Reduce, restore, replace – an approach to creating farm-level circularity

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This paper is on behalf of nature and animal welfare coalition Wildlife and Countryside Link (Link)

Summary of policy recommendations

This paper explores how reducing use of harmful artificial inputs, supporting nature restoration, and replacing inputs with more sustainable alternatives can increase farm circularity and reduce the environmental impacts of agriculture.

Summary of policy asks:

- Maintain Environmental Land Management Schemes (ELMS) funding to fund the transition to circular farming and then increase beyond 2028/29.
- Increase value for money from ELMS by directing funds towards actions with the greatest environmental benefits.
- Prioritise and promote a transition to nature-friendly farming practices that restore soil health, beyond simply replacing artificial with organic fertiliser.
- Provide farm-specific advice on nature-friendly farming focused on whole farm changes to nature-friendly practices.
- Phase out pesticides known to have significant negative impacts on public health and wildlife, including those with persistent or harmful metabolites.
- Enforce the regulatory baseline for nutrient management to reduce leakage to the environment.
- Require testing of sewage sludge for harmful contaminants, such as PFAS and microplastics, and phase out use in agriculture until proved to be a safe resource.
- Introduce extended producer responsibility (EPR) for agriplastics to reduce their use and ban particularly harmful agriplastics, including oxo-degradable plastics.
- Drive a transition to mixed farming to improve multifunctionality of land use and reduce the amount of land used to grow animal feed for intensive systems.
- Change regulations to allow appropriately treated food waste and surplus to be fed to animals.

Introduction

The Government's upcoming Circular Economy Growth Plan and 25 Year Farming Roadmap, and concurrent Food Strategy and Land Use Framework processes, present an unprecedented opportunity to apply circular economy principles to the food system to minimise impacts on climate, nature and public health, while supporting economic growth and resilient British farming. While it is important to implement circularity across the entire food system from farm to fork, this paper focuses on farm-level circularity.

It defines and explores farm-level circularity through three lenses: reduce, restore and replace. *Reduce* explores ways in which conventional farms can eliminate unnecessary inputs to save money and reduce environmental impacts. *Restore* explores how a transition to nature-friendly farming can circulate natural resources already available on farm, reducing external inputs and restoring wildlife. Finally, *replace* explores opportunities for substituting inputs for more environmentally sustainable, and sometimes cheaper, alternatives.

Farms and farmers are the root of our food system. 57% of the food the UK eats is produced in the UK.[1] However, current farming systems are not circular and rely on a large amount of external inputs from outside the farm that are often damaging to both UK and overseas nature. Nutrient pollution from fertiliser use is a key reason for agriculture having the largest impact of any sector on water quality and so freshwater biodiversity.[2] Pesticide use in agriculture globally is contributing to the decline of insects,[3] and is one cause for the decline of farmland biodiversity more generally including farmland birds,[4] as well as contributing to impacts on human health. UK agriculture is also driving biodiversity loss overseas as we import large amounts of soya for use as a feed input, with production of this soya strongly linked to deforestation, biodiversity loss and water scarcity.[5] Finally, UK agriculture is responsible for 11% of UK greenhouse gas emissions with this proportion set to grow in future without urgent action.[6] Almost a quarter of agricultural greenhouse emissions can be attributed to inorganic (artificial) and organic fertiliser use.[7]

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[1] Defra: Accredited official statistics: Chapter 14: The food chain
[2] Environment Agency & Natural England: Research and analysis: State of the water environment indicator B3: supporting evidence
[3] Sánchez-Bayo and Wyckhuys, 2019: Worldwide decline of the entomofauna: A review of its drivers
[4] State of Nature Partnership: State of Nature 2023
[5] WWF: Riskier Business: The UK's Overseas Land Footprint
[6] The Climate Change Committee: The Seventh Carbon Budget: Advice for the UK Government
[7] The Climate Change Committee: The Seventh Carbon Budget: Advice for the UK Government

These impacts means it will not be possible to achieve legally-binding targets under the Environment Act, including to halt the decline of nature by 2030 and reduce agricultural pollution by 40%; to bring waterbodies to ‘good’ status by 2027; or to reach net-zero by 2050 without making farms more circular and reducing their reliance on harmful inputs.

Lack of circularity and dependence on external inputs also harms farm resilience and profitability. For example, due to the invasion of Ukraine, fertiliser costs soared from £217 per tonne in 2020 to £870 per tonne in 2022, leading to farmers spending an estimated £1.45 billion more on fertiliser from February 2022 to February 2024 than they would have if prices had remained at pre-crisis levels. Around £400 million is also lost unintentionally each year in artificial fertiliser leaked into the environment,[8] and transitioning to low-carbon, organic, and circular fertilisers could reduce fertiliser costs by £60 per hectare, with 80% fewer greenhouse gas emissions.[9] Reducing reliance on harmful inputs through *reduce, restore, replace* could therefore increase the potential for farm profitability and improve resilience to political and climatic shocks, with reduced price volatility in the food system.

Reduce

The main challenge for farm-level circularity is overdependence on external inputs, particularly of fertiliser, pesticides and animal feed, rather than retaining and recycling resources on farm. This section focuses on elimination of unnecessary external inputs within conventional farming systems to increase circularity of individual farms, whereas *restore* looks at how the transition to nature-friendly farming can further reduce dependence on inputs by using nature to circulate natural resources on farms.

