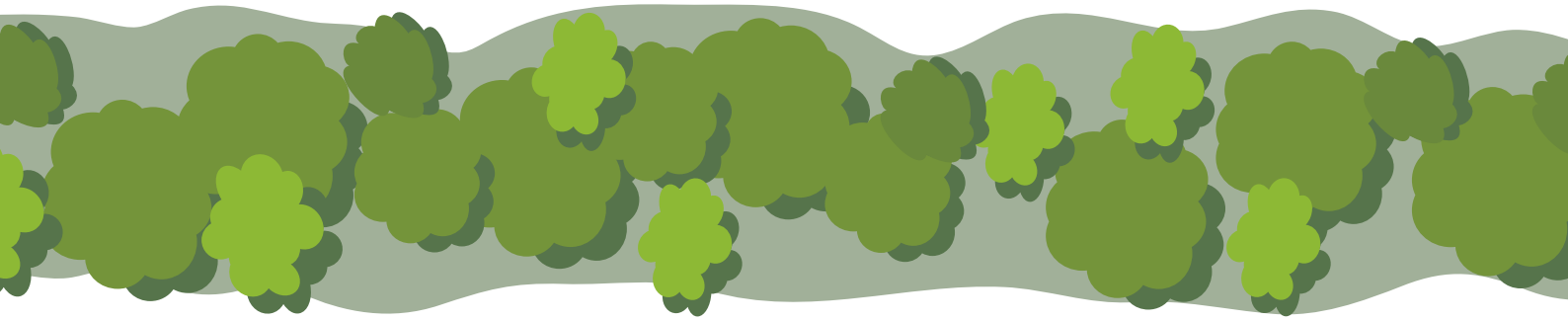
Shelterbelts

A guide to increasing farm productivity



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A guide to increasing farm productivity with Shelterbelts

UK agricultural policy once promoted and subsidised the removal of hedgerows from the farmed landscape. Only now that they are gone do we truly understand and appreciate their diverse benefits and value to farm businesses, ecosystems and landscapes.

Countries all over the world are using shelterbelts as part of smart farming practice e.g. Alberta, Denmark, New Zealand and USA. Denmark for example, have been subsidising shelterbelt planting since 1880 to prevent soil erosion by wind and increase farm productivity. Whole regions have been made agriculturally productive through improving shelter. New Zealand are changing their farming practices to include shelterbelts as standard following extensive research that highlight the benefits of farm shelterbelts. Welsh Farmer Roger Jukes has increased his on farm tree coverage from 1.5 to 5% over 280 acres, and says:

"The farm is more productive and a nicer place to work than it was 20 years ago. It is easier to manage and a kinder environment for stock. We are working with nature not against it"

Our relatively open fields mean that we can design new shelterbelts to meet specific aims, the benefits are targeted towards farm needs rather than a mere by-product of old field or farm boundaries, which were themselves a product of the needs of farmers centuries ago.

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This document provides a guide to help landowners install shelterbelts for maximum efficiency and covers the following topics;

1. Why install a shelterbelt?

Benefits to the farm

Shelterbelts when positioned correctly improve the local microclimate for crops and livestock, maximising production and reducing farm costs through and array of different mechanisms such as those outlined below (Examples used may be based on single examples from countries other than the UK but highlight how shelterbelts can benefit farm efficiency).

- Biosecurity. A shelterbelt or wide hedge planted along a boundary provides a physical barrier between neighbouring landholdings and within landholdings. This can significantly reduce the transfer of diseases between flocks by nose to nose contact. Trees can potentially act as a filter for air-borne diseases although more research is required.
- Exclusion of stock from wet areas of pasture reduces incidence of liver fluke and lameness.
- Grass production in early spring is increased by warmer air and/or soil temperatures.
    - This allows movement of stock to uplands sooner, meaning less feed is required and hay/silage fields can be vacated earlier.
- Reduced wind speed and chill factor increase crop and livestock productivity, e.g.
    - Sheltered sheep show a 21% increase in live-weight (5year trial).
    - British sheep require 19g of feed per day for thermoregulation at 6°C but only 8g for thermoregulation at 25°C. Increasing temperatures and reducing wind chill by use of shelterbelts could significantly reduce feed costs.
    - Sheltered areas have up to 17% estimated increase in dairy milk production.
    - Protected areas have shown a 20% increase in average annual pasture growth.
- Reduces lamb mortality.
- Increases crop yields.
- Reduces soil erosion by water (trees increase infiltration rates and reduce overland flow) and wind (trees slow wind speeds reducing the energy available to dry and move soil particles).
- Reduce snow drifts.
- Aid management e.g. control stock movement.
- Shelter for handling areas.
- Provides shade in summer.

