Biodiversity Technical Note

Farmers and land managers play a critical role in managing and protecting our most precious protected habitats. The importance of enhancing this offering is clear, with biodiversity on UK farms having fallen to around 30% of 1970 levels, driven largely by intensive farming practices[1].

These practices initially drove productivity; however, a decrease in traditional mixed farming, increases in farm size, and loss of on-farm wildlife habitats, including hedgerows, ponds, and meadows, has led to the fragmentation and loss of connectivity between habitats, so much so that the UK sits at the bottom of the biodiversity intactness index, the lowest of any G7 nation[2]. Overuse of artificial fertilisers and pesticides have unbalanced the complex web of life both above- and below-ground natural ecosystem services such as nutrient cycling, pollination, and carbon storage further, impacting long-term agricultural productivity.

The farmland bird index has fallen by more than half between 1970 and 2018 in the UK[3]

Biological diversity is critical to ecosystem function and human survival. The essential role that biodiversity plays is highlighted by its inclusion in the UN's sustainable development goals 13, 14 and 15: Climate Action, Life Below Water and Life on Land. This term refers to the variety of life within one region or ecosystem. Within the public sphere and media, it is generally used to refer to wild species. Within agriculture, the genetic diversity of farmed species food-producing ecosystems is defined as "agrobiodiversity". According to the Farming and Agricultural Organisation of the United Nations (FAO), this lesser-known descriptor refers to the variety of genetic resources which are used for food and agriculture. This includes crop varieties, livestock breeds, fish species and other harvested food and fibre products. Non-harvested species which are also included within agrobiodiversity's scope are soil micro-biota, pollinators, earthworms and other insects.

Agrobiodiversity

- Food production ecosystems
- Crop species + varieties
- Livestock species + breeds
- Fish species
- Soil organisms in farmland
- Natural predators for crop pests
- Wild species harvested for food

Wild Biodiversity

- Undomesticated flora and fauna

According to the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES) Global Assessment Report, biodiversity is declining faster than at any time in human history[4]. This biodiversity loss is intrinsically linked with climate change, greenhouse gas emissions and land use change via deforestation. As such, biodiversity is classified by economists[5] as a form of natural capital.

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Biodiversity and the natural capital derived from it are key drivers of what are known as ecosystem services around the world. The ecosystem services are what make human life possible by providing nutritious food, regulating disease, pollinating crops and regenerating soil. The Food and Agriculture Division of the UN (FAO) classifies ecosystem services into four types: provisioning, regulating, supporting, and cultural services[6]. Provisioning services are the material benefits we receive from ecosystems and biodiversity, such as food, fibre and fuel. Regulating services offers the regulation and balancing of air quality, soil fertility and flood control. Supporting services links directly to biodiversity and is the genetic diversity of all species, including how they interact to provide the other three services. Finally, cultural services pertains to the non-material benefits derived from biodiverse ecosystems, such as cultural identity and well-being.

The UK Government's Dasgupta Review analysed the economics of this biodiversity and ecosystem service loss, showing that between 1992 and 2014, human capital increased by 13% but natural capital per person declined by 40%[5]. The Review argues that given livelihoods ultimately rely on ecosystem services and natural resources, by losing the variability of these resources, we put ourselves at massive economic risk.

One example of this is the loss of regional livestock breeds as they are replaced with globalized breeds which are more suited to industrialized systems. These globalized breeds are far more efficient and therefore assumed to be more profitable. However, in some cases they are not as resilient to local diseases and heat stress in tropical or arid regions.

International Policy

The Convention on Biological Diversity (CBD) was opened for signature in Rio de Janeiro in June 1992. This was the first piece of international policy aimed solely at biodiversity. Four years in the making, it received signatures from 168 different countries, including the UK. Following this, in 1994, at the first "Conference of Parties (COP)", agrobiodiversity was referenced and included as a vital component of biodiversity conservation. The aim of the convention was to enable biodiversity conservation targets and status reporting to trickle down into national policy. The signatory countries must provide information on the measures they have taken to support biodiversity and their effectiveness within national frameworks.

