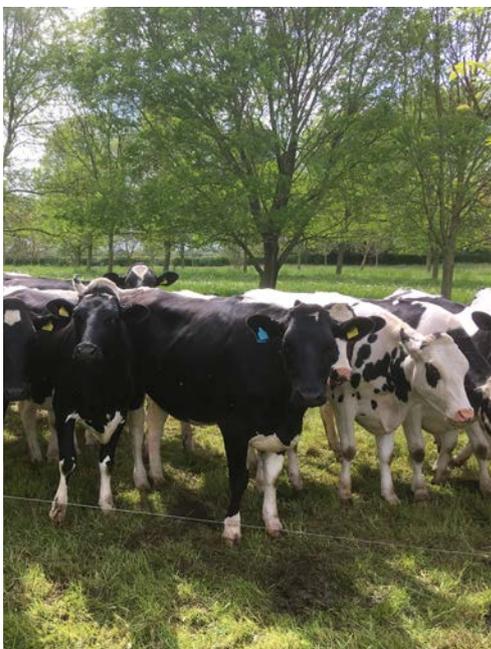
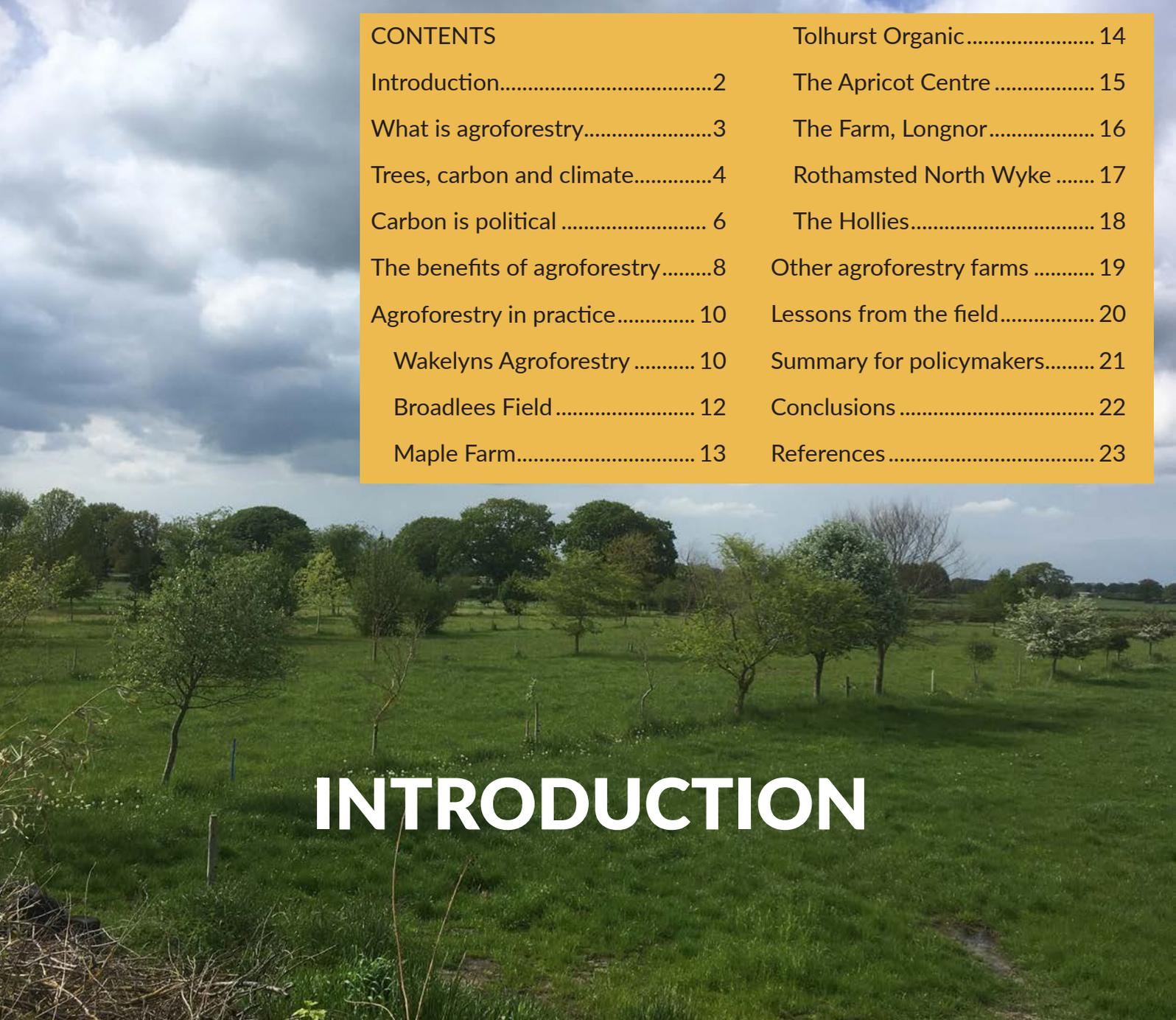




The Promise of Agroforestry

LESSONS FROM THE FIELD





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INTRODUCTION

The problems with our food system have been well documented and the loss of biodiversity together with the ongoing – and terrifying – climate crisis is equally well known.¹

Recent debates have centred on specific issues like the numbers of trees that need planting, or the re-introduction of particular species, but these can only be partial solutions on their own. At a time when pressure on land is at an all time high, we need to have both a regenerative and holistic approach.

That means looking for multi purpose solutions. And that is why we need a ‘land sharing’ approach that combines food production with biodiversity and environmental goods.

One key multi-purpose solution is Agroforestry. It can provide so much that we need: food, fuel energy, wildlife habitat, building material, soil stability, water and flood management, carbon sequestration, and shelter for humans and animals.

Agroforestry has been around for a long time, but it is currently seeing a resurgence in new and adapted forms.

The benefits of agroforestry in the form of traditional shelter belts or, say, orchards with livestock, are well known. This report looks closely at some of the newer versions of agroforestry which combine mainly larger scale field systems with strips or alleys of trees.

If we can put together our traditional farming wisdom with the knowledge gained from these recent trials and experience, we have a highly fertile set of ideas to follow.

This report looks closely at eight established and working examples of these new forms of agroforestry in the UK, and explores what we can learn from them. Prior to that it looks at the related issues of carbon and climate because they are so integral to which direction land use takes over the next few decades.