Reducing fertiliser use

97% of UK agricultural land relies on the use of artificial fertilisers.[10] Overuse of fertiliser has severe effects:

- Agriculture is responsible for around 70% of nitrogen pollution to water,[11] with anywhere from 20-80% of nutrients in fertilisers not being utilised by crops and lost to the environment.[12]

[8] WWF: Nitrogen: Finding the Balance
[9] WWF: Pounds in Pockets: Climate Policies that Cut Costs for Households and Farmers
[10] UK Parliament POST: The future of fertiliser use
[11] House of Lords Environment and Climate Change Committee: Nitrogen: time to reduce, recycle, reuse
[12] UK Parliament POST: The future of fertiliser use

- Agriculture is the number one reason for water bodies not meeting good water quality status due to phosphorus pollution.[13]
- 69% of the UK's land area and 93-97% of designated nature sites in England are overloaded with nitrogen, with increased acidity of soils,[14] and agriculture is a leading cause of eutrophication of freshwater bodies.[15]
- Agriculture accounts for 84% of England's ammonia emissions.[16] These ammonia emissions contribute between a third and a half of fine particulate matter (PM2.5) pollution in central London and a third in Birmingham, contributing to thousands of premature deaths.[17]
- Almost a quarter of agricultural greenhouse emissions can be attributed to inorganic (artificial) and organic fertiliser use,[18] with nitrous oxide pollution having a global warming potential 273x that of CO_2 over a 100-year period.[19]

Nutrient pollution is not just an environmental problem, but an economic issue for farmers too. Around £400 million is lost unintentionally each year in artificial fertiliser leaked into the environment.[20] Reducing fertiliser use within conventional farming systems is not about reducing farm productivity or profitability, it is about using the right fertiliser and the right amount, in the right place, at the right time to avoid unintended environmental impacts.

As recommended by the House of Lords Nitrogen Inquiry, we need a systems approach to calculating the stocks and flows of nitrogen across the environment and the economy, implemented using a similar methodology to the Scottish Nitrogen Balance Sheet. Having a Nitrogen Balance Sheet would enable the prioritisation of policy actions that provide the greatest reductions in nitrogen loss to the environment and improve circularity in the use of nutrients.

Increasing circularity through reducing excessive use of fertilisers requires proper enforcement of current regulations designed to minimise nutrient pollution. It is essential the minimum legal requirements for managing nutrients are met before financial incentives to support pollution reduction are considered. This requires effective enforcement action to be

[13] Environment Agency: Phosphorus: challenges for the water environment
[14] Rowe et al., 2022: Trends Report 2022: Trends in critical load and critical level exceedances in the UK. Report to Defra under Contract AQ0849, UKCEH project 07617
[15] Environment Agency: Phosphorus and Freshwater Eutrophication Pressure
[16] Air Pollutant Inventories for England, Scotland, Wales, and Northern Ireland: 2005-2022
[17] Kelly et al., 2023: Diagnosing domestic and transboundary sources of fine particulate matter (PM2.5) in UK cities using GEOS-Chem
[18] The Climate Change Committee: The Seventh Carbon Budget: Advice for the UK Government
[19] UNEP: Rise in nitrous oxide emissions endangers pathway to 1.5°C, the ozone layer, and human health
[20] WWF: Nitrogen: Finding the Balance

taken. The 2018 Farming Inspection and Regulation Review found that of 10,600 staff at the Environment Agency, only 40 are involved with farm inspections.[21] This has led to a very low risk of enforcement action: data shared by the Environment Agency shows that since 2022 only 3 prosecutions have taken place under the farming rules for water, and only 4 civil sanctions were applied, across around 100,000 farms in England. This means there is little incentive for farmers to meet legal requirements to control pollution. Recent increases in funding are welcome and must be maintained and built upon, and greater enforcement action must be taken where regulations are not followed. Compulsory soil testing, in particular, has been established recently as part of the Farming Rules for Water to support nutrient management planning and must be properly enforced.

Where appropriate, farmers need to be further supported to apply nutrients in a more targeted way, for example using precision technologies like soil pH and nutrient mapping. Nutrient management regulations should also be updated to tackle pollution of air, water and soils in an integrated way. This should incorporate actions to reduce ammonia emissions, such as a requirement to use low emissions spreading equipment and extending environmental permitting to intensive dairy and beef herds, as promised in the *2019 Clean Air Strategy*.

Some of these actions and many of the actions set out below are already supported through the Environmental Land Management Schemes (ELMS). To ensure this support remains available to all farmers who want to access it, ELMS funding must be maintained, as set out in the spending review. Payments should also be focused on those actions likely to have the strongest positive impacts for the environment. We explore how to best use ELMS funding in our briefing: *Five Asks for the Environmental Land Management Schemes*. Beyond 2028-29 ELMS funding should be scaled up to allow the level of transformative change needed to achieve the 2038 and 2042 Environment Act Targets and net zero. ELMS funding must be backed up by support, advice and training to farmers to transition away from overuse of fertiliser.