The CBD's aims were further ratified and adapted in 2011. They became the "Aichi Biodiversity Targets for 2020". The Aichi Targets were split into 5 strategic goals:

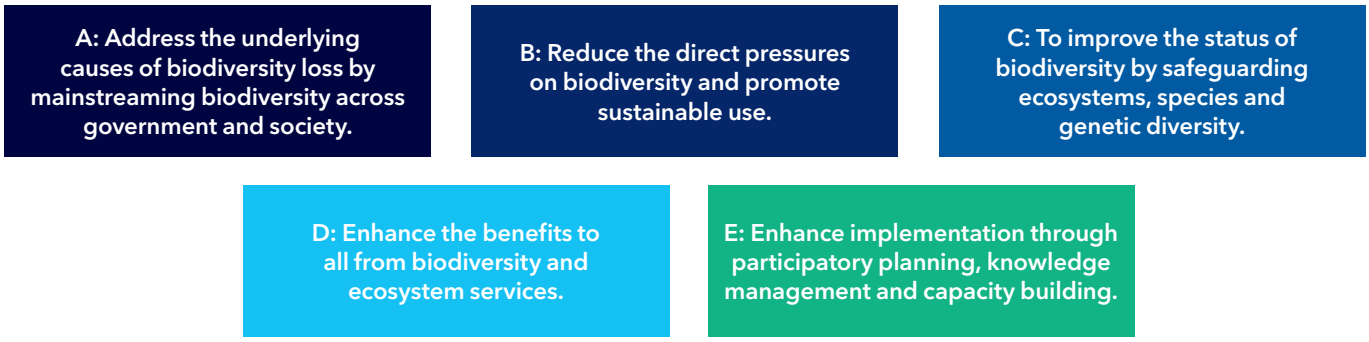

Figure 1: Aichi Strategic Goals[7]

Each of the goals encompass several key targets pertaining to biodiversity conservation, research, funding, subsidies, sustainable consumption, agriculture, pollution, agrobiodiversity and ecosystem services. Alongside setting out the goals for the targets, the COP convened a technical expert group to measure and validate international progress against each of the 5 strategic goals and underlying targets.

Following the review of progress towards the Aichi Targets, the 5th Global Biodiversity Outlook Report found that at the global level, none of the 20 biodiversity aims had been achieved[8]. Partial achievements came in the form of enhanced terrestrial water habitat conservation, reduction of invasive species, the sharing of conserved genetic resources between countries (e.g. seed banks), and the adoption of national policy instruments to protect biodiversity.

COP15

The agreement to halt and reverse biodiversity loss by the end of the decade at the COP15 UN Biodiversity Conference matched the urgency declared towards climate change within COP21's Paris Agreement. The UK, alongside nearly 200 other countries, signed the Kunming-Montreal Global Biodiversity Framework (also known as the '30 by 30' deal) to protect at least 30% of Earth's ecosystems by 2030.

Achieving ambitious targets such as halving excess nutrients, pesticide risk and food waste by 2030 will undoubtedly shape the direction of UK agricultural strategy and funding over the course of the decade. Nature-based solutions that address both biodiversity loss and climate change through 'sustainable management of agriculture' offer a key strategy for farmers and land managers to maintain, enhance and restore ecosystems across the 71% of the UK's land stock covered by agriculture, whilst contributing to the net zero pathway.

Domestic policy

Scotland's policy instrument comes in the form of the Agriculture Bill and the anticipated Natural Environment Bill. The focus of this policy is on implementing nature restoration and enhancement through landscape-scale change and support of nature friendly farming. Alongside this, introduction of biodiversity net gain is expected from 2025 to ensure housing developers 'secure positive effects for biodiversity'.

Biodiversity Net Gain

The importance of implementing urgent and effective actions to protect and enhance biodiversity is being recognised across the UK's devolved nations.
A framework for this is being developed at a different pace across each nation. Biodiversity net gain is an approach to planning and development that leaves biodiversity in a better state than before. The underlying principle of BNG is to halt the decline in native species by the end of the decade. Where a development has an impact on biodiversity it encourages developers to provide an increase in appropriate natural habitat and ecological features over and above that being affected.

