-offs between these equally important priorities. HUCG
Leave no-one behind	Many in the agriculture sector have concerns that the net-zero transition will see people lose their livelihoods and fundamentally change their way of life. We need to reduce emissions from agriculture, while leaving no one behind. Similarly, we need to address any barriers that prevent tenant farmers participating in carbon sequestration programmes JTC
Reform advisory service and develop CPD	We need a new model of farm advice, with advisory services upscaled and upskilled to help farmers and land managers identify suitable climate action for their land holdings and the funding streams to deliver them. SBCS
	Requirement for applicants to carry out continuing personal development on an annual basis. SBCS
Develop a single farm-level GHG calculator with greater functionality	Comparison of Carbon auditing tools to develop modular calculator using standardised set of assumptions and data. DCCG Development of scenario planning within the auditing tools DCCG Develop a Whole farm Climate Review tool to enable farmers to identify the optimum set of plans and actions required to address the carbon balance on farm. DCCG Farm carbon auditing tools must become more accurate to reflect the true climate efficiency of a business. HUCG A baseline scheme requirement for a Whole Farm Carbon Audit and Nutrient Management plan, taking into account all sequestration within the business ACCG

This report	Other recent reports
Improve soil carbon baseline information	Pilot programme to carbon audit all farms in Scotland DCCG
	The data collated as part of the SBCS should be used as starting point to establish a Scotland-wide database… Such a nationwide real-life dataset will provide a valuable inventory for more accurate soil carbon accounting on the basis of farmland type and management going forward SBCS
Support agroforestry and on-farm sequestration	Incentivise small scale tree and hedgerow/corridor planting with sequestration captured in the carbon audits and inventory for agriculture DCCG Encourage planting for both biodiversity and carbon sequestration DCCG There is wide support for agroforestry and where this can complement productivity and optimise use of land across the country DCCG
	The application process to obtain funding for smaller and integrated forestry projects including smaller scale on-farm woodlands, wildlife corridors, shelter belts, field margin tree lines and agroforestry needs to be simplified for all applicants and be made more accessible for tenants. HUCG
	The key findings of the group point to the following as the headline actions most likely to impact mitigation… Carbon sequestration from the atmosphere through agricultural practices that preserve soil fertility and increase organic matter content (e.g. regenerative agriculture) targeted farm woodland, agro-forestry and hedgerow planting and management. ACCG
	Use 10% of farmland for agroforestry UKCCC
Increase uptake of mitigation measures	Carry out regular soil analysis on a rotational basis on all fields that receive lime, organic manure and/or synthetic fertiliser, and complete a nutrient management plan SBCS
	Carry out annual sampling of all silage, haylage or hay used on-farm... and outline a cattle feed rationing plan on the basis of the results SBCS
	Carry out regular sampling of any organic manures and outline their nutrient management plan and farm waste management plan accordingly SBCS
	Multiple mitigation measures recommended including legumes in the rotation, nitrification inhibitors, reduced tillage, precision application technology, reintroduction of livestock, tree and hedge planting (Arable Climate Change Group)
	Multiple mitigation measures recommended including herd health, age at first calving, longevity, grassland management, anaerobic digestion, managing soil pH DCCG
	The group also recommends that further research is needed to develop a means by which methane inhibitors can be supplied to livestock in extensive systems and to consider in particular the feasibility, safety and effectiveness of a methane inhibiting rumen bolus .. DCCG
	Encourage adoption of low emission feeding strategies; Support for feeding efficiency measures including precision feeding and feed additives DCCG
Low methane breeding	More research should be undertaken into the concept of naturally low methane emitters. This should be investigated within the context of wider traits of environmental and economic importance to avoid unintended consequence of focusing on one specific trait..HUCG
New technologies (esp post 2032)	Investigate the viability of other climate change mitigation techniques and technologies not yet widely adopted in the UK but used elsewhere in the world DCCG

One important difference/contentious issue.

Carbon Trading Tread very carefully on soil carbon	Enable farmers with carbon positive balance sheet to trade assets and develop income stream… We urge government to support exploration of public/private partnerships which allow farmers to benefit from the Corporate Social Responsibility and sustainability agendas of private businesses and the opportunities for carbon credits within agriculture DCCG
	Although the HUCG appreciates that carbon credit trading offers an attractive means to generate an additional income stream for landowners, it questions the concept and meaningfulness of cross-sector carbon credit trading given that the purchasing sector uses financial capital as a means to appear more climate friendly on paper without actually having to take action to reduce its own emissions
	The development of a Scottish Agriculture PLC approach to carbon credits, trading and offsetting with a view to protecting the value creation at farm level and enhancing the GVA contribution ACCG

APPENDIX 2

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9th April 2021

STFA submission to Farming for 1.5 Degrees

Introduction

The Scottish Tenant Farmers Association (STFA) is the only organisation dedicated to representing the interests of tenant farmers throughout Scotland. Its stated aim is to support and enhance the tenanted sector and in that role welcomes the opportunity to make comments to the Farming for 1.5 Degrees Panel.

