



A New Blueprint For Scotland's Arable Sector

The Arable Climate Change Group

March 2021

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[July 2021 – Document revised, in accordance with the Public
Sector Bodies (Websites and Mobile Applications) (No. 2)
Accessibility Regulations 2018.]

Cover photograph courtesy of Crafty Maltsters

Arable Climate Change Group

Chairs foreword

In November 2020 the Cabinet Secretary for Rural Economy and Tourism Fergus Ewing MSP invited me to form a farmer led group with the purpose of recommending practical but importantly, evidence based measures that the arable and horticulture sector can implement to reduce greenhouse gas emissions and demonstrate how this sector can help achieve the Scottish Government's statutory climate change targets.

This is a fabulous opportunity for Scottish Agriculture to show real leadership and ambition in what are unprecedented times of change, forming ideas and solutions compatible with nature but importantly still being production-oriented to match Scotland Food and Drink ambitions.

Setting up this group in the middle of a global pandemic was never going to be easy, with all meetings conducted virtually which in many ways allowed an intensity and focus which might not have occurred otherwise. Early in the process it was realised that measures implemented in isolation would not take us forward; this led to recognition that a whole farm holistic approach is required. I am determined that this concise readable report can and will be used by Government and the wider industry as a template not only to meet greenhouse gas reduction targets but to allow Scottish farmers to be both profitable and sustainable, working with scientifically proven methods and good common sense.

There is no silver bullet but many approaches and methodologies (highlighted within this report) that all farmers and growers can draw down on to suit their own unique circumstances to reach individual and national outcomes. I must acknowledge that most of the heavy lifting in producing this document fell to Alison Milne who kindly agreed to be rapporteur for the group, pulling together the research and excellent written documentation taken from the call for evidence; therefore deep gratitude to those individuals and organisations who took the time to respond in what was a very tight timescale.

The individuals within the Arable Climate Change Group must also be acknowledged for timely responses and contributions, all are named at the end of the report. I also need to thank Mike Parker and Rosie Anfield who were exemplary in the role of secretariat for the group often responding late into the evening and weekends to allow prompt delivery of this report.

Andrew Moir

Arable Climate Change Group Chair

Introduction

A new blueprint for arable

The Arable Climate Change Group (ACCG) was formed in December 2020, building on the approach taken by the Suckler Beef Climate Change Group, and undertaking a remit to provide Scottish Government with recommendations on practical measures to:

- Improve efficiency, productivity and profitability of crops;
- Enhanced environmental contribution from the sector by identifying practical ways to reduce emissions;
- Mitigation of other environmental impacts of production and enhancing contribution to sustainable land use, especially soil health and crop management.

The full details of the group remit and a list of members can be found in Annex 4.

In this context the group's aim is to firmly position the role that Scotland's arable sector can play in contributing to long-term climate change mitigation, biodiversity enhancement, thriving rural communities and an ambitious food and drink industry. The group also wish to recognise the deeply interconnected relationships that exist between the sectors of Scottish agriculture, reflected in the holistic nature of our recommendations. For the purposes of this report the arable sector includes cereals, other crops, horticulture and vegetables (including for human consumption, stock feed, energy, industrial use and seeds).

Why Arable matters:

- In 2019, the combined output of arable produce in Scotland accounted for a third of agricultural output with a value of £1.1 billion:
- Around 580,000 hectares were used to grow cereals, crops, fruit and vegetables, accounting for around 10% of Scotland's total agricultural area. This is equivalent to 12% of the total arable land in the UK:
- Barley and wheat are the main cereal crops grown in Scotland, accounting for around 85% of the area of crop-land and much of it goes into whisky production. Indeed, 87% of barley and 50% of wheat requirements of Scotland's whisky production are sourced in Scotland.

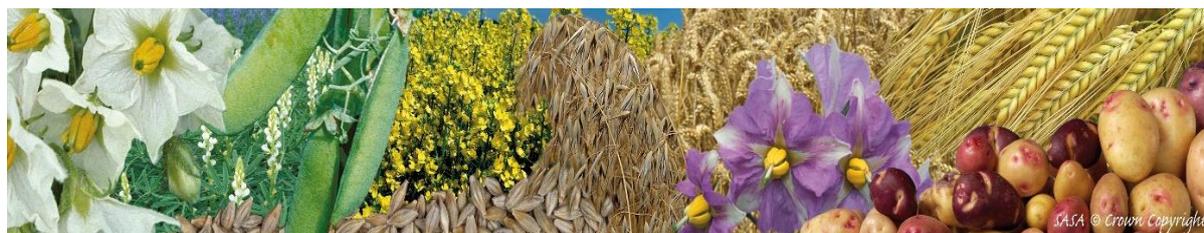


Photo credit: Science and Advice for Scottish Agriculture (SASA)

The Scottish Government target to achieve a 32% emission reduction across the agricultural industry by 2032 will require an approach that optimises contribution at individual farm level and recognises the significant impact of technological innovation and scientific research in shaping new farming practice.