It is a report for farmers, policy makers and all those who care about our land use, our environment and our food systems. Much of the information here is practical, but practice needs political support when we are trying to establish new and diverse activities. The section for policy makers can be found on page 21.



WHAT IS AGROFORESTRY?

Agroforestry is simply the use of trees within farming and food producing systems.

Agroforestry is a new term to some people, but it is a very old practice.

People have of course been using trees in agriculture for thousands of years and the history of the UK is full of agroforestry. Examples include:

- Orchards with sheep or poultry grazing underneath.
- The ancient art of pannage where pigs were put into woods to fatten on acorns in the autumn.
- Using trees as a shelter belt to protect crops and livestock.
- Our venerable wood pasture systems, with veteran trees in grazed meadows or parks, which are home to some of our rarest species and are some of our most precious habitats – these are also examples of agroforestry.
- And hedgerows too, providing shelter and secure boundaries – the list goes on.

But it is also 'new' because recent years have seen an upsurge in people looking for ways to create more sustainable and nature-friendly farming systems by integrating trees into field crops or pasture systems.

Faced with the reality that conventional, high input farming systems are leading to a loss of species, a climate crisis, a loss of farmers themselves and a huge burden on

the environment, interest in agroforestry in the last two years has soared.

And these trials, whether commercially minded or not, have given us plenty of evidence to learn from. This resurgence has been coupled with the ability to learn from examples and farms across Europe and the world, vastly increasing the pool of evidence we can draw on.

WE CAN SUB-DIVIDE AGROFORESTRY INTO DIFFERENT NAMED SYSTEMS

Silvo-pasture – trees with animals, whether that's sheep, cattle, poultry or others

Silvo-arable – trees with field scale crops, particularly grain crops

Silvo-horticulture – trees with market gardens and fruit and vegetable crops on a smaller scale

Forest farming – a tree dominated system where the emphasis is on the trees producing the desired crops themselves.

Of course, all of these could feature on one farm, and can be mixed at different scales and tree densities and tree varieties. One of the beauties of agroforestry is that it is so versatile and can be adapted to the local climate and ecology and markets, wherever it is.

TREES, CARBON AND CLIMATE



The climate crisis will not go away in the lifetime of anyone alive today, and the interplay of 'greenhouse gas emissions' (GHG) and carbon sequestration will be a defining feature of our lives for many decades to come.

Land has a fundamental role to play in the climate crisis, and agroforestry has great potential to be part of a solution because our land – and the things growing on it – will have to produce our food and have to sequester carbon. Agriculture – and our wider food system – is currently a huge source of emissions,^{2,3} and that situation will have to be changed.

NATURAL CLIMATE SOLUTIONS

We can use the natural biosphere to sequester carbon. Forests, trees, marshes, peatlands, ecological agriculture – these are 'natural climate solutions'. They are safe, multi-functional, and long established, which compares well with the far more costly and unproven technologies of 'geo-engineering'.

It would be a mistake at this point of crisis in 2021 to get fixated on single solutions – the exact number of trees we need to plant to 'solve' the climate crisis, or on whether

'pasture fed livestock' or 're-wilding' or peat bogs 'win' the argument about 'the best' way to absorb carbon. They all have a role to play in a multi-faceted ecological system, and the proportion of how much we 'need' of one or another is a hugely complex question.

More importantly, there is a challenge for society as a whole. That is to work together on a clear, step by step pathway, to get away from burning fossil fuels, and to do this in a way that is fair and just for all, retaining employment and ensuring a good quality of life. An essential part of meeting that challenge is that we create regenerative farming systems that fit with their local ecology and local economy.

This pathway must also go hand in hand with a plan that limits us from importing timber, soya, oils and other products from global forests, or land where those forests are under attack. Those forests are crucial for Earth's living systems and the people that live there, and we have to stop financing activities that pay to cut them down. The UK connection to the global trade in extractive and commodity materials is a key way in which we continue to fuel the climate crisis.



Photo: Jeremy Gugenheim

CARBON SEQUESTRATION

It would of course be very sensible to have a great deal more research on the science of soil carbon sequestration. Carbon is an element that is in constant flux i.e. it cycles between soil, plants, the oceans, the atmosphere. Although we have some figures for sequestration levels, we don't yet fully understand the relative merits or limitations of carbon sequestration over long periods of time through different mediums of grassland soil, or woodland, or the marine environment, kelp seaweed, wood pasture, and so on, specifically in a UK context. Sensible government policy would ensure this was a matter of the highest priority and would be funding soil and carbon research right across the country. These are complex biological questions which need resolving as fast as possible.

Because trees are relatively good at sequestering carbon – assuming they are managed properly – incorporating them into our food growing systems makes perfect sense. In addition we get numerous other benefits for humans and wildlife too.

Trees are large plants which carry out photosynthesis; the carbon dioxide extracted from the air can be stored as carbon in the soil and the wood. The wood can be harvested as timber and stored and used, while many tree species will regrow again naturally, this is the ancient practice of coppicing, which was also pivotal in creating many of our beautiful woodland habitats.

The science of carbon in soils is complex because carbon is stored at different depths in the soil, the sequestration takes time to happen, and then is prone to loss again, depending on the soil management and conditions. The soil can also reach carbon saturation at certain levels. Bearing this uncertainty in mind the principle should be to do what we can to retain carbon in the soil, whilst meeting other objectives.

Across the country, we need to manage our existing trees and woodlands much better, but many of these new trees that we do need can be on farms – indeed, must be on farms. And many of these can be in strips and alleys of trees as seen in the agroforestry schemes in this report.



CARBON IS POLITICAL

Most people agree that we need more trees and better management of the ones we have.

But where and how it happens is an important social and political question, not just one for scientists and politicians – and it's even less a question for corporations trying to meet their 'net zero' targets.

Scientifically speaking, we must reach and surpass a point where our emissions are matched by carbon sequestration, and 'net zero' is one name for this point, but the term has been abused by companies and governments who merely wish to set far-off targets and continue with the status quo, while avoiding immediate emission reductions. Reducing emissions immediately along a clear pathway **IS** what is needed.

Once we have that clear pathway, the discussion on what kind of 'carbon offsets' we might have, should follow. Who 'counts' carbon and who gets paid for the carbon that farmers and foresters are already working with is contentious and the wider issues here are too complex for this report to go into.⁴

But that complexity should not hinder us from following two clear principles: reduce Greenhouse Gas emissions, and in particular that means the burning of fossil fuels; and secondly, do what we can to retain carbon on our land.