Cattle utilising shade provided by trees.

Benefits to the wider environment

- Reduces sediment in streams.
- Help regulate stream temperature.
- Reduces surface run-off.
- Reduce flooding by increasing soil water storage ability.
- Benefits pollinators and wildlife in general.
- Reduces soil compaction.

Trees reduce topsoil and fertiliser loss by surface water run-off.

2. Where to put a shelterbelt.

Shelterbelts require careful planning and long term maintenance to provide their full range of benefits. At the planning stage, wind direction(s), topography and farming practices must be considered. Ask yourself/consider the following at the planning stage;

- Where needs shelter?
- If more than one prevailing wind, which is most damaging?
- Avoid frost patches by planting across the slope. This also deflects wind at a gentle angle.
- Maximum protection is offered when shelter is at right angles to the prevailing wind.
- Consider the length of shelter vs concentrations of stock. High concentrations of stock can lead to poaching immediately behind a shelter, which can manifest parasitic diseases and cause soil erosion. This can be mitigated by increasing the length of the shelterbelt.
- Are there existing woodlands the shelterbelt could be linked to?
- Are there any hollows or gulleys which already contain woodland plants?
- Do you want to plant along your farm boundary/ or around a specific field(s) in case of disease outbreak within the farm or within the local area?
- Are there are instances where a shelterbelt could aid livestock movement e.g. to funnel livestock through a gateway? Or make a handling area more sheltered?
- Are there any steep slopes that are prone to causing injury to livestock? Is it worth planting that slope?
- Are there any areas prone to soil erosion by wind or water?
- Fences, dykes and hedges can reduce fencing costs and protect young trees.
- Take care with planting densities near water courses. You don't want too many so that water resources become under threat during summer/drought conditions but equally shading will reduce high water temperatures and reduce stream evaporation and protect fish stocks. Only plant broadleaves (avoid conifers, Oak and Beech – Willows and downy birch are more suitable and ensure good water quality e.g. for fish) and not more than 60% of the streamside.
- Habitats such as wetlands, marsh, unimproved grassland are vital for birds, small mammals, plants, insects and game. These areas may become vulnerable to tree planting. Contact a Coed Cymru officer for advice if you have concerns.
- Make yourself aware of any regulations with regard to planting near roads / electricity lines.

3. How shelterbelts work and the design implications

A shelterbelt alters the microclimate of the area adjacent to it by influencing wind speeds, air temperature, soil temperature, soil moisture, humidity, night air temperature, and evaporation. The extent of the area influenced by these microclimatic changes depends upon design factors such as height and porosity (how much wind can pass through it rather than forced over/around it).

Height

The area protected by a shelterbelt is proportional to its height. Shelterbelt maximum height should be as tall as possible to maximise the area that will benefit from shelter, as long as the trees remain wind-firm themselves.

