Operations Note 053 Date: 2 August 2021

Guidance on cultivation and UKFS compliance for application in England

Purpose

This operations note has been issued to ensure that cultivation for afforestation meets not only the minimum requirements of the UK Forestry Standard (UKFS) but also ensures that the storage, sequestration and capture of CO_2 is adequately addressed and is appropriate for England. Some cultivation methods fail to meet this requirement and should not be used.

This guidance is specific to cultivation and should be viewed as one step in the overall woodland creation plan. Cultivation should only be considered once you have satisfied yourself that woodland creation is appropriate on the land and you have defined your objectives for creating woodland. Operational plans must demonstrate that due diligence has been taken in identifying the soils within the woodland creation site and how the proposed cultivation can be justified to be "the least intensive and most appropriate cultivation method to successfully establish the proposed woodland"; this is a requirement to receive approval to create new woodland and receive incentives from the Forestry Commission.

Summary

The UKFS is the reference standard for sustainable forest management in the UK. It outlines the context for forestry, sets out the approach of the UK governments to sustainable forest management, defines standards and requirements, and provides a basis for regulation and monitoring – including national and international reporting.

The UKFS states that all operations should have a plan that is used for communicating proposals and engaging with interested parties. Operational plans should be in place before major operations such as woodland creation occur. Soils often contain the major proportion of carbon in the forest ecosystem. It takes decades or centuries to accumulate but can be rapidly lost through disturbance. The UKFS states that operations should minimise the soil disturbance necessary to secure management objectives, particularly on organic soils.

FC Bulletin 119 'Cultivation of Soils for Forestry', 1999, remains the best available source of reference for silvicultural advice when deciding the most appropriate method of cultivation for a site. When deciding the most appropriate technique for native types of woodland reference should be made to Managing ancient and native woodland in England.

Cultivation is intended to increase initial tree survival rates and allow faster establishment. However, its impact on the tree will always be temporary so species must be chosen which are suitable for the site's abiotic conditions (temperature, windiness, moisture etc.), notwithstanding those changes that can be effected by drainage. Cultivation and drainage are not the same and aim for different outcomes Step 4 cultivation techniques. Choosing species and cultivation techniques appropriate to the site will help deliver long-term management objectives and the relevant requirements of the UKFS.

The UKFS requires that soil and water are protected from the potential adverse effects of cultivation operations. Without appropriate design and/or mitigation measures, cultivation can have a range of undesirable and potentially detrimental effects, including:

- enhanced weed growth
- water pollution caused by increased sediment runoff
- damaged soil structure and increased risk of windblow, erosion or landslip
- leaching of nutrients and contaminants
- greenhouse gas release through oxidation of soil organic matter

For these reasons, the least intensive, most appropriate cultivation method should be used to successfully establish woodland.

Policy

The Climate Change Act 2008 (2050 Target Amendment) Order 2019 - The amendment in this Order has the effect that the minimum percentage by which the net UK carbon account for the year 2050 must be lower than the 1990 baseline is increased from 80% to 100%.