Given the uncertainty and political upheaval on this issue, agroforestry gives us a great way forward. It allows us to form strategies that both increase tree cover and continue farming with all its attendant economic, health, and social benefits, and that is a crucial reason why we must pursue it with enthusiasm.

In the UK we have 17.4 million hectares (Mha) of agricultural land, and 3.2 Mha of woodland.^{5,6} Very broadly, an ambitious but achievable aim would be to double 'woodland' cover in the next ten years to around 6.4 Mha. This could then sequester 37-50 MtCO₂ annually⁷ – although it's important to note that sequestration rates are not simple or linear. This – with other land use and marine measures – would give us

a slim but real chance of sequestering our total annual Greenhouse Gas emissions.⁸

If we can manage to do this and create the systemic changes to our economy that arise from reducing fossil fuel dependency, then we are in with a chance of reducing the harm and devastation that climate chaos will otherwise cause.

TREES AND FARMERS

For farmers, talk of large scale tree planting can sound daunting as it implies an unstoppable and inexorable blanket of trees imposed on our land. This is particularly worrying for farms with lower grade land.

But farmers must be part of the solution and we need that local knowledge and all our skills.

Trees do not have to be an imposition. Farming and forestry need to return to work together, and it can happen in a variety of ways. In some places it may make sense to expand existing tree cover, or even set aside areas to 're-wild', because of the local context. In other places it makes much more sense to use corridors of trees, shelter belts or productive tree alleys within productive field systems that the farmer continues to farm.

In fact, agroforestry can help farms and boost employment. Far from current trends where farming families are leaving the land, investing in agroecological methods with their emphasis on human scales rather than mechanisation, means more farms and more people working the land. If we want a resilient food system, this is a good thing.

It can also go alongside a huge boost for our UK forestry industry as we train people to work with trees and timber and reinvigorate a 'green' and timber building industry.

For years we have sourced most of our timber from abroad, but there are thousands of good jobs to be created in the UK by investing in our forests and trees.

Widespread use of agroforestry is a win-win scenario, allowing us to have the environmental benefits of trees with very little loss of farmland. To see what's possible, consider this suggestion for planting strips of trees on much of our agricultural land:

There are 3.2 million hectares of woodland in the UK and approximately 17.4 million hectares of land currently dedicated to agriculture.

Of the agricultural land, some areas are not suitable to plant on because they are sensitive in some way - valuable meadows, some upland areas, peatlands and so on. As an estimate let's say this is around 2 Mha.

We could assign 1.4 Mha of the farmland to be planted as new woodland - this would be the equivalent of 8% of the UK's agricultural land. If we then planted low density alleys of trees on around 14 Mha of fields, arable and pasture, this would create the equivalent of 1.75 Mha of new 'woodland'. This would cause no significant loss of farmland.

{The equation is: 250 trees per hectare on 14 Mha = 3,500,000,000 trees. If those trees were planted at an equivalent woodland density of 2000 trees/hectare that's equal to 1.75 Mha}

That's an additional 3.15 Mha of 'woods' (1.4 + 1.75 Mha), virtually doubling UK tree cover to 6.35 Mha, 26% of the UK area, but still, for comparison, well below the European tree cover average.

And that brings not just environmental benefits - those trees can give crops and timber, and provide material to support local building and industry.

If those 14 Mha are farmed under good agroecological principles as part of vibrant local food economies - together with our marshes and peatlands and marine areas - we have a land use system that can sequester emissions and give space for nature and provide our food, and support local jobs

This can't be, and shouldn't be, carried out tomorrow. Not all fields are equally well positioned to have any kind of tree, particularly fruit and nut trees, planted there. Many places will need additional shelter first, and a carefully thought out design as part of a whole farm management plan.

But this indicates what is possible.

Deciding exactly which areas have woodlands, which should be protected from trees, which should be wood pastures, or tree alleys etc cannot be left solely to 'market forces'. Already there are issues with large corporations buying up farmland for carbon purposes with no community involvement or oversight.⁹ It will need co-ordination of farmers across landscapes, with local authorities, environmental bodies, governments and local communities. It will not be easy, but putting these decisions off will make the situation worse, and far more difficult.



THE BENEFITS OF AGROFORESTRY

Photo: Organic Research Centre

The actual benefits of any individual agroforestry scheme depend upon its purpose and local context. Not all of this list will apply to every farm and system. But the list of potential benefits is huge.

Here we set these benefits out in three parts, though of course these are actually interdependent: for farmers, for livestock and for nature.



BENEFITS FOR FARMERS

- More total productivity because intercropping captures a wider spread of resources at the same time. Space is used more three dimensionally and different crops or animals can be used in that same space. This allows business resilience and greater diversity of enterprise.
- Crops from trees could be timber, fruits, nuts, fuel, craft products – and so on
- Shade for people (and animals and plants) on a planet facing increased and sometimes extreme temperatures
- Protecting the soil – the physical and biological foundation of our farms
- Protection from the wind – trees can reduce wind effects across the field for a distance of up to ten times their height.
- Reduced feed costs and other cost inputs because the trees bring up minerals, feed the soil, and provide healthy browsing for livestock. This includes Nitrogen fixing from particular trees which aids plant growth
- Reduced crop disease due to various biological or spatial factors means higher incomes or less costly herbicides and pesticides
- Providing bedding material for animals
- Mitigating flooding by vastly increasing water retention capacity in soil
- Bioenergy: woodchip from Short Rotation Coppice (SRC) can be sold or could heat domestic or farm boilers (a study at Wakelyns showed a 50 m row of Hazel SRC could make 1.47 cubic meters of woodchip annually, cut on a five year rotation, 10 m each year)¹⁰
- Chipping small diameter branches and prunings makes ramial wood chip, a good soil improver
- Trees can be uplifting for the soul and our spirits, leading to better mental health
- Landscape amenity – trees can benefit buildings where they both screen and hide them for aesthetic reasons and provide shelter from wind, rain and sun, giving ambient temperatures.

BENEFITS FOR LIVESTOCK AND POULTRY

- Shade and shelter which benefits welfare and can reduce bills
- Browse and fodder vary the diet and can be medicinal and nutritious
- For poultry, descended from jungle fowl, trees mean security and a diverse habitat for wild food
- Reduced disease because of the more varied environment and greater access to healing plants^{11,12}
- Reduced water logging in soils which is better for welfare
- Varied micro climates and shelter mean hardier stock because spending time outdoors - in most conditions - leads to higher welfare. For farmers this in turn could mean a better meat product and more regional variety with the attendant 'food story' for marketing.