Table 1: Sector Emissions Data (MtCO₂e)¹

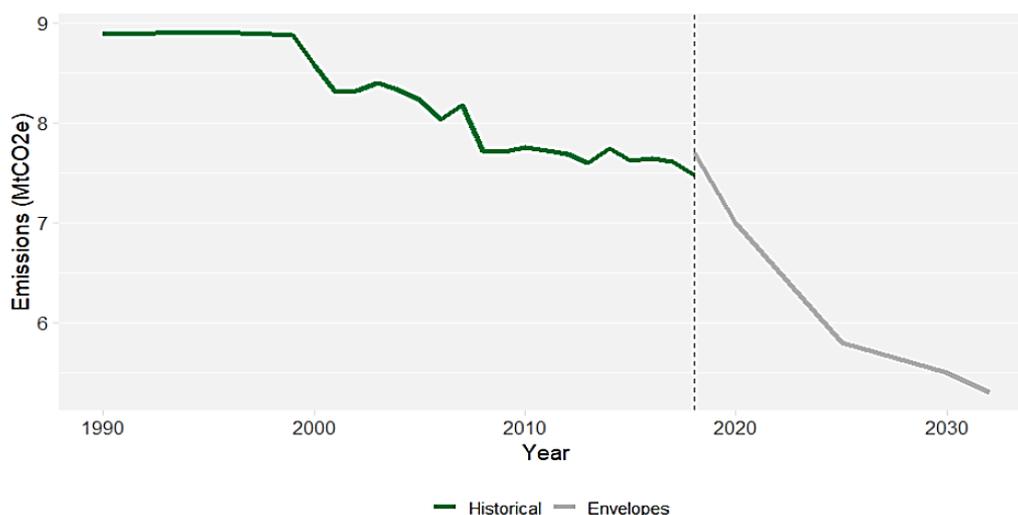
	2018	2020	2025	2030	2032
Agriculture	7.7	7	5.8	5.5	5.3
Electricity	2.2	1.7	1.3	-	-
Industry	11.6	11.5	10.7	7.3	6.5
Waste	1.8	1.6	0.9	0.7	0.7
Transport	14.8	11	7.1	6.5	6.5
Buildings	9.4	8	5.6	2.6	2.6
LULUCF	0.9	0.6	-0.1	1.8	2.3
NETs	-	-	-	-3.8	-5.7

LULUCF = Land-Use, Land-Use Change and Forestry; NETs = Negative Emissions Technologies

The ACCG recognise industry efforts have largely had to concentrate on meeting the societal need for affordable and nutritious food production. Collectively we must now strive to implement solutions that lead to the decoupling of production growth from emissions growth.

The ACCG also recognise that Scottish agriculture starts from a strong position in terms of the health of our soil and the progress made in reducing GHGs over the last 30 years. Nevertheless, as the following graph demonstrates, it is clear that if Scotland's statutory targets are to be met, then progress must be accelerated.

Figure 1: Scottish GHG Emissions from Agriculture²

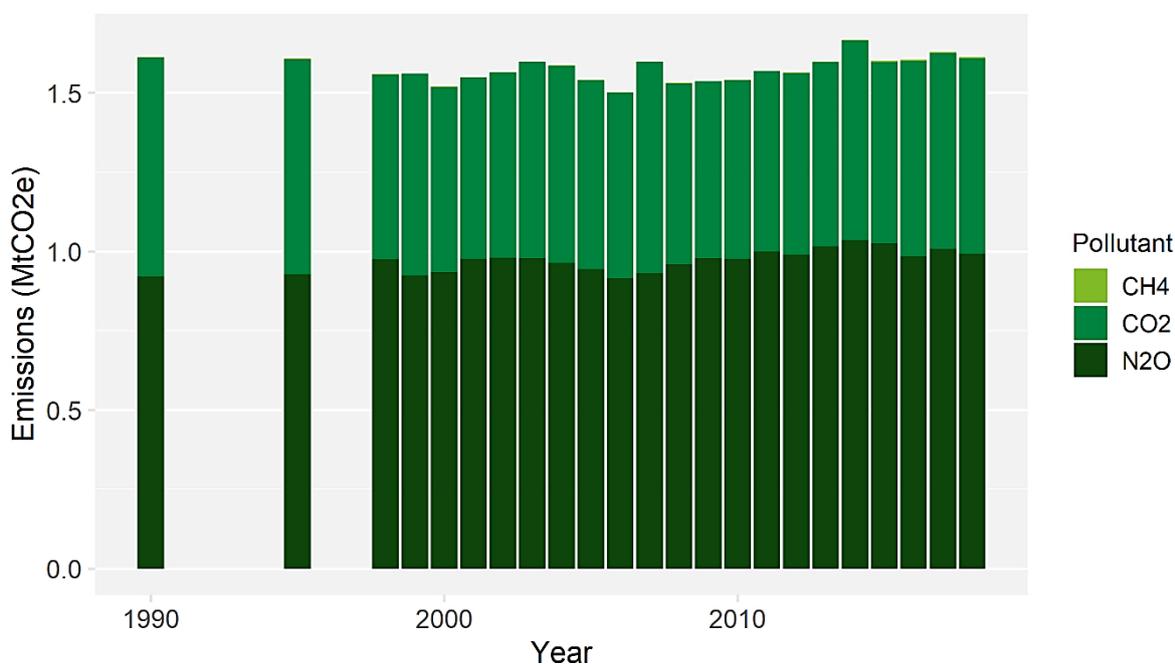


¹ Source: Climate Change Plan update 2020: Emissions envelopes by industry (MtCO₂e)

² Source: Scottish Greenhouse Gas Emissions 2018 - gov.scot (www.gov.scot), Securing a green recovery on a path to net zero: climate change plan 2018–2032 - update - gov.scot (www.gov.scot)

The arable sector has recognised how changes in farming practice can positively influence reduced Greenhouse Gas emissions (GHG's), however this has not been reflected in a reduction in overall emissions from the sector according to estimates.

Figure 2: Total Emissions from Arable, 1990 - 2018³



(Methane represents less than 1% of arable emissions and therefore does not show on the graph)

Emissions from the arable sector account for around 1.6 MtCO₂e, or 21% of total agricultural emissions. Around 60% of emissions relate to N₂O derived from fertiliser and soil management with the remainder being CO₂ largely from farm vehicles.

While efficiency of production and yields have increased, and examples of best practice exist, we have not had a coordinated strategy that effectively balances the need for climate change mitigation and biodiversity enhancement with efficient food production.