Reducing pesticide and herbicide use

Although the weight of pesticides and herbicides applied to UK farmland and the area treated has decreased somewhat in recent years, significant amounts of potentially toxic pesticides, and toxic pesticide combinations, continue to be applied to farmland, with highly toxic substances seeing an increase in use, contributing to biodiversity loss.[22] Overuse of

[21] Farm Inspection and Regulation Review
[22] Pesticide Action Network UK: Pesticide use in the UK

substances such as glyphosate is also contributing to pesticide resistance.[23] To reduce these toxic inputs and improve circularity of farms, pesticide use must be reduced.

Regulations should be updated to ban substances known to have significant negative impacts on public health and wildlife. Known carcinogens, such as glyphosate, imazalil and 2,4-D should be phased out of use; as should insecticides known to be highly toxic to bees and other pollinators, such as cyantraniliprole, lambda-cyhalothrin and acetamiprid.[24]

PFAS pesticides should also be phased out as soon as possible. There is significant evidence of widespread PFAS pollution in the UK, including Trifluoroacetic Acid (TFA) a common breakdown product of many PFAS pesticides.[25] TFA is highly persistent, mobile and is widespread in UK rivers.[26] PFAS pose significant health and environmental risks including to soil health and so agricultural productivity.[27]

The UK pesticide approval system should also be reformed to take into account impacts on pollinators and the effects of combinations of pesticides and herbicides and their non-active ingredients. We welcome the UK Government's commitment, as part of its EU reset deal, to follow existing and future EU pesticide standards. This will ensure pesticides standards match currently higher standards in the EU and ease trade barriers.

Farmers should also be supported only to use pesticides and herbicides where necessary, to reduce costs and environmental impacts. This should involve training and support in using low-and high-tech methods to assess need for pesticides before their use. Farmers are already supported through ELMS not to use some pesticides on agricultural land and this should be promoted as a key action farmers can take to reduce impacts from pesticides.

Reducing use of agriplastics

Agricultural plastics (agriplastics) are used for multiple reasons in UK farming including as protective films, nets, irrigation piping and for packaging of products for use on farms. Reporting on agricultural plastic use is poor globally. An estimate from CIWM some years ago put the amount of UK agricultural plastic waste generated each year at 135,000 tonnes.

[23] Agriculture and Horticulture Development Board: First case of glyphosate resistance in a UK weed (Italian rye-grass) confirmed
[24] Pesticide Action Network UK: Pesticide use in the UK
[25] Fidra: PFAS and Pesticides: a case for comprehensive UK legislation
[26] Fidra: Concentrations of Trifluoroacetic Acid (TFA) in UK Surface Waters
[27] Fidra: PFAS and Pesticides: a case for comprehensive UK legislation

However this did not take into account microplastic waste or all agriplastic products used in the UK, so is likely an underestimate.[28]

This plastic often breaks down during use or is not properly disposed of, leading to microplastic pollution and leaching of chemicals from plastics into the environment. This causes harm to the environment and human health, impacting and contaminating all stages of the food web. Examples include degradation in soil quality, death of wildlife, decreased photosynthesis, as well as inhibiting water and nutrient uptake by crops.[29,30] This can cause reductions in crop yield.

High rates of contamination of agriplastic products also mean waste dumping and mismanagement are common when these products become waste – exacerbating their negative impacts on the environment and human health.[31] While the focus of this paper is on plastic use on farm, further contamination of food by plastics occurs through transport and packaging so a full supply-chain approach to plastic contamination is ultimately needed.

Although non-fossil fuel, single-use alternatives are available, and their use is discussed in the *replace* section, many replacements are themselves harmful to nature. The best way to increase circularity, reduce waste and avoid negative impacts is to reduce the use of agriplastics. In a survey of supermarkets by the EIA, all supermarkets said there is a need for a sector-wide initiative to reduce agriplastic pollution. [32] Extended Producer Responsibility (EPR) for non-packaging agriplastics should be re-consulted on by the UK. This should include strong price incentives for reduction in the use of agriplastics taking into account the full environmental costs of their use, alongside support for reuse and recycling to reduce the risk of improper disposal.

As well as the intentional use of agriplastics, large amounts of microplastics are added to soils through the application of treated sewage sludge (biosolids) to farmland.[33] Biosolid products also contains PFAS and other harmful chemicals such as endocrine-disrupting bisphenols, flame retardants and pharmaceuticals.[34] As a result, the UK has some of the highest rates of soil microplastic contamination in Europe,[35] and biosolids are currently banned for use by organic certifiers due to contamination risks. Current regulations only require biosolids to be

[28] CIWM: Agricultural Waste
[29] EIA: Cultivating Plastic: Part 2 - Environmental and human health harm caused by agriplastics
[30] Iqbal et al., 2023: Impacts of soil microplastics on crops: A review.
[31] EIA: Cultivating Plastic: Part 3 - Agriplastic waste mismanagement and criminality
[32] EIA: Cultivating Plastic: Part 1 - Agriplastics and the UK grocery retail supply chain
[33] Eftec and UKCEH report for Defra: Option appraisal for intentionally added microplastics
[34] Fidra: Environmental Risks from Sewage Sludge and Fidra and EIA: The Agricultural Use of Sewage Sludge
[35] Lofty, et al., 2017: Estimations of contamination onto European agricultural land via sewage sludge recycling

tested for certain metals, meaning toxic levels of persistent chemicals and microplastics are being added to agricultural soils.