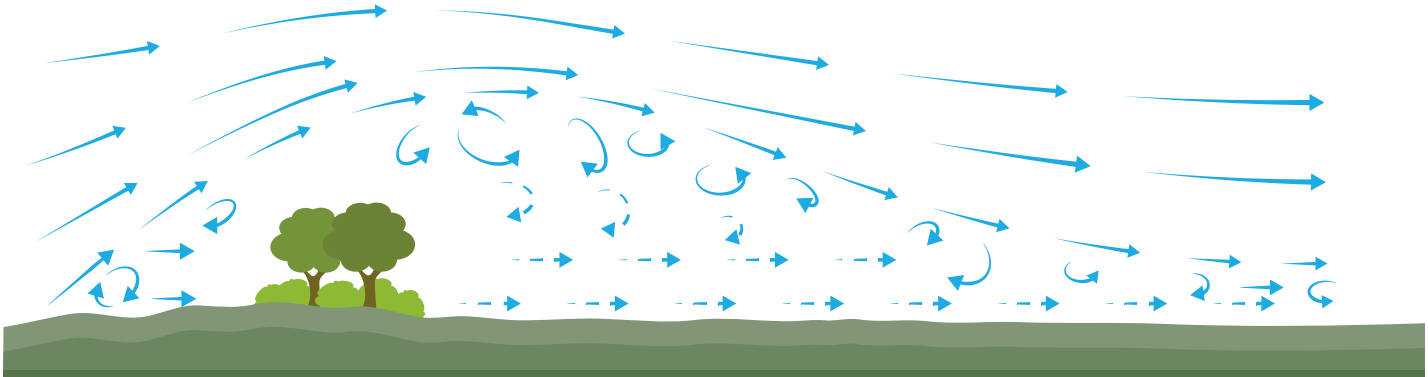

Figure 1: Shelterbelts alter the microclimate of the area adjacent to it by influencing wind speeds, air temperature, soil temperature, soil moisture, humidity, night air temperature and evaporation.

Permeability

The most effective shelterbelt allows approximately 40% of the wind to penetrate and flow through the trees with the remainder deflected across the top (figure 1). The deflected wind then descends and meets the wind that has passed through the shelterbelt (which is now travelling at a slower rate). This limits heavy turbulence and strong winds are lifted above crop and stock level providing a less hash microclimate. The affected distance away from the shelterbelt depends on the height of the shelterbelt. A permeable shelter will give 20% reductions in wind speed for distances of around 20 times its height (figure 2).

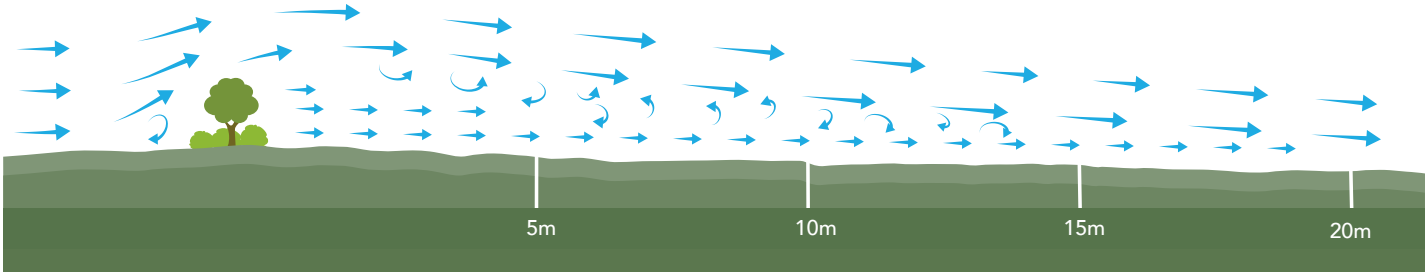

Figure 2: Showing the extent of shelter from shelterbelt into productive agricultural land

Dense, impermeable shelterbelts deflect wind upwards and create a narrow calm strip on the leeside followed by high levels of turbulence where the wind hits the ground and deflects back up to form eddies (figure 3). Because no wind passes through the canopy, there is no stream of slower wind to 'catch' the turbulent wind as it drops from the deflected height. This type of shelter may be efficient if a narrow shelter is required e.g. near a building, but bear in mind that after this narrow calm strip will be a sharp transition to turbulent, high energy winds.

Permeability may be increased or decreased by changing planting density, number of rows of plantings and/or species.