Scotland have proposed an approach to 'secure positive effects for biodiversity' through the National Planning Framework (NPF4), which will detail this further but is not expected to be approved until early 2025[10].
It is anticipated that there could be similarities to the BNG system in England, where from 2023 it will be a mandatory requirement for developers to create a 10% biodiversity uplift on all their developments, either through on-site or off-site biodiversity provision, or by purchasing statutory credits.

There has been some response to the government's consultation to this scheme that have argued that the measures don't go far enough, and that green-field developers should also prove they have replaced flood mitigation capacity, carbon storage potential and ecological network connectivity. Despite critics, the scheme does allow for farmers and land management to explore biodiversity net gain as a diversified income stream for their farm businesses, a market which has been valued at £135–£274 million per year in England[11].

Public money for public goods

As a consequence of Brexit, the UK has now left the EU's Common Agricultural Policy. The policy to replace the CAP is one that is self-reportedly climate-conscious, directly tying into net zero commitments. Subsidy payments are being swapped for payments tied to the creation of public goods, such as increasing biodiversity and restoring ecosystems.

The Scottish Government's Agriculture Bill, 'Vision for Agriculture', includes plans to reward the delivery of public goods by incentivising farmers to adopt beneficial practices or measures. This is an economic principle which quantifies the benefit to local ecosystems which land managers bring by implementing items such as beetle banks, extra hedgerows and hay meadows. The principle follows the idea that any tax upon polluting organisation should be redirected and used to reward those providing environmental benefits. Policy experts, such as Alan Matthews from Trinity College, Dublin, are arguing for UK agricultural policy to continue to move in this new direction[12].

Future Policy

The momentous agreement at COP15 to halt and reverse biodiversity loss will galvanise global action to enhance nature during this decade in a way that was not achieved with the Aichi targets.

In line with the previous Aichi targets, the UK government continues to record wild biodiversity via the annual UK Biodiversity Indicators survey and report. Furthermore, the 2021 Dasgupta review on the economics of biodiversity recommended a number of policy changes to the UK Government. Firstly, Dasgupta highlighted Gross Domestic Product (GDP) as an unsuitable metric for sustainable development. It also argues for changes in production and consumption to tackle the biodiversity crisis[5].

Most importantly, it proposes better financial accounting of nature and that natural capital, including biodiversity, be included in national accounting mechanisms across the devolved administrations. Critics argue that economic accounting of biodiversity could detract from our moral obligations to preserve it, however the Dasgupta review acknowledges that whilst this is a risk, economic incentives are the most powerful way to make long-term change.
The Dasgupta review's suggestions were drawn on during the G7 meeting in the UK. The G7 leaders agreed the G7 Nature Compact, which brings in interlinked targets around biodiversity loss and climate change. Via the agreement, they committed to address illegal activities such as deforestation, ensure nature is accounted for in economic decision making, and to conserve or protect at least 30% of global land and oceans by 2030[5].

UK Agrobiodiversity

Farm animal genetic resources are defined as "those animal species that are used, or may be used, for the production of food and agriculture, and the populations within each of them"[13]. These farm animal species are vital for the maintenance of global food security for future generations. In past decades UK livestock breeder preference has leaned towards continental breeds which are generally able to outperform the UK's native cattle breeds in terms of milk yield for dairy animals and carcass size and growth rate for beef and sheep. These preferences come as a result of market pressures forcing farmers to move towards a small number of cattle breeds to compete in a changing market[14]. Thus, livestock genetic diversity has been rapidly decreasing. This loss of diversity reduces UK cattle farming's resilience to climate change but also means the loss of culturally important breeds which could provide important agri-tourism to rural areas. Furthermore, as breeders have been pushed towards highly productive livestock types, many of the hardier, upland breeds have been put at risk[15].

