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Share The Land

Modelling an agroecological land-sharing approach to UK land use

A report by the Landworkers' Alliance (2025)
Written by: Ele Saltmarsh and Jyoti Fernandes

The Landworkers' Alliance is a grassroots union of farmers, foresters, growers and land-based workers from all four nations of the UK. We work to represent the interests of our members, and to build a better food and land use system for all.

In this report, we present evidence to guide a collective vision of 'land-sharing' - a land use system which aligns with the principles of agroecology and food sovereignty, and which could provide the majority of the UK's food needs in a sustainable way.


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Executive Summary

The UK is a set of densely packed, beautiful islands facing a food, nature, and climate crisis.

With just over 18 million hectares of agricultural land available to provide for 71 million people - the number predicted to live in the UK by 2050 - there is a need to think strategically about how this land is utlised. Through a well balanced system, we need to match the needs for food, timber and fibre production, wildlife targets, carbon emission sequestration targets, recreation, jobs, and housing.

In the UK, agriculture covers 71% of our land area but provides only 60% of our food.

In the UK, agriculture covers 71% of our land but provides only 60% of our food;[1] and we must therefore rely on international trade for the extra 40%. Recent shocks to the UK's food and farming system have highlighted the vulnerabities in our current model. A combination of Brexit, the Covid-19 pandemic, the war in Ukraine and extreme weather events as a result of global warming, has revealed that global supply chains are not as robust as we have once believed. But this is not an instance in which we can 'weather the storm.' In order to ensure the long-term sustainability of our food system, our patterns of food production, trade, and land use will need to undergo significant shifts. We need a food, forestry and land use system which is underpinned by a holistic vision for agroecology; a vision robustly upheld by policy and finance, taking into account short-term viability as well as long-term goals. This system will not only need to be resilient, but it will also need to be regenerative, actively restoring stability and health to our resources and landscapes.

We are now at a point in history where we can no longer disregard the ways in which our food and land use system impacts our environment, society, and economy. Until now, the UK government has failed to present a clear plan for how our land should be used. However, in January 2025 the UK Government published its long-awaited vision for a Land Use Framework for England, which is open for public consultation until April 2025.

A land-sharing approach

In this report we present evidence to help guide UK land use towards ou vision for agroecology, which includes a 'land-sharing' approach. Land-sharing is a term used by scientists that is commonly used to define land management that combines benefits for both agriculture and nature. We use the term to promote land use in which land which is actively producing food, fibre, timber, and other forest and wetland products also provides habitat for nature to thrive.

We extend the concept further to encompass the concept of sharing land equitably to meet the basic needs of everyone. We envision most of the farms within this agroecological model would be mixed multi-layered farms, or farms working together to create circular farming

1 DEFRA (2021) 'Agriculture in the United Kingdom 2020', Agriculture in the United Kingdom. Available at: https://www.gov.uk/government/statistics/agriculture-in-the-united-kingdom-2020.

models at a regional level, i.e. dairy farms working together with arable farms to create rotational field management systems for fertility building leys.

Land-sharing supports access to land for everyone who wants to work towards producing our basic needs as a society. More people will be needed on the land in this land use model, creating "green" jobs sustained by a common goal. We envision economic wealth as rooted in sustainable management of the land and a regulated food system where everyone has access to healthy, affordable, nature-friendly food within localised food systems.

Our model

In this report, we model the trade-offs and land use implications of meeting the nutritional needs of the UK population through an agroecological farming and land use system. This would be accompanied by trade policy that sources the remaining food from overseas while upholding the principles of environmental, climate, and social justice.

The modelling approach scientifically determines how we balance the various competing uses of land. Though it cannot represent our complex food and land use system perfectly, using a combination of recent data and some simplifying assumptions it is possible to create a basic representation of how demand for land increases or decreases as we change levels of imports, amount we consume, and how we farm.

For this report, we compare current UK farming practice and agroecological farming methods to analyse the amount of land used to feed ourselves according to current dietary habits. We then experiment with decreasing the levels of imports to increase domestic food security, and with changing the UK's consumption habits to healthier and less land-intensive foods, to see how this affects the total amount of land used. This approach helps us to develop a sustainable land use system for the UK by showing how, through a combination of increased uptake of agroecological farming and dietary change, localised agroecological food webs can play a central role in providing the majority of our food supply, whilst also contributing to climate and biodiversity targets.

In Scenario 4 we show how changes to our dietary habits could allow localised agroecological food webs to provide the majority of our food supply in a much more sustainable and resilient manner, which would be accompanied by trade policy that enables us to source non-indigenous "supplementary" foods and spices from overseas while upholding the principles of environmental, climate, and social justice.

Localised agroecological food webs can play a central role in providing the majority of our food supply, whilst also contributing to climate and biodiversity targets.

More significant dietary change, as modelled in Scenario 5, could allow areas of land to be managed in a way that promotes nature recovery and forest and peatland restoration. In this Scenario the area of land used for arable farming has to increase in order to provide enough people with calories in a sustainable way. Grassland goes down, to make room for arable, reducing the amount of land dedicated to livestock production, whilst making space for farm woodland under continuous cover forestry management and wetland restoration which supports wildlife alongside production of thatching reed. This scenario still falls under a land-sharing approach, because while the land is sequestering carbon and providing space for wildlife, it also produces timber, firewood and thatch and the associated jobs within these sectors to manage the spaces productively for both.

Models are useful tools for setting a direction of travel, but it's important to note that the models presented in this report are hypothetical scenarios which helps us to compare and contrast trade-offs between the different land uses.

This model is dynamic, not static. As the world changes, modelling should be used to update and refine our direction of travel. We will aim to put the modelling tools on an open source platform so that they are freely available as a tool to refine our understanding of land use as we all gain the confidence to engage in co-creating our common future.

1. Introduction

1.1 The need to move away from industrial farming

Industrial farming uses chemical inputs to create the perfect environment for one crop across vast swathes of land. All the resources the crop needs are applied as fertiliser and irrigation, while pesticides and herbicides remove any competition, allowing the crop to pour all its resources into the harvest. Meat production is typically high density, using high energy feeds to make up for limited grazing and promote livestock's rapid growth. This system relies on ever-increasing resource use to push for higher and higher peaks in productivity, and under it, agriculture has expanded to cover the majority of habitable land on Earth.

Yet while the industrial food chain initially caused a rapid increase in global productivity, the proportion of people without access to adequate and appropriate nutrition has now plateaued (and in some locations even increased)[2], and the unforeseen impacts of intensive cultivation are becoming ever more apparent.

We are now in the midst of an ecological disaster, with biodiversity being lost at a rate comparable to a mass extinction, repeatedly tilled and fertilised soils emitting vast quantities of greenhouse gases, runoff polluting waterways and creating unnatural 'dead' zones, and irrigation drying rivers and lakes into salinised deserts.[3] These impacts in turn make it harder and harder to reach the same yields.

Socially, the longer and more complex supply chains have decreased the quality and variety of food consumed while increasing the disconnect between people and nature, significantly impacting public health. Animal welfare and Indigenous land rights have suffered major blows, and there have been significant economic impacts on small farmer livelihoods and rural communities.

The global food system has also increased supply chain vulnerability to external threats. These are expected to become increasingly likely as resources are stretched thinner and climate change progresses relatively unchecked. Despite this, the industrial food system has become increasingly dependent on a handful of genetically similar and high-input staple crop varieties concentrated in certain regions, meaning that the risk of multi bread-basket crop failure due to lack of resources, disease, or changing climates is high.[4] It has become increasingly clear that our food system needs to change to address the combined environmental, health, and climate crises.

In addition to subjecting the UK to the volatility of global markets, this reliance on imported food has had multiple negative impacts elsewhere, ranging from un-accounted greenhouse gas emissions to land grabbing and deforestation. The pressure on less developed nations to prioritise commodity food production over feeding their own populations, especially as they face their own shocks, has been referred to as a form of neo-colonialism.[5]

Shocks to the food system have exemplified the need for a stronger domestic food supply, including the 'Beast from the East', which caused food prices to rise at least 5% and up to 186% for potatoes, and the war in the Ukraine, which is currently driving up the prices of wheat for both human and animal food. Since the 1990s the UK has assumed that abundant and easy trade is the most important element of securing a stable food supply. This led to cheaper products and more choice than ever - yet it also fundamentally changed our food system and environment. To compete on a global scale, farms need to industrialise and expand, often at the expense of the environment.

2 The State of Food Security and Nutrition in the World 2021. www.fao.org.

3 Biswas, M.R. (1994) 'Agriculture and Environment: A Review, 1972-1992', Ambio, 23(3), pp. 192–197.

4 Extreme weather and resilience of the global food system (2015). Final Project Report from the UK-US Taskforce on Extreme Weather and Global Food System Resilience, The Global Food Security programme, UK.

5 Robertson, B. and Pinstrup-Andersen, P. (2010) 'Global land acquisition: neo-colonialism or development opportunity?', Food Security, 2(3), pp. 271–283. Available at: https://doi.org/10.1007/s12571-010-0068-1.

1.2 Towards agroecological food webs

The Landworkers' Alliance is a part of La Via Campesina- a global movement representing over 200 million peasant farmers and Indigenous peoples worldwide.

The definition of peasant agroecology, as defined by social movements, encompasses multiple aspects of food systems beyond agriculture and ecology, including socioeconomics, nutrition, and equity, to create sustainable and regenerative food systems. Properly implemented, agroecology creates diverse localised food webs that provide affordable healthy food for consumers and a fair livelihood for farmers without sacrificing the environment.