We believe this farmer-led process represents a significant opportunity. Scotland's arable sector is progressive and capable, with widespread membership of quality assurance schemes and an abundance of skilled people, contributing to many world-renowned food and drink products. The sector is not just crucial to Scotland's national brand - it is crucial to our national prosperity and presents a significant economic and environmental opportunity.

We have a bold and ambitious vision for the future of the sector – inspired by the conversations and contributions to this process, from business and organisations across Scotland.

³ Source: Scottish Greenhouse Gas Emissions 2018 - gov.scot (www.gov.scot)

To achieve this vision will require radical change and a co-ordinated approach to policy-making and action, supported by the work of each of the farmer-led groups, incentivising together economic and environmental sustainability.

The close and enduring relationship between Scottish Government policy and agriculture is fundamental to success, and this group are clear that future policy must act as an enabler, empowering industry to identify and act upon their own priorities, in relation to both climate resilience and sustainable food production.

The route-map to change must be clear, recognising the multiple audiences with which agriculture interacts. Based on this approach the group believe future policy must be driven by an outcomes focused approach, clearly demonstrating what financial support causes to happen, not what it directly pays for.



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Photo credit: Science and Advice for Scottish Agriculture (SASA)

Our recommendations

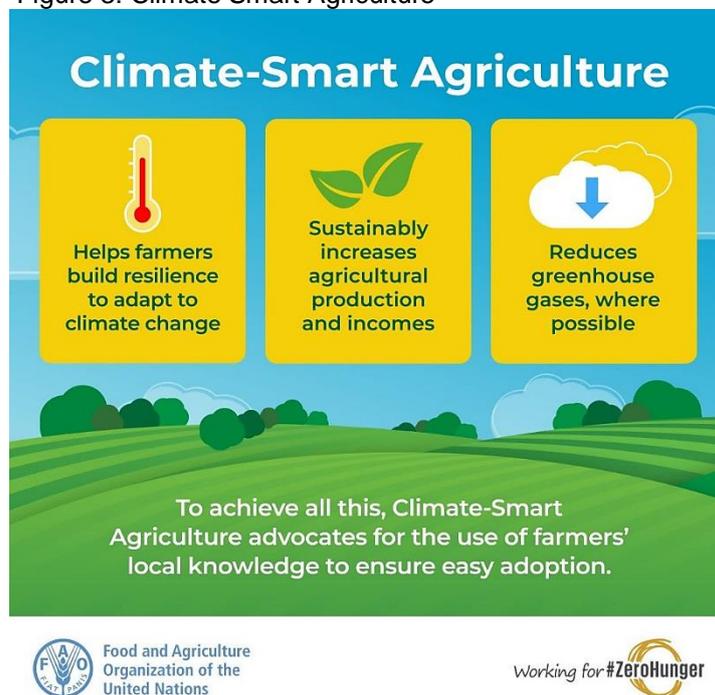
A legacy of various support schemes, over many years, has led the group to assert that producing a list of practical measures in isolation will not deliver the desired result. Only when we truly understand and buy in to the strategic outcomes, at both farm and national level, will we achieve the ACCG remit and the ambitious targets we aspire to achieve by 2032 and beyond. This view is reflected in the recommendations set out below:

1. The creation and implementation of a future industry strategy, policy framework and supporting measurement tools that are capable of adaptation as new science and evidence emerges.
2. A financial investment commitment to strengthen research, technological development and innovation that will allow the industry to achieve the Climate Change Plan targets.
3. The development and delivery of Scotland's Climate Smart Agriculture Framework – an industry route-map to the adoption of mitigation practices that lead to reduced emissions and the sustainable growth of agriculture, supported by the continuation of a Farmer Led Implementation Group.
4. The introduction of a Climate Smart Farm Plan at individual farm level, based on the principles of the Climate Smart Agriculture Framework and using the methodologies of Integrated Farm Management Planning (IFM), similar to the LEAF approach outlined in Annex 2. The Farm Plan will incorporate baseline measurements in the areas of carbon auditing, soil management, nutrient management, integrated pest management (IPM), biodiversity status, water management, and waste management.
5. A three-tiered approach to implementation, based on Good Agricultural and Environmental Conditions (GAEC) aligned to the Climate Smart Agriculture Framework, further enhanced by the introduction of standardised baseline measurements. The Climate Smart Farm Plan introduced in recommendation 4, will be a conditionality requirement to access Tier 2 and 3 funding, supported by the practical measures outlined in Annex 3 to incentivise adaptation.
6. A commitment to the introduction of a Tier 3 support package to facilitate transformation pilots and practices that require capital investment.
7. A commitment to collaborate with industry bodies and training providers to align the principles of the Climate Smart Agriculture Framework to design and implement a knowledge transfer and training strategy, designed to maximise engagement and action

Our recommendations are based on a situational analysis of the arable sector and an assessment of its climate impacts and vulnerabilities, both of which have allowed us to outline a clear strategic direction, as well as a set of practical measures we believe can have the greatest impact on the arable sectors contribution to Scotland's Climate Change Plan.

The ACCG recognise that their aims and assessment criteria have aligned to the principles of Climate Smart Agriculture, as defined by the Food and Agriculture Organisation of the United Nations, illustrated below and explained in Annex 2.

Figure 3: Climate Smart Agriculture⁴



The Climate Smart Agriculture approach firmly positions the importance of balancing both economic and environmental resilience, a principle which the ACCG feel is fundamental in setting the strategic direction for Scottish agriculture.

The ACCG Recommendations Explained

The Call for Evidence that formed part of this process allowed the group to consider evidence from scientists, organisations and working farmers, serving to highlight the complexity of climate change science and the embryonic nature of its role within agriculture. This influenced our first recommendation:

1. A future industry strategy, policy framework and supporting measurement tools that are capable of adaptation as new science and evidence emerges.

