Practical Guidance

The role of trees in arable farming

Spring 2015

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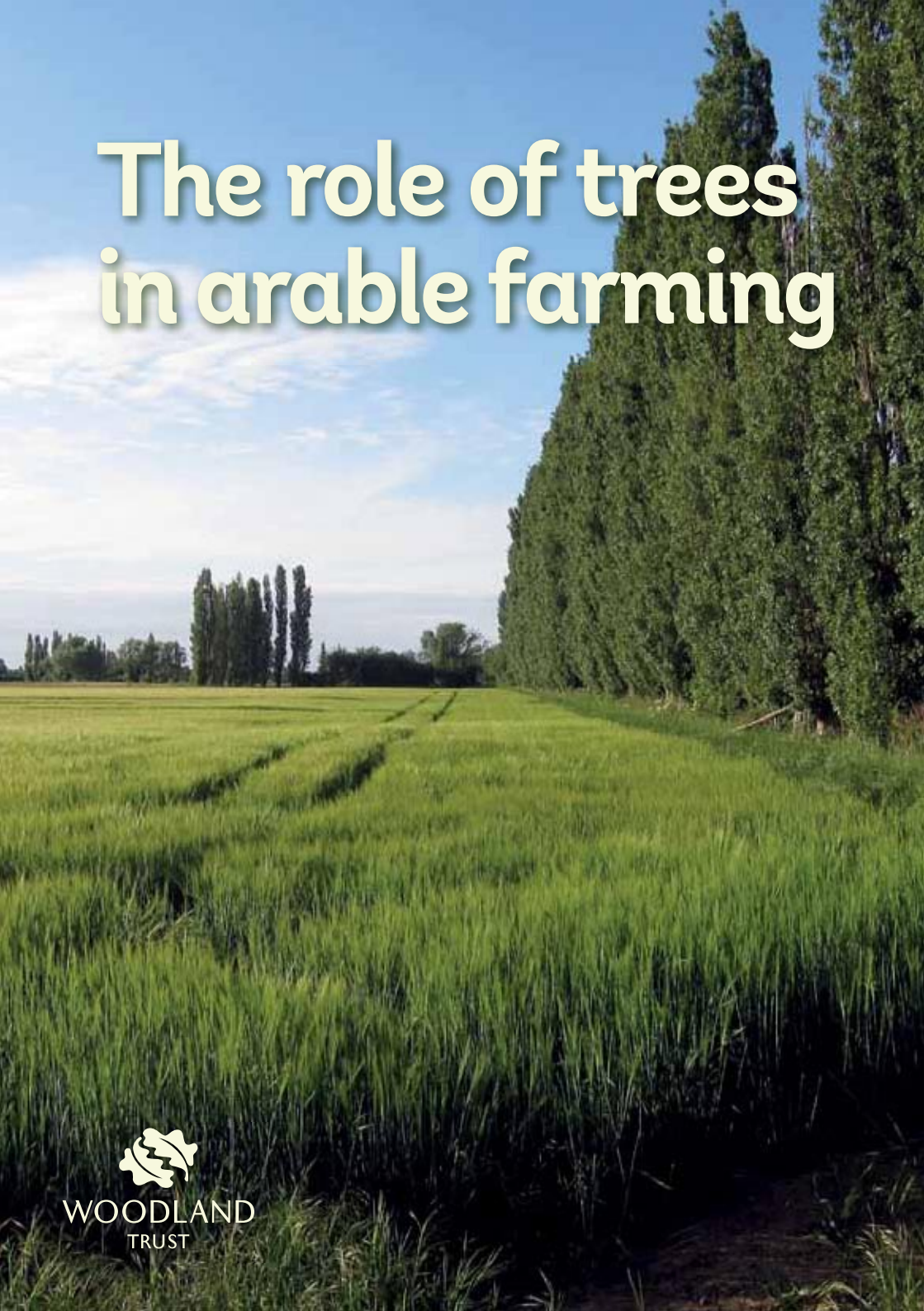