The Food and Agriculture Organisation of the United Nations (FAO) describes agroecology as:

"...a holistic and integrated approach that simultaneously applies ecological and social concepts and principles to the design and management of sustainable agriculture and food systems.

It seeks to optimise the interactions between plants, animals, humans and the environment while also addressing the need for socially equitable food systems within which people can exercise choice over what they eat and how and where it is produced." [6]

In 2009, the International Assessment of Agricultural Knowledge, Science and Technology for Development (IAASTD) report was published; a culmination of a 3-year international collaborative investigation to identify why, while global availability of calories was higher than ever, there was still so much hunger, social disparity, concentration of wealth, and monopoly power in the food system. The report reinforces the need for a fundamental shift in the development and deployment of agricultural knowledge, science, and technology in order to enable a just transition for farmers and workers to a more resilient and equitable food system that supports local communities and livelihoods worldwide.

Since then, the U.N. Committee on World Food Security's high-level panel of experts on food system transformation, as well as numerous other governmental bodies and organisations, have called for governments worldwide to increase their support for agroecological approaches to food production and domestic marketing as a solution to the social crisis of hunger and food insecurity.

75%

The percentage of food, in terms of value, produced by small scale agro ecological farmers across the world.[7]

116%

The average yield increase in 114 projects across 24 African countries since adopting organic practices.[8]

30%

The typical biodiversity increase seen across a meta-analysis of studies of organic agriculture, particularly in Northwestern Europe and North America.[9]

>10,000

The number of Karnatakan farmers now practicing Zero-Budget Natural Farming, rooted in agroecological principles, rebuilding farmer livelihoods and food security.[10]

6 FAO 'Agroecology Overview' Available at: https://www.fao.org/agroecology/overview/en/

7 ETC Group (2017). Who Will Feed Us? The Industrial Food Chain vs. The Peasant Food Web

8 United Nations Environmental Programme (2008). Organic agriculture and food security in Africa. https://unctad.org/system/files/official-document/ditcted200715_en.pdf

9 S. L. Tuck et al. (2014) Land-Use Intensity and the Effects of Organic Farming on Biodiversity: A Hierarchical Meta-Analysis, Journal of Applied Ecology, 51(3), pp. 746–755

10 The Agroecology Fund (2020). Learning Together: The Agroecology Movement Shares Strategies for Impact. https://agroecologyfund.org/learning-together-the-agroecology-movement-shares-strategies-for-impact/

2. Land Use Features of Agroecology

Mixed farming systems

One of the biggest problems with agriculture today is the growth of the same crop in the same field year after year. In 2021 the UK used approximately 871,000 tonnes of nitrogen in fertilizer, but cattle alone produce enough nitrogen in fresh manure to almost meet this demand. By rotating crops year on year, farms can help to maintain soil structure and fertility while also avoiding pest build-up. Pigs, chickens, and cows can also be introduced into the rotation, and the remains of harvested crops or cover crops can provide them with nutritious feed, while the animals help to clear and fertilise the field in preparation for the next planting.

It can often be very difficult to collect, store, and transport manure from where it is produced to where it is needed – and improper management is a major contributor to greenhouse gas emissions and river pollution. By grazing animals directly on the land, manure is returned directly to the soil.

Conservation grazing

Wildflower meadows are one of the rarest habitats in the UK with 97% of meadows lost since the 1930's. We now have only 10,500 ha of lowland wildflower meadow and 900 hectares of upland hay meadow in the UK. Conservation grazing promotes biodiversity on species-rich grassland or wildflower meadows by creating different heights of vegetation and ensuring no single plant becomes dominant. Due to their typically hardy nature, rare and native beef breeds are better suited to grazing low nutrient value meadows, though it is difficult to raise dairy cows on meadows without supplementary feed.

Agroforestry

Agroforestry - the practice of integrating trees into our farming systems - is a key multi-purpose solution to land use. Not only are trees great at sequestering carbon, but they also provide fuel, timber, and fruit, as well as create habitats for wildlife, maintain soil structure and contribute to water and flood management. Examples of agroforestry include grazing sheep in orchards, planting hedgerows, and using trees as shelter belts for crops and livestock.

Local food webs

Local food webs bring numerous benefits to both farmers and consumers by shortening the distance and the time between the harvesting of food and its consumption. While local food systems may be easier to establish in rural areas, for urban areas adopting a 'Food Zones'[11] model - a model pioneered by Growing Communities in London - would mean that at least 5% of fruit and veg would be produced in urban commercial gardens, 17.5% in peri-urban farms and 35% from the ural hinterland within a 100 mile radius of the city.

Productive woodlands

An agroecological land-sharing approach would include an increase in the amount of woodlands in the UK. Not only would these woodlands create habitats for wildilife and sequester carbon, but they would be carefully managed as productive Continuous Cover Forestry systems (see box on page 24) and would therefore create opportunities for local employment and supply important materials such as timber, firewood, charcoal, and other forest products.

11 See page 27 for more detail on the Food Zones model.

What features make our model unique?

1. Layering production systems

Many agroecological crops do not yield as highly as they would if we used agrochemicals. However, many agroecological farms can still produce as much as conventional farms regardless. This is achieved through maximising utility of available land. The main feature of layering involved in our model involves sheep grazing under orchards, providing manure fertiliser while the trees offer shelter.

In a scenario where we eat 50% more fruit, around 112,000 hectares of orchard would be created. This could be used as grazing for sheep (and mild-mannered cows), or dotted in and around croplands to provide extra shelter for both plants and animals. A 130% increase (bringing us more in line with NHS dietary targets for fruit and veg consumption) would result in 159,000 hectares. In addition, though it has little effect on overall numbers, an agroecological system involves far more integration of livestock into the arable rotation, meaning that livestock graze arable fields after harvest or in fallow years, acting as a clean-up crew for leftover crops and enhancing nutrient content of the soil in turn. Rotating both crops and animals helps to maintain soil structure and fertility while avoiding pest build-up.

2. Using waste food

Traditionally, animals were kept as a means to convert 'waste' food - i.e. food that was inedible for humans - into meat, which we can eat. Now, animal feed takes up vast swathes of high-quality arable land that could be used for human food. At the same time, food waste is becoming an increasingly large problem, with thousands of tonnes of vegetables, fruit, cereals, legumes, milk, and other produce and by-products being thrown away every year. By introducing collection schemes to gather food waste from homes, restaurants, supermarkets, processing plants, and farms, we could feed many of our pigs and poultry with much less animal feed. A considerable proportion of our cattle can also be fed on by-products, co-products, and arable residues.

We estimate that around 6% of wasted food (mainly in the form of byproducts, with some amount of waste from primary production and retail) is collected and reused as animal feed – but much more could be saved. If we introduced an agroecological system today, collecting 20% of household waste, 60% of primary waste, and all byproducts, around 25% of animal feed could be replaced. In potential scenarios with a larger population and lower imports, more domestic waste would be generated. This would mean that, in a system with fewer animals, up to 50% of feed could be replaced, massively reducing food-feed competition.

3. Replacing soy in animal feed

Though soy is an energy rich and protein-dense ingredient for animal feed, it contributes significantly to deforestation overseas. In modelling agroecological systems, we opt to replace soy and soy-based derivatives in favour of pulses, which increases animal feed demand slightly. Some of this can be compensated for by increased collection and redistribution of food waste and by-products (including by-products and co-products from increased pulse production).

4. Beef production from the dairy herd

Every dairy cow must have one calf every year to stay in milk. Typically, half of the cows will be crossed with beef sires and half with dairy. This means that about half the offspring will be beef x dairy and are used for meat. Of the full dairy half, females are retained to eventually become milk cows, but most of the males are culled at a young age. By raising these male calves for beef, we stop these calves being culled and reduce the need for the 'suckler herd,' a population of beef cows whose only role is to provide offspring to be readied for beef. This reduces the land taken for animal production by reducing the use of feed and pasture.

Over 400,000 full-dairy male calves were born in the UK in 2023. Raising these calves for meat would reduce the need for a suckler herd by around 1/3. In an agroecological system, milk yields are lower as cows are fed on forage, so we need more dairy cattle to supply the same amount of milk. This means that even more male calves are produced as 'byproducts' of the dairy system, so we make the most of this by integrating them into the beef system instead. This means that, despite lower meat yield per animal, the lack of a suckler herd and the elimination of concentrate feeds make agroecological beef one of the few products that is actually higher yielding on a per-hectare basis than current farming practice. In the same vein, the model also includes chicken production from the egg flock.

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3. Modelling Agroecological Land Use

In this section we present five scenarios which use a modelling approach to show how UK agricultural land use would vary depending on farming method, population, imports and diet.

In this section we use a modelling approach to balance various competing uses of land in order to develop a sustainable land use system for the UK. We compare current UK farming practices to agroecological production to analyse the amount of land used to feed ourselves according to current dietary habits, then show how changing import levels to increase domestic food security would affect results.

We experiment with changing the UK's consumption habits to healthier and less land-intensive foods and see how this affects the total amount of land used, and balance this against the social and environmental impacts of each production method to produce a range of potential land-use trajectories that the UK could follow balancing trade-offs between dietary change and meeting climate and biodiversity targets.