"Agriculture has been identified as the most important driver of biodiversity change over the past 45 years, with most effects being negative." State of Nature report 2019[16]

The UK government confirmed their commitment to conserving these rare and native cattle breeds in 2007 when they joined 109 other member states in signing the *Interlaken Declaration*[17]. This confirms the UK's commitment to "The Global Plan for Action for Animal Genetic Resources". This plan was designed as a "blueprint for combating the erosion of animal genetic diversity and at using animal genetic resources sustainably"[17]. Now, as we progress beyond Brexit, the UK government is provided with an opportunity to reaffirm its commitment to this plan and place the conservation of livestock genetic resources firmly into its agricultural policy legislature as they look to shift funding away from single farm payments and towards payments for agri-environmental services (AES). Rare breed livestock can also be protected from extinction using biotechnologies which complement farmer breeding programmes, collecting embryo and semen samples from live cattle and cryopreserving them to be utilised in the future or kept as an insurance against disease. UK gene-banking is exclusively led by non-government organisations, namely the Rare Breed Survival Trust[18]. In the same way that the government should re-prioritise the breeding of rare and native livestock, they should also consider public funding of ex-situ genetic cryopreservation as an important tool for saving these rare breeds. As opposed to wild biodiversity, which is prioritized by government with industry following, agrobiodiversity is primarily an industry-led area. There is little to no UK policy which complements and supports this drive.

How can UK farmers enhance both agrobiodiversity and wild biodiversity?

Agroecological practices that increase on-farm biodiversity will play an essential role in increasing climate resilience. Biodiversity is important in delivering healthy, functioning ecosystem services which can enhance productivity potential.

Biodiversity varies farm-to-farm and finding the right actions to take can be challenging. However, there are many ways in which farmers can seek to increase their agroecological value and enhance their biodiversity. Beginning to quantify biodiversity on the farm will help measure and track improvements over time and improve access to these markets.

Yields of wheat, beans and oil seed rape can be maintained in fields with up to 8% of land set aside due to the benefits derived from wildlife-friendly approaches[19].

Practical strategies to enhance on-farm biodiversity

Biodiversity can be boosted without reducing agricultural profitability by using data-led approaches to implementing practices and targeting habitat creation on the least productive land parcels. This also creates stacked income opportunities with access to nature-based solutions marketplace such as biodiversity net gain and carbon credits. Some practical actions to enhance biodiversity on farm include:

Introducing multi-species ley mixes

- Adding grass, legume and herb species to create a diverse ley provides a valuable year-round habitat and food for farmland wildlife such as pollinators and farmland birds.
- Each species can provide a unique property, benefiting the productivity of farm systems through greater rooting depth, access to nutrients and nitrogen fixation, all leading to improved soil health.

Agroforestry, woodland creation and improving hedgerows

- The provision of hedges and woodlands on farms can increase habitats for birds and invertebrates, as well as the delivery of ecosystem services, such as carbon capture and water cycling.
- Voluntary carbon markets, such as the Woodland Carbon Code[20] and Hedgerow Carbon Code[21] allow farms to calculate and verify the carbon captured on farm and open carbon markets.
- Agroforestry, the deliberate integration of trees and agricultural crops on the same land, harnesses the ecological interactions between the tree and agricultural crop parts of the system. Benefits include shade and wind breaks, nitrogen fixing trees and access to nutrients deeper into the soil.

Regenerative practices

- Practices such as reduced tillage and mob grazing, support the five core principles of regenerative agriculture by enhancing above- and below-ground biodiversity.
- Inclusion of over-winter cover crops helps to enhance the diversity of soil biota by maintaining a constant cover, maximising diversity in the crop rotation and maintaining a living-root year-round. Livestock grazing on cover deposit manure boosts biological activity, abundance and diversity by providing nutrients for soil life.
- **Careful nutrient management planning and application**
- Holistic management of synthetic fertilisers and organic manures can be achieved by thorough nutrient management planning and best-practice storage and application. This helps protect sensitive species and the wider environment, whilst saving money and increasing business efficiency.
- Nutrient neutrality schemes offer farmers the opportunity to pair with developers looking to mitigate their own existing nutrient losses by altering land use and management practices.

Diversifying cropping systems

- Diverse crop systems can enhance above- and below-ground biodiversity by reducing pest and disease outbreaks, improving water cycling and soil fertility, thus creating a system with greater resilience.
- Examples of cropping system diversification include extending rotations, intercropping, multi-cropping and cover cropping. This diversification provides additional resource and habitat and can boost biodiversity by 25%[22].

