Land Workers' Alliance
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Food, Farming, and the Climate Crisis:

How we can feed people and cool the planet

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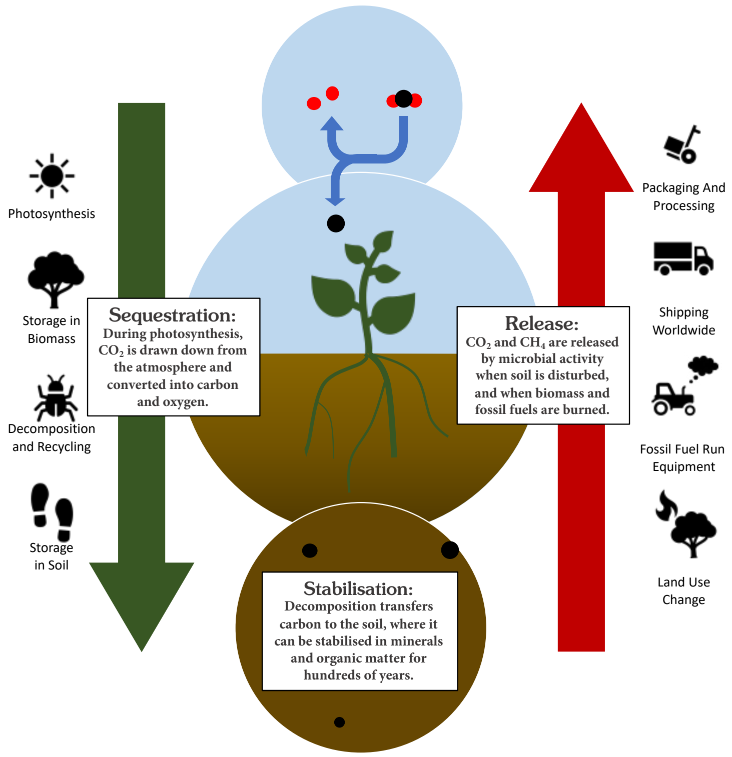
The Impact of our Food System on the Climate

Climate change is one of the greatest challenges facing humankind, and the management of our food system will determine whether agriculture controls or contributes to catastrophic change.



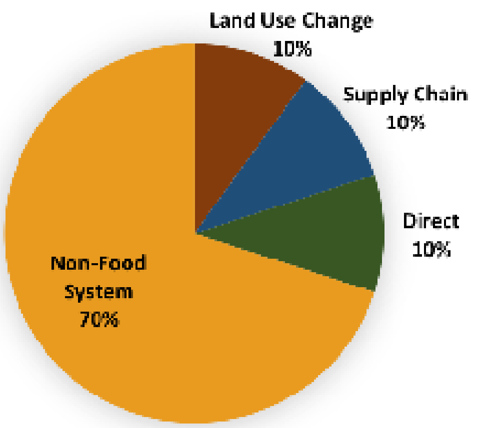
Climate change occurs when natural biogeochemical cycles become unbalanced, releasing excess levels of greenhouse gases (carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (N_2O)) into the atmosphere. Since the beginning of industrialisation, human activities have caused release of greenhouse gases at an unprecedented rate. These gases trap heat inside the earth's atmosphere, increasing global average temperatures by 1°C to date[1], and causing severe disruption to climatic patterns worldwide.

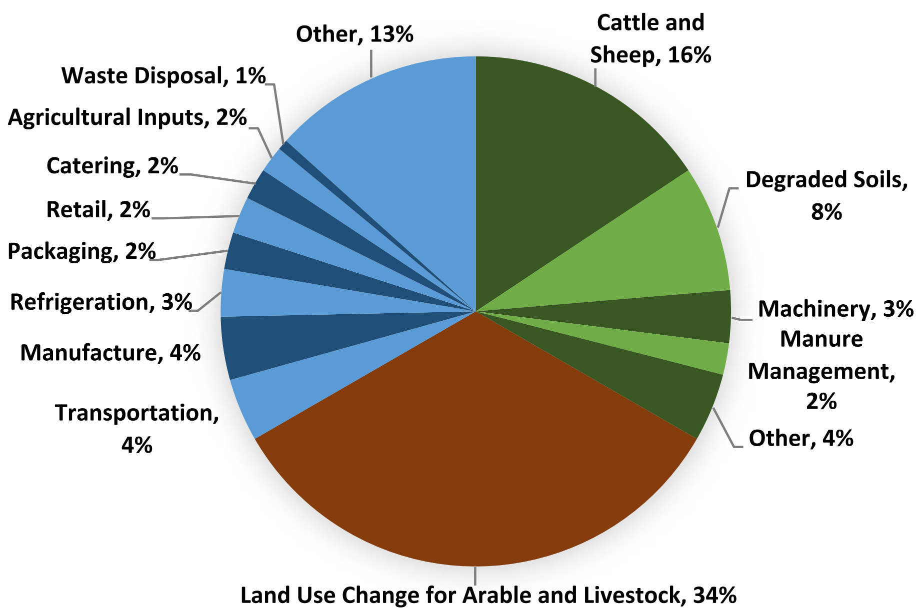
The 2016 Paris Agreement recognised that limiting global temperature increases to 1.5°C above pre-industrial temperatures would significantly reduce the risks of devastating changes to weather patterns, ecosystems, food security and human health when compared to temperature rises of 2°C or more. The Intergovernmental Panel on Climate Change (IPCC) estimates that to limit global warming to 1.5°C, net emissions of CO_2 have to be reduced to zero by 2050 with CO_2 reductions of around 45% by 2030, while CH_4 emissions have to be reduced by 35% or more relative to 2010 levels.[1]

The Committee on Climate Change calculated that agriculture in the UK is responsible for 10% of economy wide emissions.[2] However, direct emissions from agriculture are only part of the picture. To understand the full impact of food and farming, we have to account for the contributions of the food system in packaging, waste, transportation and refrigeration, and of land-use change overseas- the deforestation and cultivation of pasture for production of commercial commodity crops and animal feeds that the UK consumes. Up to 70% of deforestation results from growing commercial food crops, such as soy, maize, sugar cane and palm oil.[3] When estimates are extended to include emissions from the wider food chain (excluding land-use change) they increase to around 20% of UK emissions, and to over 30% when factoring in food consumption induced land use change.[4]

Breakdown of UK food-system related emissions (CO_2e) by source:

The food system comprises 30% of the UK's emissions, and can broadly be divided into emissions from direct production, emissions from the supply chain, and emissions from production-induced land use change.