The agriculture industry has a number of roles in delivering societal value, and the group feel it is important to recognise the balance that must be achieved across this spectrum. In particular the role played in achieving national goals in relation to health and well-being, an inclusive approach to the availability of nutritiously dense food must always be a priority. Annex 1 of the report sets out the current context or situational analysis for the arable sector, in relation to Scotland's Climate Change Plan 2018-2032, as well as the crucial role played in many food and drink value chains.

⁴ Source: Food and Agriculture Organization of the United Nations

The peer-reviewed evidence shared with the group by multiple organisations and individuals, further highlighted the opportunity that novel crops, advanced breeding and technological innovation in areas such as electric vehicles can play in the achievement of national economic and environmental goals. Before we embark on a journey to incentivise changes in farming practice we must ensure those recommendations are based on credible evidence, and crucially we must be sure that the measurement tools are fit for purpose. This view influenced our next recommendation:

2. An investment commitment to strengthen research, technological development and innovation that will allow the industry to achieve the Climate Change Plan targets.

The ACCG have already expressed the view that recommending a list of practical measures in isolation will not achieve the desired result. The group also recognise the need for our future strategy and policy framework to take a cross-sectoral approach. The ACCG therefore believe the recommendations of each of the farmer-led groups should be supported by the continuation of a farmer-led implementation group, whose remit will be based on recommendation 3 below:

3. The development and actioning of Scotland's Climate Smart Agriculture Framework – an industry route-map to the adoption of mitigation practices that lead to reduced emissions and the sustainable growth of agriculture, supported by the continuation of a Farmer Led Implementation Group.

The Climate Smart Agriculture Framework will provide a structure to support our baseline and enable transition, including the development and implementation of a new delivery model for agricultural policy and investment. We have the opportunity to remove the complexity and lack of understanding surrounding agricultural support by clearly linking it to the achievement of national outcomes. This would ensure it is well understood, accepted and celebrated for improving national economic and environmental prosperity.

The Climate Smart Agriculture Framework provides a clear industry route-map and investment strategy for the transitional journey towards realising the opportunity our industry presents in mitigating climate change and contributing to our national food and drink ambitions. It will be the tool to leverage opportunities and demonstrate that not only can agriculture support national priorities, but there are many areas where we can demonstrate leadership.

The ACCG have outlined a strategic industry direction and believe this should be aligned to activity at individual farm level. We therefore recommend the introduction of the Climate Smart Farm Plan (CSFP), supported by the principles of Integrated Farm Management (IFM), a whole farm business approach to sustainable farming, explained in Annex 2.

The IFM approach mirrors the principles of Climate Smart Agriculture, recognising the critical role that agriculture plays in not only climate change mitigation but also the delivery of nature-based solutions through agroecological and regenerative

practices, underpinning vibrant rural communities and the tourism and food and drink industries from which they stem.

Introducing a strategic and measurable approach to environmental planning at farm level will be critical to achieving targets. The ACCG therefore recommend:

4. The introduction of a Climate Smart Farm Plan, based on the principles of the Climate Smart Agriculture Framework and using the methodologies of Integrated Farm Management Planning (IFM). The Farm Plan will incorporate baseline measurements in the areas of carbon auditing, soil management, nutrient management, Integrated Pest Management (IPM), biodiversity status, water management and waste management.

The establishment of baseline measurements at individual farm level are integral to the ACCG recommendations. We must clearly understand the position from which we begin if we are to credibly measure progress. At farm level the Climate Smart Farm Plan will build on the good principles established through quality assurance schemes and be supported by a number of practical measures the group consider to be of most relevance in contributing to emission reduction and environmental enhancement, as outlined in Annex 3. The measures are proposed based on considerations of their emission reduction potential, implementation cost, and market impact.

If the Climate Smart Framework is the route-map, the Climate Smart Farm Plan is the vehicle we will use to make our journey. The ACCG recognise the transitional nature of this journey and recommend:

5. A three-tiered approach to implementation based on GAEC standards aligned to the Climate Smart Agriculture Framework, further enhanced by the introduction of standardised baseline measurements. The Climate Smart Farm Plan will be a conditionality requirement to access Tier 2 and 3 funding, supported by practical measures outlined in Annex 3 to incentivise adaptation.

Annex 3 outlines the recommended practical measures the ACCG believe will lead to greatest impact and successfully incentivise adaptation. The ACCG would also assert that a tiered approach recognises what needs to happen to allow our people and businesses to deliver, with inclusive support and a robust infrastructure, while ensuring that everything we do continues to support national priorities.

Individual businesses will reach milestones in this journey at differing stages. Recognising pioneering industry-led approaches will allow us to accelerate at a faster pace. Therefore our recommendation is for the Scottish Government to commit to:

6. The introduction of a Tier 3 support package to facilitate transformation pilots and practices that require capital investment.

We know there have been numerous papers published in the past, calling for action that, despite everyone's best efforts, were never fully achieved. We do not want that to happen this time. For that reason, we have clearly mapped out the fundamental

structural changes required for successful outcomes. We also recognise the importance of behavioural change being incentivised through carefully designed knowledge transfer and training. We acknowledge that fundamental change takes time, effort and commitment, which we do not necessarily have in the face of a climate emergency. A well thought-out engagement strategy is critical. Our final recommendation is therefore to:

7. Collaborate with industry bodies and training providers to align the principles of the Climate Smart Agriculture Framework into a knowledge transfer and training strategy, designed to maximise co-ordinated engagement and action.



Photo credit: Angus Soft Fruits

Paving the way to success

“If everyone is moving forward together success takes care of itself”

Henry Ford

The ACCG believe the reality is that only by building businesses capable of being, or becoming, both economically and environmentally resilient, will we achieve our climate targets. It is time for the sector to own its future and ensure its voice is heard, so that our ambitions and potential are delivered. It is now imperative that the actions of industry, government, and the wider supply chain speak louder than the words within this report.