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3.1 Underlying assumptions of our land use model

Our model is based on three main assumptions:

1. That a land-sharing model is preferable to a land-sparing one

2. That localised production should provide the backbone of our food supply

3. That diets should change to be healthier and more seasonal

1. Land-sharing is a more holistic and impactful model than land-sparing

Multiple studies have evaluated ways to feed the UK population while reducing its negative externalities and without destroying what precious natural area we have left, and most fall onto the spectrum that finds a balance between these goals. Some advocate for intensifying agriculture on some parts of land to free up land for biodiversity and conservation, while others favour decreasing agricultural intensity to allow biodiversity to flourish within farm boundaries - also referred to as the land sparing vs land sharing debate. Current agricultural trajectories include movement towards both goals, with many farmers continuing to rely on new hybrids and high inputs, but many others opting to convert to organic or low-input methods. Few farms are as industrialised as production in the USA, but many are looking increasingly similar. This model seeks to bring our perspective on land sharing into the debate.

The most substantial argument in favour of industrial agriculture is the yield gap between organic and industrial farming methods. When everything the plant needs is supplied externally, many can be grown in a small area, leading to significantly higher yields on a per hectare basis. Yields of staple organic crops, like wheat, oil crops, and potatoes, are up to 35% lower than those from highly industrialised farming. Some parties argue that this gap is significant enough that condensing agriculture into a smaller land area and leaving other places to nature would be more beneficial to biodiversity and the environment than having a larger area of less productive farmland. Yet there are inherent issues associated with this approach.

Problems with a land-sparing approach

- Increasing productivity through industrial farming has typically relied on increased use of pesticides and fertilisers. Recognition of the damage caused by heavy input use has led to research into intensification that supports environmental outcomes as well as yield, and some of these 'sustainable intensification' methods are improving the efficiency of agrochemical use. However, there are inherent biological constraints on yields that mean that even improved methods still involve agricultural inputs and result in negative externalities that can affect areas far beyond the land cultivated; they cannot be eradicated.[12]
- Intensive farming will require livestock rearing to be much more concentrated than they currently are in the UK, which has associated animal welfare concerns and damages the environment.
- Land sparing will result in a further reduction in the number of farms and farm workers, and in economies of scale that would very likely involve the corporatisation of the farming industry and the disappearance of family farms. Some parts of the country would be deprived of any agricultural activity, which would result in a loss of rural jobs, both upstream and downstream.
- Large areas of land in the UK are either inherently poor quality, or so degraded, that they cannot support intensive production. Even in high-yielding areas, intensive and continuous cultivation has already reduced yields by depleting soils. It is unclear how feasible this will be over the long term.

12 Matson, P.A. and Vitousek, P.M. (2006) 'Agricultural Intensification: Will Land Spared from Farming be Land Spared for Nature?', Conservation Biology, 20(3), pp. 709–710. Available at: https://doi.org/10.1111/j.1523-1739.2006.00442.x.

In addition, it is uncertain as to how much this approach would benefit nature, for several reasons:

- Much of the UK's wildlife biodiversity has evolved in symbiosis with traditional farming methods (for example, the flora and fauna associated with traditional hay-meadows) and need these methods to survive. If hyper-intensive farming of some areas allows wide expanses of agricultural land to be spared for forests, some species will benefit, but this can also result in a further decline of the sorts of biodiversity that depend on management.[13]
- Many studies on both land sparing and land sharing have assumed yield increases of up to 50% by 2050, at rates of increase that as of yet are far from showing themselves. Without connectivity between fragments of reserved land, populations can become isolated and even extinct, meaning that having areas of land set aside for nature amidst a landscape of intensive agriculture, even if the set aside areas are large, is not always conducive to species recovery and survival.[14]
- Most importantly, increases in productivity in a market economy can result in expansion of agriculture rather than a reduction in the area being farmed. This can be because farmers expand production to pay back the initial investments in equipment and resources required to improve productivity, or because higher productivity and hence gross income makes further production more appealing. Historically, despite leaps in production efficiency, declines in cultivated land area have been rare.[15]

13 Lamb, A. et al. (2019) 'The consequences of land sparing for birds in the United Kingdom', Journal of Applied Ecology, 56(8), pp. 1870–1881. Available at: https://doi.org/10.1111/1365-2664.13362.

14 Grass, I. et al. (2019) 'Land-sharing/-sparing connectivity landscapes for ecosystem services and biodiversity conservation', People and Nature, 1(2), pp. 262–272. Available at: https://doi.org/10.1002/pan3.21

15 Rudel, T.K. et al. (2009) 'Agricultural intensification and changes in cultivated areas, 1970–2005', Proceedings of the National Academy of Sciences, 106(49), pp. 20675–20680. Available at: https://doi.org/10.1073/pnas.0812540106.

2. Localised production should provide the backbone of our food supply

Many of the risk factors we mention previously apply equally to both global and local production, and we argue that we should source our food from both global and local sources, but there are several reasons we should not prioritise global supply chains and give preference to local production:

- **Political instability can undermine trade.** If all international trade were cut off, we would have just 10 days worth of food stored in the UK.[16] Climate change and increasing competition for shrinking resources will lead to political instability which undermines the predictability of trade and can lead to reduced supplies and higher tariffs. Ensuring a strong domestic food supply safeguards against these possibilities.
- **Reducing emissions.** Research suggests that food miles account for almost 20% of emissions from the global food system, and are disproportionately caused by high-income nations.[17] Because longer supply chains benefit from comparative advantage, reducing the length of supply chains could result in higher production-side emissions, so a net emission reduction would also require closing yield gaps, reducing food waste, shifting toward diversified farming, and consuming seasonal produce - all essential features of agroecology.
- **Global footprint.** Land used for agriculture abroad can result in environmental harm and a trade off with food security elsewhere. Industrial monoculture export farming takes up the most fertile land, water, and energy. In the Global South in particular, the switch from growing food for local consumption to producing for export has had severe repercussions on livelihoods and nutrition.
- **Global limits.** The global food supply is very close to the limit of what it can produce without irreversibly destroying the environment, and other countries will need their food supply. Outsourcing our domestic production to other countries protects our rural environment at the expense of theirs, while reducing the land area they can use for domestic food production. Global land use needs to be balanced carefully, with no one taking more than their fair share, to be able to feed everyone and restore the environment.
- **Global supply chains concentrate power within the food system.** One of the biggest threats to food security today stems from the increasing control a handful of corporations have over the world's food supply. Four agribusinesses account for two-thirds of the global seed and pesticide markets, and virtually all the transgenic seed market.

Local food systems also offer many other benefits. They enhance distinctiveness, culture, economy, and well-being at multiple scales across the nation, as explored in our 2021 report 'Vocal for Local.' Local food systems help to connect people to where their food comes from, green spaces, and nature in several ways.

Firstly, locally grown and sold food typically has a shorter supply chain, meaning that it travels less distance from farm to consumer. This results in fewer emissions from transportation, and a smaller carbon footprint overall, which is better for the environment.

Secondly, local food systems often involve smaller-scale farming practices, which can promote biodiversity and habitat conservation. By supporting these types of farming practices, consumers can help preserve and protect local ecosystems.

Finally, local food systems provide opportunities for consumers to directly engage with the people who grow their food. This can help build a sense of community and foster relationships between farmers and consumers. When people have a better understanding of where their food comes from and the people who grow it, they may be more likely to appreciate the natural world and the importance of protecting it.

Studies have found that local food systems can have positive environmental, social, and economic impacts. For example, a study conducted in Iowa found that farmers who sold their products through local channels

16 Department for Environment, Food and Rural Affairs (2012) Food Statistics Pocketbook 2012. Available at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/183302/foodpocketbook-2012edition-09apr2013.pdf.

17 Li, M., Jia, N., Lenzen, M. et al. Global food-miles account for nearly 20% of total food-systems emissions. Nat Food 3, 445–453 (2022). https://doi.org/10.1038/s43016-022-00531-w

tended to use fewer pesticides and herbicides, and had lower energy inputs than those who sold their products through larger-scale distribution systems.[18] Another study conducted in the UK found that local food systems can provide economic benefits for small-scale farmers and contribute to the development of sustainable rural communities.[19]

In 2050, we suggest that the systems supplying cities, towns and villages with their fruit and vegetables should resemble the Food Zones Model devised by Growing Communities and the University of Sheffield to help cities and regions plan for and support local food systems. The model is based on the idea of creating distinct "zones'' within a city or region that are designed to support different aspects of local food production, distribution, and consumption.

3. Our diets need to shift to healthier and more seasonal food

There are several changes that the UK can make to its diet to become healthier, including reducing intake of processed foods, increasing consumption of fruits and vegetables, and reducing meat consumption.

One key difference that needs to be made is reducing the amount of added sugar in the diet. The UK government has recommended that added sugars should make up no more than 5% of daily calorie intake, but many people are consuming far more than this. A study conducted by Public Health England found that the average adult in the UK is consuming around 12% of their daily calorie intake from added sugars, which is more than double the recommended amount.[20]

18 Kremen, C., Iles, A., & Bacon, C. (2012). Diversified farming systems: An agroecological, systems-based alternative to modern industrial agriculture. Ecology and Society, 17(4), 44. doi: 10.5751/es-05103-170444

19 Renting, H., Marsden, T. K., & Banks, J. (2003). Understanding alternative food networks: exploring the role of short food supply chains in rural development. Environment and Planning A, 35(3), 393-411. doi: 10.1068/a3510

20 Public Health England. (2015). Sugar reduction: the evidence for action


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Another key difference is increasing the consumption of seasonal fruits and vegetables. The UK government recommends that 40% of our food requirements should be supplied by fruit and vegetables, but our modelling suggests that this is currently less than 20%, with only 31% of adults currently eating 5-a-day (NHS Digital, 2019). Increasing fruit and vegetable intake can help to reduce the risk of chronic diseases such as heart disease, stroke, and certain types of cancer.[21]

Reducing meat consumption is also an important step towards a healthier diet. A study published in The Lancet found that a diet high in red and processed meats is associated with an increased risk of chronic diseases such as heart disease, stroke, and certain types of cancer.[22] The study recommended that people consume no more than 100 grams of red or processed meat per day.