1. IPCC, 2018: Summary for Policymakers. In: Global warming of 1.5°C. World Meteorological Organization, Geneva, Switzerland
2. Committee on Climate Change (2018): 2018 progress report to parliament
3. Lawson, S. "Consumer Goods and Deforestation: An Analysis of the Extent and Nature of Illegality in Forest Conversion for Agriculture and Timber Plantations," Forest Trends (2014)
4. Food Climate Research Network and WWF-UK (2010): How low can we go? An assessment of greenhouse gas emissions from the UK food system and the scope to reduce them by 2050

Redefining Our Food System

"Climate change isn't just about greenhouse gases – it is about land rights, agriculture, natural resources, and the right to manage them for the greater good. The food system is a central part of this fight – what we eat is responsible for more carbon pollution than all the world's planes, trains, and automobiles. Between the forests and fields converted to agriculture and pollution directly from farming, what we eat accounts for nearly a third of all the gases contributing to climate change."

-Annie Shattuck, Researcher for Food First

Feeding the Earth

Many proposed solutions to climate change argue that, to balance environmental preservation with food production, it is necessary to sustainably intensify production on the most fertile lands while setting aside other areas of land as natural reserves to sequester carbon. This ignores the fact that food produced through the industrial farming model, distributed through global supply chains, drives climate change. The Landworkers' Alliance promotes the adoption of agricultural practices that enhance the underlying fertility and sequestration capacity of soils, as well as above and below-ground biodiversity and environmental quality, without sacrificing productivity. This requires "ecological intensification", in which biological processes underscore productivity advances, rather than external, energy-intensive inputs- an approach to farming known as agroecology.[5]

Continuing high input intensive agriculture at the same rate as the previous 50 years is no longer a necessary or valuable goal. The claim that we need to double food production by 2050 to feed the world is based on outdated projections,[6] and incorporates no changes to the unsustainable dynamics of the food system, which leaves over 800 million hungry even though we produce enough food globally to feed a population of 10 billion.[7] However, 1/3 of calories produced are wasted and 1/3 of global cropland is used to produce animal feed.[8] Instead of a damaging focus on intensification, we now need a focus on developing policy actions that address how to distribute well-produced food equitably as well as addressing the climate impacts of the food system.

Cooling the Earth

While the agricultural sector is one of the major sources of greenhouse gas emissions, it can also play a fundamental role in helping to mitigate the impacts of climate change. This is because, when managed in a way that promotes soil health and biodiverse plant growth, agricultural lands have the capacity to sequester CO_2 from the atmosphere, locking it away in forests, soils and biomass. Carbon is drawn down from the atmosphere when plants and trees use sunlight to grow. While photosynthesising, plants soak up CO_2, emit oxygen, and either hold onto the carbon or transmit it to soil.

Soil quality is integral to this. Healthy, well-structured soil can hold more water and more carbon than degraded soils, and building fertility in soil helps the structure, and the health of the plants. The better and more fertile the soil, the more roots can grow, which in turn increases transfer of carbon to the soil. This in turn improves quality by enhancing nutrient and water retention. Improved soil quality and fertility has huge effects on both CO_2 sequestration and yields, meaning a nation's soil is one of its most valuable assets.

The UK uses 17 million hectares (about 70% of its area) for farming and related activities,[9] and though sequestration potential varies depending on land use and soil type, estimates suggest UK soils could sequester up to 31 megatons of CO_2 per year when managed well[10]. The activities required to make this possible provide numerous environmental and social benefits, such as timber, firewood, biodiversity, improved water and air quality, and access to local, fresh, and culturally appropriate food.

5. Holt-Giménez, E. and Miguel A. (2013): "Agroecology, Food Sovereignty, and the New Green Revolution." In: Agroecology and Sustainable Food Systems, 37:90–102
6. Hunter et al (2017). Agriculture in 2050: Recalibrating Targets for Sustainable Intensification. BioScience, 67(4), 386–391.
7. FAO, IFAD, UNICEF, WFP, WHO, "The State of Food Security and Nutrition in the World 2017: Building Resilience for Peace and Food Security" Rome: FAO
8. Muller et al (2017). Strategies for feeding the world more sustainably with organic agriculture. Nature Communications, 8(1), 1290.

Climate Justice in our Food and Trade Policy

We need to overhaul our trade rules to improve the sustainability of our food system. However, all measures would need to be examined in light of the impact on food prices, and relevant joined-up policies to mitigate any rise in food prices need to be put into place. This means programmes that support low-income households to buy fresh vegetable, fruit and cereals. It also means a focus on attention to basic income levels and issues such as the price of housing in relation to food prices.

One of the first steps in creating a climate-wise food strategy is to completely re-examine our trade regime. This will require a radical re-think of the World Trade Organisation (WTO) and bilateral trade agreements. The UK could be a world leader in a pioneering trade policy that puts the ecological crisis first. We can start by bringing ecological issues to the forefront of our bilateral trade negotiations including clauses in our agreements which protect ecology and land rights. We need to restrict imports of food produced to lower environmental, labour and animal welfare standards, including intensive factory-farmed meat. We also need to restrict imports of crops from ecologically degraded areas and those most important for carbon sequestration. Balancing and rationalising trade deficits with an eye towards reducing unnecessary cross haulage of equivalent food products is also vital to reducing GHG emissions.

Tariffs and trade regulations are often frowned upon because of their potential to raise food prices. However, we believe that this analysis is often a way for agribusiness corporations to use the poor to shield themselves from greater regulation. Often, the financial benefit accrued from cheap imports accumulates as extra profit for retailers and processors, rather than cheaper prices for the end consumer. In many cases, a ban on climate destructive produce is unlikely to raise prices on basic food products. For example, it is unlikely that the price of bread would increase because it is primarily produced now with 80% UK grown wheat.[11] We import as much lamb as we export. We also have serious trade deficits in basic food products that could be balanced through regulations and a shift in consumer habits, while keeping prices affordable. [12]

However, the impacts of any tariffs imposed should be examined on a case by case basis and appropriate regulatory mechanisms put into place to assure that essential, seasonal food products remain affordable to the end consumer. This is the role of a comprehensive Food Bill. The most likely consumer price impact of a robust climate-wise tariff system would be an increase in the price of soy meal, which would impact soy-fed meat production. We as a society need to decide if this is acceptable, an option which is becoming more feasible as understanding of the impact of the climate increases across all income levels of society. Regulatory offsets, where needed, could include domestic price support mechanisms for essential food products, well managed production support for domestic substitutes, marketing boards and income support for low income families. Government will need to invest heavily in domestic fruit and veg to keep prices affordable, and educational projects, cooking classes and Community Supported Agriculture schemes to increase local fruit and veg consumption. This fits with an approach towards less, but better consumption.