Utilising rare livestock breeds

- As well as increasing agrobiodiversity, native breeds play an important role in delivering enhanced biodiversity and ecosystem services by improving soil health, controlling weeds and invasive species, and therefore increasing plant biodiversity and productivity[23].
- Traditional native breeds have the additional benefits of high levels of animal health and welfare, a natural forage-based diet and smaller supply chains, enhancing profitability.

Industry Pressures and Opportunities

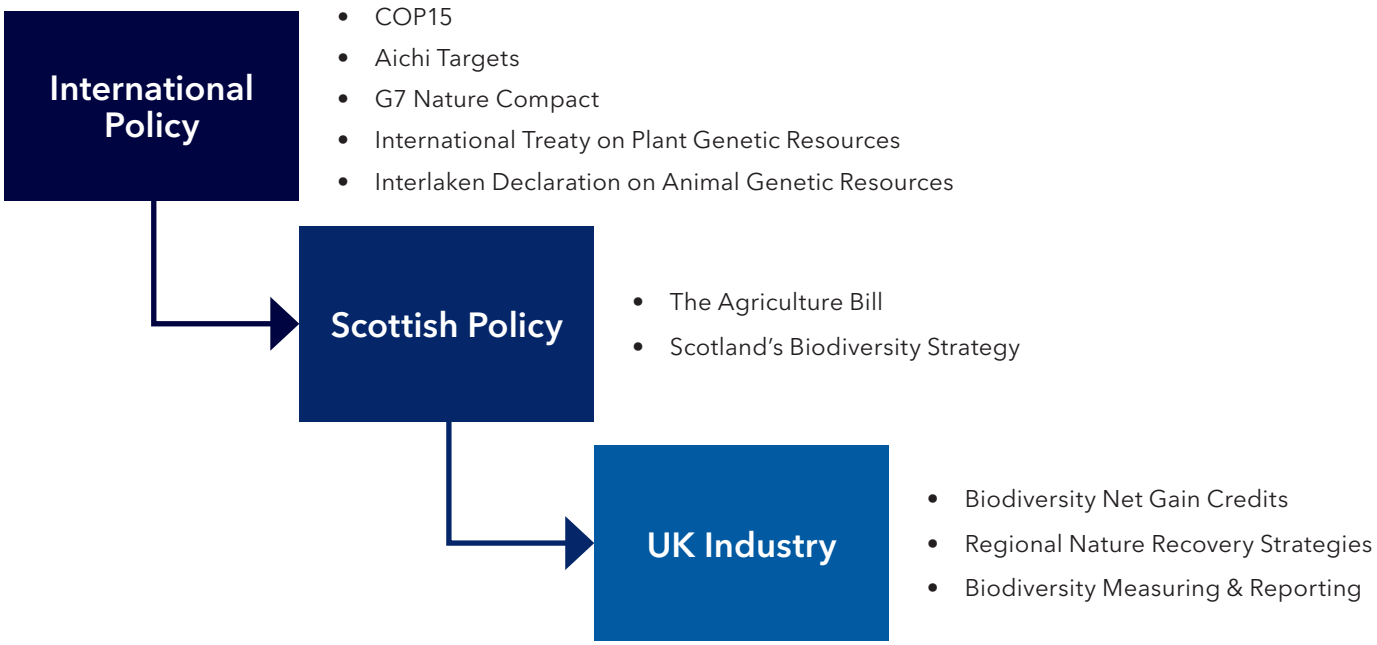

Figure 2: Flow chart demonstrating the effect of international policy on local governance and UK industry.

Many of the International and UK policy targets do now feed into industry drivers and support has renewed focus on biodiversity from UK farmers and land managers. However, this is highly varied from country to country in the UK based on devolved policy. For example, biodiversity net gain credits are currently only being introduced in England.