We have clearly outlined the view that achieving the ambitious climate change targets will be reliant on building resilient businesses who are best placed to contribute. A legacy of agricultural support demonstrates that a single sector or single-issue approach to shaping policy mechanisms has severe limitations in achieving national strategic outcomes. Optimising performance at individual farm level will be reliant on an approach which considers the whole entity and its actions. In many ways this is a common-sense approach that has been lost, amongst the complexity of agricultural policy making and support structures which have been established over the years.

The ACCG is clear that this common-sense approach must come to the fore, whilst recognising that we must move at pace to implement change and deliver measurable results. We therefore conclude that an approach that builds on existing clear thinking and established frameworks provides a distinct advantage, removing the potential for criticism of unnecessary reinvention.

The ACCG also recognise the significant effort required to change the practices and behaviours across an entire industry and its supporting bodies, but we believe the opportunity to change should be inclusive. We believe adopting the principles of Climate Smart Agriculture through an integrated approach to farm management will achieve this level of inclusivity.



Photo credit: Science and Advice for Scottish Agriculture (SASA)

Implementation

The ambitious targets contained within the Scottish Government Climate Change Plan have been clearly articulated within this report. It is now the job of industry and its supporting bodies to demonstrate the most effective way for them to be achieved through action.

The success of any future support scheme and strategy will be determined by its ability to galvanise industry to deliver, in relation to both climate change mitigation and economic sustainability. We must therefore be clear about potential challenges and suggest ways in which they can be overcome.

The early engagement of industry in adopting a new approach and its potential benefits must be coherent and relatable.

It is important to recognise that terms like “Climate Smart Agriculture” and “Integrated Farm Management” are not widely understood, and significant resource will be required to build awareness of related concepts, aims and benefits.

A supportive advisory network will be a key resource in delivering coherent communications. We must consider if this environment exists or if it is one that must be fostered. In current advisory support structures, we often have single issue/sector portals, an approach that does not always support the principles of an Integrated Farm Management approach.

LEAF (Linking Environment and Farming), an organisation who have led the way in implementation of IFM planning, have demonstrated how peer-to-peer learning and knowledge exchange can be effectively used to deliver tangible and lasting change. We must learn from this experience and adopt its best practice. We must also acknowledge the many successful knowledge transfer initiatives that exist in Scotland, and work together to build a better future



Photo credit: Lorna Dawson, James Hutton Institute

Conclusions and next steps

The challenge with this approach will be the potential for an apathetic response coupled with the complexity of implementation. This can be overcome through authentic leadership, co-operation, and clear positioning of the purpose and outcomes. Those leading the way must connect with individual businesses to engage, inform, and inspire them with real life examples of how change can be delivered to the benefit of all.

The focus for this group was climate change mitigation but it would be remiss not to make clear that now is the time to challenge the fundamental mindsets that have developed around what the agricultural industry delivers and how its actions influence wider society. Scottish agriculture has the capacity and potential to not only accelerate our transition to Net Zero and enhance biodiversity, but also to:

- Improve the competitive advantage and reputation of our food and drink industry:
- Deliver robust and resilient local/regional food supply chains:
- Create opportunities for skills development and employment, delivering wider economic impact:
- Contribute towards the achievement of national objectives, including well-being, nutrition, and resilient communities:
- Innovate to create new market segments and deliver economic impact through collaboration with research and development organisations and institutes:
- Facilitate the development of new renewable energy opportunities.

The agricultural industry requires a strategy that recognises its fundamental capabilities and opportunities.

It is important that we acknowledge that none of this can be achieved by a group of independent people who come together to agree principles but have no responsibility for action. For Scotland to be a world leader in sustainable food production we need to assign responsibility for strategy AND action. If we do not, we will continue to fail the industry and as a result the role it can play for us all.



Photo credit: Crafty Maltsters

Annex 1 – Arable in numbers

Scottish Agriculture in the context of the Scottish Government Climate Change Plan 2018-2032 - 6 outcomes for agriculture

In December 2020 the Scottish Government published an update to its Climate Change Plan 2018-2032, setting out the path to a low carbon economy while helping to deliver sustainable economic growth and secure the wider benefits to a greener, fairer, and healthier Scotland in 2032. Part 3: Chapter 7 8 (p182) discusses the agriculture sector and current actions; Annex A (p236) further sets out 6 outcomes for the agricultural sector, with associated policies and proposals. The 6 outcomes are highlighted below:

1. A more productive, sustainable agriculture sector that significantly contributes towards delivering Scotland's climate change, and wider environmental, outcomes through an increased uptake of climate mitigation measures by farmers, crofters, land managers and other primary food producers.
2. More farmers, crofters, land managers and other primary food producers are aware of the benefits and practicalities of cost-effective climate mitigation measures.
3. Nitrogen emissions, including from nitrogen fertiliser, will have fallen through a combination of improved understanding, efficiencies and improved soil condition.
4. Reduced emissions from red meat and dairy through improved emissions intensity.
5. Reduced emissions from the use and storage of manure and slurry.
6. Carbon sequestration and existing carbon stores on agricultural land have helped to increase and maintain our carbon sink.

The ACCG consider outcomes 1, 2, 3, and 6 to be relevant to the arable sector, and Annex 1 outlining practical measures aligns each option to the relevant CCP outcome.

It was also important to the group to consider how progress will be measured in relation to these outcomes, with a particular focus on the National Inventory. The group also recognised the opportunities for income generation open to land managers through sequestration, but the group are keen that carbon credits earned through the mitigation measures put in place by farmers are retained by the sector.

The role of the arable/horticulture sector in relation to outcomes

Large reductions in emissions are required from all sectors of the Scottish economy to meet Scotland's legally binding 2045 Net Zero target, and the 75% target by 2030. In 2018 agriculture represented 18% of Scotland's emissions, or 7.5 MtCO₂e. The Scottish Government's Climate Change Plan update requires a 31% reduction in agricultural emissions by 2032, a pace nearly four times faster than historic declines.