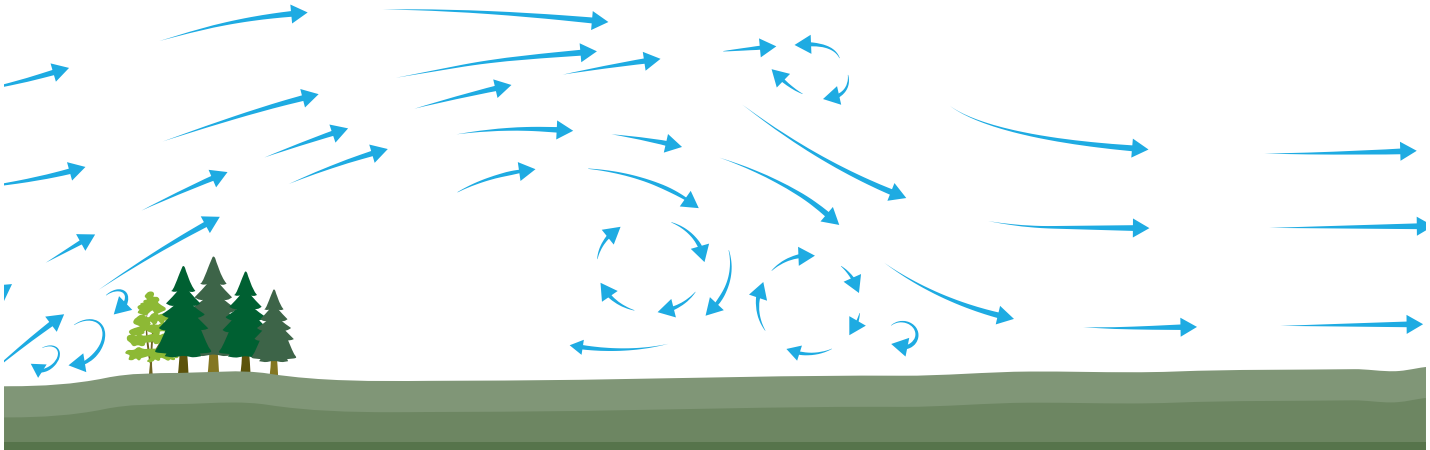

Figure 3: Dense shelterbelts create a short zone of high protection followed by immediate area of high turbulence and harsher climatic conditions. This is less suited for shelter in an agricultural landscape as it promotes poaching in the small sheltered zone, and the extent of shelter is not optimised.

Width

The optimal width for a shelterbelt can vary and should be considered in the context of the shelter required and species to be planted, all of which are closely related. It is impossible to grow a wide and permeable shelterbelt. Conifers are less permeable than broad leaved species but at wide bands of 25m or more, even leafless winter broadleaf woods may be impermeable to prevailing winds. This should be considered in context of species selection, number of rows and planting density for a required permeability.

Cross section

A vertical rather than pitched-roof shaped interface between prevailing wind and shelterbelt is preferred as it encourages wind through the tree/shrub barrier rather than deflecting the majority of the wind current over the top (just like a dense barrier described above and Figure 3). A vertical barrier promotes movement of some air through the trees. A row of dense shrubs/hedge along the windward side (Figure 4) will prevent the base becoming too open once trees begin to thin as they mature (Figure 5), adding to low level wind protection. Keeping large crowned trees back from agricultural land will also reduce their shade impacts on crops. Therefore, the ideal shelterbelt is for one or more lines of trees along the middle, with shrubs either side along the fence line, which can be kept trimmed back with a hedge brusher.

