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Think Piece

# Land Use and Climate Change in 2011 and 2021: Reflections on a Changing Narrative

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<sup>1</sup> Many thanks for feedback from Prof Colin Campbell FRSE, CEO James Hutton Institute and Pete Ritchie, Executive Director, Nourish. The usual disclaimer applies that any errors/omissions remain the author's.

## Key Messages:

1. This paper compares the key findings from the RSE's 2011 *Report section on Land Use and Climate Change* with those of the 2021 *Farming for 1.5 Inquiry Report*.
2. Over 80%<sup>2</sup> of Scotland's terrestrial areas are under "some form of agricultural management". The land use challenges highlighted in the 2011 Report are similar to those listed in 2021, namely the high carbon footprint of agriculture, and the continuing decline in biodiversity.
3. The approaches highlighted in the 2011 Report (adaptation, mitigation, integration, increased knowledge, management, ecosystem services) re-emerge ten years later in the 2021 *Farming for 1.5 Report*. In addition, and importantly, we see refinement and disaggregation of those approaches, and we see *new themes* emerging due to advances in understanding in technology, soils, precision agriculture, animal breeding, feed and health.
4. Key new elements include:
  - a. A disaggregation of greenhouse gases and associated plans for emissions control;
  - b. More nuanced mitigation menu that brings together enhanced understanding of (i) farmers' management options according to their actual farm management systems and (ii) animal nutrition and breeding;
  - c. The centrality of knowledge, science, networks and multiple agencies in creating and sustaining change.
5. Two key fundamental differences in emphasis between the Recommendations in 2011 and 2021 are that, firstly, 2011 places a focus on *integrated systems*, whereas 2021 also puts *people and mindset-change* at the centre. Secondly, human behavioural change needs to be underpinned by science, support and legislation, through collaboration.

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<sup>2</sup> This figure is sourced from combined analysis of: "70% agriculture, 18% forestry" (Just Transition Commission Scotland (2019) papers) and "Agricultural area, including common grazing, totalled 6.16M hectares in 2015, representing 79% of total land area in Scotland" (Economic Report on Scottish Agriculture (2020)).

## Telling the story from 2011 to 2021: key sources

The core approach to writing this paper has been to compare, broadly, two seminal reports in Scotland. Firstly, the RSE's own 2011 Inquiry Report section on Land Use and a Low-Carbon Society. Secondly, the 2021 Report from the "Farming 1.5 Inquiry" on *Farming and Climate Change in Scotland: from here to 2045*. This dual review paper then concludes with reflections on the ways in which the two reports have presented the land use and climate change narratives, and importantly their conclusions, bringing out similarities and differences over the intervening ten years.

## The RSE's 2011 Report: Facing up to Climate Change

The overall narrative of the RSE 2011 Report<sup>3</sup> focused on the **barriers** to achievement due to the "*challenge that climate change poses*". The single most important finding of the authors ten years ago is that "*change is held back by the lack of coherence and integration of policy at different levels of governance*". In particular, disconnection appears between policies at different levels (EU, UK, Scottish, local authorities, local communities, households and civil societies), impeding progress and generating a lack of trust amongst the general public. Given this reported disjointedness, the report's "take home message" is that coherent action is paramount at all levels if Scotland is to reap the benefits of a low-carbon society: "Everyone has a part to play in seizing a once-in-a generation opportunity". The authors proposed a number of Primary Recommendations focused around: the electricity grid in Scotland; regulation in relation to carbon emissions, in particular energy efficiency in buildings and transport; policy integration; integrated spatial and regional plans; the role of the finance industry; and role of, and engagement between, local authorities and local communities, civil society, markets and state.

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<sup>3</sup> <https://www.rse.org.uk/wp-content/uploads/2016/09/RSE-Inquiry-Facing-up-to-Climate-Change-Full-Report-med-res.pdf>

## The RSE's 2011 Report: Facing up to Climate Change: Key Economic Sector – Land Use

When examining Scotland's Land Use and its role in contributing to a low-carbon society (Chapter 6, pp.70-82; and Key Economic Sector, pp.137-145), the authors explore the then **current status** of agriculture, forests, soils, waters and biodiversity, before moving on to set out the **opportunities and challenges** in the shift to a low-carbon society in those same areas. Their key points are summarised.