In addition to these changes, it is also important to reduce intake of processed foods, which are often high in salt, sugar, and unhealthy fats. A study published in the British Medical Journal found that a diet high in ultra-processed foods is associated with an increased risk of several chronic diseases, including obesity, type 2 diabetes, and heart disease.[23]

3.2 What does the UK consume?

To calculate how much land food production would take up, we need to know how much food the average person in the UK consumes. We calculate consumption on an individual level by using UK consumption statistics from the National Diet and Nutrition survey, adjusted to account for under-reporting.[24] This gives us an average consumption of each food item per person, which can be scaled up to predict demand for a population of any size.

To calculate how much produce is needed to meet this demand, we need to account for losses at multiple steps in the supply chain. For most foods, some of the harvest will be spoiled in the field or lost during storage and transportation - this is known as primary waste. An additional percentage will then be removed during processing as byproducts.

Finally, secondary waste is produced as restaurants, retailers, and households remove inedible or unappealing items. In total, the Waste and Resources Action Programme (WRAP) estimates that over 9.5 million tonnes of food waste is generated every year, up to 20% of the total amount that consumers have access to.

To calculate how much raw produce is needed to feed the population, we adjust the amount of product consumed upwards to account for household waste to see how much product needs to be produced, then upwards to account for processing waste to see how much raw produce needs to be processed, then upwards again to account for primary waste to see how much raw produce needs to be grown.

Using this methodology, we can then change the amount of any category or the amount of food waste to project how this will affect the total UK demand. It is important to note that all the figures used in our model have been callibrated on 2021 fugures, as this is the most up to date statistics available for many of the datasets.

21 Aune, D., Giovannucci, E., Boffetta, P., Fadnes, L. T., Keum, N., Norat, T., ... & Vatten, L. J. (2017). Fruit and vegetable intake and the risk of cardiovascular disease, total cancer and all-cause mortality–a systematic review and dose-response meta-analysis of prospective studies. International Journal of Epidemiology, 46(3), 1029-1056.

22 GBD 2017 Diet Collaborators. (2019). Health effects of dietary risks in 195 countries, 1990–2017: a systematic analysis for the Global Burden of Disease Study 2017. The Lancet, 393(10184), 1958-1972.

23 NHS Digital. (2019). Statistics on obesity, physical activity and diet, England, 2019.

24 Since these statistics include use of oils for non-food or food-adjacent purposes, such as cosmetics and deep frying, we only include 50% of calories from oils when calculating total caloric intake.

3.3 Modelling different production systems

Once we know the total production demand, we can calculate the amount of raw produce required to meet it. This can roughly be divided into 10 plant-based categories (cereals, potatoes, sugar beet, legumes, nuts, oilseeds, vegetables, and soft, orchard, and tropical fruit) and 6 animal-based categories (beef, lamb, pork, chicken, milk, and eggs). We can translate this into demand for land by using the average yields achieved in different agricultural production systems.

Current farming practised in the UK today is often a middle-of-the-road scenario, where many farms use high chemical inputs and intensive cultivation to achieve high crop yields, but livestock farming can be very extensive.

- High density crops grown in monocultures, requiring high inputs of fertilisers and pesticides. Some rotation of crops and cover cropping.
- Medium density systems with high feed requirements for monogastrics, but low-density pasture for most ruminants. Some use of chemicals in raising livestock.
- Medium yields but sustainability concerns.

Agroecological farming uses knowledge of natural biogeochemical cycles to replace artificial inputs. It builds on organic farming by improving the efficiency of resource usage on farms, to decrease land take and other resource demand per unit of agricultural production, particularly for livestock.

- Medium density cropping systems rely on rotations or intercropping to reduce nutrient losses and avoid pest build up. No chemical use.
- Medium density cropping and livestock systems are layered to save space, such as grazing sheep in orchards.
- Sustainable but yields are system dependent.

The scenarios modelled include upscaling demand to account for population growth; reducing imports, especially for indigenous-type foods; and adjustment to diets to match NHS health guidelines. Since the ONS predicts a higher proportion of elderly people in the future, it is possible that the average demand for calories will decrease over time. To err on the side of caution, however, we ensure that per person caloric consumption is always greater than or equal to 2250 kcal per day, and protein is always greater than or equal to 55 g per day, sufficient for an average active adult.

Plants and plant-based products

For each plant product, we calculate land area required using recorded yields per hectare. Typically, fully industrial agriculture has higher yields than agroecological farming, and the UK's current farming practices lie somewhere in between.

Other categories

A certain amount of land in the UK is used for 'other' uses, including on-farm woodland. This is scaled up according to population to maintain supply of these other goods.

Animals and animal-based products

For each animal product, we use a population-based structure to calculate how many animals are needed (e.g., for every 100 beef cattle going to slaughter, the farmer will typically also have a 'suckler herd' of breeding cattle, as well as several younger heifers and bulls that will replace older members of the herd). We then calculate the amount of feed (divided into cereals, oilseeds, and legumes) and use the same yields as above to translate this to land requirement. We also add extra land for pasture and housing.

Scenario 1: *Current scenario*

Population: 68.265 million[1] Imports: Unchanged Diet: Unchanged

Right now, agriculture uses almost 18 million hectares of land - 70% of the UK's total land area. The majority of this is pastureland for grazing sheep and cattle. People over-consume calories and protein, with not nearly enough fruit and veg to supply a good range of micronutrients. Carbohydrates make up around 32% of consumption, proteins 23%, fruit and veg 17%, dairy 18%, and HFSS (High in Fat, Salt, or Sugar) foods 9%. This scenario shows the total land area (in 1000 hectares) currently used to grow different crops in the UK, and shows how much land would be needed to produce the same yields in an agroecological system.

	Current model	Agro-ecological
Cereals	3,114	5,506
Legumes	285	1,349
Oils	416	274
Arable - *other*	898	1,098
Horticulture	111	113
Orchards	21	37
Pasture	11,861	11,088
Other	1,316	1,677
Total	17,722	21,142

Figures presented in '1000 hectares'

Scenario 2 : *Projection for 2025*

Population: 71.4 million Imports: Unchanged Diet: Unchanged

The UK population is predicted to increase to 71.4 million in 2050. If we continued with the current model of farming, did not change imports, and ate the same diets, we would need increase the amound of land used for food production by around 800 thousand hectares.

	Current model	Agro-ecological
Cereals	3,257	5,758
Legumes	299	1,411
Oils	435	286
Arable - *other*	939	1,148
Horticulture	117	118
Orchards	22	39
Pasture	12,405	11,597
Other	1,376	1,754
Total	18,850	22,113

Figures presented in '1000 hectares'

1 Note that all the figures used in our model have been callibrated on 2023 fugures, as this is the most up to date statistics available for many of the datasets.

Scenario 3: *Projection for 2025 with reduced imports*

Population: 71.4 million
Imports: Reduced
Diet: Unchanged

To increase the resilience of the UK's food supply, it makes sense to reduce the amount of domestic-type foods that we import from overseas (that is, food that can reasonably be produced in a UK climate) and instead prioritise local food systems.

This scenario maintains imports of luxury food goods such as tropical fruit, but halves the amount of imported soft fruit, orchard fruit and vegetables.

We stop importing eggs, dairy and meat and other animal products completely (apart from fish). We also stop importing lower value crops such as potatoes, cereals (apart from rice), sugar beet, animal feed (including soy), oilseeds and fruit and grain for alcoholic drinks. The level of imports of most processed goods, such as confectionary, oils, wine, cheese, beer, and cider, are reduced but not stopped entirely.

We stop exporting milk and lamb, but we do maintain exports of highest value export product - brandy.

Though these changes to imports are important, both for bolstering our national food security in the face of climate change, and reducing our overseas burden, it would be impossible to make all of these changes in an agroecological system – or even if we continued using the current farming model - without surpassing the land available for agriculture in the UK.

	Current model	Agro-ecological
Cereals	3,585	6,328
Legumes	325	1,767
Oils	1,022	843
Arable - *other*	1,208	1,426
Horticulture	169	171
Orchards	50	83
Pasture	13,601	12,517
Other	1,471	2,023
Total	21,431	25,158

Figures presented in '1000 hectares'

Scenario 4: *Projection for 2025 with reduced imports and dietary change*

Population: 71.4 million
Imports: Reduced
Diet: Modified

As well as reducing imports to ensure a more resilient food supply, it is also important that we shift our diets to fall more in line with current health guidelines; including reducing the proportions of our calories that come from proteins, dairy, and foods high in fats, salt, and sugars (HFSS), while simultaneously increasing the proportion coming from fruit and veg.

In addition to the health benefits, reducing consumption of animal products is the most effective way to cut down on land required for agriculture and free up area for nature-focused management.

