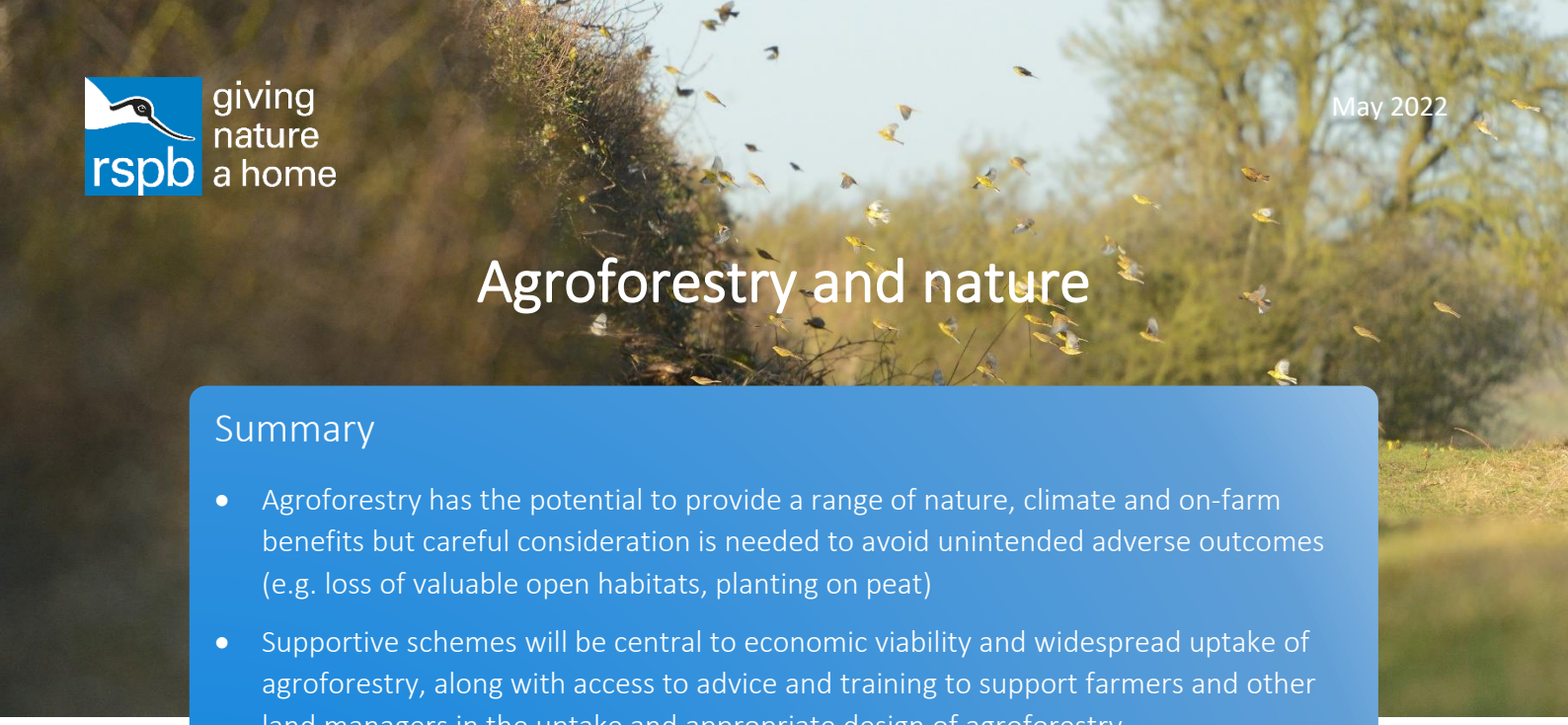


May 2022

Agroforestry and nature

Summary

- Agroforestry has the potential to provide a range of nature, climate and on-farm benefits but careful consideration is needed to avoid unintended adverse outcomes (e.g. loss of valuable open habitats, planting on peat)
- Supportive schemes will be central to economic viability and widespread uptake of agroforestry, along with access to advice and training to support farmers and other land managers in the uptake and appropriate design of agroforestry
- There is a need for further research into silvopastoral and silvoarable systems in a UK context (such as our work at Hope Farm) to better understand impacts on biodiversity and opportunities and challenges for implementation, management, and financial viability
- Linear agroforestry practices, such as hedgerows, riparian buffers and shelterbelts, have been more widely studied and can be prioritised as more immediate strategies for increasing farmland tree cover while also providing public and private goods

Agroforestry refers to a set of land use practices whereby woody perennials (i.e. trees and shrubs) are deliberately combined with livestock and/or crops within the same land management system[1]. Agroforestry is commonly divided into silvopastoral and silvoarable systems, referring to the combination of trees with livestock and trees with crops, respectively (see Table 1).