**Land:** this resource is finite and under pressure, particularly from Scotland's growing population which was expected to increase to 5.54 million by 2031, meaning more land taken into the built environment. As more land is developed, its availability for other uses reduces, including food production, biodiversity and ecosystem services. Further, converting or using land for renewable energy also creates its own pressures.

**Agriculture:** about 60% of Scotland's land area is taken up with agricultural use, dominated by livestock systems on enclosed or free-ranging land, with arable agriculture covering 11 % land area. The Land Capability for Agriculture (LCA, 1980s) classification system is based upon the physical constraints on land use. Climate is a key component in determining the LCA class; therefore, any change in climate has significant implications for land capability and therefore how land use is planned and managed at local, regional and national scales.

**Forests:** in 2011, woodland covered approximately 17% of the land area (c1,342ha) against a Scottish Government 2050 target planting rate of 10-15kha/year leading to an increase of 25% in that timeframe, versus a decline in planting rates.

**Soils:** Scotland has a wide variety of soil types due to a diverse geology, climate and variations in topography which cause further local-scale variation. Our strongly maritime climate means that, compared with most other European countries, Scotland's soils are more organic, leached, acidic and wetter. These soils form the basis of Scotland's agriculture and forest industries, and deliver ecosystem service benefits, including by storing and filtering water, and being a carbon store.

**Waters:** within the Scottish River Basin District (SEPA Inventory), there are 2,012 river, 309 loch, 284 groundwater, 40 estuary and 449 coastal water bodies; these provide a crucial link between the land-based and marine-based components of the carbon cycle. Carbon released from the soil by tillage, forestry operations, disturbance and erosion is constantly being transported via rivers and lochs to estuaries and coastal. Over the last two decades, the concentrations and loads of total organic carbon (TOC) in many of Scotland's rivers roughly doubled.

**Biodiversity:** Approximately 370 species of national and international importance (in terms of conservation) occur within 1,451 protected areas in Scotland which collectively cover around 12% of Scotland's land area. The SNH (2010) update on progress highlighted the need to: take into account the changing 'climate space' for each species and habitat; promote ecological networks and connectivity; consider the translocation of species from sites with inadequate ecological networks to new sites; and undertake a risk assessment of the threats posed by colonisation by non-native species (including pests and diseases).

## The land use opportunities and challenges in shifting to a low-carbon society in 2011

The authors focus on the need both for **adaptation** (due to impact of climate change *on* land, agriculture, forests, soils and water) and **mitigation** (due to the *role* that land, agriculture, forests, soils and water can all play through “skilful management” within a “few years”, for example in sequestering carbon).

**Land use – agriculture and forests:** the main areas of opportunity in the 2011 report are *emission reductions from agriculture alongside increase in woodland cover* (as carbon sinks), with the recognition that neither are simple solutions – either in isolation or together, due to the complexity of drivers within which both agriculture

and forestry operate. It is stated that, in 2007, agriculture contributed about 10.2% of Scottish greenhouse gas emissions out of a land use total of 13.2%, with **methane** (primarily from livestock) and **nitrous oxide** (primarily from adding fertilisers and manure to the soil) being significant contributors. The 2011 Report highlights the *Farming for a Better Climate* initiative<sup>4</sup>, funded by the Scottish Government and launched in 2010, listing the management options for farmers to lower **nitrogen** emissions and reduce costs (Box 2, below).

Although the 2011 analysis (using marginal abatement cost curves [MACC]) showed that managing land use to abate greenhouse gas emissions was an attractive *policy* option, nonetheless: “pressures to produce more food and energy are most easily achieved by activities that *increase* emissions, for example by applying more fertiliser or employing increased mechanisation... particularly if the area of good land is reduced...”. Similarly, the 2011 Report highlights

List of management options for farmers in the *Farming for a Better Climate* initiative:

1. optimising the timing of fertiliser application
2. substituting legumes for artificial nitrogen
3. livestock managed in ways that reduce the amount of methane they produce
4. undertaking low disturbance tillage of soils to minimise carbon loss
5. reducing the number of machinery passes in arable cultivation
6. increasing sequestration (in soils and in above-ground biomass) e.g. by conversion of arable land to trees and grasslands, peat restoration
7. use of carbon-neutral energy crops
8. increasing density of forest stands
9. managing forests in ways that increase sequestration and reduce ‘leakage’

Box 1: Management Options for Farmers to **Lower Nitrogen Emissions** and Reduce Farmers’ Costs; as cited in the 2011 RSE Report.