BENEFITS FOR NATURE

- Carbon sequestration in the soil and the trees
- Wildlife habitat; shelter, nesting sites, protection
- Reducing soil erosion and increasing flood prevention
- Reclaiming land for productive or wildlife use that is poor, wet or difficult
- Hosting insect predators next to crops mean less pesticides, which is good for bees and other invertebrates
- More fertility from roots and leaves feeding the soil and stimulating microrrhizal fungal networks
- Improved biological activity in the soil



WIDER BENEFITS

There are two particular benefits that it is worth noting will be crucial over the coming decades. These will be years where farming has to deal with increasing climate challenges and at the same time reduce its dependence on chemical pesticides.

The ability of trees to mitigate flooding is well known. As root systems develop they allow the soil to hold onto large amounts of water, thus slowing water movement through the landscape and reducing the severity of flood events. This ability will become more and more crucial as sudden and heavy rainfall becomes more common and storms become more intense. Simply as a measure to make landscapes resilient to flooding, tree planting in agroforestry schemes will pay for itself in large areas of the country; and that is without considering the numerous other benefits.

The second area worth highlighting is pest management for crops. As various studies have shown,^{13,14} insect biodiversity has significantly dropped over recent decades, with the use of pesticides heavily implicated. Tree lanes and the habitat of grasses, flowers and other plants that go alongside them, can play a crucial role in providing the homes and feed plants for pest predators, and so form part of Integrated Pest Management (IPM) or organic systems that aim to curtail pesticides. If we are to create far more ecological food systems, then strategies like this will be essential.

AGROFORESTRY IN PRACTICE

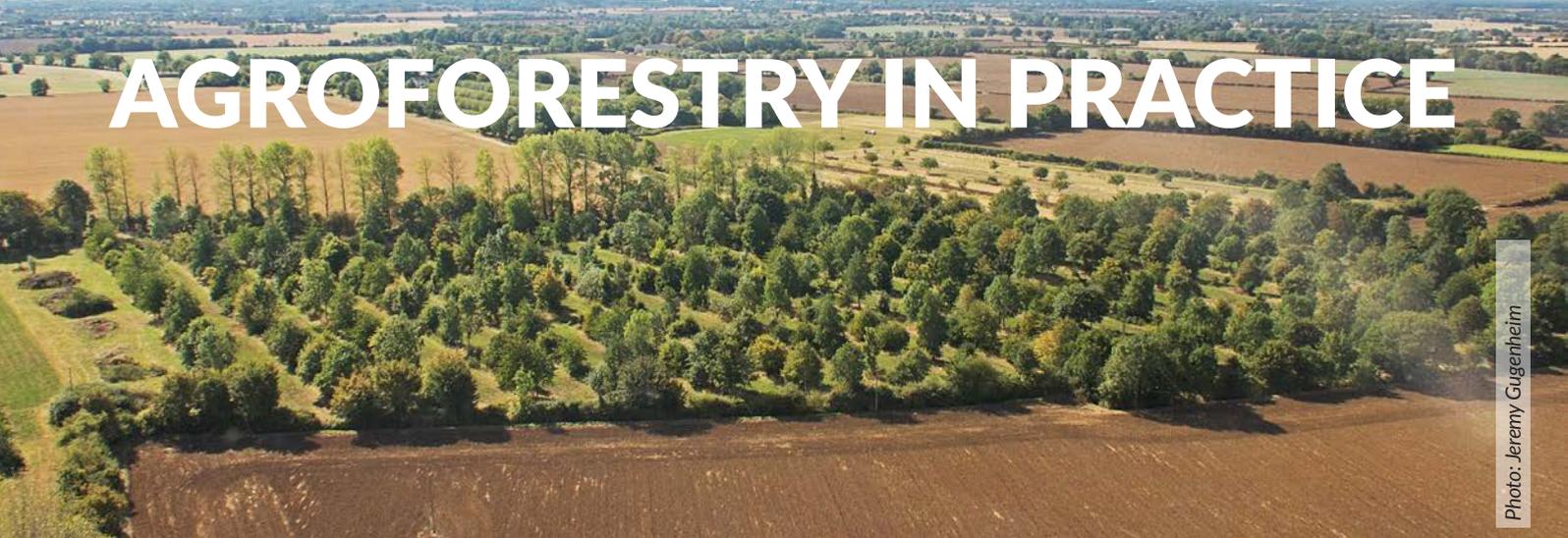
Photo: Jeremy Gugenheim

These case studies look at eight agroforestry schemes around England and what we can learn from them. They cover silvo-pasture, silvo-arable and silvo-horticulture, and range from Shropshire to Suffolk to Devon.

They demonstrate the benefits and successes as well as things that didn't work, or that could have been done better. That is entirely to be expected. The key is to learn from what these pioneers have found out.

Following these eight studies lessons are also taken from some other key plantings.

Although all of these case studies are in England, the benefits of agroforestry apply equally well in Wales, Northern Ireland and Scotland. There are excellent examples of agroforestry in all four nations and a separate report could well concentrate on regional variations and specific features. The promise of agroforestry is everywhere; it is up to us farmers and policy makers across the nations to stimulate its regeneration.



WAKELYNS AGROFORESTRY

Wakelyns is a 22.5 ha (55 acres) arable farm in Suffolk, trialling different agroforestry systems and working with the Organic Research Centre to record data and develop sustainable agriculture.

PLANTING SYSTEM

Silvo-arable. Trees in North/South rows, with organic arable grains and vegetable crop rotations. 10-12 m alleys between tree lanes. Trees consist of hazel and willow short rotation coppice in some fields and mixed broadleaves for timber, with interspersed apple trees, in other fields. The timber species are: ash, cherry, lime, oak, hornbeam and sycamore. Coppice is cut on a regular rotation of two or five years and then dried for heating a house boiler.

AGE

Planting began in 1993/4.

PURPOSE

Creating a model of a sustainable agroecological farm with little or no off-farm inputs. Shelter for crops, alongside wildlife and habitat benefit. Planting the coppice in double rows means one row can be harvested one year while the other row remains to keep the shelter constant.

KEY LEARNINGS

An inspirational farm to visit to see well established, well cared-for trees, and a productive organic arable rotation. However the farm was not a commercial operation to begin with but aimed to develop working models of sustainability.