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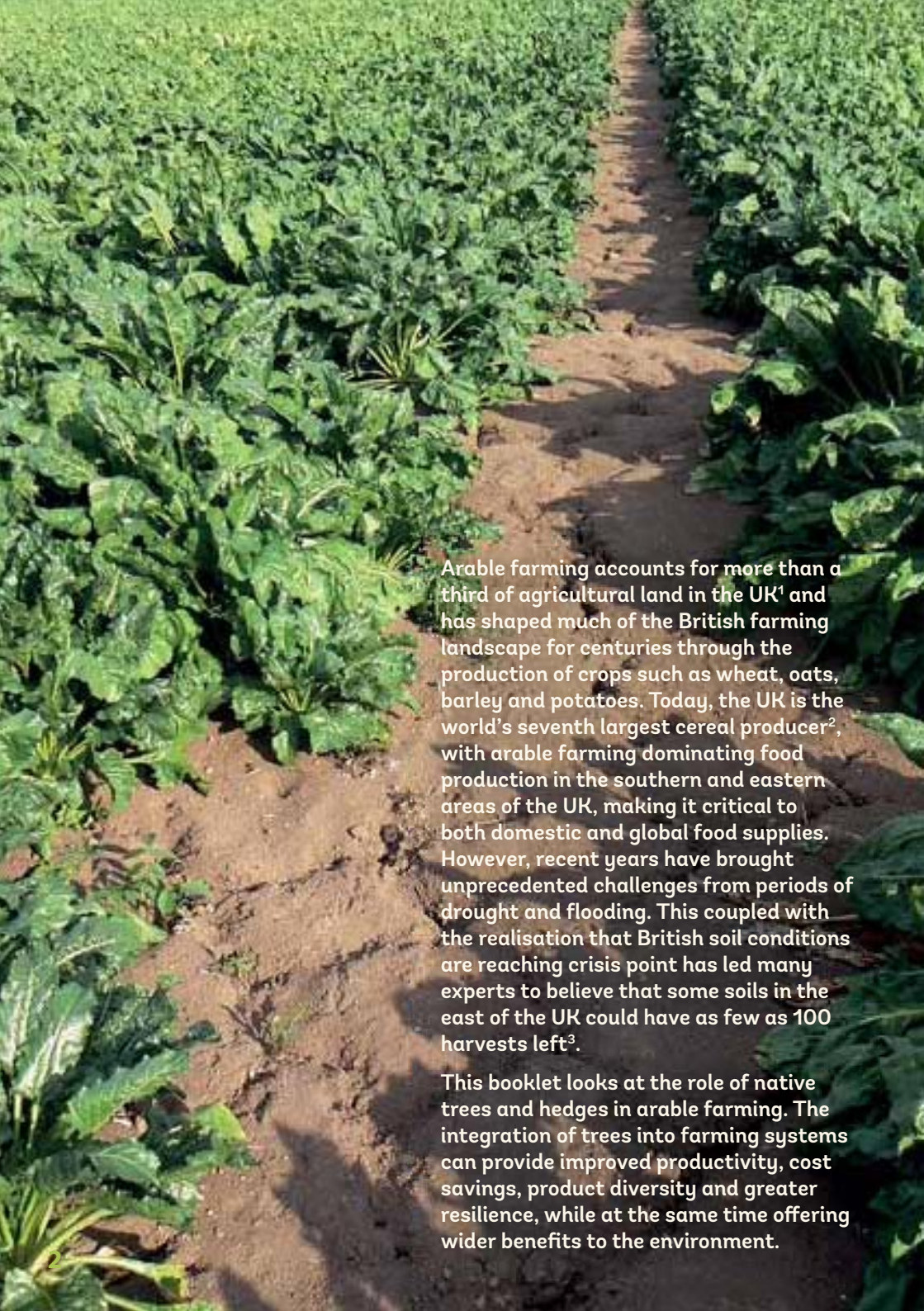


Arable farming accounts for more than a third of agricultural land in the UK[1] and has shaped much of the British farming landscape for centuries through the production of crops such as wheat, oats, barley and potatoes. Today, the UK is the world's seventh largest cereal producer[2], with arable farming dominating food production in the southern and eastern areas of the UK, making it critical to both domestic and global food supplies. However, recent years have brought unprecedented challenges from periods of drought and flooding. This coupled with the realisation that British soil conditions are reaching crisis point has led many experts to believe that some soils in the east of the UK could have as few as 100 harvests left[3].

This booklet looks at the role of native trees and hedges in arable farming. The integration of trees into farming systems can provide improved productivity, cost savings, product diversity and greater resilience, while at the same time offering wider benefits to the environment.