<sup>4</sup> <https://www.farmingforabetterclimate.org/about-us/> (see Newsletters dating back to the first one in December 2010)

how forests and grasslands have the potential to act as carbon sinks. Whilst recognising the pressure and desire to increase the area under forest (the *Scottish Forestry Strategy*), the authors also highlight that “land best suited to growing trees is the same as used for the beef cattle industry, another mainstay of the Scottish agricultural scene and the rural economy”. They call for an integrated approach, such as in the then proposed *Land Use Strategy*.

**Soils:** whilst *integration* between competing land uses is called for in relation to agriculture and forestry, the authors state that *increased knowledge* is needed to support Scotland’s soils in the context of climate change. Although there are policies and strategies to protect carbon-rich land and soils, the authors state that there is a large knowledge gap that is a “barrier to more informed decision-making”, particularly in relation to protecting or restoring peatlands. The authors argue that there is a need to know the peatland’s condition and how it will adapt and respond to future climate change. Only with this knowledge can we know whether practices that *currently* maintain the health of peat bogs (fires [including muirburn], trampling, drainage [or gripping], peat cutting and other land management practices) will continue to do so in the context of *future* climate change.

**Water:** the main focus is on *management* to realise new opportunities associated with Climate Change. Firstly, away from energy-intensive, water-treatment compliance approaches (via SEPA and the Water Quality Regulator for Scotland) towards those that involve natural processes, changes in management practices and a catchment-focused. These include natural filtration

processes in river catchments and changes in farming practice (especially the use of fertilizers and pesticides and the management of livestock and their wastes). Secondly, in the management of *organic matter in transit*, through managing tillage, forestry operations, and the installations of on-shore wind turbines, so that the export of carbon into water bodies is minimised, thereby reversing the recent upward trend. Thirdly, through river catchment approaches for management of flood risk, following the *Flood Risk Management (Scotland) Act 2009*.

**Biodiversity and Ecosystem Services:** the 2011 Report’s authors emphasised that maintaining *ecosystem resilience* is a key goal alongside the *promotion of ecosystem services*. Land supports agriculture and forestry. Land is also “multifunctional”, supporting wellbeing through “the provisioning of clean and nutritious food, clean air and water, energy and flood management, as well as health and fitness through recreation and enjoyment of the outdoors”. Land and landscapes also support tourism and ecotourism, as well as a world-class food and drink industry.

A changing climate will clearly affect that natural environment, meaning that it must be managed, with the Scottish Government and its agencies favouring the *Ecosystem Approach*, recognising the interdependence of human and ecosystem wellbeing. The Ecosystem Approach “is a strategy for the *integrated management* of land, water, and living resources that promotes conservation and sustainable use”, comprising four categories of benefits that humans receive: *Supporting Services* (soil formation, photosynthesis, primary production, nutrient cycling and water cycling); *Provisioning Services* (food, fibre, fuel, genetic resources, biochemicals,

natural medicines, pharmaceuticals, ornamental resources and fresh water); *Regulating Services* (air quality, climate, water supply and purification, disease and pest control pollination, and protecting against erosion and natural hazards); *Cultural Services* (through spiritual enrichment, cognitive development, reflection, recreation and aesthetic experiences – i.e. taking account of landscape values). A systems approach takes an integrated view of the interactions between these four categories of services, offering potential to evaluate potential consequences of decision-making at multiple scales.

## Land Use and Climate Change: the 2011 key points and conclusions

Given the above *status quo* in 2011, and the perceived opportunities and challenges at the time in relation to climate change, the authors' concluding themes can be summarised as follows. Scotland's land, soils, forests, waters and biodiversity are all likely to be significantly altered by climate change, offering opportunities for mitigation and adaptation. The key priorities for action are around: *integration* (agriculture and forestry); *increased knowledge* (soil management); *management approaches* (water); and *a whole system approach* (for biodiversity, through Ecosystem Services). These actions need to be delivered against a backdrop of a "complex array of natural, social and economic factors" within Scotland.

While global-level imperatives (securing food, water and energy) are also alluded to within the report, they are not explored in any depth.