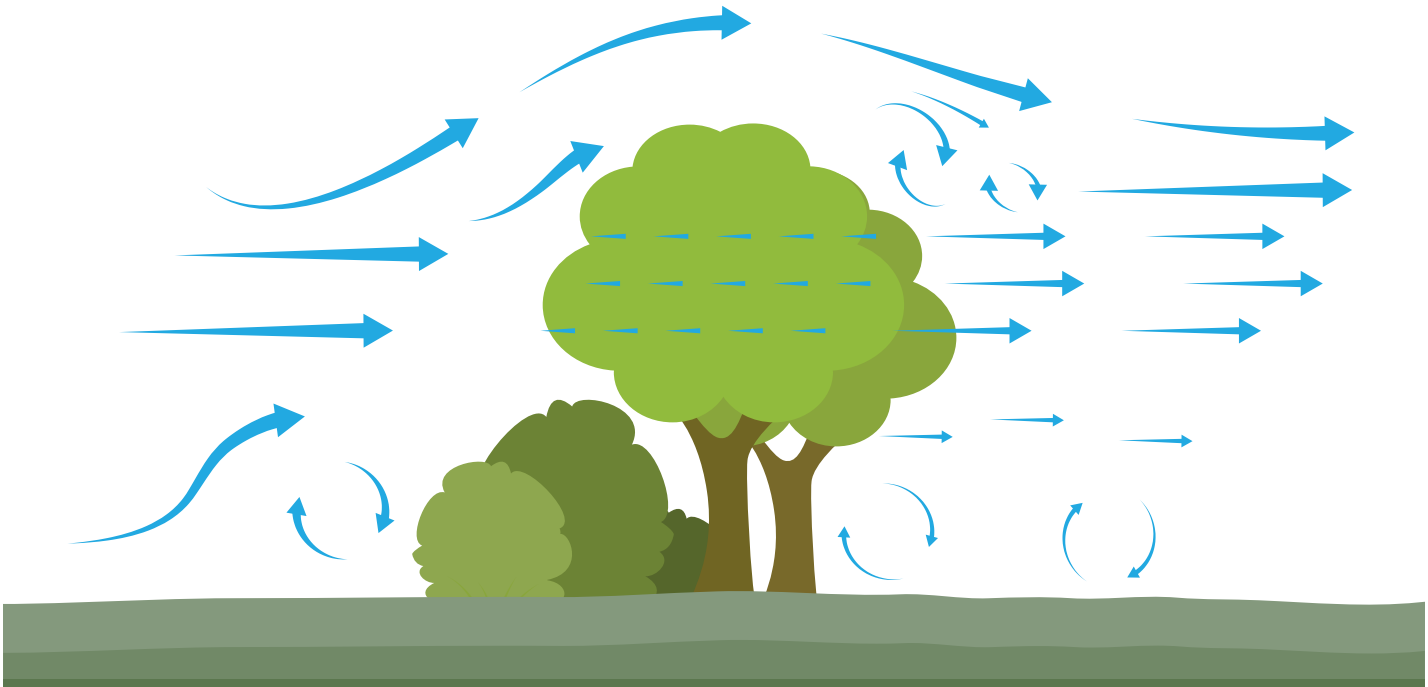

Figure 4: A vertical barrier promoting wind to pass through the canopy rather than over it, with a row of shorter and more dense shrubs for low level protection once trees have matured and thinned at the base.

Figure 5: Shelterbelts without low level protection will increase winds speeds by tunnelling the wind, making climatic conditions harsher for stock and crop.

Length

The length of the shelterbelt should as a rule of thumb, be around 10 or 12 times the height of the shelterbelt. Winds coming around the sides of the shelterbelt encroach on the 'sheltered zone', effectively creating a triangular (with the base at the shelterbelt) rather than rectangular shaped shelter (Figure 6).