Other more common, but often unacknowledged, forms of agroforestry include hedgerows, shelterbelts and riparian buffer strips, which are often referred to as 'linear agroforestry' due to their location between field parcels and along boundaries, rather than being integrated within fields.

Table 1: A typology for types of UK agroforestry[2]

	Agroforestry system	Official land use classification	
		Forest land	Agricultural land
Trees within fields	Silvopastoral	Forest grazing	Wood pasture Orchard grazing Individual trees
	Silvoarable	Forest farming	Alley cropping Alley coppice Orchard intercropping Individual trees
	Agrosilvopastoral	Mixtures of the above	
Trees between fields	Hedgerows Shelterbelts Riparian buffer strips	Forest strips	Shelterbelt networks Wooded hedges Riparian tree strips

Hedgerows have a long history across the UK, and are now widely acknowledged for their cultural, nature and climate benefits. Grazing systems with scattered tree cover (e.g. wood pasture, parklands, Ffridd) have also played a role in traditional UK agriculture and continue to be a priority habitat found in some extensive holdings, though many have been lost in the intensification of agriculture. Other forms of agroforestry have not traditionally been a major part of the UK landscape in recent decades but are increasingly seen as an important tool in agroecological farming systems.

The potential benefits and risks of agroforestry for nature

The overall biodiversity and soil health declines resulting from over 40 years under the Common Agricultural Policy are widely recognised[3]. In response, some UK policy makers have framed new agricultural policy post-Brexit as an opportunity to encourage land management that provides more environmental services. As 70% of land in the UK is currently managed for agriculture, the UK Government, devolved administrations and researchers alike have identified increased farm tree cover as key to sequestering carbon and helping to achieve national tree planting targets[3, 4].

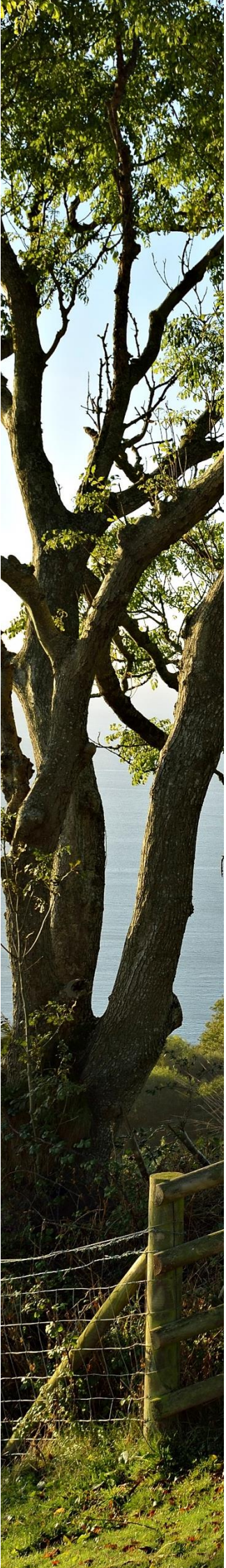
Agroforestry has been identified as a potentially important tool to drive these increases in tree cover in the farmed landscape while diversifying farm products and providing a range of other ecosystem service benefits. However, the impact that some agroforestry practices may have on biodiversity is not well evidenced.