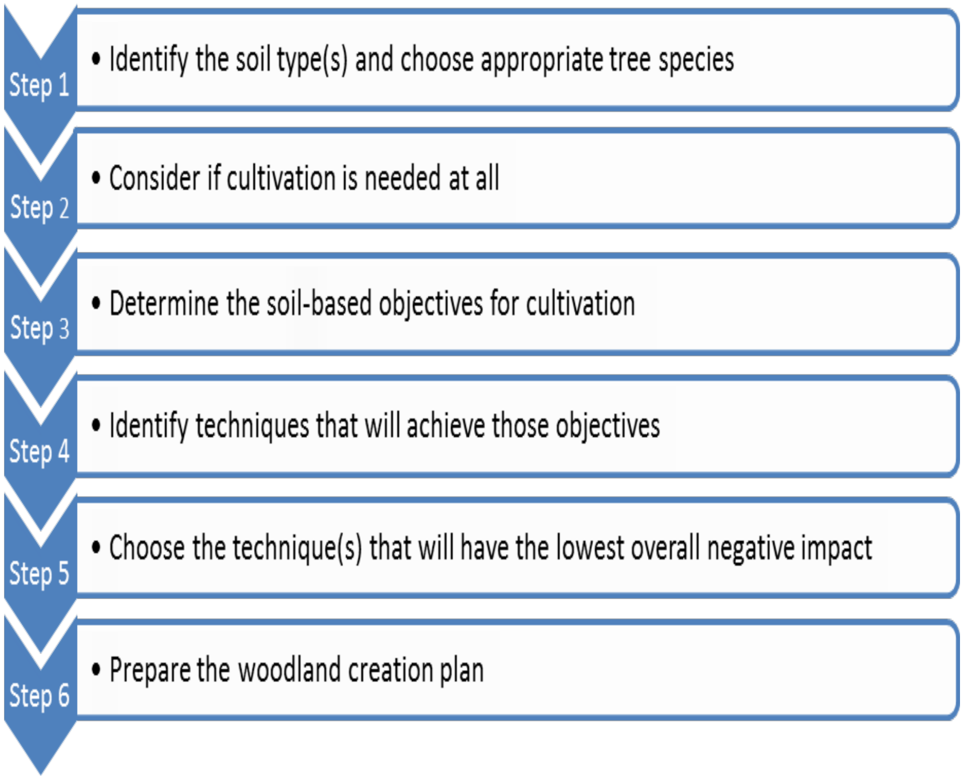
The Clean Growth Strategy - This strategy sets out our proposals for decarbonising all sectors of the UK economy through the 2020s. It explains how the whole country can benefit from low carbon opportunities, while meeting national and international commitments to tackle climate change.

25 Year Environment Plan - 'A Green Future: Our 25 Year Plan to Improve the Environment', sets out what we will do to improve the environment within a generation.

UK Forestry Standard - The UK government's approach to sustainable forestry. The UKFS includes standards and requirements, regulations and monitoring, and reporting, and applies to all woodland, regardless of who owns or manages it.

Overview of decision-making framework

This guidance sets out the advantages and risks of cultivation techniques commonly used for woodland creation. It offers a six-step process to identifying the most appropriate techniques for establishing a woodland that must be resilient under the likely changing conditions of the 21st century:



Interpretation

Given the distribution of soils, habitats and site types in England, it is unlikely that traditional "mouldboard" type forestry ploughing will be considered as an appropriate method of cultivation and therefore will not be supported by woodland creation grant agreements signed after 28 February 2021; furthermore this guidance sets out that no form of ploughing is considered acceptable on peaty soils with an organic horizon of more than 10 cm. Cultivation involving significant soil disturbance will also need to be fully justified in woodland creation plans and will be a consideration when offering incentives.

Using this guidance

Step 1: Identify the soil type(s) and choose appropriate tree species

Site amelioration techniques such as intensive drainage or fertilisation can alter soil properties so that they are favourable for different species, but climatic constraints cannot be overcome. Only a site-orientated approach to tree species selection will allow sustainable forest management to be practiced and the UKFS to be implemented.

Soil types and phases should be identified from a site-based soil survey. Guidance on collecting soil data for a woodland creation proposal can be found in Bulletin 119, and also in FC Bulletin 124 'Ecological Site Classification', 2001 and related online videos.

Ideally, a survey should also identify soil texture and particle size (as this determines soil behaviour in relation to drainage and load-bearing capacity) and vegetation.

Soil texture can influence the choice of cultivation technique in these ways:

- Clay soils are very sensitive to compaction, so soil disturbance and machine movements should be minimised. Cultivation features such as mounds, trenches and plough lines are likely to persist for a long time and affect future forest operations.
- Loamy soils are also sensitive to compaction and are often easily eroded by water, risking siltation of watercourses. Cultivation features may persist, so soil disturbance should be minimised unless required, because an ironpan or humus layer is present.
- Sandy soils are often easily eroded by water and wind and liable to desiccation, so are best not disturbed.

Identifying the extent and distribution of different soil types within the site is important to determine whether more than one technique will be required, or one technique with modifications. Wherever practicable different conditions on site should be addressed by employing different techniques or modifications.

All applications must use the FC soil classification system described and illustrated in the FC field guide 'The Identification of Soils for Forest Management' (also in less detail in FC Bulletin 124 'Ecological Site Classification', 2001).