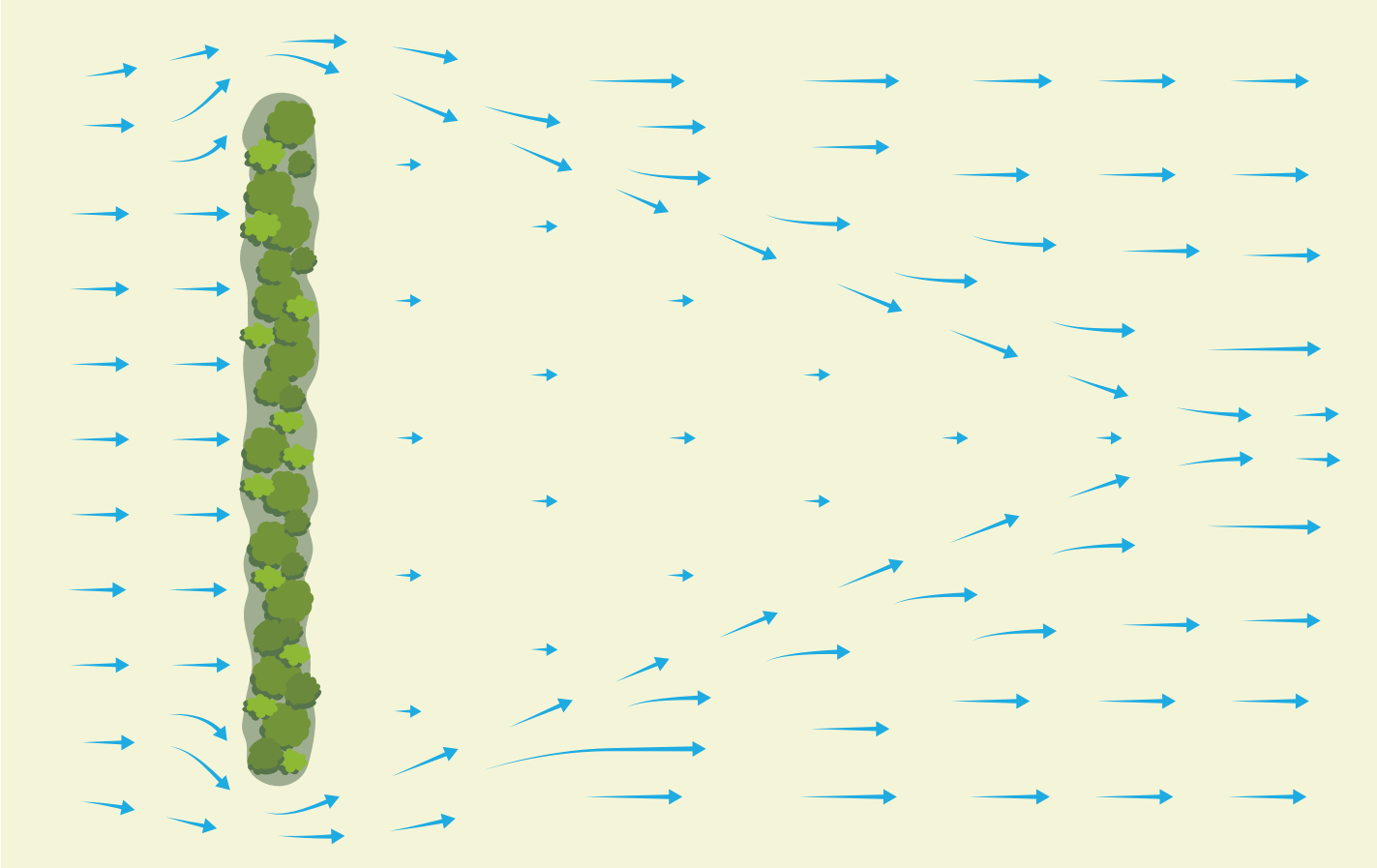

Figure 6: Winds coming around the shelterbelt will triangulate the area of effective shelter. The length of the shelter should be considered in the context of stocking density to avoid poaching and provide sufficient shelter.

A shelterbelt with frequent gaps or a shelterbelt/hedge that has become open and developed frequent gaps often exhibits harsher conditions than open habitat. This is due to tunnel winds pushing through these gaps (Figure 7). When gaps are necessary e.g. for access it is possible to reduce this tunnel wind effect by creating a small shelterbelt island just in front of the gap. Old overgrown conifer shelterbelts now suffer from this problem as wind accelerates through the trunks (Figure 5). There is little that can be done in this situation, other than to fell and replace.