The work of Farming for 1.5 Degrees, in addition to the sector reports from Fergus Ewing's farmer led groups, are likely to lead to proposals which while providing for environmental and climate mitigating gains may lead to reductions in agricultural output for some farms.

Such proposals are a challenge for farm tenants who are governed by tenancy legislation developed over the last 150 years with a focus on the maintenance of agricultural productivity and which only recognises the agricultural value of improvements. Any non-agricultural diversifications, including tree planting and environmental measures, don't sit well with existing tenancy legislation. While there have been some amendments to tenancy legislation in the 2003 AHA aimed at permitting tree planting and other diversifications, the experience of the last two decades shows that there are still obstacles to diversification for farm tenants.

The tenanted sector makes up 25% of Scottish farmland, but with the exception of the farmer led hill farming group, none of the other farmer-led reports to date discuss the feasibility of their proposals for the tenanted sector.

This submission contains two main sections: Section 1 looks at the how the nature of farm tenancies and the governing legislation will act as a barrier to tenant farmers adopting non-agricultural options; and Section 2 address some of the actual proposals and recommendations we are likely to see in the future.

Section 1

The tenanted sector faces a number of obstacles for these proposals resulting from the legislation, case law, and common law which govern agricultural tenancies:

1.1. Rules of Good Husbandry and the terms of the lease

Farm tenancy legislation has developed over the last 150 years and during that period the driver and focus has been the maintenance of agricultural production within an agricultural lease.

Tenants are bound by the Rules of Good Husbandry (as drafted in 1948) which aims to maintain the agricultural productivity of holdings. Any tenant who changes the management of the holding with the effect of lowering the productive capacity risks breaching the Rules of Good Husbandry.

That fitted well with farm policy until about 30 years ago when environmental measures were introduced for farmers which while improving environmental outcomes could have a negative effect on agricultural productivity.

At present, tenancy legislation struggles to value any improvement which does not improve the agricultural output of the holding. Many of the improvements of today and the future - amenity, environmental, trees, public access etc - don't fit well with farm tenancy legislation and the tenant may not benefit long term, and worse may risk dilapidation charges or notice to remedy for breaching the Rules of Good Husbandry. (In contrast, an owner occupier who improves the amenity and environmental value of a holding will see an increase in capital value).

Some of these hurdles may be overcome by the tenant securing detailed consent from the landlord, but in many cases that is easier said than done. In contrast, a tenant undertaking an agricultural improvement is only required to give notice to the landlord who then has limited grounds for objection, a much easier hurdle than securing landlord consent.

1.2. The nature of tenant's improvements

The new environmental and climate mitigating proposals are mainly non-agricultural improvements which are difficult to include in the restrictions of an agricultural lease. By law, a tenant's improvement is something physical which is attached to land and is included in the 1991 AHA Act's Schedule 5 list of eligible improvements. There is no certainty that tenants will be able invest and benefit from non-agricultural proposals, and way-go compensations currently focus on pure agricultural value, not amenity, environmental or carbon value.

We already know that tree planting, along with other diversifications, are a challenge for the tenanted sector despite changes to legislation in 2003. (Even the Tenant Farming Commissioner is urging tenants to be cautious with tree planting, since under an agricultural lease they may be liable for dilapidations or else required to reinstate as agricultural land).

The introduction of milk quota in 1984 and the resulting problems for dairying tenants required expensive court cases and a change in legislation to allow fair treatment of quota for tenants - an example of where feasibility for the tenanted sector was not considered in the original policy and required pain, expense and time to resolve.

We don't know for sure what the future holds but there are likely to be 'improvements' which like quota are non-physical (e.g. contracts, authorisations, consents, carbon allocation and trading rights etc), or physical but not yet thought of and which don't appear on Schedule 5.

The Schedule 5 list of eligible tenant's improvements was updated in 2018 when STFA and SAAVA/CAAV strongly argued that the Schedule should be future proofed with a catch-all provision so that innovation, new technologies and new policy could be quickly adopted by the tenanted sector without the need for a lengthy legal process to change the Schedule. Unfortunately, other stakeholders did not support a catch-all to future proof the Schedule, and the recent updating of Schedule 5 for the first time since the 1940s only covers the known improvements of today, not the unknowns of the future.