Climate impacts

The uptake of agroforestry has the potential to be beneficial in climate mitigation, as increased tree cover can result in greater carbon sequestration and storage. Research has estimated the potential for planting densities of 50–100 trees/ha to sequester between 1.0 - 4.0 tonnes of carbon per ha per year[2]. However, more research is needed on the net carbon and nature benefits of planting based on tree species used and specific site conditions, such as soil type. The full life cycle of agroforestry products must also be considered. If the end use for timber plantings is biomass burning, or other end uses that release greenhouse gases (GHGs), the subsequent emissions should be accounted for. Planting on deep peat must be avoided due to the overall release of CO_2 that occurs through the drying out of these soils, which may be exacerbated by the uptake of water by trees. As we work towards the rewetting of many degraded peatland areas there will be opportunity to research the potential for agroforestry practices to be incorporated with paludiculture, though there is little evidence at present to support the net carbon or biodiversity benefits of planting on peat. Planting on high organo-mineral soils also needs to be carefully considered; while new woodlands could be created here, there is a risk of losing more carbon from the soil than new trees would absorb, at least over the first few decades. Robust site assessments and accounting are needed to inform appropriate planting options and ensure positive carbon and nature outcomes.

As agroforestry is separate from forestry, there are also some ambiguities around the potential contribution of agroforestry to woodland creation targets. Where agroforestry is implemented in the form of larger tree blocks, such as riparian buffers, shelterbelts or other boundary planting, it is likely more appropriate to count these plantings as woodland creation and follow the according guidance on woodland expansion for species selection, location, and management. However, silvopastoral and -arable systems with low density planting, such as alley cropping and wood pasture, are inappropriate for inclusion in current woodland creation metrics as they are unlikely to attain the minimum canopy cover needed for classification as woodland. However, we support the creation of subsidiary native woodland targets, as well as Trees Outside Woodlands, with sub-targets for agroforestry and hedgerows. Despite the emphasis being placed on planting targets, we believe that the current focus on tree numbers can be unhelpful because it drives maximising of planting density. This can limit choices for habitat delivery, for example where low-density tree cover is preferable for supporting species such as black grouse.

Agroforestry can also support increases in soil health and livestock welfare, as well as reduce wind speeds and soil erosion[6]. Upland farms have been identified as particularly vulnerable in the face of changing climatic and economic conditions, as compaction and overstocking have resulted in biodiversity declines and increased flood risk[7, 8]. With around 70% of UK freshwater originating from upland catchments[7], the role agroforestry can play in flood reduction risk and water filtration should not be overlooked. The opportunity for agroforestry to provide these environmental services while still supporting food production systems and farmer livelihoods suggests it is an important pathway forward for vulnerable upland farms[9]. Riparian buffers in



particular help intercept nitrogen, phosphorous and pesticide runoff from agricultural land as well as providing bank stabilisation and preventing erosion[10]. However, while the positive impacts that various types of broadleaved agroforestry have on water infiltration and pollutant filtration at the field scale have been shown in numerous studies[11, 12, 13, 14], the effect of tree planting for flood mitigation at the catchment scale is still subject to much uncertainty. The use of non-native species (including broadleaved species such as *Eucalyptus* and *Paulownia*) must also be carefully considered, where any potential climate benefits may be outweighed by adverse impacts on biodiversity. Many extensive farms with low density silvopasture, such as Ffridd or wood pasture, currently see the environmental, biodiversity and on-farm benefits in practice. These systems sometimes rely partly on natural regeneration and low density grazing to maintain a diverse and multi-functional habitat, minimising the inputs and management interventions needed.

Biodiversity Impacts

The uptake of agroforestry on agricultural land has been shown in many cases to support increased biodiversity through increasing plant diversity, structural complexity, connectivity and provision of habitat[15, 16]. However, the biodiversity impact of agroforestry will depend on the changes to the baseline habitat and design of the system, including whether native, naturalised or non-native species are used. In addition, there are concerns regarding the introduction of new pests/diseases if importing stock, and we recommend use of locally sourced, native planting stock and natural regeneration to reduce reliance on imports where possible. The use of native planting stock will support of a wider range of native species, contributing to biodiversity conservation aims and possibly to supporting greater biodiversity-dependent benefits (e.g. greater diversity and resilience of pollination and pest-regulation communities). In climate adaptation terms it is important that the species selected now will still be able to thrive in the predicted climate of years to come. In any agroforestry practice implemented, the effects on biodiversity will be largely dependent on species choice, management practices and location of planting. The RSPB strongly advocates ‘right tree, right place’ and stresses that implementation of agroforestry should not be at the expense of protection, improvement and expansion of existing native (especially ancient) woodlands and scrub on farmland.