Application of biosolids to agricultural soils should be phased out until they are proven to be a clean, safe resource through changes to regulations to require testing for all potentially harmful contaminants before application. Phasing out biosolid use without increasing use of other fertilisers will require a transition to nature-friendly farming as outlined under *restore*, so that less fertiliser is needed overall.[36]

Reducing water use

It is important that farms reduce their abstraction from natural water sources where possible to avoid impacts on freshwater ecosystems. Although agriculture is responsible for a relatively small proportion of direct water abstraction (about 1% in England[37]), farms are concentrated in areas with high water stress, low levels of available water for abstraction and therefore high impacts of abstraction on nature.[38,39] Reducing abstraction is also essential to farm resilience as abstraction may not be possible during periods of high water stress, meaning farms must rely on their own sources of water.

Within conventional farming systems there are clear circular economy opportunities to reduce water abstraction by capturing water for reuse. For example, relatively low-cost systems can capture rainwater from roofs and divert it to storage tanks or reservoirs on farm, saving farms money.[40,41] Other options involve reusing clean water from on farm processes, such as water used for cooling milk,[42] or investing in cleaning of industrial wastewater, such as wastewater from meat industry processes.[43] Engineered solutions, such as bunds, can also be used to slow the flow of water off the land and retain moisture in soils, benefitting crops and grasslands during drier periods. Capital grants for farms should be expanded to further support water reuse and recycling on farm, as well as support increased storage capacity where it is not available, to reduce the need for abstraction.

[36] Fidra: Farmer Case Studies: Pioneering Agroecological Farming Approaches for Healthy Sustainable Food Production: Doug Christie
[37] Defra: Accredited official statistics: Chapter 11: Agri-environment
[38] The Institution of Engineering and Technology: Water for UK agriculture - key challenges and opportunities
[39] Knox et al., 2010: Development of a water-use strategy for horticulture in England and Wales – a case study
[40] Pinpoint: Best Practice: Recycling Water
[41] Defra: Water: How we've helped farmers reduce their usage and tackle pollution
[42] Pinpoint: Best Practice: Recycling Water
[43] EU CAP Network: Circular water solutions

Restore

Whilst *replace* explores what is possible in terms of reducing external virgin resource inputs within conventional farming practices, true circularity requires farmers to work with and restore nature. By employing nature-friendly farming techniques, farms can provide nutrients for plants, manage pests, and feed livestock by circulating natural resources already available on farm. Nature-friendly farming puts nature at the heart of food production, working with it rather than against it, above and below the soil. It treats the whole farm as a single, interconnected ecosystem and supports farmers to enhance their natural assets - from healthier soils that hold water and nutrients more effectively, to insects that pollinate crops and control pests. This section explores specific nature-friendly techniques for increasing circularity and reducing the need for inputs.

Regenerating soils to restore nutrients

Fertilisers improve crop yields by providing nutrients for growth that may be deficient in the soil or in the soil and not accessible to crops. However, as set out above, excessive fertiliser use has severe environmental consequences. Nature-friendly farming practices focused on soils (such as organic, regenerative or agroecological practices), seek "to enhance and sustain the health of soil by restoring its organic matter, boosting its fertility and productivity".[44] This encompasses a wide range of techniques including:

- minimising tillage to reduce damage to living organisms;
- managing crops to restore soil nutrients, including through use of leguminous crops (that host nitrogen fixing bacteria and so can increase soil nitrogen), cover cropping, crop rotation, and perennial crops;
- building soil biodiversity through application of compost and crop residues to crops, intercropping, and agroforestry;
- restoring border areas to encourage beneficial wildlife that restores soil health.[45]

All these practices focus on reducing the need for fertiliser application by recycling and restoring nutrients to the soil as well as restoring natural soil processes based on growth of beneficial bacteria, fungi and animals (such as earth worms) that increase the accessibility of nutrients to crops.[46] These practices are not new and, in many cases, have been used for

[44] IUCN: Approaches to sustainable agriculture
[45] UK Parliament POST: Regenerative Agriculture
[46] Khangura et al., 2023: Regenerative Agriculture—A Literature Review on the Practices and Mechanisms Used to Improve Soil Health

centuries to maintain soil health. However, our farming systems have often moved away from these processes that naturally recycle resources towards monocultural systems requiring large amounts of external inputs.

Many of these sustainable practices are already rewarded under ELMS, again reinforcing the importance of maintaining or increasing ELMS funding. However, in some cases ELMS is being targeted towards the wrong practices in the wrong place, with minimal benefits for the environment. A key example is herbal leys funding which is sometimes being used inappropriately where land would be better restored to biodiverse meadows. In addition, soil actions under the Sustainable Farming Incentive (SFI) do not require proven results in terms of restoring soil health: farmers are currently paid for producing nutrient and soil management plans with no requirement to implement them. This represents poor value for money without assured outcomes. Our recommendations for improving the SFI can be read in our briefing: *Improving the Sustainable Farming Incentive*

The profitability of nature-friendly farming can be increased through reduction in inputs making it a viable business proposition once properly established.[47] As discussed above, it also reduces exposure to fluctuations in input prices. Though improved soil health in the long-term supports yields as naturally available nutrients increase, transitioning to nature-friendly farming can initially reduce yields per area of land. This reinforces the need to reduce food waste, and reduce the use of arable land to feed livestock in order to free up additional arable land for feeding people. This latter point is explored in depth below.