The trees cover 25-35% of the land and so clearly reduce the arable harvest below its maximum, but provide a wealth of other saleable products and sustainability assets.

This is now being supplemented by additional businesses fitting in alongside the tree lanes; so recent years have seen a bakery start on the farm, and a veg growing/ market garden business using one of the alleys. This increases local employment and strengthens the local food economy.

The 3700 m of boundary hedge (cut on a 15 year rotation) and the 3600 m of hazel and willow rows (cut in five or two year rotations respectively) produce around 160 m³ of woodchip annually. This is twice the 80 m³ that is needed to heat the (energy inefficient) old farmhouse each year.

The timber trees are now old enough at 25 years, to be pollarded or thinned, as their canopy is shading out the crop area – which is a relatively narrow 10 m wide alley.

The hazel rotations have gone from seven years to five, as the vigour of the hazel has increased.

The hazel being more dense than the willow has provided more biomass and energy , but the willow has been lighter and easier to manage and in some localities will have a market as rods themselves.

The fruit trees, being intercropped at low density have not made a commercial market yet, but the fruit goes into the on-site bakery as a very useful addition (the bakery uses the wheat from the farm).

NOTES

A farm where its founders, Martin and Ann Wolfe deliberately set out to undertake research and work with Organic Research Centre. They wanted to show that heterogeneity (i.e. genetic diversity) could lead to great stability, and the farm has used genetically diverse plants to gradually build up local distinctiveness, in various arable crops and grains.

This research has also covered wider sustainability issues and the trees themselves: for instance a 2012 study looking at apple scab found that incidence of this damaging fungal disease was twice as high in a nearby organic orchard as in the mixed agroforestry system at Wakelyns.

Much of this information comes from the booklet: 'Wakelyns Agroforestry: Resilience Through Diversity' by Jo Smith and Sally Westaway, Organic Research Centre 2020.



BROADLEARS FIELD



Broadlears Field is located on the Dartington Estate, in South Devon.

PLANTING SYSTEM

Silvo-arable. A 19 hectare (48 acre) arable field planted with rows of elder, and apple trees, North/south rows. A previous planting of Szechuan peppers in an adjacent part of the field, has now been removed. This was due to a combination of pest damage, exposure and the soil/plant fit not being good - all valuable lessons.

The elder is in double rows about 4 m wide, planted at 3 m spacings, diagonally offset from the previous tree. The cropping alleys are 15 m wide.

The apples are in single lines in strips about 3 m wide.

The field is owned by the estate, the arable crop farmed by the tenant farmer and the trees are managed by a separate fruit drinks company and another local fruit producer on a 25 year licence. The drinks company picks the elder flowers to make a cordial and is now looking into harvesting the elderberries.

AGE

Planted 2016/17.

PURPOSE

To create a productive harvest of elder and apples along side arable crops. It has taken 4-5 years for the harvest of elder flowers to reach a productive yield.

The apples are only beginning to yield at higher levels after five years.

KEY LEARNINGS

It is a challenge to absorb the costs of planting like this, as it can take years to produce a harvest.

Some limited testing for soil carbon has so far shown little change when comparing the arable alleys to the tree strips.

The elder trees are healthy but there is a problem with a lack of pollination in some of them, and its not clear why that is. It could be a problem stemming from poor tree stock.

The licence system for a separate producer to take the fruit crop for a fee they pay the tenant farmer, seems to be working, and is an innovative model to allow different users to access the different crops.

The apple trees have not produced good yields yet. The field is a challenging one, with areas of poor drainage and weather exposure to wind and rain, and some varieties have not done well. Possibly planting extra shelter belts of alder or other hardier trees first would have helped, or choosing areas more specifically for the fruit. Not all fields are suitable for an unsheltered fruit crop.



MAPLE FARM



Maple Farm in Kelsale, Suffolk is a 142 hectare (350 acre) mixed farm with eggs, vegetables and arable crops. Organic since 2004.

PLANTING SYSTEM

Varies around the farm but arable fields have double rows of trees in a 3m strip with 24m wide crop alleys, and wide headlands for tractor access. About 10% tree cover. They feature native woodland species like oak, birch, cherry maple, with some apple trees.

More recent plantings for the poultry fields have hazel/poplar/alder for biomass and cover for the birds.

North/south rows.

AGE

Trees first planted in 2014/15 and further fields planted since then.

PURPOSE

Shelter for poultry and arable crops, biodiversity, poultry welfare and health, general environmental benefit

KEY LEARNINGS

Mike loves the system and says its one of the best things he's done on the farm.

Great benefits for wildlife with insects in the grass understorey of trees, and it's made the poultry birds healthier, so it has made big gains in the organic system.

The M106 rootstock for apples were too dwarfing for

the trees to compete with the grass well, M25 rootstock would have been better.

Trees suffered from a lack of mulch in the early years.

Mike has been expanding the agroforestry across the farm, and aims to do more in following years.



TOLHURST ORGANIC

Tolhurst Organics is a 7 hectare (17 acre), organic stock-free farm, with one 3 hectare (7 acre) field in tree alleys, and one area of willow copse.

PLANTING SYSTEM

Silvo-horticulture. Rows of trees at 23 m centre to centre, north/south. Native trees at 1 m spacings in rows, with an apple tree every 10 m. Tree strips are 3 m wide, cropping alley 20 m wide. Roughly 12% of field area given to trees.

Tried planting rhubarb and artichokes under the trees but due to weed growth and Verticillium wilt in the soil this understorey has not been that successful.

The willow copse, cut on a 7 year rotation, has been great for wildlife and creating useful woodchip from a poor and wet bit of land. The woodchip is added to the main compost system and it also makes ramial woodchip which is a soil improver made from small diameter branches and stems.

AGE

Planted early 2016.

PURPOSE

Shelter for crops and protection from wind. Habitat for beneficial insects in an organic vegetable rotation. General wildlife benefit.

KEY LEARNINGS

Alder and Birch were not successful, possibly the conditions were too dry, and birch roots penetrated the field growing area.

Some trees did not get enough water in the early years and died or have had stunted growth ever since. Tolly says he should have planned in more tree care.

Economic benefits are limited so far, but its still a young planting. The main benefits so far have been for nature and carbon sequestration.

In future he would consider more apples or other fruit like damsons.

The main downside has been being unable to move the crop covers sideways, everything must happen up and down the crop alley.