Drought and water conservation

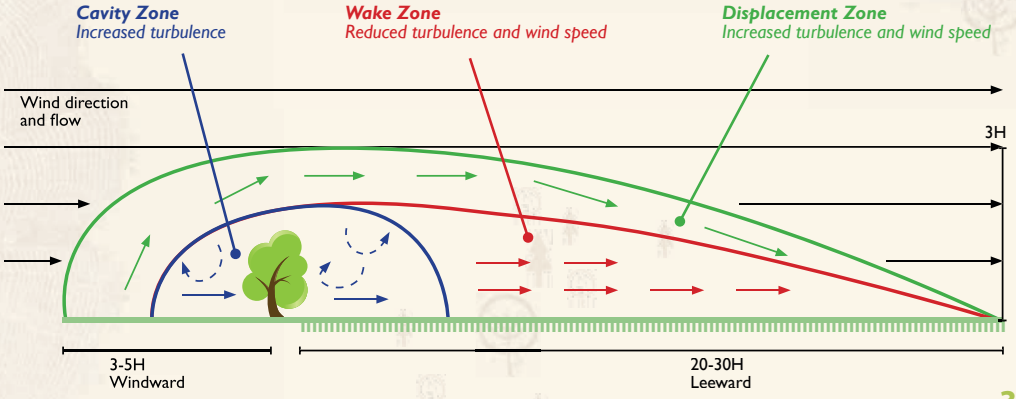
The dry springs and summers of recent years are expected to continue, with climate change scenarios predicting greater extremes of weather – including drier summers. Such periods of drought during the growing season can mean poor crop germination, reduced growth rates and lower yields. Arable crops cycle water to the atmosphere through evapotranspiration – a combination of evaporation from the soil surface and crop transpiration, as water vapour leaves plants through leaf surfaces. As this occurs, humidity levels increase around the soil or leaf surface. As the air becomes saturated, the process slows down unless water vapour is removed. Higher wind speeds will remove saturated air more quickly, increasing evapotranspiration rates. When levels of available soil water drop below a certain amount, the crop becomes water-stressed and this ultimately results in a reduction in crop yield.

However, trees could act as an insurance policy against droughts. Field edge or in-field shelterbelts modify the crop

Crops protected by a shelterbelt.

microclimate by reducing wind speeds and reducing evapotranspiration losses. It has been shown that shelterbelts can increase wheat yields by at least 3.5 per cent as a result of more efficient water usage. Shelterbelts can also reduce mechanical damage to crops, potentially reducing the ingress of plant diseases. In addition, tree shelter can also help prevent crop lodging caused by wind and subsequent harvesting losses.

Trees can compete with crops for water and nutrients, but any yield limitations because of this are typically restricted to an area immediately adjacent to the tree line. This impact is greatly outweighed by the overall yield increase caused by more efficient water use over the total sheltered area. Shelterbelts and agroforestry tree lines with an optimum porosity of between 40-60 per cent can protect an area up to 30 times the height of the shelterbelt itself.



Wind speed and turbulence in shelterbelt zones. Source: after Gardiner et al. 2006.

Soil management and erosion

There is a growing recognition that the decline in soil organic matter, increased compaction and soil erosion, represent threats to the long term productivity of agricultural land. It is estimated that the degradation to soils on farm land in England and Wales costs around £200 million per year to the agricultural sector and that indirect costs to the wider community may exceed four times this amount[4].

Soil erosion by both wind and water represents a significant economic cost to agriculture. It has been estimated that some 2.9 million tonnes of top soil are eroded in the UK each year[5]. The risk of soil erosion by water is higher where rainfall is more intense and it can reduce the long-term fertility of the soil by removing nutrient-rich top soil and organic matter.

On more vulnerable soils – especially peats and sandy soils – wind erosion can result in soil being transferred to nearby ditches and water courses, compromising their performance and affecting surface water quality.

By strategically planting tree belts along contours, perpendicular to prevailing winds or in areas known to be vulnerable, farmers can build natural barriers that protect soil and crops from the full impact of intense rainfall or strong winds, helping to prevent top soil erosion. Deeper rooting trees improve soil stability and additional organic matter from leaf litter and root debris

can also promote soil structure reducing further surface water run-off.

'Continuing degradation of UK agricultural soils risks compromising their long-term productivity. Soil degradation in England and Wales has been estimated to cost the agricultural sector £200 million a year, yet the costs of good soil management are not excessive and the economic case for managing soil optimally is a strong one. A key issue is properly matching the production type and management to soil capability. Fields should be used for production for which they are suited, avoiding any temptation to achieve short term gains from inappropriate crops at the expense of soil degradation and loss of longer-term productivity. Production should be planned around the capability of the land and then measures implemented to further reduce risks of soil degradation (such as by using tree belts to reduce erosion)'.