Mixed farming to reduce external animal feed inputs

Additional nutrients are not only introduced to farms in the form of artificial fertilisers. Animal feed brought in from outside the farm adds a large amount of nutrients, of which a large proportion end up as slurries. These slurries then have to be disposed of, usually by spreading on the land. Where intensive livestock production is concentrated in specific areas, the amount of slurries often exceeds the local requirement for nutrients, leading to excess nutrients applied to land and the pollution issues set out above.[48] In addition, we import large amounts of feed from overseas, including on average 3.6 million tonnes of soy per year, at least 75% of which is used for animal feed or in animal products.[49] This feed mostly comes from countries with a high risk of deforestation, contributing to global biodiversity loss and climate change.[50]

[47] Savills: Is regenerative agriculture financially viable?
[48] Natural England: Nutrient and pollution management - intensive livestock
[49] WWF: Riskier Business: The UK's Overseas Land Footprint
[50] WWF: Riskier Business: The UK's Overseas Land Footprint

Transitioning to mixed farming systems operating based on the resources naturally available on the farm could help increase circularity and profitability, while reducing environmental impacts. Mixed farming systems are those in which livestock and crops are combined on the same farm. For example, livestock grazing can be integrated into crop rotations with livestock consuming cover crops and the manure from livestock grazing on the farm then helping to restore soil health as an organic fertiliser. Another example is silvopastoral systems, which combine forestry and grazing in order to increase efficiency, enhance livestock health and welfare, and restore biodiversity by recycling nutrients from deep underground through leaf drop.

To be circular, mixed farming systems should aim to ensure that they are not importing or exporting large amounts of nutrients. They should seek to achieve "maximum sustainable output" where output is maximised using the naturally available resources of the farm (e.g. naturally available grass, rain, and feed, such as hay, grown on the farm). This means that imports of nutrients, in terms of both fertilisers and feeds from outside the farm should be kept to a minimum. Research carried out by Nethergill Associates with 165 farmers showed that by reducing artificial inputs to zero in this way, commercial returns can be increased by 10-45%, depending on the type of farm.[51]

Equally, it should not be necessary to export large amounts of nutrients in terms of slurries or composts sent off the farm. Rather the amount of nutrients produced by livestock should match or be below the ability of the farm to use these nutrients. In this way nutrient circularity is maximised, without significant additions of nutrients to the environment on the farm, adding to local pollution, or pollution through nutrients being exported elsewhere in the form of excess slurry. In fact, where mixed farming systems incorporate hay cutting on floodplain meadows, water pollution may actually be reduced as plants growing on floodplain meadows absorb excess nutrients which are then fed to animals.[52] Specific further suggestions for how mixed farming can be used to benefit biodiversity and reduce nitrogen pollution are available from the EU's Platform on Sustainable Finance.[53]

This transition away from large inputs of feed and fertilisers within livestock systems would require a reduction in livestock numbers as production is reduced to match the resources naturally available to farms. This is already recommended by the Climate Change Committee as necessary to reach net zero. They recommend a 38% reduction in cattle and sheep

[51] Nature Friendly Farming Network and The Wildlife Trusts: Farming at The Sweet Spot
[52] Floodplain Meadows Partnership: The benefits of floodplain meadows
[53] EU Platform on Sustainable Finance: Technical Working Group: Supplementary: Methodology and Technical Screening Criteria (pg. 59)

numbers and a 35% reduction in meat consumption by 2050.[54] We already eat 50% more protein than national dietary recommendations, so this would still allow UK consumers to meet nutritional goals.[55]

Over 50% of the UK's arable land is currently used to grow feed for animals.[56] Reduced livestock numbers as farms transition to mixed farming systems less reliant on external inputs would reduce the need to use arable land to produce animal feed. More arable land could be used directly to feed people, increasing the efficiency of the food system: currently 89% of crop-produced calories fed to animals are lost during the livestock rearing process and do not end up as food for humans.[57] Reducing this loss of nutrients when crops are fed to animals, means less land would need to be farmed to feed the same number of people. This could free up some farmland for other goals, including nature restoration (although grazing will remain essential for the natural management of some habitats). This is required to meet environmental goals as set out in the Land Use Consultation, which explained that 9% of land will need to change away from agricultural use entirely.

The Food, Farming and Countryside Commission's modelling shows that reduced livestock numbers and increased plant consumption by people would require the UK to increase production of homegrown pulses. This would provide a source of protein for humans, as well as help meet remaining (significantly lower) feed requirements without the need for imported feeds with a high-deforestation risk.[58]

Regulatory changes will be needed to aid this transition to nature-friendly mixed farming and away from intensive livestock farming with excesses of slurry. The Government should bring in additional permitting requirements that account for emissions to water as well as air for intensive cattle; bring in lower thresholds for pigs and poultry; and make decisions about new intensive livestock farms based upon the calculated cumulative impact of slurry stores on each farm and within a catchment. Cumulative capacity thresholds should be set well below the point at which catchment ecological condition could be significantly negatively impacted. Farmers should also be supported to develop a nutrient management plan underpinned by a farm-level nutrient balance sheet and risk assessment to determine environmental impact and soil need. The balance sheet should include nutrients imported via feed.