The **specific land-use elements for Scotland in the face of climate change** are summarised as follows:

- Land use, soils and water offer opportunities to sequester carbon and mitigate the effects of climate change by changing production systems and the management of soils, especially peatland
- Actions on forestry, soil carbon and restoring peatlands each have the potential to reduce emissions in 2020 by hundreds of thousands of tonnes
- All actions to reduce emissions from land use have beneficial effects on ecosystem services – if we can cut emissions we improve the environment
- The cost of reducing emissions through land use change is low in relation to other means of cutting emissions
- The Scottish Land Use Strategy and the Ecosystem Approach it calls for, employing the concept of ecosystem services, offers a way of balancing environmental, social and economic demands on the land

We shall refer to these aspects again during the remainder of this paper and in final reflections.

## 2021 “Farming 1.5 Inquiry” on Farming and Climate Change in Scotland

### Background to the 2021 Report

**Farming for 1.5**<sup>5</sup> was established in 2019 as an independent inquiry by the National Farmers Union of Scotland (NFUS) and Nourish Scotland with the purpose of developing a “consensus roadmap” for farming in Scotland in the context of the climate and nature emergencies, alongside the Scottish Government’s commitment to net zero by 2045. The Inquiry Panel published its interim and final reports<sup>6</sup> in November 2020 and August 2021 respectively.

The *Farming for 1.5* Inquiry highlights not only the drivers of Scottish Government net zero 2045 commitments, Scotland’s Environment Strategy (2020) and the Statement of Intent<sup>7</sup> for Biodiversity (Dec 2020), but also retailers’ and processors’ supply chain commitments alongside banks’ and investors’ views of risks associated with climate emergencies. All this sits within the global context of the current UN Decade of Ecosystem Restoration. The 2021 Report therefore takes a slightly wider “sweep” than the 2011 Report in terms of the global context and drivers affecting land use.

### The 2021 Report’s starting point

As with the 2011 Report, the 2021 Report sets out the challenges when seeking to address Climate Change. With over 80% of Scotland’s terrestrial areas being “under some form of agricultural management”, there are some similar high-level, land use challenges in 2021 as in 2011. Firstly, Scotland’s agriculture has a high carbon footprint, with emissions around 7.5Mt of CO<sub>2</sub> equivalent per year (c20% of the Scottish total), due to its focus on livestock production since most of Scotland’s land is unsuitable for growing crops commercially. Secondly, Scotland’s biodiversity is in continuing decline (*State of Nature Scotland* 2019 report).

Although the approaches highlighted in the 2011 Report (adaptation, mitigation, integration, increased knowledge, management, ecosystem services) re-emerge in the 2021 *Farming for 1.5 Report*, they are not all categorised in the same manner. Some do come through clearly, such as emissions, mitigation approaches and agroforestry. However, the 2021 Report proposes a plan of action that pulls together these different approaches, refines them, unpacks them into their component parts, and then reassembles them into a land use approach putting people at the core: farmers, scientists, the public, politicians, communities, conservationists, civil servants. There are six major themes in the 2021 Report that build on, yet show marked points of difference from, the 2011 RSE Report, and these are briefly discussed in turn below.

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<sup>5</sup> <https://www.farming1point5.org/>

<sup>6</sup> <https://www.farming1point5.org/reports>

<sup>7</sup> Scottish biodiversity strategy post-2020: statement of intent - gov.scot ([www.gov.scot](http://www.gov.scot))

## Emissions Reduction

Significantly, the 2021 Report recommends targets for **each of the three key greenhouse gases rather than focusing on “greenhouse gas emissions” as one totality with a single reduction target**. The Panel concluded that, by addressing individual gases, it would be possible to allow the “impact and persistence of *each gas* to be factored into a reduction strategy with measures that are quantified and audited... and understood by farmers and his/her team.” (p.43). The targets defined in the report are believed to contribute to national reduction:

- **Carbon dioxide:** efficiency savings in the next ten years, while preparing for fully decarbonising farm machinery in the 2030s
- **Methane:** 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
- **Nitrous oxide:** 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

## Mitigation Menu

The RSE 2011 Report highlighted nine *Farming for a Better Climate* management options for farmers, including: optimising fertiliser application; reduction of methane production through livestock management; low disturbance tillage; reducing machinery passes; conversion of arable land to trees and grassland; and management of forests to increase sequestration (Box 1, above). At the same time, the 2011 Report also recognised *the pressures on farmers to produce more and produce faster*, with the associated challenges therefore of implementing such mitigating measures.