A tariff system can also improve prices for farmers in the UK, encouraging a stronger, more financially viable agricultural sector as part of a vibrant domestic food economy. Seasonal tariffs encourage our domestic arable and horticulture sectors to flourish. We need a global re-envisioning of the WTO to align global trade policy with our global climate emergency. This overhaul of our trade systems includes negotiating an international set of standards for countries engaged in bilateral and regional trade agreements to put climate, the earth, and social justice at the heart of negotiations.

9. Department for Environment Food and Rural Affairs. (2015). Agriculture In the United Kingdom 2014.
10. The Royal Society. (2018). Greenhouse Gas Removal.
11. The National Association of British and Irish Millers (2018). "Flour milling in the UK: facts and figures 2018".
12. Chatham House (2018), 'resourcetrade.earth', http://resourcetrade.earth/

Systemically Addressing the Climate Emergency

Carbon sequestration cannot save us from climate disaster unless combined with a rapid reduction in emissions from the wider food system. A systemic approach is absolutely vital in tackling climate change. We need to create an ecologically intensive climate-wise localised food system; feeding the world through systems that work with nature, while changing distribution and consumption patterns to reduce the impact of agriculture on land use in other countries.[13]

Within this context, we also believe there is a climate case for creating more mixed farms to achieve a better integration of livestock, horticulture and arable that can support direct to customer local food systems and reduce fertilizer use and manure management emissions though nutrient cycling of composted manures. This all needs to be considered in a strategic land use plan for the UK which balances environmental restoration with food production from agroecological mixed farms.

Maintaining a Global Perspective

Our UK development assistance budget has an enormous impact on the climate, as do our contributions to the World Bank and IMF. All of these international relationships significantly impact our carbon emissions by encouraging export orientated commodity crop production and undermining the regional food chains that support agroecological farming.

The Environmental Justice Network suggests that global warming will result in 1.4 billion climate refugees by 2060.[14] A significant proportion of these refugees will be peasant farmers displaced because extreme weather conditions make it difficult to grow the crops they need for their own consumption and livelihood, as well as many displaced by land used for increased production of biofuels.

It is important to use our development assistance budget and power within the FAO and World Bank to improve access to high quality agricultural land for vulnerable peasant communities and improve knowledge of agricultural techniques like water harvesting, soil improvement, diversity, and saving adaptable seed to improve small farm resilience in the face of climate change. Agroecological techniques have proven to be resilient in the face of severe weather like hurricanes and drought.[15]

It is clear that to mitigate the impact of agriculture on the climate, we must take into account the wider food system, particularly the impacts of land-use change in other parts of the world that are driven by food imports and dietary habits. Acting to mitigate climate change through agriculture requires systemic thinking that recognises agriculture and the food system as a complex whole, and envisions change beyond domestic emissions and targets. Without understanding the connections between our consumption, agricultural production, distribution, and the environment, we will not be able to address the challenges we face.

The following pages outline a climate-wise agricultural strategy with concrete measures we can take to:

1) **Reduce indirect emissions related to land use change and the wider food system**

2) **Reduce direct emissions from crop and livestock production**

3) **Increase carbon sequestration**

4) **Improve farm adaptation by maximising resilience.**

13. Taylor, M. (2018). "What's Smart About Climate-smart Agriculture?" Policy Brief #22, January 2018. Oakland, CA: Food First/ Institute for Food and Development Policy
14. EJF (2017). Beyond Borders: Our changing climate- its role in conflict and displacement
15. Holt-Giménez, E. 2002. "Measuring farmers' agroecological resistance after Hurricane Mitch in Nicaragua: a case study in participatory, sustainable land management impact monitoring." Agriculture, Ecosystems & Environment. 93(1-3): 87–105.

Reducing Emissions Related to the Wider Food System

Reducing Expansion onto our Global Carbon Sinks

By separating agricultural emissions from the wider food system, the different impacts of local and global supply chains are obscured. Currently, our food system is geared towards global supply chains. A large part of global deforestation is caused by expansion of intensive farming, but in many other cases the monopolization of the most fertile lands for commodity and cash crops pushes peasant farmers and local food production onto marginal lands that are easily degraded and become net CO_2 emitters. The UK needs to localise its food production to avoid shifting its emissions impact elsewhere. A climate-wise system protects the carbon sinks of the planet, while each country's most fertile land is used for producing food for the people who live there.

Local and Regional Supply Chains

The UK needs to localise food production to avoid the significant fossil fuel consumption that is required to import produce. In many instances, supply chains are responsible for comparable emissions to production itself. The climate importance of local food is often underestimated because transport emissions are the only metric used. However, local sales tend to also involve significantly less processing, packaging, refrigeration and waste. Direct sales between farmers and local customers through short supply chains can significantly reduce the climate cost of food by reducing supply chain emissions. Buying direct from a local producer can in many instances halve the climate impact of food.[16] In addition, local food sales will have considerable beneficial impacts for local economies, that will help offset any economic losses from reduced processing and transport.

Less, Better Meat; More Fruit and Veg

The widespread adoption of the 'nationally recommended' diet, which includes increased consumption of fruit and vegetables, and a reduction in proteins, could cause food-related emissions to fall by up to 17%.[17] This would also improve public health with related savings from treatment of dietary related ill health. An increase in domestic production of fruit and vegetables for local sale through direct to customer local supply chains would provide an optimisation of reduced food system emissions and public health, whilst creating employment opportunities in horticulture as a higher per-ha labour sector than meat and dairy production.

16. Garnett, T (2011). Where are the best opportunities for reducing greenhouse gas emissions in the food system (including the food chain?) Food Policy Journal
17. Behrens et al. (2017) Evaluating the environmental impacts of dietary recommendations, PNAS

The Committee on Climate Change estimates that agriculture is responsible for 10% of the UK's greenhouse gas emissions.[2] However, these figures separate the direct emissions from agriculture from broader food system emissions related to the indirect emissions associated with land use change and the impact of supply chains. This leads to underestimation of the climate impact of intensive systems while downplaying the potential for agroecological farming to provide solutions. The role of UK imports must be examined, looking again at our supply chains and retail system to ensure local food economies and low food miles are being rewarded and encouraged, and the high mileage model is discouraged.