[54] The Climate Change Committee: The Seventh Carbon Budget
[55] WWF UK: The future of feed
[56] Defra: Agricultural land use in the United Kingdom
[57] Cassidy et al., 2013: Redefining agricultural yields: from tonnes to people nourished per hectare
[58] Food, Farming and Countryside Commission: Farming for Change: Charting a course that works for all

Natural pest management

Integrated pest management (IPM) is a general term for the management of pests, diseases and weeds where chemicals are used only as a last resort, meaning minimum external inputs and improved circularity. While this can involve simply only applying pesticides when observations show they are needed (as discussed under *reduce*) or high-tech methods for managing pests without chemicals, we focus here on methods for managing pests that involve restoring natural processes.

This encompasses an extremely wide range of practices which must be tailored to individual farms and crops. However, some general practices include:

- Choosing crop and animal varieties suited to local conditions;
- Using larger and more diverse crop rotations and other nature-friendly farming methods covered above that maintain natural soil biodiversity and resilience to pests;
- Mixed and companion cropping to discourage weeds, disease and pest proliferation;
- Allowing vegetation, ponds, and flower rich habitat in field and in borders that encourage insects and other beneficial invertebrates and vertebrates, such as amphibians, that feed on crop pests;

All these practices encourage natural biodiversity that controls pests without the need for chemicals, reducing costs for farmers and reducing the risk of chemical pollution. Many of these practices are similar to those designed to restore circular natural processes and soil fertility discussed above, further demonstrating the whole-farm benefits of transitioning to nature-friendly farming practices.[59]

Whilst some IPM actions are supported by the SFI, these only reflect a narrow range of approaches and again farmers are paid for producing a plan with no need for implementation, representing poor value for money. Farmers should be paid for reducing pesticide use overall with free advice provided to farmers on how best to apply IPM practices to their specific situation. This advice should focus on natural management of pests and the management of pests across the whole farm, rather than management for individual crops, as natural pest management requires significant changes to the farming system towards nature-friendly practices.[60]

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[59] Pesticide Action Network UK: Putting Integrated Pest Management at the heart of UK agriculture

[60] Institute of European Environmental Policy: Effective policy options for reducing environmental risks from pesticides in the UK

Natural water management

Many of the actions cited above designed to restore soil health, such as minimising tillage, reduced compaction, crop rotation, and applying organic matter to crops, also have the potential to reduce the need to abstract water for irrigation, increasing the circularity of water use on farms. Healthier soils, with higher organic matter, have been shown to hold more water than degraded soils.[61] This is helpful in the UK where farms experience humid conditions and high rainfall during some periods, but also dry, low-rainfall periods. Moisture retained in soils during wetter periods can be used by crops and grasslands during drier periods, negating the need for irrigation.[62] This reinforces the need to support farmers to transition to nature-friendly farming practices that restore soil health through ELMS, as well as through free farm-specific advice and peer-to-peer learning systems.

Water can also be stored naturally through creation of ponds, ditches, and other natural storage areas on farms, through restoration of rivers and streams to their natural meandering courses, and through reconnection of rivers to floodplains. The Spains Hall Whole Farm Reservoir concept is an example of the restoration of multiple natural water storage features, including agricultural ditches and wetland creation through beaver reintroduction, alongside water retention in soils. A study alongside the Environment Agency estimated that fully employing these nature-based solutions across the farm could increase river flows by 5-10% during summer months, increasing water availability.[63] Crucially, efforts to store water have strong benefits in terms of flood risk reduction as well. The same study found peak water flows could be reduced by 15-30%. This can also help reduce erosion of soils during high rainfall and resultant water pollution.

On farm water retention also has major benefits for wildlife. For example, restoring "ghost ponds" ("former ponds deliberately filled-in due to agricultural intensification") on farms has been shown to rapidly restore biodiversity.[64] More about using nature-based solutions to tackle flooding and drought can be found in our briefing: *Working with nature to build resilience to flooding and drought*.

Planning barriers to using nature-based solutions on farms should be reduced to enable these benefits. Small changes such as building ponds and wetlands should be allowed under

[61] Khangura et al., 2023: Regenerative Agriculture—A Literature Review on the Practices and Mechanisms Used to Improve Soil Health
[62] Lankford et al. 2022: Exploring the Critical Role of Water in Regenerative Agriculture; Building Promises and Avoiding Pitfalls
[63] Environment Agency, Essex & Suffolk Water, Spains Hall Estate and Atkins: Spains Hall Whole Farm Reservoir
[64] Alderton et al., 2019: "Ghost ponds" – How to resurrect in-filled farmland ponds to assist aquatic biodiversity conservation in agricultural landscapes

permitted development rights, where they meet pre-approved design and location criteria and do not impact protected areas. A farmer building 0.2ha pond under permitted development rights could save an equivalent of £298.[65]

Replace

In most cases, the environmental impacts from overuse of external inputs to farms derive from the quantity of inputs used as their production is linked to environmental damage and/or their use on farms directly contributes to pollution. Therefore, reducing the amount of inputs used through natural processes that cycle nutrients must be the absolute priority for farm circularity. However, there are some scenarios in which a farm replacing one input for another may reduce environmental impacts and therefore form part of more sustainable farming. Those opportunities are explored in this section.