NOTES

Tolly has taken a lot of data and facilitated a lot of research on his farm. He uses green manure in the rotation to build soil fertility but woodchip plays a key element in soil condition and in farm sustainability. Currently most woodchip is brought in, but the aim is to supply it from on the farm.

This will mean using the woodchip from tree prunings in the next couple of years, so the trees become much more part of the cycle, and can be chipped straight onto the growing beds.



Photo: Organic Research Centre

THE APRICOT CENTRE

Apricot Centre at Dartington in Devon has 8 hectares (20 acres) taken on a lease in 2015 for a mixed biodynamic farm, selling to local markets. The farm exists alongside a therapeutic wellbeing charity that works with traumatised children.

PLANTING SYSTEM

Silvo-horticulture. There are different systems in different fields. The main field has tree rows planted along the contour with 25 m wide alleys and 3m tree strips. The tree rows are hazel or native species like alder, rowan, crab apple, birch – some rows have fruit trees. Cropping areas are 25 x 100 m – just over half an acre.

Poultry fields have tree rows with 6 m wide alleys, wide enough to put the hen houses through, as they rotate around the system.

Other areas have fruit trees in an orchard design again with 6 m wide rows, or wider spacings.

AGE

Planted 2016/17

PURPOSE

To arrest water flow and soil erosion. To provide shelter to crops and farm workers from strong winds and other weather, and also shelter for the polytunnels. To help with pest control through habitat for insect predators. Wider wildlife benefits. Hazel woodchip was intended to feed a heating system but may also now create ramial woodchip for soil improvement.

KEY LEARNINGS

The agroforestry is very successful. The tree rows are working well at breaking up a medium sized field to aid with the rotation of crops and the conditions for the workforce. They also bring nature right 'into' the field, as the habitat for insects is adjacent to the crops.

They are selling raw birch sap at the local market –

currently from nearby older trees, but building a market for onsite production in years to come.

The site has seen a huge increase in wildlife and a 50% increase in birdlife since 2015.

The soil sequestration for the farm overall is at 5 t/ha/year, which is really encouraging for a site producing a lot of crops

A lot of time was spent considering the orientation of the tree rows. Going along the contour means erosion has been halted, but does mean the tractor is on a camber – so the degree of slope is important to consider. If it had been steeper land, or much flatter land, north/south rows would have been better.

NOTES

The Apricot Centre is a very successful model of the transition from conventional to agroecological farming. It has transformed what is conventionally a small area of 8 hectares (20 acres) into a multi functioning food hub using biodynamic principles. Its annual turnover is over £10,000 per acre and it employs six full-time staff – one person for every 1.3 hectares (3.3 acres). It does benefit from a relatively wealthy and informed local consumer market, but the farm is not on the best ground and the model could be repeated through much of the country.



THE FARM, LONGNOR



The Farm at Longnor in Shropshire is an organic dairy and beef farm. 400 hectares (1000 acres) with 300 milking cows. Agroforestry tree strips on less than 1 hectare (2 acres).

PLANTING SYSTEM

Silvo-pasture .One block of willow rows and two blocks of mixed native and broadleaf trees. Alleys at 8 m or 15 m wide, trees in 1 m wide strips. Willows originally planted at 2-3 m spacings in rows.

Tree species include: ash, hornbeam, elm, lime, birch, alder. Small blocks of walnut also planted near to the yard buildings.

Willow planted north/south, but one field of native trees is planted east/west to align with the field shape

AGE

Planted 2015/6.

PURPOSE

Aim was for shelter and supplementary feed as part of a healthy, medicinal grazing system.

KEY LEARNINGS

Some of the willows and others died in dry conditions in the early years, and some of the native trees are struggling even now. Others are doing well.

Willows and some other trees were pollarded in 2020 to keep the height down and the browse within reach, and

a leaf-hay crop was harvested then to use as feed in the winter, which worked well.

But browsing on the leaves has not been as much as predicted or desired, and Tim would like to see more.

Some trees will be allowed to grow out, some will be kept pollarded.

Some benefits are clear but specific financial improvements are hard to measure. Its too early to see longer term outcomes.

For the willow, closer spaced plantings to create more of a hedge effect would have been good, there is too much grass in the tree rows.

If there was proper funding and resources to do further plantings, they would do more, but Tim is not sure of the extent. The work involved in establishment is considerable, and on a large farm like this, would obviously have a significant upfront cost.

The fencing system has to be robust with cattle. With willows be aware of drains in the field, as roots can really grow strongly.



ROTHAMSTED NORTH WYKE

Rothamsted North Wyke is an agricultural research station in Devon conducting various and assorted trials. This was a trial on a 12 hectare (30 acre) pasture field at 150 m altitude.

PLANTING SYSTEM

An early trial agroforestry scheme using ash and sycamore at different densities. In square blocks at 100 trees /ha and 400 /ha. Some areas were planted at 2500/ha - a woodland density, to compare the timber quality with the wider spaced, lower density blocks.

AGE

Planted 1985. Stock was mainly from Europe and may well have been poor.

PURPOSE

To trial a silvopastoral system, with a view to looking at any loss of grazing together with potential for timber income.

KEY LEARNINGS

The results are mixed. Most of the sycamore died over time, probably due to bad seed stock and the wet, heavy ground, and possibly with a lack of care.

The ash has then suffered badly from chalara - ash dieback in recent years. This is an example of where a more diverse planting scheme could have been good.

The trees have not produced the timber as intended - perhaps the lesson is not to plant monocultures!

On the positive side, there has not been much loss of grazing and the different blocks don't indicate much difference in quality of pasture.

The current managers advise to undertake grass control early on and look after the young trees, or one may end up using glyphosate

Use proper stakes for the trees, not cheap, 25mm square sawn stakes, which have largely tended to break in this case.

The plantings at the woodland density show much straighter and taller trees - but the ash has dieback disease now, so the trees are unuseable.

The trees on the windward side of the tree blocks were noticeably smaller, showing the clear affect of wind pressure - so in a block system think about hardier varieties on the windward side with any productive trees 'behind' them.

The pasture is still very useful as pasture; as a drier field it forms an important part of the rotation for the cattle grazing ground.





The Hollies in Shropshire is a 8 hectare (20 acre) organic silvo-pasture farm with dairy cattle.

PLANTING SYSTEM

Single lines of mixed trees in 20 m wide pasture alleys for cattle. Trees are a great mix of evergreen, broadleaf, native, and some 'exotics'.