Agrisound – interpreting nature's noises to enhance biodiversity

Casey Woodward
Founder/CEO

Agrisound is a technology company specializing in measuring pollinator abundance and diversity via soundwave recording devices. Agrisound's technology can measure both environmental conditions within beehives and wild pollinator activity within land areas. This can support businesses and landowners to access to improved ecosystem services, such as pollination, and to better quantify the impact of biodiversity measures to access biodiversity net gain markets.

Casey Woodward, the company's CEO, recently won the Young Innovators Award from Innovate UK and The Prince's Trust. The company currently collaborates with Innovate UK, The UK's Agri-Tech Centre Group, The World Bee Project and the Yorkshire and Humber Institute of Technology.

The company's core business plan pertains to insect and pollinator diversity being a key metric of landscape biodiversity as well as ecosystem function. As such, by recording and measuring insect abundance via their technology and algorithms, they can ascertain both wild biodiversity and domestic bee colony health. This use of the soundwave technology is directly focused on biodiversity measurements and the markets centred around this.

Figure 3: Agrisound's "Polly" pollinator monitor

Casey Woodward explained that within both government policy and industry sustainability targets (within corporate social responsibility (CSR)) much more focus is on greenhouse gas emissions compared to biodiversity loss. This is despite many greenhouse gas emissions being a symptom of biodiversity loss and ecosystem destruction.

With the introduction of biodiversity net gain credits, natural capital reporting, and the new UK National Pollinator Strategy, Agrisound is afforded a number of huge market opportunities via recent policy changes. Indeed, the company is currently in talks with The Department for the Environment, Food and Rural Affairs (DEFRA), to understand if its remote pollinator recording could be used as an addition to the "Defra Biodiversity Metric Assessment" ecological survey. The latter must be done by a registered ecologist and is therefore highly labour intensive and costly. On the other hand, Agrisound's technology can record biodiversity in real time and with almost no labour other than placing the recording devices at specified locations. In this way, when recording how many biodiversity net gain credits a land parcel has produced, the recording technology would greatly complement the ecological survey.

As well as the opportunities of the technology to support CSR reporting for large multi-national businesses, measuring biodiversity improvements is also relevant to small-scale agribusiness ventures who want to show the benefits that the production of their food items brings to the local environment. One example of such a business is the Knepp Wilding Project in Southern England. The landowners Charles Burrell and Isabella Tree run two ventures as part of this: an extensive parcel of rewilded land and an extensive farm nearby. In her book, "Wilding"[24], Isabella describes biodiversity as being the main output of the rewilded area, with red meat as a by-product. On the extensive farm, the opposite is true: red meat is the main output, with biodiversity as a by-product. This highlights another potential marketing avenue for Agrisound: the technology's ability to tie in with regenerative agriculture principles, a type of farming which is becoming increasingly popular in the UK and parts of Western Europe.

Given the recent onset of the feed and fuel price crisis, Agrisound's team are concerned about a sudden lack of focus on emissions and biodiversity by agri-food and land management businesses as the market prioritises procurement of the raw materials needed to maintain supply chains. Despite this concern, given the new policy instruments coming into play in the UK, biodiversity metric technology and servicing is an emerging market with huge potential in the next 10 years.

Conclusion

Biodiversity within the context of food supply chains, agriculture and agroecological systems is known as agrobiodiversity. It is both separate yet intrinsically linked to wild biodiversity. Biodiversity conservation can no longer be thought of as only pertaining to wild animals and must be perceived by everyone in the supply chain as crucial to sustainable farming practices. The Scottish government's focus on wild biodiversity within the Agriculture Bill and Scotland's biodiversity strategy is admirable. As opposed to this, there is little to no focus on agrobiodiversity within current policy. Food retail businesses, farms and other rural businesses have a challenge ahead to educate the consumer on the importance of both types of biodiversity and the role it plays in putting food on their plates. There are a small number of companies addressing this challenge, but this number is expected to grow as international biodiversity policy resulting from the historic agreements at COP15 comes into fruition. A measure of success in the long-term would be if biodiversity eventually received the same focus as greenhouse gas emissions from all industry stakeholders for this. If enough international and national policy was brought in to encourage this to happen, there is a huge market opportunity for businesses who can utilize this focus.

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