Replacing crop-based feeds with sustainable alternatives

As outlined under *restore*, the current practice of using a large amount of arable land to grow food for livestock is inefficient and has a large opportunity cost because the land used to grow food for animals could be used to grow food for humans or to restore nature. While a transition to nature-friendly mixed farming must be the main focus to address this, some feed could be replaced with sustainable alternatives. Food-industry by-products, such as rapeseed meal and sugar beet pulp, and surplus and wasted food are key potential animal feeds with a low opportunity cost. In addition, restoring floodplain meadows could provide a source of hay while reducing water pollution, as noted above. Currently we only have 3,000ha of floodplain meadows but this could be expanded to at least 74,000ha with significant biodiversity benefits as floodplain meadows support a wide range of wildlife. [66]

WWF estimate that UK farms could produce 20-31g of animal-derived protein per person per day from by-products, food waste, and ruminant grazing on grassland.[67] The upper end of this estimate is only a 3% reduction from the amount of animal-derived protein produced in the UK today. We currently eat 46g of animal-derived protein per day in the UK on average, so a significant portion of current diets could be provided for without feeding animals crops grown on land that could be used to grow food for humans. 31g is also well above the average

[65] WWF: Pounds in Pockets: Climate Policies that Cut Costs for Households and Farmers
[66] Floodplain Meadows Partnership: Floodplain Meadows in LNRS Key facts and background
[67] WWF UK: The future of feed

amount of protein implied by the Eat-Lancet recommendations for animal-sourced food in diet.[68]

Unlocking the potential of low-opportunity cost feed will require changes to business practices as well as regulations. By-products will need to be prioritised for use in feeding animals over other applications, such as for human consumption or use in producing fertiliser or bioenergy. This will require carefully considered trade-offs, reinforcing the priority on transitioning to mixed farming with reduced livestock numbers. While food waste is potentially the biggest opportunity for producing greater amounts of circular, low-impact feed with fewer trade-offs, under current laws any food waste potentially containing animal products cannot be fed to animals. Increasing the availability of food waste for animal feed will require careful changes to the law as well as investment in treatment processes for food waste to increase feed availability while minimising health risks. For example, Japan allows food waste from catering processed through heat treatment to become an ingredient for feed for pigs and poultry. These changes could potentially triple the volume of food waste available for feeding to animals.[69]

Replacing artificial fertilisers with organic alternatives

Simply replacing artificial fertilisers with organic alternatives is unlikely to significantly reduce the environmental impacts of farming. There are clear benefits of nature-friendly farming systems using organic fertilisers to provide soil nutrients and improve soil structure. However, some studies show that, both in terms of greenhouse gas emissions and nitrogen and phosphorus pollution, simply using organic fertilisers in conventional farming systems does not automatically deliver clear environmental benefits.[70,71,72]

Levels of pollution and greenhouse gas emissions are highly dependent on the specific types of organic fertiliser used, what type of land they are used on and how and when they are applied. Furthermore, attempts to incentivise use of animal-derived organic fertilisers, such as digestate, without a transition to nature-friendly farming practices and mixed farming, could have perverse effects in terms of incentivising maintaining or increasing livestock numbers. As covered under *restore*, circular, sustainable livestock production depends on

[68] Willet et al., 2019: Food in the Anthropocene: the EAT–*Lancet* Commission on healthy diets from sustainable food systems
[69] WWF UK: The future of feed
[70] Litskas, 2023: Environmental Impact Assessment for Animal Waste, Organic and Synthetic Fertilizers
[71] O'Brien and Hatfield, 2019: Dairy Manure and Synthetic Fertilizer: A Meta-Analysis of Crop Production and Environmental Quality
[72] He et al., 2023: The impact of organic fertilizer replacement on greenhouse gas emissions and its influencing factors

farms using only the resources naturally available on farm, without significant exports of slurry to other areas.

Animal-derived organic fertilisers, such as digestates, have a higher concentration of nitrogen and lower water content so can be a more efficient organic fertiliser than animal manures or slurries applied directly. However, the environmental benefits of replacing artificial fertilisers with digestates are again unclear. Whilst lifecycle greenhouse gas emissions may be comparable or lower, eutrophication risk may be higher.[73,74] Environmental impacts from biogas and digestate production depend heavily on the feedstocks used, with production relying on maize as a feedstock generally having the highest environmental impacts.[75] In the UK specifically, ammonia emissions from non-manure digestate spreading have increased from 0 in 1990 to 16 thousand tonnes in 2023,[76] methane leaks from biogas plants contribute up to 3.8% of UK methane emissions,[77] and research has shown digestate contains significant levels of microplastics.[78]

Efforts to reduce environmental impacts from farming should not be focused on purely incentivising the replacement of artificial with organic fertilisers. Large scale meta-analyses generally find that, whilst organic farming has lower impacts per hectare farmed, it has higher impacts per kg of food produced when all environmental impacts are considered.[79,80] This reinforces the need to change diets, reduce food waste and reduce livestock production to free up farmland to allow a transition to less intensive, lower impact forms of farming.