Linear Agroforestry

Shelterbelts and riparian buffers have been shown to support greater biodiversity on farms through the provision of shelter, breeding and feeding habitat for many species in addition to increasing soil biodiversity[10]. Biodiversity benefits of hedgerows are also well established, as highlighted in the RSPB’s recent Mind the gap report. Hedgerows support a diverse range of species such as hedgehogs, yellowhammers, bees, butterflies and bats. At least 30 bird species nest in hedgerows, including bullfinches, turtle doves, whitethroats, linnets and dunnocks, although in the case of many of the so-called ‘farmland birds’, for example turtle dove, linnet and yellowhammer, it is the suitability of the surrounding habitats for feeding which is likely to limit their population, rather than the availability of places to nest.

Linear agroforestry, such as riparian buffers and shelterbelts, can be used to enhance connectivity between existing woodland and create wildlife corridors throughout the farmed landscape. Riparian areas are currently a rare and threatened habitat in the UK, but are recognised for their biodiversity value. They support communities of highly specialised fungi and insects, along with high conservation priority bird species such as the willow and marsh tit. Priority should be placed on restoring, expanding and joining up existing habitats to benefit species of high conservation priority, where connectivity enables movement through the landscape and access to different woodland patches. Some species such as willow tit, nightingale and turtle dove can also benefit from the early thicket stage of new planting. Wildlife value will also likely be greatly increased where livestock are excluded to allow patches of dense scrub to establish. For example, many riparian buffer strips are designed to incorporate an ungrazed/uncut grass and shrub layer transition zone between the field and tree component

which can provide a refuge for small mammals and overwintering site for invertebrates. Additionally, some trees can be left to mature and provide dead wood, nest holes and taller song posts.

Silvopastoral and Silvoarable Agroforestry

While hedgerows, shelterbelts and riparian buffers have been more widely studied, there is greater uncertainty regarding the biodiversity impacts of silvopastoral and silvoarable systems in a UK context. A recent metanalysis[17] found that agroforestry did result in increases in biodiversity in silvoarable systems in relation to cropland, as well as a greater biodiversity of birds and arthropods across all agroforestry systems. Pollination service, bee species abundance and diversity are also higher across a range of agroforestry systems when compared to monocultures[18, 26]. It is important to note that biodiversity benefits will be highly variable depending on management, where intensive systems are likely to have lower biodiversity benefits when compared to lower input or more extensive systems. For example, extensively grazed upland farms which incorporate silvopasture may see greater biodiversity benefits due to lower reliance on chemical inputs and pesticides and the presence of scrubby areas and structural complexity, such as seen in highly diverse Ffridd habitats. Alternatively, silvoarable practices (such as alley cropping) integrated into highly intensive lowland farms may have a higher reliance on inputs and fewer undisturbed zones, leading to lower biodiversity gains.

In order to ensure that agroforestry results in positive impacts on biodiversity, planting should be designed to enhance or expand habitats, and be careful to avoid displacing existing valuable habitat. For example, many farmland bird specialists such as skylarks and lapwings rely on open fields and their numbers could be negatively impacted by a change of use. While some new planting could occur in priority habitat areas, it is crucial that woodland created is low density, native and appropriately sited. These low density, native woodland habitats can also provide greater support for species such as black grouse. In both silvoarable and silvopastoral systems, the impacts on biodiversity are likely to be heavily dependent on the previous land use, amount and type of inputs used, primary crop and tree species selected, and surrounding habitat.

Agroforestry and on-farm benefits

In addition to the potential nature and climate benefits, agroforestry may provide a suite of benefits to landowners in the form of livestock shade, shelter and health benefits as well as the production of tree crops, fodder or fuel. While the production of commercial timber may be limited due to high management needs and challenges at scale, there is opportunity to produce a range of fruit and nut crops, or fodder for livestock. Additionally, there is the potential to produce biomass for household use*. Many woody species used for fodder production contain condensed tannins, which are connected to a range of livestock health benefits, such as reduced parasitism[19]. Additionally, the reduced wind exposure and temperature stress of livestock in agroforestry systems lead to higher weight gain efficiency and reduced mortality rates[14, 20].