Stop agricultural land expanding into forests	Reduce biofuel production and support	Reduce support for inefficient production	Global land use regulations	Tax production in important forest areas
Development money should not encourage expansion of intensive agriculture for global supply chains. Development programmes should support agroecology, land rights, and food sovereignty.	Biofuel crops directly compete with food production on the best agricultural land across the world. Firewood crops from sustainably managed small wooodlands and agroforestry systems are the most sustainable forms of biofuel.	Stop all economic incentives and development loans given for commodity crop production, crops that are highly processed and refined, and animal feeds. Instead we should encourage pasture and food waste based feed systems, with European production of feed where necessary.	Legal regulations on multinational agri-food businesses should regulate expansion into areas of significant global impact for carbon sequestration. Governments should be incentivised to protect forests and wetlands, but these programmes must respect indigenous land rights.	Tariffs should be placed on imported goods, such as soya, sugar, biofuels, and palm oil, that are produced in areas that lead to the degradation of carbon sinks, such as rainforests.

Reduced food transport	Local food strategies	Direct supply chains	Reduced packaging and food waste	Peri-urban food production
Rationalise food distribution to improve efficiency and regional production. Balance trade deficits to rationalise the import and export of food equivalents.	Tariffs should be introduced on imports, and direct support for local food production (especially where we have a significant trade deficit) should be implemented through national and regional schemes.	Increase support and grants for infrastructure that can develop direct sales to the consumer through local markets, which also reduces carbon footprint and increases revenue without increasing cost to consumers.	Encouraging direct sales and local supply chains where packaging and waste is minimised whilst regulating supermarkets to penalise waste and ban plastic packaging.	Use planning law to encourage production of food on greenbelt land that surrounds population centres to reduce transport, refrigeration and packaging.

Side policies to promote seasonal consumption	Support for fruit and vegetable producers	Ban factory farming	Public education on meat production systems	Training on agroecological livestock farming
Taxes or tariffs to reflect the increased GHG emissions of out-of-season production. Research and development into low impact techniques for season extension.	Direct support for start-up costs to encourage fruit and vegetable producers, and tariffs on imported produce to reflect the additional GHG emissions in their production and transportation.	While intensive housed livestock systems may have higher protein to input ratios than extensive systems the import of feeds and waste management problems offset any benefits and encourage overproduction.	Public education about the climate impacts of different kinds of livestock farming systems, highlighting the importance of low-input agroecological livestock farming.	Farmer-to-farmer training on agroecological livestock systems that minimise climate emissions and maximise carbon sequestration

Reducing Direct Emissions From Production

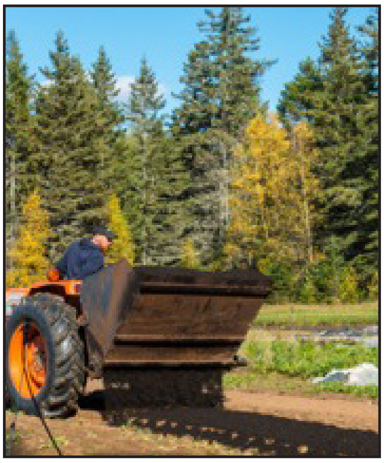
Livestock Production and Animal Feeds

The FAO estimates that livestock production is responsible for 14.5% of global emissions, of which 44.1% is CH4 from enteric fermentation, 23.4% is CH4 and N_2O from manure management and 22% is primarily CO_2 from feed production and related land use change. However, the FAO also estimates that some systems of animal husbandry can reduce emissions by 20-30%.1 Pasture-fed UK cattle and sheep and pigs and chickens raised on forage and waste food, including the "default" byproducts from arable systems, have a low carbon impact, and, as part of some land management systems, can sequester carbon and increase biodiversity. With appropriate management, agroecological UK livestock can provide an important source of sustainable food and livelihood for farmers. Agroecological production systems are significantly more efficient, and focus on producing livestock to levels that can be sustained in woodlands, on mixed farms, carbon-fixing pasture and recycled food system waste. But, this livestock is special, and people who consume animal products should be encouraged to adopt the "less, but better" approach towards consuming animal products from agroecological, local farms, instead of intensive farms.

Manure Management

Manure management in the UK accounts for 16% of our agricultural emissions, with a further responsibility for some of the 24% due to soil management and fertiliser use.[2] Globally, it accounts for 23.4% of livestock related emissions, 5.7% as CH4 from the anaerobic decomposition of manure in liquid form, and 13.4% as N_2O from manure application.[18] Over 60% of Europe's cattle and pig manure is handled as slurry, but this emits significantly more CH4 and N_2O than composted manure and is harder to store, leading to increased N_2O emissions from application in inappropriate conditions.[19]

Soil Management



Volatilization of nitrogen after fertilizer application is one of the biggest sources of N_2O emissions. Methods such as reducing fertilizer application to precisely meet the requirements of the crop, using more stable compost and composted manures where possible, and applying at times of peak crop uptake, can all reduce nitrogen pollution. In addition, decreasing soil disruption can increase soil organic matter content, further reducing nutrient and water losses.[20] Combined with other practices, including crop rotations, green manures, and cover crops, soil fertility and structure will improve. This also reduces the need for nitrogen and water inputs.

18. FAO (2017) Livestock solutions for climate change
19. RISE H. van Grinsven & A Bleeker, Evaluation of the manure and fertilisers act 2016: synthesis report PBL Netherlands Environment Assessment Agency
20. ADAS UK, (2007). 'The effects of reduced tillage practices and organic material additions on the carbon content of arable soils - SP0561' Defra Science and Research Projects

While the majority of emissions outside of the agricultural sector come from the burning of fossil fuels for energy generation, agricultural sources are much more variable. Fossil fuels are still used to power agricultural equipment, and to generate energy and heat for raising crops and livestock, and these fuels need to be replaced by renewable energy sources. Alongside this, we need a range of innovative equipment and methodologies to reduce dependency on heavy machinery and to use passive, well designed systems for heating. Other sources of emissions may be less easy to manage without increased support for a concerted and systemic approach to identifying and implementing ways that these emissions could be reduced.