Data from the soil survey and vegetation indicator species should then be inputted to the Ecological Site Classification Decision Support System (ESC) to assess the soil nutrient, moisture and climatic regimes of a site. This will help identify which tree species are most ecologically suited to the site. In line with the UKFS, the species mix and the methods of cultivation used to establish them must be appropriate to the site's soil type.

Having selected an appropriate species mix and site layout ('appropriate' meaning one where young trees are likely to survive as woodland at the required stocking density and deliver the stated management objectives), proceed to Step 2.

Step 2: Consider if cultivation is needed at all

Cultivation of some soils can have a negligible or even detrimental effect and should be avoided on the soil types listed in Table 1:

Table 1 – Soils on which cultivation is not advised

Soil type	Why cultivation is not recommended
Some relatively fertile brown earth and cultivated gley soils	Existing soil conditions are good, so extensive cultivation is likely to promote weed growth and increase competition for nutrients and moisture
Calcareous soils over chalk or limestone	Soil mixing likely to increase the soil's alkalinity and exacerbate nutrient deficiencies
Skeletal soils	Negligible potential for improving soil conditions. Loosening could promote soil movement/slip and erosion on steeper slopes
Littoral soils	Limited potential for improving soil conditions
Some man-made soils	Loose soils unlikely to benefit from cultivation, while cultivation on some brownfield sites could release contaminants
Bogs (peat >30 cm)*	Woodland creation not permitted due to risk of carbon loss

***** And on sites that would compromise the hydrology of adjacent bog or wetland habitats

Where cultivation is not recommended, seek advice on vegetation management using Forest Research resources. If it is clear that cultivation is needed to aid tree survival and growth, move to Step 3.

Step 3: Determine the soil-based objectives for cultivation

Once it is clear what the site's soil type is, and that cultivation of some form is needed, the next step is to identify which growth-limiting soil characteristics need to be addressed for the proposed woodland to grow well.

Making good cultivation decisions that address the soil's characteristics will set the context for how the woodland will be managed through to harvesting, rather than just focusing on a five-year establishment plan.

Use Table 2 (below) and your data on the site's soil properties to identify which soil characteristics might affect growth and consequently the objectives for cultivation. Note that the information in Table 2 is necessarily simplified. Greater detail on these matters can be found in FC Bulletin 119 (for example, on the relationship between cultivation and soil temperature).

Step 4: Identify techniques that will achieve those objectives

The bottom row of Table 2 suggests what the cultivation objectives for the site might be, given the soil's characteristics. Applying this information to Table 3 (below) will help identify which techniques will achieve those objectives.

If there is more than one kind of soil on the site, more than one technique (or adjustments, such as a change of tool or setting) might be needed. Excavators will be more versatile in these conditions.

Although certain cultivation techniques improve drainage around the tree by creating an elevated planting position, they do not solve problems with waterlogging across the site in the long term. Cultivation techniques should not be used to manage excess water – an integrated drainage system should be put in place at the same time or immediately after cultivation.

When using techniques that create linear channels, appropriate design and/or mitigation measures are key to reducing the risk of surface runoff, peak flows, soil erosion and sediment delivery into watercourses.
Further information on design and mitigation measures is provided in Step 5.

Linear techniques must be used in a way that complies with UKFS stipulations on water management and forest drainage, which in practice means:

Gradient of lines	To avoid the risk of soil erosion, linear cultivation channels should not generally be used on slopes greater than 11^{o} (20%). Only use discontinuous forms of cultivation on steep slopes. Exceptionally, where a detailed analysis of the nature of the soil on site is carried out, and it is established that the soil erosion risk is low, it may be acceptable to create linear cultivation channels on moderate slopes 11-18^{o} (20-33%), provided appropriate mitigation and controls are deployed.
For trench mounding done in connection with drains	Maximum gradient of 2^{o} (3.5%), with drains leading towards the head of the valley.
For trench mounding other than in connection with drains and on a gradient steeper than 3^{o} (5%)	Spoil trenches should be cut off every 20m.