Prof. Mark Kibblewhite,
Director, MK Soil Science Ltd

Pollution

As well as representing a loss to the farm, water pollution is also costly for the environment. The Environment Agency estimates water treatment costs of soil erosion to be around £21 million per annum[6] and approximately 25 per cent of phosphates and 50 per cent of nitrates in rivers are from agricultural sources leached from soils or carried in surface water run-off.

By integrating natural solutions such as shelterbelts, riparian planting and buffer strips across a catchment-wide area, water infiltration rates can be improved, helping to reduce surface water run-off and delay flood peaks. As well as this, trees can also act as nutrient sinks. Phosphates in particular are associated with the trapping of sediment, while nitrate can occur by plant uptake. A UK study showed that 99 per cent of sub-surface nitrate applied to a nearby

Severe surface water run-off on an arable farm

Dr Richard Smith

arable field could be removed by grass or tree buffers (Haycock and Pinay, 1993)[7]. Nitrate, which leaches from soils and would normally be lost through drainage or into water courses, can be captured by the roots of trees integrated into the system. Targeted tree planting has been identified as one of the ways to mitigate diffuse pollution from agriculture, and deliver the quality standards of the Water Framework Directive.

Shelterbelts and trees integrated into farming systems can also help reduce agrochemical spray drift. There is substantial evidence to show that trees in leaf provide a physical barrier against pesticides, trapping up to 90 per cent of spray drift (2012 cited Ucar and Hall 2001; Lazzaro et al, 2008)[8]. The reductions in wind speed afforded by tree belts and agroforestry systems also benefit farmers in being able to access land on more days for spraying operations than in open fields. In a windy environment such as the UK this has significant benefits for timeliness of operations and in reducing spray drift.

Such knowledge at the farm level, coupled with the willingness of landowners across a catchment to take action in partnership with environmental bodies, will help to fight pollution of the waterways.

Crop pollination

Across Europe, there have been serious declines in pollinators throughout the agricultural landscape[9], which have been attributed to a range of factors – including loss of habitat. For crops requiring insect pollination, such as oilseed rape and field beans, this is a serious issue. It has been estimated that the monetary value of insect pollination in the UK is more than £510 million per annum[10]. The trees, habitats and plants associated with shelterbelts, hedges and trees in agroforestry alley cropping systems, provide important over-winter refuges, nesting sites and pollen and nectar feeding sources to help sustain pollinator populations throughout the year. They also provide shelter, which helps improve pollinator success by allowing insects to settle and browse for longer, with the shelterbelts used as 'highways' for the movement of bees, hoverflies and other pollinators. Importantly, the regular spacing of trees, understorey refuges and insect feeding areas in agroforestry alley cropping systems, overcome the ecological deserts in the middle of large arable monocultures.

Northeastwildlife.co.uk

istock Ulrich Knaupe

Silvoarable schemes

Silvoarable agroforestry systems present farmers with an opportunity to increase productivity per hectare (an average land equivalent ratio of between 1.1 to 1.4, when compared to mono-cropping an equivalent area) while also helping to create a more resilient farming system. This means that silvoarable agroforestry systems are between 10 per cent and 40 per cent more productive than monoculture arable systems (where the total output of the system is from the arable crop and tree components combined).
The integration of productive trees in rows within an arable system offers an opportunity to increase the area farmed both above and below ground. The trees capture sunlight at different times to most arable crops and their root and canopy systems occupy a different space. The trees modify local microclimatic conditions and provide benefits to the crops grown between the trees by reducing soil degradation, improving water efficiency and enhancing pest and disease control. The trees provide additional marketable products such as fruit, nuts or timber in addition to their role in soil management and supporting crop yield within the alleys.

Barley growing amongst rows of trees

Wider benefits

Emissions and wood fuel

It is estimated that agriculture is responsible for around nine per cent of the UK's greenhouse gas emissions[11]. Planting trees can offset these emissions by capturing atmospheric carbon. Wood fuel, as a renewable energy source, displaces fossil fuels and reduces a farm's carbon footprint, as well as securing part of the farm's energy needs.

Wood fuel can be grown on land which is difficult to farm, or harvested from trees planted for other purposes such as shelter. Around three hectares of woodland can heat an average farmhouse, with larger woodland able to feed a boiler to heat other farm buildings. Native trees produce good quality firewood while also supporting biodiversity – important for creating a diverse and resilient farming system.