In this scenario we simulate how land use would change if the following changes were made to the average diet for a person in the UK:

40% less pork, poultry, beef and lamb

40% less eggs and dairy products

33% less sugar and oils

50% more fruit and vegetables

50% more plant-based proteins such as legumes

8% more cereal grains and potatoes

This represents a diet that falls around halfway between our current diet and NHS recommendations, with carbohydrates making up 37% of consumption, fruit and veg rising to 27% and protein dropping to 18%, dairy to 12%, and HFSS foods to 7%.

If we were to make the above changes to our average diets, we could grow most of the UK's food supply here in the UK using agroecological methods, without changing the amount of agricultural land.

	Current model	Agro-ecological
Cereals	3,221	5,379
Legumes	419	1,299
Oils	505	565
Arable - *other*	1,125	1,332
Horticulture	254	257
Orchards	68	112
Pasture	8,160	7,448
Other	1,411	1,752
Total	15,163	18,143

Figures presented in '1000 hectares'

Scenario 5: *Projection for 2025 with reduced imports and a greater dietary change*

Population: 71.4 million
Imports: Reduced
Diet: Modified significantly

This final scenario represents a more significant shift in diets, resulting in overall lower land use for agriculture.

66% less pork, poultry, beef and lamb

50% less eggs and dairy products

66% less sugar and oils

130% more fruit and vegetables

130% more plant-based proteins such as legumes and nuts

20% more cereal grains and potatoes

In this scenario, oils and sugars are reduced by 66%, bringing HFSS foods down to 3% of overall consumption, close to the NHS recommendation of 2%. Animal products (except dairy) are reduced by 66%, making protein consumption 14% of total intake (12% recommended) and dairy is reduced by 50%, maintaining calcium intake and keeping dairy at 9% of intake (8% recommended). To make up for lost calories, cereal and potato consumption is increased by 20%, bringing carbohydrate consumption to 37% (38% recommended). Fruit and veg consumption is increased by 130%, making it 37% of intake (40% recommended), and 130% more plant-based proteins also contributes to calorie, protein, and micronutrient consumption.

	Current model	Agro-ecological
Cereals	3,175	5,511
Legumes	601	1,120
Oils	212	287
Arable - *other*	1,049	1,286
Horticulture	389	393
Orchards	97	159
Pasture	5,070	4,712
Other	1,372	1,575
Total	11,964	15, 042

Figures presented in '1000 hectares'

Obviously, the extent to which people will be willing and able to change their diets will vary, and on top of this, the amount of land that should be dedicated to nature-focused management depends very much on country-level targets for delivering ecosystem benefits such as carbon sequestration and forest recovery. Therefore, Scenarios 4 and 5 represent two points on a spectrum of potential trajectories for UK land use, reflecting the trade-off between dietary change and freeing up more land to help meet the UK's climate and biodivesrity targets.

4. What Would Change?

If we are to build a more resilient UK food and land use system by reducing imports and producing food in a way which regenerates land and ecosystems through agroecological farming techniques, then this will require us to make certain changes to land use, diets and trade.

4.1 Land use

One of the unique features of our agroecological model is the emphasis on multifunctional land use- including mixed farms and mixed woodland.

All areas will layer enterprises to integrate horticulture, orchards, agroforestry, chickens, pigs, etc to create circular farming systems providing employment, economic activity and a variety of fresh local foods.

A diversity of agrobiodiverse crops and livestock are grown on these mixed farms rather than monocultures of single crops, being produced for the commodity market.

Because agroecology is rooted in local landscapes, within our model, agroecological programmes are tailored to the demands and opportunities for mixed farms and mixed woodland on the three main types of UK land.

The balance between yield and ecology is calculated differently according to the grade of agricultural land.

These diverse mixed farms would look different on different types of land in order to maximise the potential for agricultural production and conservation in the most appropriate areas.

The main types of land are:

- **High quality land**, mostly in the centre and east of the country, which produces high yields of wheat, barley, potatoes, etc. On these farms there is huge room for ecological improvement by converting them into mixed farms. Great care must be taken to maintain yields, but over time with careful rotation systems the farms layer mixed farm elements into these farms, like dairy cows providing fertiliser, and mixed crops decreasing weeds and pests. This will restore the currently degraded soils to ensure long-term productivity.
- Large expanses of **moorland and rough hill pasture** mostly found to the west and north of Britain. Most land will be dedicated to specific ecosystems, such as conservation meadows, grazed by rare breed traditional livestock breeds and managed to preserve traditional heritage landscape features, such as dry stone walls. Trees will be sensitively introduced across these farm landscapes through agroforestry systems. Areas of low-productivity peat will be restored to a semi-natural state, becoming valuable to us through ecosystem service provisioning, however care must be taken to integrate the production previously undertaken on that land onto mixed farms.
- In between lie considerable areas of **mid-quality land,** which tend to be under-farmed, with many holdings producing only sheep or beef, or providing grazing for recreational horses. Some small fields are more or less abandoned. In these areas there is potential for making the most of the resources available, such as introducing orchards and market gardens to create mixed farms.

1. Grassland

One of the most significant land use changes in our modelled scenarios is a reduction in pasture land area, in scenarios with both small and larger dietary change. This is because pasture is relatively inefficient in terms of food production. However, some areas of land are not well suited to more intensive cultivation, and some areas of grassland are valuable habitats in their own right.

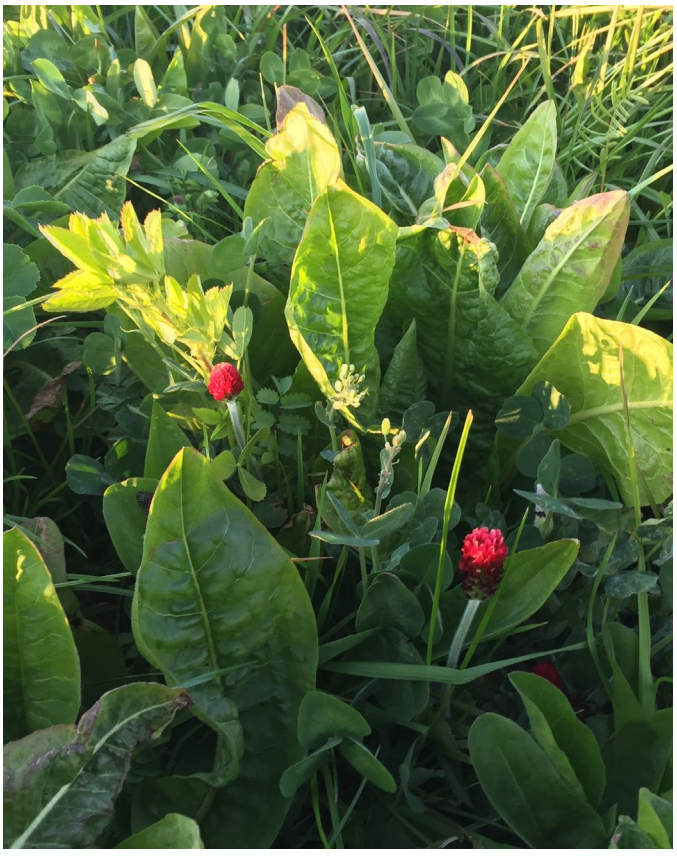
Remaining pasture would be managed in a variety of ways, including developing herbal and legume rich leys to enhance forage quality on high-quality pasture, integrating trees across fields in silvopastoral systems, and eliminating the use of agrochemicals and grazing at low densities to support biodiversity-rich conservation meadows. Silvopastoral systems with 400 trees per hectare can sequester up to 16 tonnes of CO_2e per hectare per year, though the level to which this can be achieved while maintaining forage yields varies depending on system characteristics, and in some cases - such as wildflower meadows - introducing many trees would change the desired land use. The actual number of trees planted would vary according to individual farm soil, climate, and management plan.

In an industrial farming land-sparing scenario intensive grazing and high agrochemical input on pastureland would mean the complete eradication of biodiversity in meadow ecosystems. Even if all the 'spared' land was dedicated entirely to conservation grassland, the fragmentation of such habitats, and the surrounding barriers of chemical-intensive fields, could mean extinction for many of the UK's most beloved and rare species.

Rare breed livestock is compatible with the management of wildflower meadows because rare breeds are more efficient at digesting and utilising fibre rich hay which is cut later in the season, after the wildflowers have dropped their seed. Traditional hay making, including mowing with a scythe, is also compatible with meadow management and a skill that should be kept alive for its heritage value.

2. Cultivated areas

To free up the land needed to feed a larger population with lower yielding crops, even considering scenarios with dietary change, would require conversion of pasture into arable or horticultural fields. Despite development of methods of no-dig cultivation, in many cases cultivation disturbs the soil and causes carbon to be released into



the atmosphere. However, under an agroecological farming model, there are numerous steps we can take to compensate for this disturbance.

Silvoarable systems, with 156 trees per hectare, can result in sequestration of 8 tonnes CO2e per year over a 40 year span,[25] and recent research suggests that organic silvoarable systems do not suffer yield losses from tree integration.[26] This means that after the initial disturbance, emissions should decrease and may eventually become negative. In systems where higher densities are not possible, such as horticultural systems, some soils may still become net neutral if managed with reduced tillage and carefully planned crop rotations that include deep-rooting crops and perennials.