Given the pace of change as farming adopts to play its part in climate change mitigation, STFA believe an opportunity was missed to future-proof the tenanted sector by addressing the limitations of Schedule 5 in 2018. Instead, given the inevitable legislative delays to any future update of Schedule 5, there is a genuine worry that the tenanted sector will always be behind owner occupiers when adopting new technology and policy.

1.3. The short term nature of new lettings

Short-termism is a blight across the UK's tenanted sector, with the vast majority of new lettings which make up around 40% of the tenanted sector being for a term of 5 years or less.

As any farmer will know, improving soil health and increasing soil carbon which will certainly feature in future policy, are long term operations over decades and in many cases requires significant on farm investment - e.g. converting an all arable unit to incorporate livestock will require fencing and watering of fields and livestock handling equipment. A tenant is unlikely to make that level of investment with short term lets.

1.4. Scotland's ambitious tree planting targets

More consideration is required of the effects of tree planting targets on the tenanted sector. Current fiscal and subsidy support make commercial afforestation an attractive option for landlords who take land out of the tenanted sector for planting and deny new blood the traditional upland route into farming.

Many now see the demise of tenancy opportunities resulting from afforestation targets as being acceptable for policy makers. Environmentalists also question the wisdom of such a drive for afforestation as much of the upland grassland currently being planted is high in carbon (peat) and in terms of climate change mitigation, diversity and the environment would be better left as grassland.

Options should include collaborative approaches between landlord and tenant, reviewing the historic resumption compensation payments to tenants who have land resumed for forestry, and introducing small woodland creation schemes tailored for the tenanted sector.

1.5. Access to finance

When an owner occupier invests in buildings or fixed equipment (e.g. houses, dairy units, AD plants) the asset can be used as security for the purpose of finance (a bank can have a charge over the asset). In contrast, a tenant building the same piece of fixed equipment on a secure lease cannot use the asset as security for finance, the result being that a tenant's access to finance is limited. For that reason, some of the more capital intensive renewable investments, e.g. AD plants, will not fit well with agricultural leases.

1.6. Woods, water courses, roadsides an other areas not included in agricultural leases

While an owner-occupier tends to own the whole area of a farm, including woods, water courses, roadsides etc, a farm tenant's lease is likely to include only the fields and steadings which has been shown in the past to be an obstacle for some renewable projects. E.g., for hydro the tenant may need to negotiate a separate lease for the watercourse; or a landlord can effectively block a renewable development by not allowing access or services through a strip of land (e.g. wood or roadside) which is not part of the lease (in effect a ransom strip). Existing

woods may have value in the future as a biodiversity requirement, but they are excluded from the vast majority of farm tenancies.

Section 2

Practical proposals and recommendations from Farming for 1.5 Degrees and Fergus Ewing's farmer-led groups (Beef, Hill, Arable & Dairy)

2.1. Increasing soil carbon and improving soil health

Both should be feasible aims for existing secure tenants, but more of a challenge for fixed term leases where the majority of lettings across the UK are for 5 years or less. Improving soil carbon and health will require the adoption of some regenerative farming techniques which may not be appreciated or understood by all landlords. E.g. a diverse winter cover crop may resemble a field of weeds to the uninitiated.

2.2. Rotational cropping and introducing livestock to arable rotations

Rotational cropping and investing in livestock infrastructure (fencing and watering) should be feasible for secure or long term tenants unless the lease restricts activities to purely arable production. With short term leases there is the temptation to focus on short term gain at the expense of a diverse rotation.

2.3. Farm infrastructure - standards of slurry collection and storage

Scot Gov's recent consultation, 'River basin management plans - silage, slurry and anaerobic digestate – improving storage and application' has raised much concern in the tenanted sector: Firstly, the tenanted sector will have a disproportionate higher amount of old, pre-1991, slurry stores which need to be addressed; and secondly, there will be arguments over who - landlord or tenant - is required undertake the investment needed to bring up to standard. It is potentially a very big hurdle for tenants to undertake with limited access to finance where landlords are not willing to invest.

2.4. Domestic housing standards and energy efficiencies

Part of the drive to net zero will be improving the efficiency of domestic housing, and housing within agricultural tenancies is currently not subject to the Repairing Standards which applies to other let housing. There is potentially a big investment burden within the tenanted sector to bring housing up to not just the Repairing Standards but also up to future energy efficiency standards. As with slurry storage, there will be arguments as to who provides the investment - landlord or tenant.

2.5. Renewable energy - solar, wind, hydro, AD, biomass

Schedule 5 list of agricultural improvements of the 1991 AHA Act was updated in 2018 to include the 'Installation, provision, distribution or storage of electricity, gas, power, heat or light', which should cover some renewables.

