Forest Research

BPG NOTE 19
Best Practice Guidance for Land Regeneration

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SOIL PREPARATION FOR THE CREATION OF SPECIES-RICH GRASSLAND HABITATS

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Introduction

It is commonplace in land regeneration for the available soils to be physically damaged, with variable nutritional status. A common misconception is that these soils are inherently suitable for the creation of species-rich grassland habitats, yet such habitats do require soils of a suitable quality to establish. The soil should be of low fertility and prepared to a good standard in order to maximise germination rates and establishment of the sward. The aim of soil preparation is to produce a functional soil profile that provides the plants of the target vegetation type with an appropriate balance of drainage and moisture retention through the creation of void spaces of various sizes.

Information on the specific soil characteristics required by different species-rich grassland habitats is provided in the following Best Practice Guidance Notes:

- 15. Wildflower meadow: creation and management in land regeneration
- 16. Lowland acid grassland: creation and management in land regeneration
- 17. Lowland neutral grassland: creation and management in land regeneration
- 18. Lowland calcareous grassland: creation and management in land regeneration

This BPG Note presents the essential considerations and practices required to prepare the soil profile for the establishment of a species-rich grassland habitat.

Figure 1 Subsoil ripping using tracked machinery *(Photo: © Tim O'Hare Associates)*

Initial considerations

Timing of operations

The timing of key operations, such as soil placement, cultivation, seedbed preparation and seeding, need to be considered at an early stage of the project. Soil handling stages should be timed for periods of relatively dry weather and periods of wet weather should be avoided (see Soil preparation section below). Seeding is best done during the autumn period,[1] when soils are still warm from summer and there is a low risk of drought, though always check this is the preferred seeding time for your target species. Spring seeding may also be successful once soil temperatures have risen above 10°C.

Species-specific requirements to break seed dormancy before germination, such as stratification (a period of frost/low temperature), should also be factored in at this stage.

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[1] Does not include green-hay strewing as the source of seed. See BPG Notes 16, 17 and 18 for further details on green-hay strewing.

Soil texture and drainage potential

Soil texture refers to the relative proportions of sand, silt and clay-sized particles that comprise the soil matrix. Clay and silt-dominated soils tend to be characterised as 'heavy' and moisture retentive, with sandy soils being 'light' and typically free-draining (possibly prone to drought). Soils with roughly equal weighting between the particle sizes are often referred to as 'loamy' and have a good balance between moisture retention and drainage.

The prevalent soil textures and the site's drainage potential should be assessed so that they can be factored into the design of the proposed habitat (vegetation type and seed selection) and to direct soil preparation and placement operations.

Soil depth

A soil profile of 500 to 700 mm is generally recommended in land regeneration for the establishment of grassland habitats (except calcareous grasslands, see below). This should comprise both a 'topsoil' and a 'subsoil'. 'Topsoil' refers to the surface 150 to 300 mm of soil, which should be prepared to a higher specification of physical condition and usually contains a higher level of organic matter and nutrients, and 'subsoil' refers to the worked soil resource below the 'topsoil'.

A minimum recommended total soil depth of 300 mm is needed for the establishment of grassland. While it is possible to create neutral and acid grasslands on a total soil depth of 200 mm, the grassland sward may be prone to drought on shallow soil horizons and its productivity is likely to be reduced. Grassland habitat creation on shallow total soil depths should therefore only be considered if detailed analysis of the site-specific conditions show it to be appropriate, where it is recommended by a suitably qualified soil scientist or when creating calcareous grasslands, where a total soil depth of 100 mm is preferred (and the depth should not be greater than 200 mm).

Soil preparation

Soil placement

The sequence of operations required to prepare the total soil profile for grassland habitat creation is presented in Figure 2. Good soil husbandry and management should be practised at all times to maintain the physical condition of the soil and avoid structural damage. Accordingly, perform soil operations, including soil stripping, stockpiling, re-spreading (placement), cultivating and seeding, only when the soil is reasonably dry and non-plastic (friable) in consistency (see Box 1).

Figure 2 Sequence of operations for preparing the total soil profile for grassland habitat creation

Subsoil placement → **Topsoil* placement** → **Subsoil decompaction** → **Topsoil cultivation** → **Seedbed preparation**

* Where desirable, it may be possible to ameliorate the subsoil or an alternative soil-forming material to perform the role of topsoil (see the Soil-forming materials section). This process is known as topsoil manufacture. See BPG Note 5, and those BPG Notes related to the specific grassland type to be created, for further details. Alternatively, project-specific advice may be sought from a suitably qualified soil scientist.

Avoid working on the soil during and after heavy rainfall to prevent damage, such as compaction, and do not continue until the soil is once more friable in consistency.

Box 1 Soil plasticity

Soil plasticity may be assessed on site using the field plasticity test, as follows. If a handful of soil can be rolled between the hands to a 40-mm-long cylinder ('worm') with a diameter of less than 6 mm it may be classified as plastic and would be too moist for safe handling. Moist/wet soil should be allowed to dry before further handling.