3. Woodlands and wetlands

In all our scenarios depicting an increased population, on-farm woodland is scaled up in line with population growth to around 1.2 million hectares, allowing continued provision of wood and related goods. There is also room to achieve restoration of 100,000 hectares of wetland chosen as a target by the WWT, supported by government priorities. However, in a scenario with larger dietary change, even accounting for urban expansion, the reduction in agricultural land use frees up almost 3 million hectares of land for nature-focused management. The additional land could be replanted as woodland or restored to wetland depending on historic use and natural value.

An increase in woodland area would require mass afforestation, with consideration of which areas should be reforested, and with which tree species, creating some forests that would be harvested regularly for wood products, and others left to grow into the beautiful, ancient stands that the UK is so well known for. Conversion of pasture into forests would result in a burst of new growth and carbon storage, both in wood and in soils. Though this rate of carbon sequestration slows over time, long-lasting woodland stands lock up carbon in soils, and harvested woodland results in continued drawdown and capture of carbon in wood products.

25 The Woodland Trust (2022). Farming for the future: how agroforestry can deliver for nature and climate.

26 Tosh, C.R., Staton, T., Costanzo, A. et al. Biotic stress and yield stability in English organic silvoarable agroforestry. Agron. Sustain. Dev. 44, 46 (2024). https://doi.org/10.1007/s13593-024-00979-z

What is Continuous Cover Forestry (CCF)?

Continuous Cover Forestry (CCF) is a forestry systemthat avoids large clearfells and the associateddetrimental effects that they have on forest soils andecosystems. CCF builds resilient forests with irregularstructure and a range of different aged trees, which also contain high value older trees which can be harvestedas required. This produces structurally, visually andbiologically diverse forests, which provide qualitytimber alongside a wide range of ecosystem services including soil protection and carbon sequestration.

The Forestry Commission estimates that planting new native woodland can result in capture of 300-400 tonnes of CO2e per hectare by year 50, and 400-600 tonnes CO2e by year 100.[27] Regardless of whether land is converted to forest, many areas of agricultural land have high agroforestry potential, where we can integrate trees across productive farm landscapes. Our model does not count these silvo-arable or silvopastoral systems as 'woodland' in the strict sense, but they can still contribute significantly towards increasing tree cover and carbon sequestration.

Wetland restoration on top of the 100,000 hectares planned by the WWT would play a large role in supporting biodiversity and scientific research, and decreasing or reversing carbon emissions in semi-natural and farmed environments. It is estimated that in the UK, over 75% of inland wetlands have been lost over the past 300 years, often becoming net emitters of carbon. Most cultivated soils are a source of greenhouse gas emissions, rather than a sink.

This is especially true on peatlands that have been drained to allow crop growth, with damaged UK peatlands emitting between 3-30 tonnes CO2e per hectare per year.[28] By recovering these soils - rewetting and replanting natural vegetation, stopping peat removal, and managing through low-intensity grazing - we could change this to a net sink. Grasslands and woodlands also have areas of peaty soils that can be partially restored, reducing emissions, or increasing sequestration. In an industrial farming scenario which intensifies agricultural production, there would also be the space to restore all these ecosystems. However, it is unlikely that such efforts would be successful, especially in currently cultivated peatlands. Surrounded by a network of high-input arable fields and pastures, the effects of chemical and soil run-off on wetland diversity would be severe, with knock-on consequences for ecosystem services such as water filtration and carbon sequestration.

5. Developed areas, including housing

In the government's Land Use Framework (under development at time of writing) they assume a 1.1% expansion in urban area in England by 2050. Though development in other sections of the UK may not be as prolific, and there is a strong chance that a lot of development will occur in areas that currently fall into the 'urban green' classification (green belts and similar areas), we assume a 1.1% increase in total developed area to err on the side of caution.

27 Forestry Commission (2021). Creating new woodland: Woodland Carbon Code. Planting trees to tackle the effects of climate change.

28 IUCN UK Peatland Programme (2009). Peatlands and Climate Change.

4.2 Diets

In Scenario 4, we describe a diet that would go a substantial way towards meeting NHS recommendations. Most changes could be achieved by eating smaller portions of meat in each meal.[29]

These suggestions for diets are averages for what would be available for the UK population as a whole. Individual dietary choices would vary and have to reflect health needs and personal choice and life circumstances. Some people can eat more animal products and many will choose not to within these national averages.

Roughly speaking, what might the dietary changes in Scenario 4 this look like for someone's daily diet?

90g more fruit & veg

such as one medium apple or 9 broccoli florets

120g of dairy in total

such as a portion of milk on cereal

190g of protein-rich foods *(e.g. meat or pulses)*

enough for a portion of beans and a burger, small chicken fillet, or piece of fish.

35g less oil or sugar

around 2-3 tablespoons

29 Vonderschmidt, A., Jaacks, L.M., Alexander, P. et al. Smaller meat portions contribute the most to reducing meat consumption in the United Kingdom. Nat Food 5, 982–987 (2024).

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4.3 Local food systems

In 2050 we envision that food production will be embedded in localised food webs, where food is sourced as locally as possible. For rural areas this can be more easily achieved, but for urban populations food would be sourced based on the 'Food Zones Model'. This means that food is produced close to where people live giving people access to seasonal and fresh food. It minimises waste and the use of fossil fuels in transportation through low carbon distribution methods.

This focus on fair trading, by distributing the sale price of vegetables along a short supply chain to ensure that all suppliers and workers get a living wage, is why the Food Zones model is essential to reinvigorating horticulture. It is essential, when recruiting young people for careers in horticulture, to ensure that they will be able to earn a decent livelihood. Food Zones and Better Food Trader outlets, along with a diverse range of other types of local food web, are a way for food suppliers and workers to generate a reasonable livelihood while providing high quality, affordable, fresh food.

The Food Zones Model

The Food Zones model includes four main types of zones:

Production Zones: These zones are focused on food production, such as urban farms, community gardens, and peri-urban agriculture. Production Zones aim to increase local food production and reduce the distance that food travels from farm to consumer.

Processing Zones: These zones are focused on food processing and manufacturing, such as food hubs and shared kitchens. Processing Zones aim to help small-scale food producers access the facilities and resources they need to scale up their operations and bring their products to market.

Distribution Zones: These zones are focused on food distribution, such as farmers' markets, food co-ops, and online marketplaces. Distribution Zones aim to connect local food producers with consumers and help ensure that local food is easily accessible and affordable.

Consumption Zones: These zones are focused on food consumption, such as restaurants, cafes, and community kitchens. Consumption Zones aim to promote local food and provide opportunities for consumers to experience and appreciate local food culture.

The Food Zones model is designed to be flexible and adaptable to different contexts, and can be used by policymakers, planners, and community groups to guide the development of local food systems. The model has been used in several cities and regions around the world, including Sheffield, England and Victoria, Canada. Overall, the Food Zones model suggests that urban populations could be fed from a blend of 5% urban, 17.5% peri-urban, and 35% rural hinterland produce sold by direct traders, supplemented by 20% national, 15% European, and 5% international produce via wholesalers.

Food supplied is seasonal, fresh and minimises waste, while the model operates using low carbon distribution methods. Alongside Food Zones systems in cities and towns, and green belt areas producing food close to where people live, rural local food webs composed of agroecological farms, market gardens, community supported agriculture schemes and online trading will have a key role to play in building up supply capacity. There will clearly be a need for larger growers to meet the need for the wholesale produce to supplement sets of food zones suppliers for many years to come. However, over the course of the next 30 years, given a focused "Horticulture Renewal Programme", combined with financial support to incentivise growers, a transformation to agroecological horticulture is a goal worth striving for.

4.4 Trade

Reducing our imports this low might sound like a bold proposal. However, the majority of food and agricultural products imported to the UK are products that we produce ourselves and they come from countries with climates similar to our own.

If food can be produced in the UK this should be the priority, and trade policy should be shaped to support this. Seasonal tariffs, which would be applied incrementally as the domestic production comes into season to protect farmers when supply increases locally, could be used for goods that can be produced in the UK some of the year; an approach which would be particularly effective in supporting seasonal UK horticultural production.

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Solidarity Trade with the Kayapo of Brazil

The Indigeous Kayapo people of Brazil live in one of the last remaining areas of primary forest in the Amazon's south east region. The Kayapo number around 7,000 people scattered across 46 villages in five territories. Together, these territories span 10.6 million hectares of primary forest.

For the Kayapo people, the Brazil nut is an important source of food and every year they travel through the forest to collect pods from under the trees. Their ability to protect these forests, the Brazil nut harvest, and their livelihoods, however, is under threat from extractive industries like logging and mining.

In 2022 the Landworkers' Alliance - in partnership with the Roddisck Foundation and Hodmedod's - established a solidarity trade project with the Kayapo-led cooperative 'COOBA-Y'. The partnership has opened up an export market for the Kayapo, allowing them to sell the surplus Brazil nuts from their annual harvest. This means that the Kayapo are assured a degree of financial autonomy to protect themselves and their forest on their own terms.

This is a positive example of a solidarity trade model ensures that international trade is in the interest of exploring communities, provides a food product that is not able to be produced in the UK, and which contributes to environmental justice.