Table 2 – Soil characteristics that help identify objectives for cultivation

Soil type	Typical brown earth	Podzol/ podzolic brown earth	Podzol/ podzolic brown earth	Gleys (non-peaty)	Peaty gley	Rankers (13b, 13g, 13p, 13z)
Soil properties	Free draining, wide range of textures. Little or no surface humus	Free draining, aerated, acidic soil. Generally sandy texture. Often humus at surface	Fine-textured podzolic soil with thin cemented layer of clays and metal oxides	Waterlogged, variably textured soils	Waterlogged, variably textured soils with surface peat layer of 5 to 30 cm	Shallow versions of the main soil types, less than 30cm deep over bedrock or induration
Soil Moisture Regime	Slightly Dry to Moist	Moderately Dry to Fresh	Fresh to Moist	Moist to Wet	Moist to Very Wet	Very Dry to Very Wet
Soil Nutrient Regime	Poor to Very Rich	Podzol Very Poor. Podzolic brown earth Very Poor to Poor	Very Poor to Poor	Poor to Very Rich	Very Poor to Very Rich	Very Poor
Soil factors limiting tree growth	Brown earths with medium to very rich SNR can have aggressive weed competitio n for nutrients and moisture. Can erode easily on exposed slopes, especially if a high humus or silt content.	Poor fertility because metal oxides have washed down from topsoil into subsoil. Sandy texture means risk of desiccation. Can erode easily on slopes if exposed. Vegetation likely to be heather, which makes planting difficult.	Root growth may be compromise d by the ironpan. Anaerobic waterlogged conditions may arise if the downward movement of water is stopped by the pan. Poor fertility.	Waterlogged topsoil creates anaerobic conditions in topsoil and subsoil. Gleys with medium to very rich SNR can have aggressive weed competition. Gleys with poor SNR will have poor fertility. Can erode on exposed slopes, especially if a high humus or silt content.	Waterlogged topsoil creates anaerobic conditions in peaty topsoil and mineral subsoil. Imbalanced nutrient supply between peat and mineral soil can restrict rooting to the peat layer. Peaty gleys with medium to very rich SNR can have aggressive weed competition. Those with poor to very poor SNR will have poor fertility. Can erode on exposed slopes, especially if a high humus or silt content.	Erosion after disturbance very likely on such shallow soils. Very poor fertility. Root growth affected by shallow soil depth and potential waterlogging.

Table 2 (con't) – Soil characteristics that help identify objectives for cultivation

Soil type	Typical brown earth	Podzol/ podzolic brown earth	Ironpan	Gleys (non-peaty)	Peaty gley	Rankers (13b, 13g, 13p, 13z)
Objectives for cultivation	Where needed, create weed-free planting position. Minimal soil disturbance	Remove heather. Mix soil to improve soil fertility/nutrient availability. Minimal soil disturbance.	Reduce or break iron pan deeper than 30cm if it is within reach. Mix soil to improve soil fertility/nutrient availability. Minimal soil disturbance.	Manage soil wetness and waterlogging from the water table. Where needed, create weed-free planting position. Where needed, mix soil to improve soil fertility/nutrient availability. Minimal soil disturbance.	Manage soil wetness and waterlogging from the water table. Mix soil to improve soil fertility/nutrient availability. Where needed, create weed-free planting position. Minimal soil disturbance.	Mix soil to improve soil fertility/ nutrient availability. Reduce potential for waterlogging. Minimal soil disturbance.

To identify which techniques achieve your cultivation objectives, apply the information from the row immediately above to Table 3.

Table 3 - Capability of different cultivation techniques

Technique	Capability for cultivation objective(s)			
	Reduce weed competition for nutrients and moisture	Mix soil to improve fertility or nutrient availability	Reduce or break deep pan (>30 cm) or induration	Create drained planting position (short-term effect)
Manual screefing	Y	N	N	N
Sub-soiling aka ripping or tining*	N	Very limited	Y	Depends on soil type
Patch scarification using excavator	Y	N	N	N
Inverted mounding	Y	Y	Y	Y
Hinge mounding	Y	Y	Limited	Y
Patch scarification using scarifier (aka continuous mounding)	Y	Y	N	Depends on depth scarification tool is set
Trench mounding	Y	Limited	N	Y
Rotary (helix) ploughing*	Y	Depends on soil type	N	Y
Line scarification using disc scarifier*	Y	Y	N	N
Shallow ploughing*	Y	Depends on soil type	N	Y
Deep ploughing*	Y	Depends on soil type	Y	Y

***** Techniques that involve linear cultivation may result in enhanced run-off. Before deciding if they are appropriate to use, consider the characteristics of the soil type, the caveats of use, and the necessary mitigation measures (described in the main text and appendix sheets).