Supporting agroforestry across the UK

Despite the potential nature, climate and on-farm benefits discussed, there remain several key barriers to the adoption of agroforestry. Studies of UK adoption have consistently cited concerns around economic viability, land use change, additional management and labour requirements and lack of knowledge as primary barriers to planting[4, 6, 21, 22]. Therefore, the success of agroforestry is likely to depend on good design, technical management and a robust business plan. Supportive schemes will likely be central to widespread adoption and ensuring positive

* Provided that the system is drawing down more carbon than emitted through burning over short timescales

climate and nature benefits of agroforestry. We recognise the essential role of access to advice, training, and support of peer-to-peer knowledge exchange to promote appropriate planting, and the need for supportive schemes across the four nations to make agroforestry economically viable for widespread adoption. These **schemes should include**: **provisions for ongoing advice** throughout the design, implementation and management of new planting, **attractive payment rates** which cover costs and provide a fair return, **flexibility in planting design** to accommodate site-specific factors, and should require **long-term commitments.**

Partnerships should also be supported between scientists and landowners/managers to encourage ongoing monitoring of on-farm climate and nature impacts of agroforestry adoption over time, feeding back into the evidence base for appropriate planting strategies. In addition, efforts to support local supply chains and strengthen markets for products produced in agroforestry systems (e.g. advertising nut crops as a viable source of protein and fat in consumer diets) can help reduce the perceived and real risk of diversifying farm income through uptake of tree crops. Likewise, support of local markets for native tree species may help boost grower confidence in producing native stock, reducing our reliance on imports and the production of non-native stock in UK nurseries. Further research and testing are required to ensure that the expansion of agroforestry in the UK delivers real climate and nature benefits. Priority research areas include quantifying the agriculture-biodiversity conservation synergies, such as contributions to pest regulation, soil health, increased grass growing season length, improved quality and/or healthiness of products produced and carbon sequestration. Potential disbenefits of tree planting, such as shading and land taken out of production, must be understood better to ensure that planting advice reconciles farming and biodiversity objectives and captures synergies between them.

Agroforestry at RSPB's Hope Farm

At Hope farm we are currently implementing a long-term research project looking at alley cropping in an arable system. The trial consists of just over 1000 trees being planted into an 11ha field in eight 6m alleys, 24m meters apart. These trees consist of 212 apple trees of 13 varieties, 546 cobnut trees of two varieties, and 273 shelterbelt trees of six species, all native to the local area. The purpose of the trial is to contribute to filling the current knowledge gap around temperate alley cropping and as such we have implemented a long-term monitoring scheme measuring:

- Carbon capture both above and below ground
- Implications for biodiversity, with a suite of invertebrate sampling accompanied by an annual Common Bird Census survey and audiomoths to detect bat activity
- Yield implications and field economics

With this trial we aim to improve knowledge about this type of system both practically and scientifically to better inform our advisory and advocacy work. We are also collaborating with other organisations to provide a wider knowledge base on the impacts of agroforestry, including data from other agroforestry sites.

Agroforestry in England

Defra has expressed an interest in achieving high uptake of agroforestry and has proposed funding agroforestry via the Sustainable Farming Incentive (SFI). Defra has already incorporated the simplest form of agroforestry into the SFI through a hedgerow standard as part of the scheme pilot. Beyond the proper management, restoration and re-creation of hedgerows, it is not clear that agroforestry sits comfortably within the SFI given the design principle Defra has set. To maximise public goods delivery, it is vital that funding for agroforestry is subject to longer that the 3-year SFI agreement length. In addition, the SFI is designed to operate without the provision of advice and is therefore unsuitable for supporting agroforestry adoption. In response to the Environmental Land Management Schemes under development in England, the scheme features that agroforestry need, such as advice, flexibility and long-term commitments, suggest that it would sit more suitably in the Local Nature Recovery scheme, as opposed to the SFI.

Agroforestry in Northern Ireland

In Northern Ireland agroforestry has been an option within the Environmental Farming Scheme (Wider) since 2017. The scheme provides payments of £1637per ha in the first year of establishment with payments of £65 per ha from years 2-5. Farmers and land managers can also receive funding for capital investments during establishment. As part of the wider scheme, face to face advice is not provided to farmers, with written and video guidance the preferred route. Agroforestry was highlighted as a key land management intervention within Northern Ireland's Sustainable Land Management Strategy and has been promoted through various on farm events and webinars to encourage uptake. However, uptake has remained low, with 55 agreements totalling 40 ha in place from 2017-21. Although the reasons for this are not fully known, it highlights that achieving high levels of uptake may prove difficult, even when being driven by public policy objectives, high payment rates and promotion. The limited level of advice is likely a contributing factor to low uptake, especially for a change in management which is longer-term in nature. Advice will be crucial in determining whether agroforestry can provide benefits to the farm business, nature and climate, supporting farmers to make long-term decisions which avoid perverse outcomes.