5. Policy Recommendations

To implement this vision Government should invest in 5 things:

- **Incorporating an agroecological, land-sharing vision into the National Land Use Framework**
- **Transitioning to agroecological farming systems**
- **Regenerating local food systems**
- **Encouraging dietary change**
- **Building a framework for positive trade**

5.1 A Land Use Framework

The Landworkers' Alliance has been promoting the establishment of a Land Use Framework since its inception. Since the 2021 National Food Strategy proposed a rural Land Use Framework to better understand the incentives, payments and regulations to achieve nature, climate and food goals (among others). Picking up on this, in its 2021 National Food Strategy, the Government committed to publishing a Land Use Framework for England, and the House of Lords Land Use in England Committee's report recommended a Land Use Framework and a Land Use Commission, which would work across different government departments. This Framework is now under development, with the aim of being published in 2025. Government should develop this framework in a way that supports a land-sparing vision for the food system, based on the principles of sustainable agriculture, healthy diets, and local food. Wales, Scotland and Northern Ireland are developing their own land use decisions processes, which should also incorporate these.

The governance of a Land Use Framework must meet the twin objectives of national oversight of targets and obligations, whilst supporting democratically engaged decision making by local communities. It is important that these community based processes are inclusive of marginalised communities with an eye to establishing food and land justice.

Once a Land Use Framework is completed, a Land Use Commission should be established within the Government. The Land Use Commission should have oversight and research capacity to update and monitor progress towards an equitable food and land use system. The relationship between food security and land use should remain at the centre of analysis. This should include land-led data assembly and coordination, compiling national targets, and ensuring quality evidence is available to track progress towards them.

The research and recommendations should feed into a wide range of legally binding, cross-departmental policy measures across government departments, arms-length bodies, local authorities and regulated sectors including the planning laws, payments to farmers, trade rules and environmental land management systems.

Ultimately, legislation setting key statutory targets should be embedded in law so that the recommendations of the Land Use Commission succeed in creating a land use system that balances the needs of all living beings who inhabit this Earth.

5.2 Transitioning to agroecological farming systems

Research and development

Targeted research and development of pioneering techniques is needed to ensure that sustainability improvements can be made without decreases in yield, to increase the viability of agroecological and mixed production systems, and to enhance resilience of the whole food system in the face of climate change. Research should be led by farmers and disseminated through farmer-to-farmer training methods, which is often much more cost-effective and more rapidly adopted than non-farmer-led research.

For example, a significant amount of research is happening in East Anglia through the British pulse and grain company Hodmedods. Farmers are experimenting with diversifying production on arable farms to integrate pulses into arable rotations, selling produce directly to Hodmedods. These farmers are working directly with pork and poultry producers to recycle the co-products of legumes processed for human consumption to create a regional-level mixed farming system. Experimentation is ongoing to develop varieties of legumes with higher yields which are easier to process, even when the weather is wet during harvest, and to develop animal feed blends and high-yielding livestock breeds that can make efficient use of these co-products.

A transition approach can build on the current production methods that use high-yielding arable crops and livestock breeds, integrating gradual improvements to sustainability and diversity using techniques such as integrated pest management, circular recycling of nutrients, and breeding of population wheat or mixing crops in fields. As specific areas of research are successful, improvements can be made across multiple levels of the food system.

These are the specific areas that need to be drastically improved with knowledge exchange and focused R&D. They are primarily innovations that deal with the ecological intensification of holistic agricultural systems, improving knowledge and skills to improve the whole farm - from primary production to recycling of inputs to the processing, packaging, and distribution of the end product.

Examples of high-priority R&D areas include:

- Optimising legume management, leys, and green manures for fertility building
- Recycling nutrients from organic wastes and effective reintegration into agricultural systems
- Composting to recycle agricultural waste
- Increasing nutrient use efficiency and reducing nutrient leaching and run-off using intercropping, catch crops, and border crops
- Alternatives to tillage that minimize soil disturbance and alternative weed control systems
- Integrated pest management and intercropping
- Integration of trees into arable and pastoral systems with minimal yield losses, and investigation of how to most effectively create the benefits of additional crop harvests, shelter, habitat creation, and carbon sequestration in different systems
- Developing high-yielding organic sugar beet and

oilseed varieties, and development of effective techniques to organically and efficiently process sugar, oils, and lucerne.

- There is an urgent need to create more resilient grain populations and to increase the yields of agroecological cereal systems in the context of significant and uncontrollable climate changes in the coming years and extensive research into breeding organic arable grains and pulses to enhance yield and resilience should be starting as soon as possible.
- Investigation into perennial crops and other techniques that improve soil structure and carbon sequestration at depth for long-term storage
- Research into cattle breeds for dual-purpose dairy production and beef production from the dairy herd using default beef production systems
- Drawing on heritage cattle breeds to develop the ability to efficiently convert low-grade forage and mixed herb leys into proteins and sugars for muscle mass or milk production
- Breeding to increase feed conversion efficiency across all breeds of animals
- Safely using waste food, co-products and by-products in animal feed while meeting nutrition requirements.
- There are many research needs for the growing pasture-fed livestock sector, as represented by the farmers organisation Pasture For Life. Government should work in partnership with PfL and similar farmer-led research programmes to improve efficiency and develop management techniques for pasture-fed livestock.

Currently, a tiny proportion of the R&D budget is directed towards agroecology. The scale of investment needs to be proportional to the actual changes that need to be incentivised, which is why it is so important to have the R&D budget guided by a vision for sustainable land use. Care should be taken to avoid expensive proposed solutions to our land use crisis that may not deliver as much as they promise. For example, vertical farming does not spare significant land area since horticultural production takes up minimal land compared to livestock and arable. Research and investment into vertical farming is also costly, meaning there is little return on investment. Instead, a significant amount of R&D could be done on the ground by paying farmers to research and breed to evaluate new systems and open-source crop varieties, with priorities dictated by lived experience.

A well designed and adequately financed support scheme in which all agricultural payments are linked to the delivery of environmental benefits, such as the Environmental Land Management scheme in England (which includes the Sustainable Farming Incentive)

Government should maintain payments for provision of environmental benefits or based on adoption of agroecological principles. Much work has been done towards development of these schemes across all 4 nations since the passage of the Agriculture Act, so we give minimal detail here, but these schemes should continue to be developed and refined. To prevent issues such as the premature termination of SFI 2025, the scheme should be adequately financed - in recognition of the fact that this transition will underpin progress towards a number of key governmental priorities. All such payments should be tapered, with larger farms receiving slightly less per hectare on the grounds that they benefit from economies of scale, and payments should be capped at a certain level (we suggest a threshold of £120,000) for individual farms to ensure benefits support as large a number of individual businesses as possible and to support a mix of small and family farms. Payments should be coupled with stringent rules to prevent irresponsible farming practices, and a 'Polluter Pays' principle should be adopted to tax harmful farm inputs - which can in turn be used to support beneficial practices.

A ' just transition' for livestock farming

Agroecological intensification needs to pay particular attention to improving systems in order to transition to "default livestock" because livestock are often the most extravagant use of land. If mixed farming systems get livestock balance right, other things fall into place. We must transition away from intensive livestock production, and need to consume less meat overall, but we must avoid the loss of farmer and farm worker livelihoods. Thus, we must invest in a transition to agroecological mixed farming models. This will require training in direct sales and other short supply chains to increase the economic viability of farms producing fewer, but more sustainable animal products, as well as training and advisory services in how to convert to production of legumes or horticulture, increase arable production, and incorporate forestry. In order to make a "just transition" work we must avoid importing meat with a much higher environmental impact elsewhere, and phase out intensive and unsustainable factory farms.

A grants scheme to support a transition to mixed farms

Mixed farming refers to the production of both arable crops and livestock, where ruminant livestock are an integral part of the arable rotation. The waste parts of one enterprise (crop residues) which would otherwise be loaded onto the natural resource base are returned (as manure) to the other enterprise. Mixed farming offers many opportunities for more efficient resource use, nutrient recycling and a varied traditional landscape that supports higher biodiversity. For example, dairy can be combined with pig production to recycle the whey produced by cheese-making. Many mixed farms in the Uk rely for their fertility on legume/grass leys, which are effective at sequestering carbon. In a typical mixed farm, the role of livestock will be a) to take advantage of the fertility building grass and legume crop, b) to support a diversity of crops that keep the land weed free and avoid pest build up; and c) transfer nutrients in the form of manure from outlying permanent grassland to arable land.

It can be costly to convert farms to mixed enterprises, but these systems offer many benefits in the longer term. A mixed farm scheme would provide both capital for initial conversion costs and time limited maintenance grants, which would support running costs until the benefits of mixed farming systems begin to manifest.

Reformed animal feed legislation

In collaboration with academia, vets and the feed and pig industry, the UK government should produce technical guidelines for industry, change animal feed legislation, and invest in a system for feeding waste food to pigs and chickens drawing on the Japanese production of a product called "Eco-feed". Eco-feed converts post -consumer waste food into safe pellets which can be fed to pigs and chickens.

The systems for feeding waste food to animals will need to have extremely strict safety measures but should follow a 2-tiered approach - one industry version, where the food waste is processed in specialist facilities which operate according to technical guidelines, such as when household waste is turned into feed safely via insects; and a second tier that would work for small scale farms in a future agroecological food system. The system would have differentiated risk levels because small scale diversified farms pose less risk epidemiologically.[30]

5.3 Encouraging dietary change

Dietary change is not our area of expertise, but there are multiple organisations that have reached the same conclusions about dietary changes that need to occur for our health and to support a sustainable land use system. The Better By Half Roadmap[31], for example, outlines changes to be taken across 5 sectors to create an enabling environment to drive the necessary transition in eating habits.