Emissions from the arable sector account for around 1.6 MtCO₂e, or 21% of total agricultural emissions. Around 60% of emissions relate to N₂O derived from fertiliser and soil management with the remainder being CO₂ largely from farm vehicles.

Evidence suggests precision application of nitrogen and lime in addition to increased legume rotations and pH management are the areas where significant contribution is most feasible. Evidence provided by Rural Environment Science and Analytical Services Division of the Scottish Government, (RESAS)⁵ suggests that increased adoption of these measures could deliver reductions in the region of 0.3 MtCO₂e, if applied to their maximum technical capacity based on current levels of arable land. This would equate to 19% reduction of arable emissions and would not be sufficient to meet agriculture's envelopes by 2032, even if matched with equivalent reductions across all sectors. In fact it would fall short of targets by around a third.

Data on CO₂ emissions from machinery and vehicles associated with arable and horticulture is derived from a model using units of machinery (combines, tractors, etc.) and estimates of utilisation and fuel efficiency. Currently, there is limited data routinely available regarding the use of renewables and biofuels to replace the use of fossil fuels in mobile machinery, and to improve the accuracy of inventory reporting will require more data gathering/research across the sector.

The group believe that there are longer term gains for the sector in adoption of renewable technologies including electric vehicles, development of battery storage which will build on the existing use of renewables in fixed equipment such as grain dryers/climate control systems. The group would recommend that data gathering and research continues and that in the meantime businesses are supported to increase the proportion of renewable energy used in both fixed and mobile machinery, as well as where practical reducing overall energy use.

SRUC estimates suggest that of the necessary 0.46 Mt reduction required, a realistic estimate from implementation of the agronomic measures described on p13 is 0.24 Mt. This is because some measures cannot be carried out on the same land in certain combinations, or may be less effective if they are. This is mainly related to the combined uptake of slurry measures, pH management, variable liming, nitrification inhibitors and legumes on the same land. The group recognises that while technological advances will help to reduce this gap there is a need to drive uptake of these measures as high as possible and in addition to promote other measures as set out in Annex 3 if targets are to be met.

⁵ Source: <https://www.climateexchange.org.uk/research/projects/marginal-abatement-cost-curve-for-scottish-agriculture/>

The group recognises that further work will be required to put realistic figures on the impact on emissions of our recommendations and on costs of implementation. This work will be key in development of the framework in conjunction with a farmer-led implementation group.

The Climate Change Committee⁶ states changes in farming practices, woodland planting, and reductions in cattle numbers are all required to achieve Net Zero. However, the ACCG believe that this process, and the introduction of the Climate Smart Agriculture Framework, represents an opportunity to find action-orientated ways of balancing improved productivity with climate change mitigation.

The group have therefore considered a wide scope of practical measures, including some that require further research and development to support feasibility and potential impact. The group have also considered practical measures in the context of Scottish Government targets on biodiversity, recognising the impact the sector has on habitats and species diversity.

⁶ Source: <https://www.theccc.org.uk/>

Annex 2 – Climate change frameworks

The International Context

What does Climate Smart Agriculture mean?

The Food and Agriculture Organisation of the United Nations define Climate Smart Agriculture using the following three pillars -

Productivity/Food Security: CSA aims to sustainably increase agricultural productivity and incomes from crops, livestock, and fish, without having a negative impact on the environment. This, in turn, will raise food and nutritional security. A key concept related to raising productivity is sustainable intensification.

Adaptation: CSA aims to reduce the exposure of farmers to short-term risks, while also strengthening their resilience by building their capacity to adapt and prosper in the face of shocks and longer-term stresses. Particular attention is given to protecting the ecosystem services which ecosystems provide to farmers and others. These services are essential for maintaining productivity and our ability to adapt to climate changes.

Mitigation: Wherever and whenever possible, CSA should help to reduce and/or remove greenhouse gas (GHG) emissions. This implies that we reduce emissions for each calorie or kilo of food, fibre, and fuel that we produce; that we avoid deforestation from agriculture; and that we manage soils and trees in ways that maximize their potential to act as carbon sinks and absorb CO₂ from the atmosphere.

The World Bank have adopted the CSA approach and define the climate mitigation benefits in the following terms –

A focus on climate change: Like other sustainable agricultural approaches, CSA is based on principles of increased productivity and sustainability, but it is distinguished by a focus on climate change, explicitly addressing adaptation and mitigation challenges while working towards food security for all. In essence, CSA is sustainable agriculture that incorporates resilience.

CSA = Sustainable Agriculture + Resilience – Emissions.

What does Integrated Farm Management mean?

The term Integrated Farm Management (IFM) is widely used but often little understood, resonating with many as an iteration of 'good farming practice'. It will be familiar to some through the LEAF definition of "a whole farm business approach to sustainable farming," but what does this really mean in the context of designing a new support scheme and strategy for Scottish agriculture, and how can we use the principles that underpin the theory to assist us in achieving the Scottish Government's ambitious climate change targets?

At the heart of the IFM approach lies the principle of balancing the economic, environmental, and social aspects of agriculture, to deliver more resilient businesses. In a Scottish context it is critical that any change of future policy in agriculture recognises the symbiotic relationship between the economy, the environment, and societal impact.

The IFM approach can be seen in operation across several frameworks, most notably the LEAF Marque scheme and the European Initiative for Sustainable Agriculture (EISA). It is based on a holistic approach to farm management, encompassing the areas highlighted in the diagram below:

Figure 4: LEAF Integrated Farm Management⁷



The EISA approach also incorporates two further elements, Climate Change/Air Quality, and Crop Nutrition, both of which are highly relevant in a Scottish context.