Y = Yes, achieves the objective. N = No, does not achieve objective and may exacerbate the problem.

Appendix 1 illustrates the relationship between soil types and cultivation techniques and recommends best practice.

Step 5: Choose the techniques that will have the lowest overall negative impact

The techniques chosen should cause the least soil disturbance possible to secure long-term management objectives, particularly on organo-mineral soils, and that will, after mitigation measures, have the lowest overall impact on the forest and wider environment.

For a fuller description of the techniques please refer to Bulletin 119. Please note however that we do not approve of any planting on soils with peat greater than 30cm in depth so the relevant section, pages 50,51, are not considered as current advice.

Alongside the factors detailed below, there are also potential negative impacts from the machines being used (for example, their weight causing compaction).

It is increasingly important to consider the influence of climate change on whether a cultivation technique could create a negative overall impact. Projected changes in the frequency and strength of rainfall, drought and wind mean a greater potential risk of soil erosion, soil desiccation and windblow.

Carbon loss

Carbon sequestration to help mitigate the impacts of climate change is a major reason for afforestation supported by state aid. It is therefore essential to minimise losses of carbon by cultivation.

It is known that an increase in soil disturbance enhances the oxidation and mineralisation of soil organic matter, leading to a loss of soil carbon. The loss of carbon due to disturbance increases in proportion to the amount of organic matter in the soil, thus soils holding high organic matter, such as organic and organo-mineral soils, are more vulnerable to carbon loss than mineral soils holding much less.

To reduce potential carbon loss, the UKFS asks forest managers to minimise the amount of soil disturbance necessary to secure management objectives, particularly on organo-mineral soils, and to consider the potential impacts of soil disturbance when planning cultivation operations.

There is no definitive threshold of what is an acceptable level of soil disturbance in relation to carbon loss because the impact depends on the soil type, previous land use, amount of vegetation cover removed in order to plant, and cultivation technique – and the extent to which carbon lost through cultivation can be balanced by the additional amount sequestered by better establishment and tree growth and litter input to soil. Research has demonstrated that trees planted using techniques that disturb more than 30% of deep phase peaty gley soils will not become carbon-positive until more than 20 years after planting.

Furthermore, a recent study aimed at quantifying the medium-term (~100 years) impact of afforestation with Sitka spruce on carbon stocks of peaty gley soils observed a noticeable carbon loss of about 30% on sites that had experienced intensive site preparation practices during the first 30 years of the first rotation, consequently taking up to two rotations to recover and balance out the carbon deficit.

Techniques that create a medium to high level of disturbance on organo-mineral soils with an organic layer >10 cm represent a significant risk of losing soil carbon.

To ensure that woodland creation proposals create a positive soil carbon balance within an acceptable timeframe, techniques that involve a medium or high level of disturbance (marked amber or red in the table 4 below) should be restricted to soils with a peat depth layer of 10 cm or less.

Appendix 1 – decision making matrix illustrates the relationship between soil types and cultivation techniques and recommends best practice.

Table 4. The expected impact of using different cultivation techniques.

Method and depth disturbed	Volume disturbed m3/ha	Approx. % of topsoil (0-30cm) disturbed	Level of disturbance
Manual screefing (10 cm)	Negligible	0%	None
Sub-soiling (ripping/tining) (45-60 cm)	60	2%	Low
Patch scarification using excavator (20 cm)	90	3%	Low
Inverted mounding (30 cm)	160	5%	Low
Hinge mounding (30 cm)	160	5%	Low
Patch scarification using shallow scarifier – aka continuous mounding (15 cm)	215	7%	Low
Trench mounding (50 cm)	380	13%	Medium
Shallow plough using double throw rotary mouldboard (30 cm)	560	19%	Medium
Line scarification using disc scarifier (shallow continuous strip) (20 cm)	630	21%	Medium
Shallow plough using double throw mouldboard (30 cm)	710	24%	Medium
Line scarification using disc scarifier (deep continuous strip) (20 cm)	840	28%	Medium
Deep plough without tine using single or double throw mouldboard (45 cm)	1,030	34%	High
Deep plough with tine using double throw mouldboard (60 cm)	1,430	48%	High
Deep plough with tine using single throw mouldboard (45 cm)	1,575	53%	High
Agricultural ploughing (30 cm)	2,500	83%	High

For more detail please refer to FC Bulletin 119 'Cultivation of Soils for Forestry', 1999.