Wildlife conservation

Native woodland creation helps wildlife, particularly where it buffers and extends ancient woodland. Newly created woodland leads to a rapid increase in insects between the establishing trees, which in turn can attract birds such as skylarks and linnets, and foraging bats. Up to nine species of bat have been found to use very early stage woodland. Targeted woodland creation can also help other species to move around the landscape as climate change alters their ranges.

Although many of the plants associated with ancient woodland will not establish for some time, some plants such as lords-and-ladies and honeysuckle are faster to colonise.

Harvested wood fuel can help to heat the farm

Sport

In the right places, native woodland can increase the potential of game shooting on farms, particularly pheasants as well-designed rides can provide shelter and a valuable food source. Development of the woodland edge is also important, and can be achieved by expanding existing woodland.

Where trees in agroforestry alley cropping systems are used, the regular rows of trees with the associated understorey vegetation provide refuges for game and areas rich in insect food. The tree lines provide 'edge' habitat which is ideal for most game birds. The close proximity of insect rich understorey, tree cover and adjacent arable crop results in high quality habitat for pheasant and partridge which is easy to drive for shooting sport.

Whitehall Farm – Planting to improve economic returns

Stephen Briggs is a tenant farmer at Whitehall Farm in Cambridgeshire and since integrating trees into his wheat, barley, clover and vegetable-producing business, his farm has established the largest agroforestry system in the UK.

Stephen initially decided to implement the system to reduce wind erosion affecting his fine grade one soils on the farm, enhance biodiversity, create a mix of perennial and annual crops better able to meet the challenges of climate change, and to diversify his cropping. Apple trees were planted in rows to act as windbreaks, but also to be productive in their own right, leaving 24m alleys in between the tree rows for cereal production. Tree rows are orientated north:south to minimise shading and tree canopies are managed by annual pruning. A diverse range of pollen and nectar species and wildflowers has been established in the 3m wide tree understorey strip beneath the trees to benefit pollinating insects and farmland birds. The arable crops use water, nutrients and sunlight in spring and early summer, whereas the trees need these resources from late spring right through to late autumn. Tree roots gather nutrients and water from deep in the soil, beneath the zone used by the arable crops. This system now uses another dimension of space above the

ground enabling maximum energy to be captured from sunlight and turned into food, as the farm moves seamlessly from a cereal harvest during mid-summer, to a fruit harvest in late autumn.

The 52 hectare silvoarable agroforestry scheme cost an initial £65,000 to establish in 2009. In total eight per cent of the land is planted with trees and the remaining 92 per cent is cropped under the existing cereal rotation. It took five years for the trees to mature into full production, and it is expected that the economic return per hectare from fruit and cereals combined will be greater than the cereal crop alone.

The new scheme has simultaneously provided another income-earning crop, protected and nourished the soil, attracted pollinators and encouraged local wildlife.

WTPL/Helen Chesshire

Managing and planting shelterbelts, riparian strips, hedges and agroforestry

A good starting point is to undertake a whole farm tree assessment; utilising the farmer's knowledge of any issues on the farm and combining it with the knowledge of a woodland or farm adviser. This will identify where there is existing tree cover and how maintaining or restoring it might improve the benefits it delivers. It will allow management of existing woodland or a new planting scheme to be designed to meet the specific objectives of the farm.

When designing shelterbelts and agroforestry alley cropping systems, there are a number of things to consider; land tenure, number of years to tree maturity, intended use, likely wind speed and direction, soil type (susceptibility to erosion), tree row orientation, sensitivity of the arable crops to competition and shade (especially tender horticultural crops), topography and existing farm layout. In some landscapes, there may be aesthetic or landscape character considerations.

Thought also needs to be given to possible future changes to cropping or farm management that might be affected by the siting of windbreaks, shelterbelts and agroforestry alley cropping systems.

The ideal design for a windbreak or shelterbelt is a long, uniform, narrow

Haywood Oaks Farm – Planting to prevent soil erosion

Haywood Oaks is one of 10 linked holdings forming Robert Thomas Farms, an arable unit extending to over 1000 hectares in Nottinghamshire. In the last decade, owner Richard Thomas and farm manager Andrew Bainbridge have significantly changed their farm management methods, incorporating trees as a way to combat wind and water erosion.

Comprising rolling hills and sandy soil, Haywood Oaks Farm in Blidworth is open to the elements and vulnerable to substantial soil erosion. Before land management schemes were in place, it was common for strong winds to blow valuable top-soil away and for intense rainfall to wash the top-soil into neighbouring land and local communities.