The individual elements all require plans in their own right, but form part of an overarching business plan, where the impact of change of practice in one area is rightly considered for its impact on another. The notable exception to this would be

⁷ Source: <https://leafuk.org/farming/integrated-farm-management>

in businesses who do not adopt mixed farming practices, rendering a sectoral plan irrelevant. The critical aim with this approach is to make clear the economic consequence or benefit from changed practice, recognising the obvious motivation/necessity of improved profitability for creating behavioural change.

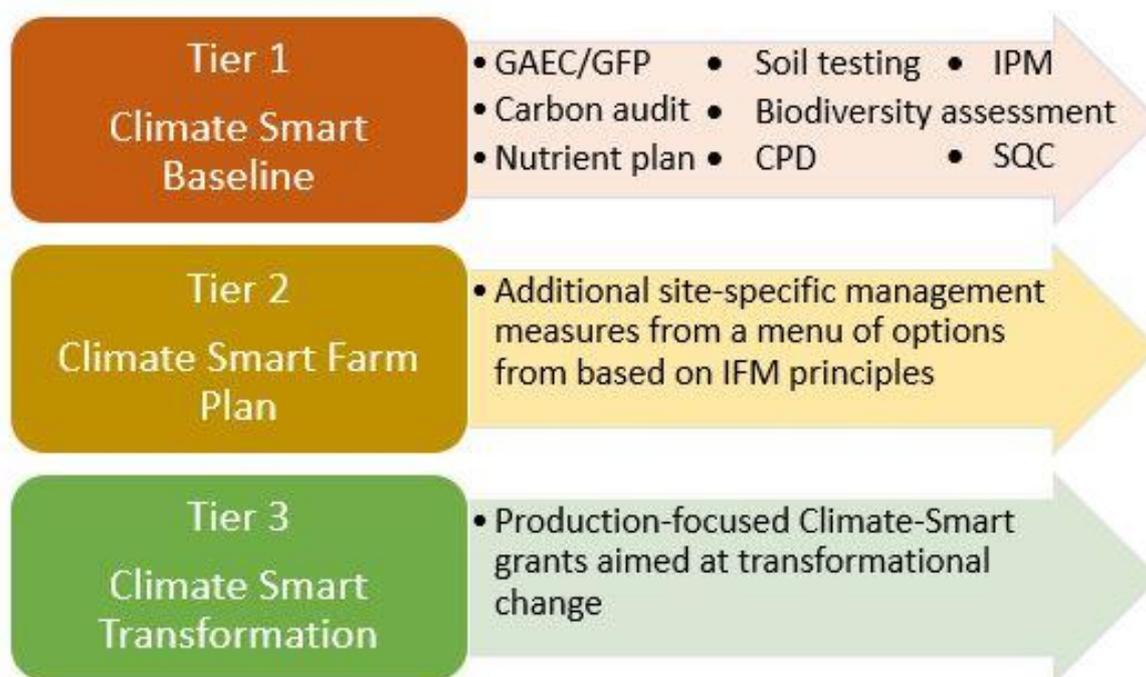
The IFM approach is based on planning, monitoring, evaluating, and the need for continuous improvement at individual farm level. It provides a framework for implementing more effective decision making, in relation to both environmental and economic consequence and crucially, provides clear accountability, measurement parameters, and auditable evidence. The requirements for each element of the IFM are aligned to the practical measures suggested by the ACCG to clearly indicate how they achieve the aim of reducing GHG emissions.

Annex 3 – Practical measures

This Annex sets out the practical measures and principles that have come forward from the ACCG Call for Evidence. The measures have been grouped according to their relevance to the Scottish Government Climate Change Plan outcomes. The rationale for this approach is that if future support is to be driven by climate change mitigation and environmental conditionality, we must make clear how each measure contributes to the outcomes the industry has been tasked with delivering. The diagram below outlines our recommended tiered approach to implementation.

The Tier 1 Climate Smart baseline scheme requirements recommended by the ACCG consist of the need to complete a whole farm - carbon audit, nutrient management plan, soil management plan and biodiversity map. An industry wide uptake of these practices will allow us to accurately map progress and provide the first steps to an Integrated Farm Management approach to tackling climate change mitigation.

Figure 5: Three-tiered system



Our recommendation is that the next delivery phase include additional measures designed to build on the main baseline, clearly demonstrating their contribution at a whole farm level, through the Climate Smart Farm Plan. The key findings of the group point to the following as the headline actions most likely to impact mitigation:

- Increasing production efficiency with sustainable intensification that increments production through a more efficient use of inputs;
- Reducing emissions by optimising nitrogen fertilisation (e.g. amount, timing, precision technologies), and the efficient use of agrochemicals and water;

- Producing and saving energy while increasing the energy efficiency of machines used, as well as installation of power plants from renewable sources;
- 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.

Climate Change Plan Outcomes and associated measures

The Climate Change Plan includes 6 outcomes, 4 of which are particularly relevant to the arable sector; these have been listed below (Table 2). The individual outcome is then supported by principles and measures that have come forward from the ACCG call for evidence. Some of these changes are considered to be mitigation factors that will directly reduce emissions; others are 'enabling' and will support implementation of the direct mitigations.