The 2021 Report *also* highlights this same challenge “*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*” (p.49). Recognising these pressures, the Report proposes a dual approach of Whole Farm System Change towards Low Emission Production, tailored to *actual farm management systems* and their future development:

- Approach A covering **precision farming**<sup>8</sup>, which 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.

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<sup>8</sup> This can be defined as a series of strategies and tools that allow farmers to optimise and increase soil quality and productivity putting in place a series of targeted key interventions, a result that can be accomplished thanks to the introduction of increasingly advanced technologies.

Comparing the 2010 Farming for a Better Climate list (Box 2, above) with the 2021 Farming for 1.5 list (Box 3, below) **Mitigation Menu**, we can see the nuanced understanding that has developed in the intervening 10-11 years, reflecting the significant advances in technology and further understandings in soils, animal breeding, feed and health:

Farmers are encouraged to deliver "Baseline Requirements" (5-year cycle soil analysis plus designating 10% of their area to support biodiversity) and choose three initially from this list, with more options required over time. Importantly, there would be emphasis on results measurement and data collation (on "greenhouse gas reduction contracts") with support from the advisory service.

### Agroforestry

The 2011 RSE Report highlighted how forests (and grasslands) have the potential to act as carbon sinks. However, the key challenge is that land best suited to growing trees is the same as used for the beef cattle industry – creating an inherent complexity around competing pressures on land, and the need for a multifunctional approach to land use in the context of climate change.

The 2021 Farming for 1.5 Report similarly recognises this complexity. However, the authors' focus is on **agroforestry**, defined as "the growing of woody perennials on the same piece of ground as an agricultural crop, either livestock or crops" (p.49). They highlight how agroforestry is recognised internationally as "a sustainable climate-smart agriculture option that can help deliver on many Sustainable Development Goals"

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 Anaerobic Digestion (AD) plant
7. Slurry/manure exchanged with another farmer
8. Slurry stores covered
9. Application of organic manure/slurry/compost on at least 25% of cropping area
10. Spring cultivation 1
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. 1Herd or Flock Sires – balanced breeding goals – index top 25%

Box 2: Farming for 1.5 Mitigation Menu

because it has the potential to **deliver carbon sequestration and biodiversity gains** without significantly reducing (and even increasing) the productive potential of a farm. Agroforestry can enhance agricultural production depending on planting methods, time scale and species choice. There are associated reductions in nitrate leaching, they contribute to improved water and air quality, support biodiversity and improve soil structure, can protect better quality pasture, improve animal health by providing a diversity in diet, and give protection from adverse weather. The Panel also states that suitable agroforestry species can deliver good quality timber for a range of markets, “with resultant benefits to increasing resilience in Scotland’s woodland resource, landscape and rural businesses”. They argue that agroforestry remains one of the most effective ways to achieve Scotland’s climate goals in both mitigation and adaptation across a range of soil types, while improving agricultural and biodiversity resilience and providing a diversity of products.

Despite these considerable benefits, there is limited experience of agroforestry in Scotland, and agroforestry remains absent from the current Scottish Forestry Strategy. There are a number of barriers that need to be addressed, including: farmer perception (including that trees bring problems to livestock); landscape aesthetic appeal; lack of knowledge on silviculture in the farming community; resistance in the forestry sector; land ownership and tenancy issues; and a lack of key policy incentives. The Panel therefore 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.

### Land Use Change

The 2021 Report talks of “cumulative landscape impact” of: farm-level changes (e.g. 30% of the holding being used for sequestration and 30% for biodiversity; legumes in the rotation; wide uptake of agroforestry); grassland and upland habitat restoration; peatland restoration; and commercial afforestation. This cumulative effect creates intended as well as unintended consequences. Therefore the Report set out the need for land use change to be “planned to optimise economic, environmental and social outcomes rather than be purely market-driven”. They emphasise the need for **Regional land use planning** to “bring stakeholders together to discuss future land use scenarios and options” as a form of “polycentric governance” (p.55). It is important to note that although Regional land use planning is a requirement of the 2019 Climate Change Act, with five areas of Scotland designated as pilot areas, partnerships are not yet fully operational.