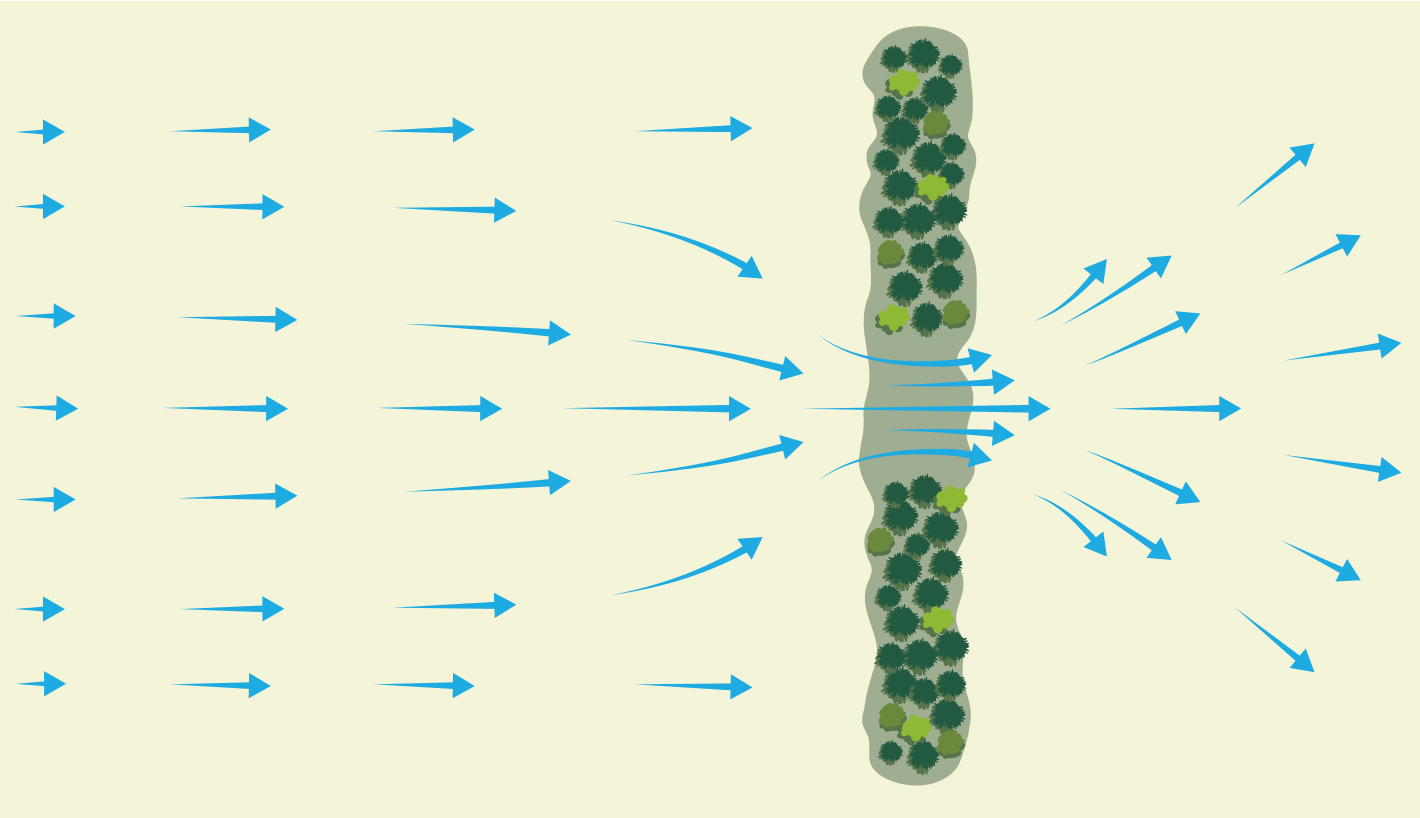

Figure 7: A shelterbelt with a gap will increase wind speeds through the gap as tunnelled wind.

Profile

An irregular canopy is more efficient at breaking up and reducing wind eddies than a homogenous flat canopy of trees of equal height. Planting a variety of species will help avoid establishing a shelterbelt with a canopy of uniform height.

Additional benefits through creative design

By not planting a shelterbelt right up to an existing fence and leaving a gap, not only do you allow access for possible future timber harvest but you're also creating more diverse habitats for wildlife and game. If fenced off, this area of rough grass areas such as these are important for breeding, dusting, sunning and feeding as well as being sought after hunting and feeding areas for Hoverflies, Bees, Barn Owls Kestrels etc.

4. Species selection

Important considerations;

1. Obtaining height in the shelterbelt as soon as possible
    - Shelter depends on height. Fast growing species with a relatively short life-span may be necessary for initial establishment. e.g. poplars, alder or birch. These must be wind resistant and able to grow vertically and tall to establish shelter for less wind resistant but more long lived species (e.g. Oak) to then establish.
2. Provide low shelter once the main trees thin out underneath with shade tolerant species.
    - A shrub layer provides low level shelter. This is best achieved through planting shrubs e.g. Hawthorn.
    - An alternative is the coppicing of tall understorey species such as hazel, chestnut, ash, oak, sycamore, alder, hornbeam, lime, birch or willow. These species produce shoots from the base when cut, adding to lower level 'thickness'.
3. Local species of trees and shrubs
    - These are usually best adapted to the local climatic and soil conditions and are more likely to succeed.
    - Important for local wildlife.
4. Hardy smaller trees that can survive the harsh wind conditions of exposed edges
5. Lower shrubs or hedges are good for shelterbelt margins
6. Plan for the required purpose
    - Consider belt permeability and its purpose. E.g. if a low permeability is required, confers or wide band of broadleaves should be used. If moderate permeability is required, consider broadleaves of a suitable width.
7. Optional; plan for timber supply though remember that edge trees will produce heavy side branching, which will limit timber quality.

These considerations are 'ideals' that may not be possible to achieve due to site conditions e.g. peat soils may not be suitable for the desired species as a result of pH, and drainage. For the shelterbelt species to succeed trees must be suited to site conditions. Contact our experienced Coed Cymru officers for advice on what species to plant where.