Local Animal Feeds	Optimizing Feeding Regimes	Managing Pasture	Feeding Waste Food	Decreasing Stocking Density
Higher taxes on imported soya and corn, and support for UK-grown feed will reduce carbon footprints. Many leguminous, nitrogen-fixing, crops can be grown in UK crop rotations. Lucerne, peas and field beans are high in protein and replace soya.	Funding should support research into developing optimal feeding regimes for livestock that increase nutritional value, reduce bloat, and reduce overconsumption. This reduces methane and ammonia (a precursor to N_2O) from being released in manure and urine.	Graze livestock on permanent pasture using frequent rotations to avoid degrading land. Development of diverse permanent pastures or growth of forage in cover crops or rotations provides nutrient rich and healthy plants that reduce emissions as well as improving animal health.	Pigs and chickens can be fed safely on heat treated food waste, providing a low emissions feed that recycles nutrients. The ban on feeding waste food should lifted and farmers should be given grants for technologies to treat waste food.	High densities of livestock on small areas degrades soil, whereas reduced numbers of animals can graze pasture while it sequesters carbon. Livestock should be kept at levels that allow sustainable land management and enhance biodiversity.

Composting Animal Manures	Targeted manure application	Mixed farming systems	Reducing Run-Off	Support for Composting
Aerobic composting of animal manures leads to significant reductions in the CH_4 and N_2O that is produced when manures are handled in an anaerobic form as slurry. Compost is also significantly more stable than liquid manures reducing the risks of contamination of herbage and run-off.	Application of manures to soil should be targeted to times of peak crop needs when there is minimum chance of run off through heavy rainfall and when soil conditions allow micro-organisms to stabilise nutrients.	Integrated livestock and crop production means that animal manures are used as a fertility source for crops, alongside green manures and cover crops. This leads to significant emission reductions from manure and reduces the need for chemical fertilisers returning nutrients to the soil.	Run off from spreading manures should be minimised by ensuring that soils are not left in compacted states, that plant cover is able to stabilise nutrients and that hedges and trees reduce water flow.	Many livestock systems depend on liquid manures for waste management. To incentivise sustainable manure management the equipment and facilities for on farm composting of animal manures should be supported.

Reducing Disruption	Reducing Degradation	Reducing Pollution	Optimizing Nutrient Use	Increasing Sequestration
Support should be given for reducing tillage area and depth, reducing carbon release and maintaining organic matter in the soil. Reduced tillage allows fine roots and mycorrhizae to stay in the soil, which improves structure and supports plant growth.	Agrochemical inputs should be more highly taxed to reduce use, reducing the amount of chemicals that can decrease soil quality by decreasing biodiversity and increasing emissions, as well as reducing compaction by heavy machinery for better drainage.	An escalating tax on nitrogen fertiliser would help the move away from overuse. Farmers should be encouraged to use legumes in rotation to increase fertility, while crop residues and cover crops should be left in soil to increase organic matter and decrease nutrient leaching.	Both nutrient and water use efficiency can be improved through intercropping crops with complementary resource needs. Research should be funded to develop optimal cropping mixtures and rotations for different targets.	Growth of perennials and deep-rooted crops should be incentivised, particularly in areas with reduced soil disturbance. Use of bio-tillage crops, such as radishes, improves subsoil quality to increase deep root growth and downwards carbon transfer.

Increasing Carbon Sequestration

Forestry, Agroforestry and Silviculture

Forests provide a wealth of ecosystem services and functions. Trees draw down enormous quantities of CO_2 from the atmosphere, storing it deep in the soil where it can avoid disturbance. Deforestation and degradation of forests releases these carbon pools into the atmosphere, while destroying wildlife habitats and refuges. Planting more forests and conserving those that we still have will reduce the impacts of climate change while increasing the areas available for wildlife and recreation. The incorporation of trees into agricultural systems through, forestry, silvopasture and agroforestry can provide the additional benefits of shade and water retention, while allowing production of crops such as fruits and nuts, as well as timber, linking forestry and farming industries.

Managing Wetlands

Wetlands, including peatlands, bogs, and salt marshes, have an incredible sequestration capacity. As water moves over the soil, it causes sediments to build up in layers. This means that where most soils become saturated with carbon, wetlands carry on sequestering carbon in deposits that can be metres deep. However, this means that when these environments are disturbed, the amount of CO_2 released is phenomenal. This highlights the need to ban the industrial harvesting of peat and the draining of bogs and other wet areas, and to maintain or create wetlands in appropriate locations. In Europe alone, coastal and inland wetlands are estimated to provide \$3.42 trillion worth of ecosystem services and globally this rises to \$47.4 trillion, or around 43.5% of the value of all natural biomes.[21]

Deep Pasture and Appropriate Tillage

Increased sequestration of CO_2 in pasture can be achieved by preventing overgrazing, maintaining consistent soil cover and returning organic matter, such as composted manure, to the soil.[22] Deeper root systems, with good water and air penetration sequester more carbon and improve soil structure, thereby reducing soil erosion and enhancing our soil asset. On arable land carbon losses can be minimised by keeping tillage operations targeted and shallow, and integrated with other soil health practices including crop rotations, leguminous green manures and cover crops. These practices have the added benefits of building soil fertility and structure through reducing organic matter loss, which also increases the soil's capacity for nutrient and water retention, and promoting establishment of beneficial mycorrhizae and bacteria.[23]

21. Davidson, van Dam, Finlayson, McInnes. (2019) Worth of wetlands: revised global monetary values of coastal and inland wetland ecosystem services. Marine and Freshwater Research
22. Pasture Fed Livestock association (2018) the animal welfare and environmental benefits of pasture for life farming – interim findings
23. Soil Association (2018) To plough or not to plough: tillage and soil carbon sequestration

Alongside reducing emissions, we can use soil and plants to soak up the excess carbon we have already emitted using forests and crops. The key to this is building healthy soil, which has numerous additional benefits. Actions that can be taken to support soil development will have multiple other benefits, both for the environment, and for farmers. For example, reduced soil compaction can be achieved by decreasing heavy machinery. Less use of heavy machinery results in decreased CO_2 emissions, particularly if support is given for developing renewably-powered electric vehicles or draught animals. This also decreases cost of fuel for the farmer. The soil itself is more hospitable to root growth, increasing carbon sequestration, and improving crop yield and profits.