[2] If compaction through trampling will be a regular occurrence after habitat creation then this should be taken into consideration when selecting which habitat(s) to be created, during the planning process.

Ensure that the soil is not unnecessarily trampled or trafficked as this can lead to compaction.[2] If the soil is structurally damaged and compacted during any stage of the works, it should be cultivated to relieve the compaction and to restore structure prior to seeding (see below).

See BPG Note 4 (on loose tipping) and BPG Note 5 (on imported soil or soil-forming materials placement) for further information on placement of the subsoil and topsoil layers.

Following placement of the subsoil and topsoil layers, subsoil decompaction, topsoil cultivation and seedbed preparation should be completed as required. These operations are given based on typical, relatively deep, soil profiles and should be adapted where soil profiles are thin (<300 mm), stone content is high (>25% w/w) or 'soil-forming materials' are used (see below).

Subsoil decompaction

Subsoil decompaction (also termed 'subsoiling') should be performed to break up layers of compaction created during placement of the topsoil. Subsoiling involves the use of agricultural type equipment (Figures 1 and 3) to fracture and loosen deeper soil (below 300 mm) in order to improve its rootability and drainage and to avoid stagnation of water within the soil profile. This operation is important as it will also 'key in' the topsoil to the subsoil, helping to create natural conditions and to promote healthy soil function and movement of water through the soil profile.

A working depth of 450 to 600 mm should be selected, with spacing of 600 to 1000 mm. For open areas, with access for large-scale machinery, subsoiling should be carried out using a large tractor (>100 horse-power) or a tracked machine fitted with a 'subsoiler' (agricultural type).

Smaller sites and areas with restricted access (including corners of fields etc.) can be worked using a suitable mechanical excavator with a single rigid tine attachment (Figure 4).

Figure 3a Tractor-drawn wing-tined subsoiler.

Figure 3b Wing-tined subsoiler in use.

Figure 4a Tracked excavator with a single rigid tine.

Figure 4b The single rigid tine in use.

(Photos on pages 3 & 4: © Tim O'Hare Associates)

Topsoil cultivation

Following successful subsoil decompaction, the topsoil should be cultivated to its full depth using suitable tillage equipment, such as a power harrow (Figure 5), set of discs or chisel plough (Figure 6), to break up soil lumps and produce a suitable soil structure. For smaller areas, a mechanical excavator fitted with a 'landscape rake' (Figure 7) offers a versatile means of topsoil cultivation.

Figure 5a Topsoil cultivator – power harrow.

Figure 5b Topsoil cultivator – power harrow in use.

Figure 6a Topsoil cultivator – chisel plough.

Figure 6b Topsoil cultivator – chisel plough (close-up).

Figure 7a Topsoil cultivator – tracked excavator with landscape rake attachment.

Figure 7b Landscape rake attachment in use.

Seedbed preparation

A seedbed should be prepared from the upper 100 mm of topsoil using a suitable harrow to create a fine tilth (<10 mm aggregates). This is particularly important given the small size of many wildflower seeds and the often low seeding rates (5 g m^{-2}). The soil is now ready for seeding, which should be undertaken according to the seed being sown and the habitat type sort (see BPG Notes 15, 16, 17 and 18 for further details).

Following seeding, the seedbed should be gently firmed, using a Cambridge roller where necessary.

Soil-forming materials

A variety of soil-forming materials may be used for the creation of grassland habitats. These include subsoils, quarry overburdens and wastes, building wastes, dredgings, railway ballast, crushed brick, chalk and limestone. The likely poor nutrient status of these materials can encourage floral diversity, but typically these 'formed soils' require an extended period for the development of a satisfactory sward. The development period could be reduced by conducting 'topsoil manufacture'. This is the process whereby a suitable organic amendment (e.g. paper-mill sludge, green compost or spent-mushroom compost) is incorporated into the soil-forming material at a suitable application rate to create the topsoil layer (see BPG Notes 5, 15, 16, 17 or 18 for target specifications).

Careful consideration must be given in relation to the use of soil-forming materials. Appropriate testing for potential contaminants and fertility status is required; see BPG Notes 2 and 5. Further information concerning the characteristics for many soil-forming materials and organic ameliorants may be found in Bending *et al*. (1999). Alternatively, project-specific advice may be sought from a suitably qualified soil scientist.

While it is possible to adjust soil pH and fertility by selecting soil-forming materials and amendments with varying characteristics, you should aim to create a habitat that is most suited to the inherent quality and conditions of the planting medium on your site, as this is a more sustainable practice. You should also aim to create a habitat that is in keeping with the local character and landscape.

References

Bending, N.A.D., McRae, S.G. and Moffat A.J. (1999). *Soil-forming materials: their use in land reclamation.* DETR/The Stationery Office, London.

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