The focus should be on a transition to nature-friendly farming where the priority is long-term soil health, with the ultimate result being a reduction in the need to apply fertilisers of any type. Organic fertiliser replacements do then have a place as part of this wider transition as a way of recycling existing nutrients in the system and restoring soil organic matter. It can also be cheaper with potential savings of up to £60 per hectare.[81]

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[73] Herrera et al., 2022: Environmental Performance in the Production and Use of Recovered Fertilizers from Organic Wastes Treated by Anaerobic Digestion vs Synthetic Mineral Fertilizers
[74] Zilio et al., 2022: Using highly stabilized digestate and digestate-derived ammonium sulphate to replace synthetic fertilizers: The effects on soil, environment, and crop production
[75] Fusi et al., 2016: Life Cycle Environmental Impacts of Electricity from Biogas Produced by Anaerobic Digestion
[76] Defra: Accredited official statistics: Emissions of air pollutants in the UK – Ammonia (NH3)
[77] Bakkaloglu et al., 2021: Quantification of methane emissions from UK biogas plants
[78] AquaEnviro and WRAP: Plastics in composts and digestates
[79] Hashemi et al., 2024: Organic food has lower environmental impacts per area unit and similar climate impacts per mass unit compared to conventional
[80] Clark and Tilman 2017: Comparative analysis of environmental impacts of agricultural production systems, agricultural input efficiency, and food choice
[81] WWF: Pounds in Pockets: Climate Policies that Cut Costs for Households and Farmers

Replacing chemical pesticides with biopesticides

According to a study from the Institute of European Environmental Policy, "Biopesticides include micro-organisms or other living organisms, pheromones or other semiochemicals, products based on plant extracts, and novel low-risk products. They are generally highly specific and usually have a lower environmental impact than conventional chemical pesticides".[82] They are therefore a potential replacement for chemical pesticides.

However, not all substances classified as biopesticides are less toxic than chemical alternatives. They may also drive antimicrobial resistance,[83] with risks to human, animal and wider ecosystem health. A strong evidence-base for lower environmental impacts is required before promoting their substitution for chemical alternatives. In addition, biopesticides are generally only available for very specific use cases and often have lengthy approval processes, so they are not likely to widely replace chemical fertilisers.[84] The focus must therefore be on reducing the application of pesticides and herbicides before exploring potential replacements.

Replacing agriplastics with potential alternatives

Agriplastics in certain applications could be replaced with degradable alternatives. However, direct substitution would not likely deliver significant environmental benefits and would pose additional environmental risks.

Oxo-degradable plastics are alternatives to conventional plastics that break down into smaller particles but are not broken down by micro-organisms. This means plastic particles remain after the plastic has degraded so they can still contaminate soil with solid plastic fragments and microplastics. Their use as a "sustainable" alternative to conventional plastics is misleading and potentially harmful. Due to these risks, their use is banned in the EU. The UK should urgently follow the EU in banning oxo-degradable plastics.

While biodegradable plastics are potentially more sustainable, strong standards do not exist relating to their sourcing and use in farming. Very little evidence exists to show that biodegradable plastics are consistently and predictably broken down by micro-organisms in

[82] Institute of European Environmental Policy: Effective policy options for reducing environmental risks from pesticides in the UK
[83] Kaze, Brooks and Sistrom, 2021: Antimicrobial resistance in Bacillus-based biopesticide products
[84] Defra: UK Pesticides National Action Plan 2025: Working for a more sustainable future

the real world.[85] They may still be leaving behind micro and nano-plastic fragments. Research also shows that biodegradable and bio-based plastics are similarly toxic to conventional plastics.[86] Therefore, caution must be applied in encouraging replacement of conventional agriplastics with biodegradable alternatives, with robust testing being but in place to ensure that replacements are safe and sustainable. Only then will replacement reduce environmental impacts.

Conclusion

UK farming is currently unsustainable with enormous impacts on the environment, public health, climate change and the economy at home and overseas. To reduce these impacts, the government must support farms to transition to more circular practices focused on reducing harmful inputs, restoring natural processes, and replacing unsustainable inputs with proven sustainable alternatives. This will not only benefit the environment, it will reduce UK farms' dependence on expensive imports, supporting their resilience and profitability.

Wildlife and Countryside Link (Link) is the largest nature coalition in England, bringing together 94 organisations to use their joint voice for the protection of the natural world and animals.

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www.wcl.org.uk

[85] EIA: Cultivating Plastic Part 4 - Caution with regards to the adoption of potential agriplastic alternatives
[86] Zimmerman et al., 2020: Are bioplastics and plant-based materials safer than conventional plastics? In vitro toxicity and chemical composition

The following organisations have inputted into this paper and support the transition to farm-level circularity:

Bat Conservation Trust

PESTICIDE ACTION NETWORK UK

Soil Association

CPRE The countryside charity

COMPASSION in world farming

WWF

Plantlife

The Wildlife Trusts

SUSTAINABLE SOILS ALLIANCE

Fidra