Conserving Forests	Afforestation	Agroforestry and Silviculture	Wildlife and Livestock	Biomass and Timber
Most of the UK's natural forest has been removed. Those that remain, particularly with very old trees, need to be protected. Current support for forest conservation should be extended to cover more area, and to target older sections of forest and species at higher risk of diseases or felling.	Increasing the number of trees significantly enhances the amount of carbon that can be stored in biomass. Tree-planting projects should be encouraged, and could be valuable opportunities for city-dwellers to reconnect with nature.	Trees should be integrated into cropping systems when possible, benefiting crops by increasing shade and water retention, and slowly building soil fertility. Fruit and nut trees also provide a source of income while creating a local supply of typically imported produce.	Growth of trees in and around fields supports both wildlife and livestock by providing shelter. Diversity in tree species provides habitats for a number of different beneficial insects and larger species. These refuges around fields also benefit crops.	While felling of established forests is damaging, sustainable forestry can be carried out using techniques such as coppicing. Fast-growing tree species can sequester carbon, but can also provide fuel and building materials as a source of income.

Stopping Degradation	Maintaining Existing Area	Converting Areas of Land	Newly-Created Areas	Increasing Biodiversity
Pollution from waterways, including nitrogen, phosphates, and sediments, can decrease quality of wetlands. Farmers and industries need to reduce agricultural run-off and pollution in waterways, and support should be given for restoring degraded areas.	Many wetlands have been drained to make way for farmland or developments, releasing carbon in enormous quantities, which takes hundreds of years to return to previous levels in restored wetlands. The draining of wetlands and burning of peat needs to be banned.	Development of wetlands can encourage wildlife, including game and fish. They also act as a living filter for water, improving quality. Support should be given for creating wetlands in natural depressions and around existing waterways, and stocking them with diverse plant species.	As climate change progresses, sea water intrusions will create flooded coastal areas. Managing these areas as tidal marshes promotes sequestration, as well as acting as a nursery for fish species. Lamb can be raised on these areas without damaging them.	Diversity in plant species promotes efficient recycling of nutrients and supports a number of ecosystem services. Grasses, shrubs, and trees can create effective barriers to nutrient and sediment run-off into the water. Support should be given for planting diverse plant species.

Shallow Tillage	Cover Crops	Green Manures	No Overgrazing
We need research and development of min-till systems that do not rely on herbicides. Min or no-till systems generally rely on herbicides to kill weeds. This has a damaging impact on soil biodiversity and the environment. Reducing tillage depth and targeting tillage to optimum conditions has a more significant impact on soil carbon than the nature of tillage systems employed. Shallow tillage, in combination with other soil health management practices can be more important than min-till systems reliant on herbicides and occasional deep tillage.	Keeping soil covered by living plants over winter reduces runoff and degradation of soil structure. It also reduces the leaching of mobile plant nutrients whilst accumulating biomass and sequestering carbon.	Leguminous green manures and cover crops fix atmospheric nitrogen and increases soil organic matter through biomass production. This can increase soil carbon sequestration and reduce the need for chemical nitrogen whilst providing nitrogen in a more stable form for plant uptake.	Maintaining stocking levels and pasture rotation to prevent overgrazing has a significant impact on the ability of plants to sequester carbon. Grasses grazed to 50% will be able to maintain photosynthetic capacity and regain biomass without reductions in root growth, whereas overgrazing pasture reduces its capacity to sequester carbon until leaves have regrown.

Improve Farm Adaptation by Maximising Resilience

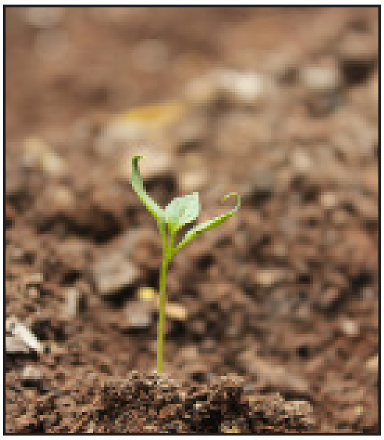
Breeding Resilient and Adaptable Seeds and Livestock

In the current agroindustrial model, hybrid and GM seed is being bred for resistance to drought. However, this approach is commonly unsustainable and costly for farmers, particularly when patenting reduces their ability to save the best seed from year to year. Seed saving results in precise adaptation to the local climate and soils, meaning over time crops often become more successful than industrial varieties bred for a much wider region. Resilient agriculture in the face of climate change will in a large part depend on giving farmers the tools to develop regional and highly resilient cultivars that can withstand harsher and more variable climatic conditions. Investment in training farmers to save seed, and in regional seed banks and breeding centres, will be valuable, as will research into finding resilient landraces from areas of the world that already face drought, salinity, temperature extremes, and other adverse conditions we may face.

Cropping System Design

Diverse mixed farms and agroecological systems are more resilient to economic and environmental shocks because diversity in production reduces risk.[15] Intensive annual production degrades soil, with negative effects on both the environment and crop growth. Cropping systems which maintain roots in the soil also maintain soil health. Intercropping or crop rotations with legumes and deep-rooting plants increase transfer of organic carbon and nitrogen to soil, expanding the resource base for crop growth. The increased diversity provided by these mixtures, or by creation of border strips, beetle banks, and wildflower meadows, promotes diversity in pollinators and other wildlife, ensuring the agroecosystem will be more resilient to perturbations caused by climate change.

Soil and Water Management



Better soil increases the resource bank that crops can rely on in times of scarcity. This includes making the soil more hospitable to root growth, and increasing its retention of resources. Increasing organic matter content by adding crop residues can improve water retention in sandy soils, decreasing nutrient leaching.[20] This means that in periods of drought, deep-rooted crops may still have access to water stored in the subsoil. In silty-clay soils, drainage can be improved by reducing soil compaction by heavy machinery, and directing runoff water to ponds and ditches, which aerates the soil to allow better crop root growth, while reducing methane production, and reducing silting and pollution of waterways.

Many of the most pronounced effects of climate change will have significant impacts on agricultural yields, with changing weather patterns already responsible for reduction in yield of several major crops. Changing our farming practices will be not only beneficial, but necessary, as shifting temperatures cause more frequent and severe flooding, drought, and extreme temperatures, testing the resilience of crops and agricultural systems to the extreme. This may mean that production areas will shift, or dominant crop cultivars will change to maintain yields in a harsh environment. Adaptation to these changing conditions can be accelerated by using traditional seed saving techniques, and taking advantage of the wealth of genetic diversity in heirloom varieties and landraces, while agricultural system design can increase resilience to perturbations in normal weather patterns through complementary resource use and increased resource use efficiency.