Knowing that something more had to be done, Richard and Andrew began to make significant changes to their farming practices. After ploughing, fields are now pressed to compress the soil, nurse crops are planted amongst other crops and vegetables and 30km of hedgerows have been restored to provide greater protection. In addition, field margins, grassy field corners and ridges have been incorporated to slow the flow of water, and several years ago Richard and Andrew planted numerous shelterbelts as part of their HLS scheme to mitigate strong winds and improve the water infiltration rates of the soil.

Soil erosion on a sloping field on Haywood Oaks Farm

However, with the intensity of rainfall increasing significantly over the past few years, Richard and Andrew felt that more needed to be done. Andrew commented: "There were instances where we could literally see the soil leaving the farm and once that happens, we've lost that forever. We knew we really needed to take steps to keep that in the field – we needed to slow the water so that we could ensure the sediment and nutrients stayed on the farm and that we weren't impacting on other land, local people and properties."

Richard and Andrew contacted the Woodland Trust and, with help from an adviser, they identified several areas for planting that could not otherwise be utilised due to less favourable growing conditions. During the winter of 2014/15, 4,000 trees were planted, amounting to one hectare across varying areas of the farm, with a further 0.2 hectares

Andrew Bainbridge planting trees with farm staff

planted on another of their linked holdings, Inkersall Grange Farm. Planting consisted of 10m wide shelterbelts with two metre spacing, and species consisted of oak, holly, rowan and birch as these were already present on the farm and were proven to grow well in the soil type. Furthermore, two rows of shrubs were planted on the field side of each belt to act as an added buffer, and stakes, guards and biodegradable mulch mats were used to aid with initial maintenance.

Over time, the additional planting carried out by Richard and Andrew will show that, when planted in the right places, trees can significantly help to lessen soil erosion and the loss of vital nutrients by acting as a natural barrier and improving the water infiltration rates of the soil. Similarly, the trees will also prevent strong wind gusts from lifting valuable top-soil away from the farm. By keeping the seedbed in situ, the cost of repeat practices will be significantly lowered and the risk of long-term soil degradation minimised. In addition, the trees are very much a visual statement to the local community, highlighting the action taken by Richard and Andrew and positioning the farm as proactive in relation to taking responsibility for any impact on the wider environment and community.

New trees planted in a field corner opposite older shelterbelts on Haywood Oaks Farm

Photos: Andy Tryner

belt of trees and shrubs, perpendicular to the prevailing wind. In practice, the landscape, farming system and the existing layout of fields, drainage ditches, field drains, habitat, access roads, farm buildings and other features will influence what is possible. It is often expedient to compromise design slightly to fit with the practicalities of other aspects of the farm's management. For agroforestry alley cropping systems, north:south orientation of tree rows is preferable to reduce shading – typically this also helps manage prevailing winds from the south west and east.

Contour or riparian planting on mid-slope and down-slope field edges can be effective in increasing water infiltration, reducing and slowing water run-off and intercepting nutrient and sediment. The width of the buffer, slope, gradient, amount of vegetation and leaf litter and the soil type will all influence the time taken for water to pass through the buffer. The longer the buffer holds the water, the better it will function.

The choice of native tree species will help ensure the trees are well suited to the site and are able to deliver wider benefits to wildlife. Exact choice will depend on location, soils and altitude. Newly planted trees will require weeding for the first few years and protection from voles, rabbits, hares and deer, depending on where you are in the UK.

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Andy Tryner

Free advice and support

Are you interested in planting trees on your farm?

The Woodland Trust is working in partnership with farmers across the country to study the effects of strategic tree planting on farms. Our woodland creation advisors have years of experience advising landowners on the benefits of trees and can provide free advice and support with a whole farm tree planting assessment, design of a planting scheme and identification of potential funding support for trees and guards. We then work with you over the subsequent years to monitor the results.

To find out more about opportunities to increase the tree cover on your farm, please call **0330 333 5303** or email **plant@woodlandtrust.org.uk**

"Incorporating trees and hedgerows into existing land management practices on arable farms proves there are a wealth of benefits to be had. By reducing the threat of erosion and loss of valuable topsoil, increasing crop water efficiency and enhancing pollinators and crop protection, trees are a valuable asset which contribute to improved crop yields and soil management, as well as enhancing the local environment."

Richard Laverick, Head of Regional Development, AHDB

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