However, some changes would need to occur in the agricultural sector to ensure that the food we need is available. Central to this is increasing fruit and veg production, representing a massive scaling up of the horticulture sector. At present, agricultural subsidies are distributed on an area basis, favouring livestock and arable farming, and providing little support for the UK horticulture sector. While commercial viability and independence from subsidies is a source of pride for many large growers, the UK has become increasingly dependent on imports of fruit and vegetables, with the contribution from domestic production having decreased by 48% between 1987 and 2013. While the UK is classified as "least vulnerable" to climate change disruption, we import 32% of our fresh produce from countries classified as "climate vulnerable", including countries such as Spain, Morocco, South Africa, and Chile where water scarcity is a "high risk".

For both global fairness and local health, it makes sense to support more UK vegetable and fruit production. To increase the proportion of domestic production, grow food in a sustainable way, and to support the increased fruit and veg production necessary for a healthier diet, would require increasing the horticultural land area by 100-200% compared to at current. This is, however, a relatively small land area compared to the amount used for arable and pastureland. A larger concern would be recruiting and training new

30 For more information on replacing soy in UK pig and poultry feed see Landworkers' Alliance, Sustain, Hodmedods, Pasture for Life (2023) "Soy No More": https://landworkersalliance.org.uk/wp-content/uploads/2018/10/Digital-Soy-No-More-.pdf

31 Eating Better, 'Better by Half Roadmap' (https://www.eating-better.org/better-by-half/#:~:text=Better%20by%20Half%3A%20A%20roadmap,actions%20are%20already%20taking%20place.)

horticultural growers, requiring a focused "Horticulture Renewal Programme", combined with ELMS packages that adequately incentivise growers to deliver public goods.[32]

5.4 Regenerating local food webs

These are national targets for local food production and distribution that can and should be implemented on a regional level to regenerate our local food webs while enabling access to good food for all.

Supporting new entrants to farming

A secure UK food supply based on the principles of agroecology, with more mixed farms and horticultural production, would be dependent on increased numbers of new entrant farmers. The UK farming sector is ageing, and as a consequence we are facing a major renewal crisis in farming and food production.

New Entrants currently face multiple barriers to entry, including the ever-increasing price of farmland, a near absence of starter farm opportunities, a lack of suitable training and funding, and the discouraging ongoing sell-off of county farms. There is therefore an urgent need for the UK government and devolved administrations to acknowledge these issues, and to implement policy which supports young and diverse New Entrants into farming. Targeted policies to support New Entrants should include increased funding and support for on-farm agroecological training and apprenticeships, a capital grant scheme to overcome some of the barriers to entry, and a land access scheme to both support organisations providing farm incubation opportunities and to put a stop to the sell-off of council owned farm estates.

Community Food Production

Growing evidence points to the value of community food growing as a benefit to not only physical health and diet, but also mental health and the combating of loneliness. In 2050, a greater proportion of food would be grown for subsistence, either in private gardens and allotments or as part of community gardens. Farmers would be incentivised to contribute land to the local community and offer more opportunities for public engagement such as seasonal farming events. Home grown food, including eggs, milk, and meat, as well as fruit and vegetables, would make a significant contribution to the household economy of many, including those with long term mental health issues, while doctors could prescribe gardening and farming to get people fit and healthy again when appropriate.

A Community Food Resilience Fund

This should be a national programme that invests in strengthening food systems and facilitating access to safe and nutritious food for at-risk populations, similar to the LFIF fund available in Canada. The funding would be aimed at community-based, not-for-profit organisations with a mission to reduce food insecurity by establishing and/or strengthening their local food system.

Its objectives are to:

- Improve access to safe, healthy, and culturally diverse food while promoting community development
- Support local economies
- Improve health outcomes for most at-risk communities
- Promote environmentally sustainable food systems

This scheme would correct the market failure where local foods have become niche, high products by helping to create community food projects and networks, and by supporting grassroots activities (such as community gardens, community food kitchens and social pantries) that create social inclusion and provide food insecure populations with access to healthy food. This would be achieved while taking into consideration the specific beliefs, culture, traditions, dietary habits, and preferences of diverse communities, as a matter of human dignity and to avoid further marginalisation.

32 For more information see Landworkers' Alliance (2024) "Horticulture Across Four Nations": https://landworkersalliance.org.uk/wp-content/uploads/2018/10/LWA-Horticulture-Across-Four-Nations-2023.pdf

Public procurement

A public procurement policy focusing on local food would enable us to reorient school feeding programmes and other institutional food services to provide food that is healthy, local, regionally sourced, seasonal, and sustainably produced.

A local food infrastructure fund

This should provide central government financial support for local food businesses such as:

- Processing facilities (which also reduce food waste)
- Local market infrastructure- open air markets, community shops
- Small abattoirs
- Open and collaborative online distribution networks
- Tax incentives for local food retailers

The infrastructure should include facilities suitable for both regional distribution/processing and very local direct supply chain sales. The funding should be distributed by local economic partnerships (LEPs) to support regional level local food strategies which link to national targets for domestic production.

Curbing market power of agribusiness

We could achieve this by implementing rules that limit the power of TNCs and reduce corporate concentration in the food sector. This includes

- Regulation of supermarket power through the Grocery Code Adjudicator
- Maintaining high trade standards by legislating for high standards in animal welfare, antibiotics, pesticides and so on, which helps control corporate system abuse.
- Planning regulations

We should change planning regulations to protect independent food retailers, address food deserts, regenerate town centres, and control the proliferation of supermarkets.

CSA (Community Supported Agriculture) start-up scheme

This scheme would be community focused, providing advisory services and capital to facilitate any communities in creating farms which are either owned by the local community or where community members can invest in direct shares. For capital funding, priority would be given to low-income areas where there are food deserts, but advisory services should be for all areas. This could be coupled with community assets transfer policy so that public resources like county farms can be transferred into CSAs.[33]

33 For more information see Landworkers' Alliance (2021) 'Vocal for Local': https://landworkersalliance.org.uk/wp-content/uploads/2018/10/Vocal-for-Local.pdf *and* Landworkers' Alliance, Sustain, FFCC, SFT and Pasture for Life (2025) "Local Food Growth Plan": https://www.localfoodplan.org/the-plan/

5.5 Building a framework for positive trade

Our model shows that producing the majority of our food consumption with the UK using agroecological methods, but the remainder should be imported according to fair trade principles.

Trade Rules

Tariffs, border taxes and non-tariff measures can and should be used to monitor, regulate, and control the products that reach our markets. To be most effective, each tariff line must be considered in isolation and set to a level that promotes domestic production when it is socially and ecologically sensible to do so, taking into consideration transport efficiency, UK production ability and impact of production on the trade partner. Seasonal tariffs should be used to ensure that UK production is protected when it is in season.

Define investment and development agendas to realise global food sovereignty

Supporting global food sovereignty must be a unified aim across foreign investment and trade policy. Investments abroad should support infrastructure and local capacity building for diverse agroecological farming and agroforestry. Local governance models that enable local decision making and local control, such as cooperative models, are crucial. Land purchases for export crops that permanently deny local people access to land to produce for their local community should never be allowed.

Increase responsibility of businesses in food supply chains

The UK government is a world leader in supply chain responsibility. The 2018 Modern Slavery Act, and integration of due diligence legislation in the Environment Act pave the way, but do not go far enough. Supply chains must protect people in supply chains around the world to the level enjoyed in the UK. Supply chains must go beyond UK ecological baselines to enable regeneration of global soil health and biodiversity.

Mandate transparency in Trade Negotiations

Transparency and democratic oversight are fundamental in effective trade agreements. Parliament requires adequate time and capacity to properly scrutinise all trade deals before they are ratified, and the UK government should mandate full transparency of all trade deals and negotiation processes while they are ongoing. This will enable civil society organisations to play their role in holding the government to account.[34]

34 For more information see Landworkers' Alliance (2021) 'A Vision for Positive Trade': https://landworkersalliance.org.uk/wp-content/uploads/2021/01/A-Vision-For-Positive-Trade.pdf

6. Conclusion

As the impacts of a broken food and land use system guided by the market become more visible every day, the need for broad-scale transformative system reform is as pressing as ever. The land is our most important resource, the very foundation of systemic reform, and needs to be treated as a commons, with collectively held understanding to enable us to care for it together.

This model is one tool that we can use to build our collective vision and a series of actions for land reform across government and at all levels of society. It doesn't present a prescriptive vision for what the UK must do, but rather highlights the trade offs and opportunities of an agroecological land-sharing approach which prioritises local food webs over global supply chains, so that we can build a pathway forward together based on a more complex understanding of the complexity and nuance we must hold.

It gives us confidence by showing that with the right trade policy and dietary change, localised agroecological food webs could provide the majority of the UK's food supply in a sustainable way.

And it gives us scientifically rooted fuel to debate the arguments put forward by agri-business corporations saying agroecology can't produce enough to feed a growing population or we need to intensify to make space for nature.

We, as a land movement that cares about justice, equity, nature and abundance, let us go forward with optimism and knowledge to restore the land.

If we have the will to make it happen, all of this, it can be done!

The Landworkers' Alliance is a grassroots union of farmers, foresters, growers and land-based workers from all four nations of the UK. We work to represent the interests of our members, and to build a better food and land use system for all.

Find us online

www.landworkersalliance.org.uk

Facebook: @landworkersalliance

Instagram: @landworkersalliance

Blue Sky: @landworkersuk.bsky.social

Email: info@landworkersalliance.org.uk