Seed Banks	Collaborative Seed Breeding Programmes	Hardy, Adaptable Animal Breeds	Farmer Autonomy	Restrict Patenting of Genetic Resources
Access to locally adapted seeds is crucial for the development of the diverse genetic base necessary in the breeding of varieties that can thrive in changing environments. Seed banks should be supported to encourage seed exchange between farmers.	Farmer-led seed breeding is the fastest and most appropriate way to adapt varieties to local conditions and rebuild our genetic resource base. Farmers should be supported to develop new varieties and populations	The development of locally adapted landraces is crucial for the development of the genetic base that can adapt to changing conditions. Farmers should be encouraged to maintain hardy, adaptable breeds and develop new landraces.	Regulation should encourage farmers to breed plants and livestock, and protect their rights to save, exchange and sell farm adapted breeds and varieties. This will increase the resilience of farms and increase their potential to adapt to the changing climate.	Patents, Plant breeder's rights and GMOs restrict the development of new breeds and varieties by limiting rights to owners of intellectual property. This slows down adaptation of seeds and breeds and is counter to efforts to rebuild the genetic base of our agricultural systems.

Growing Cover Crops	Growing Perennials	Growing Legumes	Increasing Biodiversity	Using Crop Rotations
Cover crops should be encouraged during periods where land would usually lie fallow. They can be grown over winter to reduce soil erosion, and used as forage or green manure in the spring. Coinciding cover crops with fertilization also helps to reduce nutrient losses.	Perennial plants improve soil structure and encourage diverse beneficial bacteria and mycorrhizae. Leguminous perennials can provide nutrient-rich forage while maximising soil fertility and carbon sequestration.	Legumes can provide nitrogen for crops in organic forms, which are less susceptible to leaching. Legumes should be incorporated into cropping systems or rotations as an alternative to fertilizer, and to provide protein-rich food for humans and livestock.	Diversity in crops grown typically means that they have complementary resource use, so can be grown together without reducing yields. Different physiological traits mean that, as the climate becomes more variable, diverse farms will be more resilient.	Continuous cropping allows pests to build up and depletes specific nutrients. Rotating the crops in a field keeps soil pests low and allows incorporation of beneficial species such as legumes or pest-reducing plants to improve subsequent crop yields.

Increase Organic Matter	Building Soil Fertility	Improving Soil Structure	Increasing Root Growth	Increasing Biodiversity
Support should be given for replacing agrochemical use with cover crops that can provide similar herbicidal and pesticidal properties without resulting in the contamination of soil and loss of organic matter.	Levels of soil nutrients should be routinely monitored and gradually restored to optimal levels, followed by replacement of nutrients extracted by the crop. Organic matter in the soil should be encouraged for nutrient retention.	Reduced tillage and reduced compaction should be encouraged to maintain soil aeration. Earthworms and other macrobiota can be encouraged to improve porosity, whilst mycorrhizae and bacterial can improve aggregation.	Deeper roots sequester more carbon, as well as accessing more stable water reserves. Deep rooting should be encouraged by using bio-tillage plants to improve subsoil hospitality by decreasing compaction.	Diversity in microbiota can result in microbes that support plant growth by repelling disease, mineralizing nitrogen, and producing plant hormones. They can be encouraged by reducing chemical use and inoculation of seeds.

Avoiding Climate Policy Distortions

Including food in the Green New Deal and Green Industrial Revolution

Alongside the energy sector, all progressive growth strategies should include R&D, targeted investments, and training to transform our agricultural system into one that enhances the environment and creates a significant amount of jobs in the new food and farming economy. Government has an obligation to retrain those employed in the agricultural sector for low carbon, highly skilled, well paid agricultural jobs. This can be a part of a Green Industrial Revolution or a Green New Deal. Climate friendly agroecological farming, including the production of high animal welfare pasture and waste fed livestock, employs more people per hectare in decent work. Job losses must be avoided, including those working in the meat industry, and replaced with better jobs that respect people, animals and the environment.

Payments through the Environmental Land Management Schemes

Government intends to link payments for farmers to "public money for public goods", a scheme of payments designed to incentivise farmers to adapt to and mitigate climate change.[24] The ideas proposed, so far, are largely designed to increase carbon sequestration. We believe that carbon sequestration alone will not accomplish the wide range of measures that need to be adopted in order to fully tackle the emissions impacts of the food system as a whole. We advocate payments for whole systems approaches, such as agroecology, which will incorporate holistic measures, including improved animal feed systems and composting, alongside an approach that incentivises localised distribution systems.

Re-wilding and re-foresting

Re-wilding and afforestation will be essential steps in supporting and maintaining biodiversity. However, these need to be carried out carefully and strategically, in order to maximise biodiversity impact while avoiding adverse impacts on food and timber production. We support an agroecological approach to forestry, which maintain livelihoods for foresters to earn a livelihood producing sustainable timber and forest products while maintaining woodland biodiversity and health. The livelihood of all people who live and work in forests should be protected. Forest dwellers can be the best guardians of healthy forests.

There is much emphasis in the Climate Action Plan on reforestation in the UK. However, this only one of the many activities the UK should undertake. We should also focus on re-foresting degraded ecological hotspots globally, and our top priority should be on protecting those areas that are not yet deforested, which typically have higher carbon stores.

Overemphasis on no-till systems

There is an overemphasis on no-till and min-till systems that is not backed up by evidence. Research from DEFRA and other organisations suggests that there is only limited scope for additional soil carbon storage and sequestration from zero or reduced tillage practices, and that there are significant further questions over the implications of min-till on N_2O emissions.[25] Min or no-till systems also generally rely on herbicides to kill crop residues and weeds. This has a damaging impact on soil biodiversity and the surrounding environment and may well offset any soil carbon advantages gained. Furthermore, min-till soils are often ploughed occasionally to control grass weeds leading to loss of many of soil carbon gains made. Instead shallow tillage, especially when integrated alongside other soil health management practices including leguminous green manures and overwinter cover crops, are likely to outweigh the benefits of no or min-till systems.

Avoiding carbon leakage

Measures to reduce emissions from livestock and change diets should be coupled with trade rules that do not allow reduced production of UK meat to be replaced with imports of beef produced in Brazil and the USA, which can incur 3 times the environmental impact of UK production.[26] This means implementation of trade rules and tariffs on meat imports, particularly from high environmental value areas like the rainforest. The UK should avoid free trade agreements that make these measures difficult, or even illegal, to implement.