Water management

Mitigation measures should manage the pathway of water flow, and thus the potential movement of sediment and diffuse pollutants that may be caused by the chosen cultivation technique. By slowing down runoff, reducing soil erosion and trapping sediment, mitigation measures can help limit a potential increase in peak flows and prevent sediment from reaching a waterbody, and so make the difference between a technique having a higher or lower overall negative impact.

Watercourses, standing water, water abstraction points and wetlands should be protected from disturbance by using buffer areas. When planning cultivation, consideration must also be given to groundwater dependant terrestrial ecosystems.

Mitigation measures should also consider the potential interactions between cultivation and existing site drainage, including overgrown connected ditches (whether they are dry or running), as any water channel that connects to a flowing body of water is classified as a watercourse.

The UKFS recommends the following minimum widths of buffer area:

Buffer width	Situation
10 m	Along permanent watercourses with a channel less than 2 m wide. (Narrower widths of buffer area may be allowable along minor watercourses with a channel less than 1 m wide, especially on steep ground.)
20 m	Along watercourses with a channel more than 2 m wide and along the edge of lakes, reservoirs, large ponds and wetlands.
50 m	Around abstraction points for public or private water supply, such as springs, wells, boreholes and surface water intakes.

Ion

The UKFS also states that within buffer areas, only hinge mounding should be used as a cultivation technique (Water Guideline 19). This guidance expands on that guideline:

Within buffer areas, cultivation is restricted to manual screefing, inverted mounding and hinge mounding because they create a lower negative impact. In general, the aim in buffer areas is to establish and maintain a partial cover of riparian woodland comprising species native to the location and soils.

Long term Forest Research studies have demonstrated that the mitigation measures described in this Guidance are effective for controlling erosion hazards in most circumstances where the soils are of low or moderate erosion risk. However, erosion risk on slopes steeper than 11^0 (20%) is high for many soil types and confidence is reduced about whether mitigation measures would be effective at controlling the erosion risk and protecting the water environment. In these situations, where linear cultivation channels are being proposed it will be necessary to survey the soil and assess the soil texture and water absorbency in order to determine the erosion risk. Details of how to do this are provided in the FC soils identification field guide.

Information on good practice water and soil management is available in the FC Practice Guide: Managing forest operations to protect the water environment. Please note this guidance was produced before the decision was taken that given the distribution of soils, habitats and site types in England, it is unlikely that double mouldboard forestry ploughing will be considered as an appropriate method of cultivation and therefore will not be supported by woodland creation grant agreements signed after 31 December 2020.

Forest stability

Wind risk is one of the most significant threats to UK forests, a situation likely to be exacerbated by the projected increase in extreme weather events linked to climate change. Wind damage results in economic losses through reduced rotation lengths, reduced yields of recoverable timber and increased harvesting costs.
Windblow has a negative effect on the carbon balance of forests as storm damage increases carbon losses from the soil and overall carbon sequestration in trees is reduced, as shorter rotations lead to smaller long-term carbon stocks when compared to longer rotations.

Windblow also has a negative impact on the landscape and wildlife habitats, and can lead to an increase in the occurrence of tree pests and diseases.

The risk of windblow is significantly higher on sites with a Detailed Aspect Method Score (a method of determining windiness) of 16 or above ('highly exposed'), particularly on wet, poorly aerated soils such as surface water gleys and peaty gleys, where rooting depth is typically restricted to less than 50 cm. Where soil conditions prevent deep rooting, radial symmetry becomes increasingly important. The main structural roots are determined in the first 6-8 years of a tree's life and their distribution is critically affected by cultivation.