5.Maintenance

Once shelterbelt design and composition is planned, it is important to understand that the shelterbelt is going to require long term maintenance. There are three main stages of lifetime maintenance which include the following;

a. The early years: Establishment and maintenance

Maintenance is important for a long lived healthy shelterbelt. Weeding, replacing dead trees and fence repair/replacements are essential.

- Planting spacing depends on species and shelterbelt design requirements.
  - E.g. balancing species appropriate for the site, permeability and belt purpose. As standard you would expect to be planting a density of at least 2,500 trees per hectare, (2 Meters apart) and 1m away from fence lines.
- Exclusion of browsing e.g. livestock, deer, rabbits and hares is required by use of fencing and tree guards. Grazing animals damage tree stems, roots and ground vegetation.
- Tree failures will need to be replaced in the years following the initial planting to maintain overall density.
- Weeds must be controlled within at least a 1m radius of each tree base for the first 3-5 years. Herbicide application will encourage successful establishment of shelter sooner (in some areas control of grass can treble the rate of height growth in young trees).
- Fertilising; There is usually no need for fertiliser.

Please seek advice on establishment and management needs of specific projects.

b. The mid-term: on-going management needs of shelterbelts

With age, woods become too dense and then become draughty as growth slows and trees die. Management of the woods is required to keep the density (and porosity) optimal and ensure the long term value of the woodland belt as shelter.

15-20 years after planting

The crop must be thinned to allow growing room for the trees you want to keep. This will;

- Increase timber yield over the long term as well as produce timber immediately. This will be good fuelwood or fencing stakes, etc.
- Thinning reduces the risk of wind blow, which prolongs the life of the shelter
- Maintains permeability required to shelter a large area.
- Removal of the first fast growing species by thinning gives room for the longer lived species e.g. sessile Oak to establish successfully.
- Coppicing increases the structural diversity of the shelterbelt and therefore its effectiveness.

c. The final stages: Clear felling and re-establishment of shelterbelt options

Clear felling will remove all shelter provided by any existing trees. If the shelterbelt is correctly specified, this is not usually necessary. Options exist to maintain shelter while also felling the old trees. These include;

- Cut and re-plant the leeward half of the belt, let that re-establish, then continue with the windward side. This method carries wind blow risks and takes time and considerable amount of care to achieve successful results.
- Plant a new shelterbelt alongside the existing one that is to be felled. Once the new belt can provide adequate shelter, the old one may be felled. This option is expensive in terms of land area.
- In larger shelterbelts that can withstand group felling it may be possible to enlarge existing gaps and re-plant. This takes longer due to the small scale felling.
- If trees in existing shelterbelts have sufficient light reaching the ground e.g. due to sparse trees remaining and/or trees have small crowns it may be possible to re-plant under these trees with shade tolerant species such as Douglas fir, Western Hemlock, Beech, Hazel or Holly.
- In fenced off shelterbelts, natural regeneration of natural coppice regrowth may occur. In more open woods this will allow understory trees to establish and eventually replace older trees naturally. Gradual coppicing will help this process along once the understory trees have established.

6.Case Study

See how Roger Jukes made his farm more efficient by use of trees on the Pontbren Virtual Tour (www.coed.cymru).

7.Funding

Contact us for more information about costs and whether grant aid is available.

www.coed.cymru

8. On-going research

While we know a great deal about the role of trees in shelterbelts on soil and water from the work at Pontbren, most of the hard evidence we have about the impact of shelter on farm productivity comes from scientific experiments conducted in other countries and a limited amount of experience in the UK. We are now working with the Bangor University 'Multiland' project to quantify the impact of shelter in the farmed landscape.

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MULTI-LAND

Enhancing Agricultural Productivity and Ecosystem Service Resilience in Multifunctional Landscapes

- Aims to identify positive interactions between trees, livestock and soil and improve our understanding of animal behaviour and metabolism (feeding, growth, defecation and use of shelter)
- Aims to increase productivity and reduce GHG emissions by multifunctional landscapes and exploiting the potential synergies between trees and livestock.
- Examines the role of shelterbelt systems in the provision of ecosystem services and in increasing ecosystem resilience to perturbations of upland livestock systems.
- Will inform policy on how sustainable intensification of farming practices can improve agricultural productivity and local livelihoods whilst enhancing the delivery of a range of regulating ecosystem services.

http://www.nrn-lcee.ac.uk/multi-land/

If you would like to take part in their research please contact Coed Cymru.