However, this recognition of renewables as an agricultural improvement is deemed to apply only to situations where the majority of the energy produced is used on farm. Projects where the majority of energy is exported off-farm would be deemed as a non-agricultural diversification which is more problematic for tenants.

Access to finance, as covered in 1.5 above, is a hurdle for tenants so the more capital intensive renewables are not common on tenanted holdings.

As covered in 1.6 above, with agricultural leases being limited to fields and steadings, access for services through woods and other areas not included in the lease may be an obstacle for on-farm renewables.

2.6. Future energy standards - recharging points for farm kit - electric and probably hydrogen

The tenanted sector in Scotland tends to be concentrated in the more marginal and remote areas which are likely to suffer from limited national grid capacity, for both import and export of electricity. That may limit recharging capacity.

2.7. Sequestration - possible obligations to maintain or manage a percentage of the holding for sequestration

An obvious area to manage for carbon sequestration is existing woodlands, however for tenants the woods are generally not included in the lease. Such a requirement to manage a percentage of the holding for sequestration is likely to have a disproportionate effect on tenanted holdings.

2.8. Areas outside of the lease

Covered above in 2.7, 2.5, & 1.6.

2.9. Controls over permanent pasture and/or rough grazing to avoid releasing carbon

Should not be a problem for tenants providing the area was permanent pasture at the start of the lease and there are no lease obligations to improve the permanent pasture. Providing the areas were permanent pasture of rough grazings at the start of the lease the tenant should not be liable for loss of agricultural productivity.

2.10. Biodiversity - possible obligations to maintain, create or manage part of the holding for biodiversity

As with 2.7 above, areas of biodiversity, e.g. woods, water courses etc, while available for owner-occupiers, are generally not included in farm tenancies. Such an obligation may have a disproportionate effect on farm tenants compared with owner occupiers.

2.11. Following UK CCC policy outline - potential controls on livestock numbers

This should not be disproportionate on farm tenants (assuming it is aimed at intensive livestock systems) - the more intensive livestock production systems which require high capital investment are more likely to be found on owner occupied farms.

The only problem may occur if the livestock carrying capacity of the holding is detailed in the lease (as is often the case with hill and upland farms), and Govt. policy requires a reduction in numbers to below the lease requirement.

2.12. Woodland creation - risks and rewards - tenant/landlord

Tenants might be advised at present to avoid large scale plantings which would reduce the agricultural productivity of the holding. However, on most farms there are smaller unproductive

areas which could be planted. Though not of commercial scale there are amenity and environmental benefits. Current woodland creation schemes appear to be aimed at single larger scale plantations, but there is potential for lots of small woodland areas on farms which would require a simplified scheme.

2.13. Carbon off-setting - obligations /rewards - tenant/landlord

Who would benefit from carbon gains, both in soil and timber - landlord or tenant? Is increased soil carbon a mineral (reserved to the landlord) or a manure (a tenant's improvement)? There are both rewards to consider, e.g. carbon credits, and potential liabilities, e.g. where a woodland plantation might fail due to wind-blow.

2.14. Public Access

Public access is recognised to bring benefits to public health, and farmers are being encouraged to provide footpaths etc. This is problematic for tenants - often areas outside of the lease (woods, margins etc) act as ransom strips to path creation, and the path creation leads to reductions in agricultural productivity.

2.15. Restoration of wetlands and other re-wilding

In common with some other environmental proposals, these options reduce the holding's agricultural productivity and are likely to be a risk for tenants resulting from dilapidations or the need to reinstate.

2.16. Determination of rent

The Section 13 rent test of the 1991 AHA contains provisions for dealing with the determination of rent. Developed with agricultural value in mind, it has it's own problems, one of which is uncertainty around the effect on rent of non-agricultural diversifications including tree planting, renewables for exporting energy, environmental schemes and other diversifications. Concerns over the effect on rent is one reason why these types of diversifications are less common in the tenanted sector.

Conclusion

The risks for the tenanted sector are twofold: firstly, tenants may not be able to benefit from the new environmental and climate mitigating proposals; and secondly, some of the proposals, e.g. re-wilding and forestry, maybe more attractive for a landlord than having an agricultural tenant, especially on the more upland areas which are the traditional route into farming for new blood.

Mitigating the first risk may require changes to tenancy legislation to allow the move away from purely agricultural production, and all future policy should be feasibility tested for the tenanted sector.

The second risk, that tenants are replaced by re-wilding or trees, could be mitigated by ensuring a robust link between future support and continued agricultural activity.

Fergus Ewing has promised a level playing field for tenant farmers, to allow equal access to benefit from future policy for both tenants and owner occupiers. That is a reassuring approach, but further thought is required to consider the feasibility of new policy for the tenanted sector.

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