Cultivation techniques should encourage conditions that will decrease the risk of windblow. Research carried out on stands of Sitka spruce and Lodgepole pine established that mounding encourages regular root development on poorly aerated soils, whilst spaced furrow ploughing or line scarification restricts root spread, thus prejudicing future tree stability. Whether the impact on rooting results in catastrophic windblow will depend on many factors, such as exposure, rotation length, thinning history or where felling for road lines or initial clear fell coupes expose unstable 'brown' edges in the remaining crop.

As a result, ploughing or line scarification is not recommended on woodland creation sites with a DAMS score of 16 or above, particularly on gley soils.

When preparing your woodland creation proposal, you will be required to evaluate the risk of the proposed cultivation technique on the long-term stability of the forest and its impact on future management options.

Where, despite the increased risks of windblow, ploughing is proposed, future coupe boundaries and access roads must be carefully planned and implemented on the ground during forest establishment. This will involve incorporating unplanted permanent rides, sufficiently wide (15-20 m minimum), to ensure the formation of wind firm coupe boundaries.

Alternative solutions include designing forests so adjoining coupe edges are composed of different species of different growth rates, or long-term management proposals such as an increase in permanent native woodland strategically integrated within the planting design.

Further information on managing forests to reduce storm damage can be found in Living with Storm Damage to Forests.

Landscape and Heritage

Most linear cultivation (and some point cultivation) techniques have a strong visual impact due to the amount of material exposed and the regular patterns they create on the landscape. Visual ground disturbance will fade with time but the planted trees may carry on the pattern until the canopy structure matures.

Assessing the landscape context of a forestry proposal by appreciating its landscape and visual sensitivities is part of the forest design process. You can find advice on this on the Forest Research website.

Before any cultivation operations are undertaken every effort should be made to check for any known historic features. Information about protected heritage assets can be found on the Magic website and in the National Heritage List, with advice available from Historic England. Information and advice on non-designated heritage assets should be sought from local authority historic environment/archaeology services. Disturbing the ground on Scheduled Monuments requires prior Scheduled Monument Consent; to plant trees or cultivate on a Scheduled Monument ahead of tree planting without consent is a criminal offence. Even if no historic features are recorded, there may still be unknown remains present and cultivation techniques may affect these, so reinforcing the need to minimise soil disturbance as a precautionary measure.

Step 6: Prepare the woodland creation plan

Once suitable cultivation techniques and the associated constraints, impacts and relevant mitigation measures have been identified, the woodland creation plan, including any operational plans such as cultivation and drainage plans can be prepared. The cultivation part of any plans should demonstrate that the chosen technique – or multiple techniques/modifications on a single site - is the most appropriate for the site's conditions.

One way to do this would be to show that this guidance has been worked through in order to arrive at a decision. Explain how the technique will be applied on the ground and what specific mitigation measures will be used. Make sure the measures are realistic and achievable – it is the forest manager's responsibility to ensure plans and measures are implemented effectively. Include all the data asked for and ensure that it is accurate.

Read more on GOV.UK

Versions

Version 1 issued 16.02.2021

Appendix 1 – decision making matrix

Legend:
+ + + ... recommended best practice
+ + ... possible alternative
+ ... acceptable under certain circumstances, e.g. on small areas
* ... manual screefing only
** ... clay soils only

least intensive → most intensive

Drainage (top to bottom): freely draining – variable – waterlogged

Soil	Condition	No cultivation	Subsoiling/Ripping	Inverted mounding	Patch scarification	Disc scarification (linear)	Mulching	Hinge mounding	Trench mounding	Shallow strip ploughing (linear)	Deep complete ploughing
Brown earth	SNR Poor or Medium	+ +			+ + +	+ + +	+ +			+	
Brown earth	SNR Rich or Very Rich	+ + +			+	+					
Podzol		+ +		+ +	+ +	+ + +	+ + +	+		+	
Ironpan	Pan poses no obstacle to rooting	+ +	+ +	+ + +	+	+	+	+		+	
Ironpan	Pan limits root growth		+ + +	+ + +							+
Ironpan	Pan is out of reach →		Treat like gley / peaty gley / deep peat, depending on prescence and depth of organic layer.								
Ranker		+ + +			+ +*						
Gley	SNR Poor or Medium	+ +	+ +**	+ + +	+		+	+	+		
Gley	SNR Rich or Very Rich	+ + +	+ +**	+	+			+	+		
Peaty gley		+		+ + +			+				