Table 2: Climate Change Plan outcomes relevant to the arable sector

CCP Outcome	Measure	Enabling or Mitigation
1	A baseline scheme requirement for the completion of a Whole Farm Carbon Audit & Nutrient Management Plan, taking into account all sequestration within the business.	Enabling
1	To establish a baseline, mandatory soil testing (possibly including organic matter) will be a scheme requirement, allowing for progression towards a soil management plan at individual farm level. It will be important that soil testing is done in a standardised format by individual testing providers, and that capacity exists for industry wide testing.	Enabling
1	Support and training relating to carbon auditing, nutrient management planning, biodiversity mapping and other data collection measures.	Enabling
1	Maintaining and preventing loss and damage to existing habitats considered to be of biodiversity or wider environmental value, such as hedgerows, field margins, areas of species rich grassland.	Mitigation
1	Farm waste management plans/energy usage to be incorporated into whole farm carbon audit.	Enabling
1	Capital grants for on-farm technology to reduce energy usage, for example grain dryers	Mitigation
1	Support for the introduction of Integrated Pest Management plans, to reduce agro-chemical usage and support enhanced biodiversity.	Mitigation

1	Support for increased areas of buffer strips/wildflower field margins/green manures, beyond existing greening requirements.	Mitigation
1	Support to encourage greater efficiency in energy usage and climate control, including efficient refrigeration, improved refrigeration systems, improved thermal insulation in stores, rapid shut doors for cold stores	Mitigation
1	Capital investment support to encourage efficient water usage and improved water treatment, including: water harvesting from roofs (to fill sprayers), construction of bio-beds for sprayer washout, waste water treatment, filtration and recycling systems, new water pumps to upgrade older inefficient pumps, irrigation monitoring equipment and rigs to make irrigation more efficient, electrical controls to maximise efficiency of variable load pumps, e.g. in irrigation, creation of boreholes, creation of irrigation lagoons.	Mitigation
1	Support to increase the uptake of trickle and drip irrigation.	Mitigation
1	Support introduction of grass/clover leys into rotations, including for biomass/industrial use.	Mitigation
1	Capital support for small scale renewable energy projects.	Mitigation
1	Capital investment support for the purchase of in-field meters e.g. chlorophyll meters, sap meters.	Mitigation
1	Automatic climate monitoring and control of poly-tunnels	Mitigation
1	Electric transport to move produce from field.	Mitigation
1	Weather stations to aid decision making.	Enabling
2	Support research into plant development and breeding targeting lower input goals, linked to farm level trials and a requirement for knowledge transfer to change on-farm management practice.	Mitigation
2	Support for farmer-led collaborative initiatives, building on the example of the Rural Innovation Support Service.	Enabling
2	Support for investigating the adoption of a supply chain approach to carbon auditing, led by farmer co-operatives through the work of the Scottish Agricultural Organisation Society and others.	Enabling
2	Support for the promotion of and establishment of Producer Organisations and other forms of cooperatives, building on examples of best practice	Enabling
2	Support to encourage farm level trials of novel crops and other innovations in partnership with research institutes.	Mitigation

2	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.	Enabling
2	Develop the green market/add value by demonstrating to consumers and retailers the environmental credentials of Scottish production	Enabling
3	Incentives for the inclusion of pulses and legumes as part of a mixed rotation to reduce inorganic fertiliser use (with consideration given to a strategy for new market creation and processing requirements/investment). Include research into limitations to legume uptake in Scotland.	Mitigation
3	Capital support to increase the use of precision application technology, smart sensors (Smart Rural) and crop yield prediction tools to assist decision making that ultimately results in reduced waste, and lower GHG emissions from inorganic fertiliser applications and other outputs.	Mitigation
3	Support for participation in innovative use of drone and robot technology in precision application to reduce GHG emissions from inorganic fertiliser applications and other inputs.	Mitigation
3	Support for the use of nitrogen inhibitors/slow release fertiliser (provided evidence change demonstrates no negative influence on soil microbiota)	Mitigation
3	Support for soil testing and mapping in relation to more efficient lime application, including capital support for variable rate spreading technology	Mitigation
3	Support for nutrient testing of farm manures intended for arable application	Mitigation
3	Support for the incorporation of livestock grazing, as part of an IFM plan demonstrating a reduced inorganic fertiliser usage, including capital support for livestock infrastructure such as fencing.	Mitigation
3	Capital support for collaborative machinery initiatives, to allow for more efficient working that results in more opportunity for early crop establishment and therefore increased ability to incorporate cover cropping and intercropping.	Mitigation
6	Support for the introduction of agroforestry and its continued management.	Mitigation

6	Support for the testing and continued monitoring of soil structure, based on a managed rotational crop plan	Enabling
6	Encourage the return of straw as organic matter to the soil including as farmyard manure.	Mitigation
6	Support peatland and wetland restoration.	Mitigation
6	Reduce peat usage in horticulture.	Mitigation
6	Support improved soil health/organic matter through the requirement to establish soil cover at particular times of the year, particularly over winter	Mitigation
6	Support minimising soil disturbance through the practice of minimal, zero tillage or rotational inversion tillage.	Mitigation
6	Consider capital incentives for improving in-field drainage, with the aim of improving soil condition as part of a plan.	Mitigation
6	Promote increased rotation length for all break crops and recommend best practice minimums for crops including legumes, potatoes and vegetable crops.	Mitigation
6	Support for increased tree and hedge planting where appropriate.	Mitigation

Annex 4 – Group members

Andrew Moir NCA FRAgS (Chair)
Brian Henderson
Anne Rae MacDonald
Willie Thomson
Amy Geddes
James Porter
Professor Fiona Burnett
Pearson Whyte
Professor Lorna Dawson, CBE, FRSE, FRSA, F. I. Soil Sci, CSci
Ross Mitchell
Andrew Gilchrist
Mark Clark
Dr Matthew Brander
Colin McGregor FRAgS
Alison Milne MBE ARAgS

Further information and papers are available at:
<https://www.sasa.gov.uk/accg>



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This publication is available at www.gov.scot

Any enquiries regarding this publication should be sent to us at

The Scottish Government
St Andrew's House
Edinburgh
EH1 3DG

ISBN: 978-1-80201-162-3 (web only)

Published by The Scottish Government, July 2021

Produced for The Scottish Government by APS Group Scotland, 21 Tennant Street, Edinburgh EH6 5NA
PPDAS875346 (07/21)

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