### Implementation and costs for land use change for climate benefit

The *Farming for 1.5* Report proposes a **series of pilots to encourage/test adoption**, including: establishing agroforestry schemes; methane-reducing feed additives; controlled-release fertiliser; scrappage scheme for broadcast slurry spreaders; and ambitious livestock health improvement measures.

They also consider **financing the change**. The Report recognises that while some costs can be borne by the agricultural support envelope, others will require upfront investment. This must come either from Scottish Government to accelerate and sustain change, and/or by a combination of: farmers; the end customer; processors and retailers; business that benefit directly and/or wish to offset residual emissions; and investors in carbon reduction schemes. The authors also point to the need for a “*just transition*”, that is, support for more marginal, cash-poor farms to make these changes.

### Principles and Recommendations

**Principles:** the *Farming for 1.5* Report sets out Principles to underpin the proposed land use/climate change action plan. They highlight themes of **integration** and **emissions reduction** (echoing the 2011 RSE Report) – with targets for individual gases. Additionally, they focus on the role that **everyone** has to play, the explicit need for **science** to inform process, for a “science-informed climate and nature literate” **transformation group**, for **adoption practices** and associated **advisory support** to be part of the mix, and for **land use change to be planned** rather than left to the market.

**Recommendations:** the *Farming for 1.5* Report concludes that their recommended transformation process “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.**” They recognise that while some farmers in Scotland are *already* delivering on best practice, it is still important to make it easier for everyone to adopt best practice and for all farmers to innovate.

They argue that this involves **redefining the role of farmers as stewards**, where delivering for nature and climate are on an equal footing with producing food, meaning that:

“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”. (p.59).

The Report’s 15 Recommendations (Box 3, below) echo this stance. They bring in **human behaviour for farmers** (e.g. continuing professional development, training, advisory service; through training and employing young people) and for **the academic community to engage with farmers** (e.g. establishing a farmers’ advisory panel as a reference group for the Strategic Research Programme; farmers, academics and Scottish Government working together to accelerate advances). They are also underpinned by **science, systems thinking**, and **hands-on actions** (mitigation menu, agroforestry targets with ringfenced budget, regional land use planning and modelling, and soil carbon trading).

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 AgriTech 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 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.

Box 3: *Farming for 1.5* Panel Recommendations from 2021 Report

## Concluding reflections in comparing the two narratives: 2011 and 2021

The **2011 RSE Report section on Land Use and a Low-Carbon Society** provides a thorough analysis of key land use components under threat and the opportunities for greenhouse gas emission reduction afforded by agriculture, forestry, soil carbon and peatland restoration. The challenges of integration are discussed, primarily due to the drivers pressuring agriculture, with an Ecosystems Services approach being called for as a way of balancing environmental, social and economic demands.

The **2021 Farming for 1.5 Report** echoes many of the findings from its 2011 predecessor, in terms of high-level threats posed by, and opportunities to be realised from, the land-based sector, where over 80% of Scotland's terrestrial area is under some form of agricultural management. Integration and systems thinking are still writ-large, with the continued focus on emissions reduction, the importance of woodland and soils, and of a regional approach. Where the 2021 Report has moved its arguments *further* include: the explicit roles both of people and science – both separately and as integrated into mobilised networks – and for a timed, monitored plan built on data, evidence and resources. There are also specific *refinements* of the 2011 arguments, for example: the need to consider greenhouse gases separately rather than as a collective; and the push for agroforestry as a strategy and as an effective means to tackle climate change.

Perhaps the difference that stands out the most, however, is that while the 2011 Report Land Use section appears to focus primarily on *systems*, the 2021 Report does so but concludes with the critical recognition that transformation requires the support of a *change in mind-set* – through collaboration, underpinned by science, support and legislation. This *human behaviour* element is critical to the Inquiry's Principles and Recommendations<sup>9</sup>.

*These think pieces are the personal views of the contributory authors. The views expressed are not necessarily those of the RSE but are intended to offer different perspectives on current issues.*

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<sup>9</sup> It is recognised that the overall 2011 Report's chapter 10 on Multi-level Governance does address issues of roles for communities, importance of regional approaches, and discusses "the role of individuals, civil society, business and the state", with the Recommendation that "Closer engagement is needed between people, civil society, market and state in the pursuit of Scotland's low-carbon society". However, the Land Use Chapter (6) does **not** develop these points in any detail.



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