Rotational grazing in the alleys. Electric fencing lines the alleys.

Prioritised late leafing trees to maximise grass growth.

North/south rows.

AGE

Planted around 2000.

PURPOSE

Cattle browse, shelter, mixed environmental benefit, experimental tree species. Leaf litter also benefits the soil, no other feed inputs for soil.

Timber use in time, and potentially nut crops.

Some trees keep away flies from cattle.

KEY LEARNINGS:

This has worked well, but the farmer would consider wider alleys in future if the farm had more land and more livestock.

A lot of unusual trees like osage orange (*Maclura pomifera*) and Paulownia, potentially for timber, *Ostrya*, from the Birch family, Siberian elm (*Ulmus Pumila*) and Gutta Percha (*Eucommia ulmoides*) for rubber production.



Peter recommends monkey puzzle (*Araucaria araucana*) for the nuts, and walnuts for their late leafing habit, nuts, and because they help keep away pests and flies. He also likes the shagbark hickory which has grown fast and straight.

The tree lane is less than 0.5 m wide, so now that the trees are established there is virtually no loss of grazing area.

A single line of electric wire on temporary posts is all that's needed to control the cattle, with static fence posts at the corners of grazing blocks to provide stability. The strips provide an easy way to manage the mob or rotational grazing.

Keep the stems clear for 2 m from ground or the cows will pull off the branches and cause damage, but the higher branches can still hang down for browse.

Some trees have not done well, either through local conditions or poor seed stock, but they provide great shelter and wider landscape benefits for soil and the farm.

Wildlife benefit considerable with many more hares, insects and birdlife on the farm.

NOTES

One of the earliest 'modern' agroforestry plantings in the country, but sadly little data has been collected on the great variety of tree species here. It has been a passion of the farmer Peter Aspin, rather than a scientific study. It shows great promise regarding the range of ancillary crops that could be generated to diversify income, but also plenty of trees have not done well. As Peter says: "Like all experiments some things work, others do not and I find that you learn more from failures than successes."

A research body or government should be working with farmers like Peter to analyse his results and inspire other farmers...

OTHER AGROFORESTRY FARMS

Photo: George Browning

There are of course many other examples of agroforestry systems around the UK, and more are being planted all the time.

Some further examples are these three farms, not visited for this report, but all noteworthy in their way and very worth learning from.

CANNERHEUGH FARM

The Renison family have a well known silvo-pasture system on their mixed livestock farm in Cumbria.

On their 140 hectares (350 acres) they've planted new hedges and woodland blocks for providing shelter for stock and wildlife benefit. They've used native broadleaf trees and have been expanding their planting every year since 2014. They are big fans of the system and its benefits, and it shows what can be done in an upland setting and in a Less Favoured Area. Agroforestry is certainly not just a lowland system.

WHITEHALL FARM

Stephen Brigg's silvo-arable system in Cambridgeshire is another well known farm on very different ground in the Fens. Stephen has been a great advocate of agroforestry.



Photo: Organic Research Centre

He has the largest 'modern' tree strip system in the country, on 50 hectares (125 acres) of his 100 hectare (250 acre) farm. He has lines of apple trees on semi-dwarf rootstock with 24 m wide cropping alleys. The apples are sold in his farm shop. Such a large extent of trees required about £65K investment, but payback was calculated after 7.5 years; the trees generate about 5 tonnes/hectare.

Whitehall Farm's trees are more commercially profitable than many systems but the trees also have a crucial role to play in preventing soil erosion from the peaty Fens, and in wildlife habitat, and creating climate change resilience as weather extremes become more common.

FELDON FOREST FARM

George Browning has a well established silvo-pasture system at Feldon Forest farm in Warwickshire (above), first planted in 1999. It's a 2.7 hectare (7 acre) planting on a 32 hectare (80 acre) farm using hybrid poplars with an understorey of hazel; the poplar was intended for timber sale. The poplar is now affected by poplar rust disease and squirrel damage has also been significant. Despite that, the trees have offered great shelter and biodiversity benefits as well as some nuts and products from the hazel. The poplars are yet to be harvested so a value is hard to put on them.



Photo: George Browning

LESSONS FROM THE FIELD



Photo: Organic Research Centre

This is a summary of the lessons and experience from the systems profiled in this report.

When planning an agroforestry system it is essential to think it through! The biggest problem for existing agroforestry plantings has been a lack of detailed planning plus the adequate resources for tree care in the early years. So, talk to people who've done this before and take good advice.

- The need for adequate planning applies particularly to irrigation and the use of mulch. Trees will fail or be slow to establish in dry conditions or may die from grass competition if this isn't properly prepared for.
- Plan for who will do the tree care, management, pruning, and watering, especially in the early years.
- Planning also means considering carefully what species you are planting and for what purpose.
- Not all fields are suitable for all kinds of trees. Especially fruit and nut trees where a commercial crop is wanted, the context has to be right. They may need additional shelter from wind and exposure, or need specific varieties, or the ground may need subsoiling and preparation.
- Further on, what is the plan for the product in the future? It might be edible crops like apples, or hardwood timber in 50 years, or softwood timber in 30 years. Or woodchip from willow coppice, or hazel thatching spars, or bean poles – but how will it fit into the farm plan?
- Particularly for fruit and nut trees, get local knowledge on varieties and what will thrive in particular places.
- If wildflowers or certain leys are wanted under the trees, sow that first, rather than after the trees are planted.
- Pest control: Squirrels and deer can be a serious problem. They may require buffer zones so that control is easier, or a specific fencing plan to prevent intrusion, or a culling plan.
- Using Nitrogen-fixing trees in the mix can help localised plant growth.
- Think through leafing times for the shade impact they will have e.g. Acacia and Oak come into leaf later than some others.
- How big will the trees get, and with the shade produced – is there a need for a pollarding or a felling plan in 20 or 40 years?
- Think through root growth into the field – suckering plants like Blackthorn may not be suitable.
- What width of the alley is needed for machinery and headlands, turning, and access? Or it might be a rotation of poultry sheds through pasture alleys.
- The orientation of tree strips or blocks. This means thinking about light levels, wind impact, and land contours. It also may affect water management in existing drains and ditches and across the surface. A standard orientation on flatter ground in the temperate UK is a North/South tree strip, because that gives even sunlight on both sides, but that may not be right for specific fields and hills.
- Subsoiling beforehand can also help with marking out the tree lanes to begin with.
- Demarcate tree positions on the site and mark them out clearly, especially if contractors or others are doing some of the planting or fencing work.
- In complex systems, with multiple outputs in mind, plant with the main reason foremost, as that reason needs to work out successfully.
- Make sure that whoever is physically doing the planting, they can do it well. A bad start in life can last a long time. Plant 100 trees well – better than planting 1000 trees badly.
- Don't take tree guards off too early, especially in northern or exposed positions.