Agroforestry in Wales

Current Glastir funding can be used for hedgerow planting as well as the creation of small woodland blocks for use as shelterbelts or riparian buffer zones. However, there is no explicit provision for agroforestry, and therefore in-field tree planting such as silvopasture and silvoarable systems are not currently supported in available funding schemes. The lack of recognition of hedgerow, shelterbelt and riparian buffers as agroforestry practices has led to a lack of a *de facto* account of the extent of agroforestry in Wales. However, the National Forest Inventory has classified approximately 93,000 ha of tree cover outside of woodlands in Wales, predominately located in rural areas, as well as an estimated 76,000 km length of hedgerows[23]. It is clear that agroforestry currently plays a significant role in Welsh agricultural landscapes, despite that lack of explicit recognition of these forms of tree cover as such. Clarity around what constitutes agroforestry under future woodland creation and agri-environment schemes in Wales will help tailor appropriate strategies for funding and support, where it currently falls in the scheme and advice network gaps between forestry and agriculture. Despite increased calls for tree planting on farms from both the private and public sector, adoption is still low, with just 290 ha of total new woodland planted in 2020/2021[24]. Researchers in Wales stress the role that lack of clarity and communication of policy aims play as a barrier to participation of Welsh farmers in agri-environment schemes[4], further supporting the need for increased access to information and advice to build farmer trust and willingness to participate[25].

Agroforestry in Scotland

Scottish Forestry launched the Sheep and Trees Initiative in 2017, with the aim of encouraging integration of tree planting onto upland farms. The Initiative was designed to contribute to national tree planting targets while providing an avenue for income diversification in vulnerable upland farming systems and avoid mass land abandonment to full afforestation. The initiative provides funding for upland sheep farmers to plant small blocks (10-50 ha), of productive conifer alongside continued sheep farming. Despite this targeted policy support, uptake has been low, which is partially attributed to negative farmer perceptions of forestry, particularly a bias against the use of conifers, and lack of flexibility in appropriate planting design at the farm level[9]. In order to achieve positive outcomes for nature, climate and on-farm benefits, agroforestry funding must be refocused to support opportunities for native tree species, as well as more scheme flexibility and advisor support to create appropriate design and implementation of agroforestry at the farm level.

Conclusions

Agroforestry is increasingly discussed as one of a range of strategies for expanding tree cover on agricultural land across the UK to help attain national tree planting targets while mitigating concerns surrounding reduced food production. The integration of trees into farmed landscapes has the potential to deliver a range of nature and climate benefits, along with on-farm benefits for landowners. However, the uptake of agroforestry must be approached with appropriate planning and support to ensure expansion of tree cover delivers biodiversity, climate adaptation and mitigation, and economic benefits whilst avoiding damaging impacts which could result from inappropriate planting. The RSPB strongly advocates 'right tree, right place' and encourages planting native species and in areas that enhance or connect existing woodland. Care should be taken to avoid planting on peat soils and valuable open habitat which may lead to adverse outcomes for carbon storage and biodiversity. Linear agroforestry practices, such as hedgerows, riparian buffers, and shelterbelts have been more widely studied and can be prioritised as the more immediate strategies for increasing farmland tree cover while also providing public and private goods. However, there are currently greater challenges associated with the uptake of silvopastoral and silvoarable systems due to uncertainty around markets for products produced, more intensive management inputs needed, and a current lack of evidence supporting the nature benefits and economic viability of some of these systems. Early adopters and on-farm trials such as our work at Hope Farm will continue to provide insight into the potential role of these agroforestry practices within a UK context.

For more information please contact Ro Osborne, ro.osborne@rspb.org.uk

Additional Resources

https://www.woodlandtrust.org.uk/plant-trees/agroforestry-benefits/

https://www.soilassociation.org/causes-campaigns/agroforestry/what-is-agroforestry/

https://landworkersalliance.org.uk/new-report-the-promise-of-agroforestry/

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