24. Defra (2018). "Health and Harmony: the future for food, farming and the environment in a green Brexit."
25. Liu, X. J., Mosier, A. R., Halvorson, A. D., & Zhang, F. S. (2006). The impact of nitrogen placement and tillage on NO, N2O, CH4 and CO2 fluxes from a clay loam soil.
26. Blandford, D. and Hassapoyannes, K. (2018), "The role of agriculture in global GHG mitigation", OECD Food, Agriculture and Fisheries Papers, No. 112, OECD Publishing, Paris.

Intensifying production and 'sparing land for nature' is not a solution

As part of the Industrial Strategy, BEIS has set out further details of its proposed £90m Challenge Fund to transform food and farming. On the technology side, the fund will focus on measures such as artificial intelligence, robotics, remote monitoring and data science. This fund is one of the actions in agriculture the UK government is claiming will mitigate climate change, citing a link between decreased GHG emissions and improved productivity. The analysis, largely perpetuated by agribusiness, is that expanding industrial agriculture to produce more food more efficiently on less land leaves land for nature. However, there is little evidence that increasing production decreases demand. What usually happens is overproduction of cheap commodity crops. Often increased productivity increases the area devoted to crops since farmers have taken out loans to pay for equipment and need to maximize returns, and so they expand.[27]

It is also clear that in tackling climate change, resource efficiency is more important than yield. We advocate ecological intensification using agroecological methods, even if farms only adopt a handful of techniques. We want to see significant R&D investment into knowledge and technologies that are affordable and can be widely implemented, such as composting technologies, on-farm animal feeds, food waste for animal feed, and low emissions equipment, all of which minimise external inputs.

Is climate smart actually climate smart?

Climate-smart agriculture is a term often used by agribusiness companies for high-tech inputs which perpetuate the same models of intensive agriculture that drive climate change. Climate-smart agriculture is distinct from the new progressive vision of climate-wise farming we advocate, based on agroecological principles. It is not about purely technical changes at the production level but, rather, the political dimensions of food production, distribution, and consumption understood as a whole.[13]

Biofuels

There is not enough land globally to produce biofuels and all of the food we need in a sustainable way. Although many people around the world rely on wood biomass for heating and cooking, biofuels made from intensively produced corn, palm oil, soy and rapeseed incur carbon costs in their production and release carbon in their use. Furthermore, they drive deforestation and land use changes.

We do not have enough land to produce enough to meet our energy needs. To meet even 20% of the world's energy demand in 2050 through biofuels would require us to double our current annual production of plant material (including that grown for food, fuel, and fibre), and devote it all to biofuels.[28]

Voluntary measures for reducing emissions are not enough

We agree with the "Reducing UK Emissions: 2018 Progress Report to Parliament" from the Committee on Climate Change (June 2018), which clearly states that voluntary measures are not enough for the UK to meet our emissions targets.[2] Government needs to adopt strong regulations, clearly linked to targets for reducing emissions, as well as incentives for development of farming systems with net-zero emissions. Some regulations should be baseline requirements for all farms- not just those who will be receiving ELMS payments. Others should be linked to the "polluter pays" principle, where farms that continue high emission practices pay penalties into a fund to support farms to convert to carbon neutral farming.

"Voting with your fork" is not enough

Governments and activists often put the burden of improving our food system on consumers asking consumers to "vote with their fork" and voluntarily change eating habits. Individual action is important, but nowhere near enough. Voluntary actions will never impact the problems embedded in a food system faced with enormous structural issues on a global level. Agribusiness corporations hold enormous power. Even if the demand for commodities decreases, they actively create false markets, including dumping excess produce on vulnerable markets- sometimes as "food aid". These corporations need to be regulated and controlled Citizens need to organise to demand ambitious policy actions by government, incentives, training, regulations and trade rules to fight climate change.

27. Shattuck, A. "Food, Climate, and the Myths that Keep our Planet Hot," Summer 2017 Food First Backgrounder Volume 23 Number 2 (2017). Oakland, CA: Food First / Institute for Food and Development Policy.
28. World Resource institute (2015): Avoiding bioenergy competition for food crops and land

For Inclusion in Policy:

The Landworkers Alliance calls for a Climate, Food and Agriculture Bill creating a comprehensive set of land use, food, agriculture and trade policies implemented across all government departments in the UK.

1. Reducing emissions.

1.1 Introduce strict regulations on unsustainable agricultural practices, such as limiting over-application of fertilizers and untreated slurry , or requiring buffers between agricultural lands and waterways, and banning removal of peat and draining of bogs.

1.2 Incentivise local production of animal feeds and pasture / food waste-based systems. Remove the ban on feeding safely-treated surplus food to pigs and chickens. Incentivise good management practice for soil health and manure management.

1.3 Implementation of higher tariffs on imported food and animal feed, based on source of production, distance and ecological importance.

1.4 Investment in boosting domestic, agroecological food production to reduce trade deficits and food miles.

1.5 Investment in developing local and regional supply chains, including development of the infrastructure needed to support local sales, and education in direct marketing techniques.

1.6 Stopping development assistance money that promotes intensive export-orientated agriculture, while supporting a sustainable climate-wise food system.

1.7 Provision of capital grants to encourage the uptake equipment and practices necessary for net-zero farming systems.

1.8 Encourage local production through a change in planning policy to enable more producers to live on their farms.

2. Enhancing sequestration.

2.1 Support for farmer-to-farmer or researcher-led training sessions that focus on techniques that improve sequestration capacity, and for demonstration farms that exemplify these techniques.

2.2 Incentives to adopt sustainable sequestration practices, such as planting woodlands, maintaining permanent pasture, enhancing soil quality, and creating wetlands.

2.3 Provision of capital grants to buy equipment necessary for changed practices.

3. Enhancing resilience.

3.1 Support for developing regional seed banks and training in seed-saving techniques.

3.2 Incentives to increase biodiversity in and around agricultural fields, including enhancing wild plant and animal diversity as well as crop diversity over space and time.

3.3 Development policy focusing on agroecological techniques for small-scale farmers to build resilience.

4. Research

4.1 Major investment into research and development of climate-friendly farming practices including optimal soil management; identification of beneficial crop mixtures for yield, soil restoration, pollinator support, pest management, building fertility, and others; ways to maximise carbon storage capacity in soils; livestock feed mixtures for reduced emissions; optimal manure management; waste-food management systems; and so on.

4.2 Creation of a continually updated guide of best practice based on R&D results, connected to the network of demonstration farms.

The Landworkers' Alliance (LWA) is a grassroots union of small-scale, ecological and family farmers across the UK. We campaign for the rights of producers and lobby the UK government for policies that support the infrastructure and economic climate central to our livelihoods.

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