SUMMARY FOR POLICYMAKERS

Photo: Organic Research Centre

Much of this report has been aimed at farmers and practitioners. It gives practical advice and experience. But practice cannot be separated from the political and economic context that it functions in. If we are to fulfil the promise of agroforestry and see it expand across the country, it needs the full support of our wider political system: the Welsh Government, Scottish Government, Northern Ireland Executive, Defra, and local authorities. Trees are a long term investment, and they require a long term approach. Farmers need to know our work and our farm plans will be properly supported.

1. For climate reasons, every policy should be predicated on reducing fossil fuel emissions and the long term management and economic planning that this entails.
2. Fully fund tree plantings and the relevant fencing costs, and be willing to do this upfront. There is a huge willingness to install agroforestry systems but it is a capital cost that many cannot currently afford, especially amidst other pressures. Alongside this, it must be available to all sizes of farm, not just the largest operations, as this ensures rural regeneration, not further concentration. This is a cost, but its an investment – see No.7 below
3. Establish a comprehensive analysis of soil carbon sequestration across the different geologies and landscapes of the UK. Its essential we improve our understanding of how to maximise sequestration and what land use practices we need to encourage and avoid.
4. Fully resource a training and outreach programme to give farmers and landworkers/ owners the specific and targeted knowledge and skills they need. The best advocates are farmers with experience of doing similar things – support us to spread the word. Some steps have been made across the four nations to fund the transition to a resilient regenerative farming model, so this is part of that process.
5. Convene a process for collaboration and mutual understanding between the forestry and farming industry. In this way farmers will have access to the knowledge about trees and timber that they need.
6. Improve tree stock and supply. Invest in tree nurseries to significantly increase the supply of locally adaptive, regionally specific, seed and tree varieties from good stock. There has been increasing use of overseas stock in recent years which has spread disease and reduced local adaption. It is very possible to align this with research into disease and climate resistance at research centres and tree nursery hubs.
7. See people as an opportunity and increase employment. There is a huge appetite from all sorts of people to be out in nature and to be a constructive part of solving the climate crisis. Use this energy to upskill people to work on farms, planting trees, fencing, getting to know the local habitat. Clearly this has to be done in partnership with the farmer, but the government could encourage and invest in processes and structures to make this happen. View it as a business investment in creating jobs for the future in a rural landscape that supports much more economic activity, just as built infrastructure is viewed as an investment.
8. Put resources into education and training about food systems and trees from school upwards. Use various means to influence the cultural paradigm so that food growers and foresters are seen as heroes!

CONCLUSIONS

Photo: Organic Research Centre

Using the proven benefits of trees to enhance our farms and landscapes, and in ways that integrate those trees with farming production, is surely an idea whose time has come.

For some of the schemes in this report it's still too early to see specific economic outcomes. But some do show the costs have been matched by financial benefits, and all show valuable environmental benefits. Where time and money and care has been spent on the system like at Wakelyns in Suffolk, the results can be inspirational.

Of all the farmers surveyed here, no one regretted it, and everyone said they could see positive benefits. Everyone was planning or considering expanding onto further areas if they could. If there were proper incentives to reward the environmental benefits and carbon sequestration, they would all do more.

These positives were in line with expectations: mixed browse and better shelter for stock, loads more wildlife, shelter for soil and crops and habitat for pest management. In some cases there were products and saleable harvests equivalent to the loss of income from the field crop.

There is no reason why there should not be far, far higher integration of trees across the farms and landscape of the UK. This would contribute to a mosaic effect of different physical spaces which is in fact the traditional landscape of the UK. With obvious exclusions for sensitive habitat, and if the training and skills resources were coupled with the finance, tree strips or blocks could be effectively integrated into the majority of agricultural land in the UK.

There are some obvious places we don't want trees. Peat soils hold huge amounts of carbon and don't need trees; in many cases they need to be peat bogs again. Some uplands and moors need to be open habitat for the native ecology, and landscape value. Unimproved wildflower meadows and grasslands need to be expanded, not necessarily have trees planted on them.

But, across much of our arable regions and improved

grasslands, we could plant belts and strips and alleys of trees, which are only another form of hedgerow after all, alongside occasional orchards and wood pasture systems, and this would do only good.¹⁵

Of course, there must be adequate funding, resources, knowledge and management support – there is no point in doing it wrong or badly...

Doing it well means thinking it through and integrating agroforestry with other land objectives. It means having a long term management strategy.

But if we wanted to, we could build up significant tree seedling stocks for the next 2-5 years, prepare plans, and then plant millions of new trees in our fields with no significant loss to the farmed area by 2030.

We could certainly see tree alleys over 60-70% of agricultural land if we make it our intention.

A two to three year launch pad is also the time needed to resolve the complex questions on where and where not to plant, involving the various people that must be included.

The government has made some big commitments to a sustainability agenda in recent years. There are new Bills and encouraging words. But words need backing up with resources and clear plans for action, and so far those are not yet clarified. More deeply, we need to see a systemic shift with land use to a more holistic and regenerative approach, and we are yet to see the UK government recognise the depth of the problem, or its own role within it. It will take a lot more than isolated tweaks to restore our farming and ecological heritage, but yet we must all do what we can.

The Landworkers Alliance has said it before, but it bears repeating: The barriers to take up of agroecological solutions are not a lack of willingness or ability. The barriers are a lack of resources and information, and the political will to make it happen.

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ACKNOWLEDGEMENTS

Thanks very much to all eight farms we visited for this report, for their generously given time, and their hospitality and inspiration.





Photo: Organic Research Centre

Published by the Landworkers' Alliance, 2021.
Written by: Oli Rodker, with editorial input from the LWA Campaigns Team.

All photos by Oli Rodker, except where stated.

Layout by Phil Sumption, Bio Communications



The Landworkers' Alliance (LWA) is a grassroots union of ecological farmers and foresters across the UK. We campaign for the rights of producers and lobby the UK and devolved governments for policies that support the infrastructure and economy central to our livelihoods.

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