Fundamentals of Mechanical Site Preparation
FRDA Report 178
ACKNOWLEDGEMENTS

This manual was produced through funding support of the Canada-British Columbia Partnership Agreement on Forest Resource Development (FRDA II). This manual is based, in part, on the publication *Instruktion för Markberegnning* produced by SCA Skog AB, Sundsvall, Sweden. I would like to acknowledge their cooperation and support.

I would like to thank Dr. Stig Hagner for acting as facilitator in Sweden, artists Martin Holmer and Karen Somerville, and Curt Clarke for his help in report preparation. I would also like to thank Dr. R. G. McMinn, Anne Macadam, and all Ministry staff and site preparation contractors who reviewed the translation and offered their comments.

Marc A. von der Gönna

TABLE OF CONTENTS

- Acknowledgements ........................................... 2
- Objectives ..................................................... 3
- What is site preparation? ..................................... 4
- What can be accomplished through site preparation? ....... 5
- Site preparation methods ...................................... 6
- Choosing the site preparation method ....................... 19
- Spacing .......................................................... 20
- Matching the site preparation method to the site .......... 22
- Post treatment follow up ....................................... 24
- Operational considerations ................................... 25

Compiled by
Marc A. von der Gönna
Silviculture Branch
British Columbia Ministry of Forests
The objectives of site preparation can be summarized in three points:

- Create sufficient numbers of suitable, well-spaced growing sites for newly established seedlings, either planted or natural, to survive and attain good growth.
- Do so without causing detrimental or excessive soil disturbance.
- Obtain the desired result at the lowest possible cost.

Site preparation may also achieve any one of the following points:

- Facilitate planter access.
- Control competing vegetation.
- Control pests.
- Reduce the hazard from fire.
WHAT IS SITE PREPARATION?

Site preparation creates a favourable growing area for seedlings and good germination spots for seeds. This is accomplished by physically altering slash, duff, and soil layers by a variety of methods, including scalping, trenching, plowing, mixing and mounding. Through site preparation, factors that are limiting for seedling survival and growth may be overcome.

Correctly performed site preparation creates enough disturbance to overcome limiting site factors without causing excessive soil disturbance or degradation. Combined with natural seeding or proper planting techniques, site preparation can give seedlings a good start. This is shown by evidence of the following results:

- Quick development of the root system (good establishment).
- High survival.
- Good growth.
WHAT CAN BE ACCOMPLISHED THROUGH SITE PREPARATION?

Through proper, ecosystem-based prescription, site preparation can overcome many unfavourable site factors. However, when applied incorrectly or on the wrong site or ecosystem, site preparation can also create unfavourable growing conditions.

The temperature in the root zone can be increased.

Available oxygen in the soil can be increased.

The risk of frost damage can be decreased (in some cases).

Moisture problems, such as drying out or waterlogging, can be overcome.

Competing vegetation can be reduced.

Nutrient availability can be increased.

The risk of insect attack can be reduced.

Planting can be made easier.
# SITE PREPARATION METHODS

This guidebook deals with five mechanical site preparation methods commonly used in British Columbia—scalping, trenching, plowing, mixing and mounding. Drag scarification for natural regeneration and slash treatments, such as piling or windrowing, is not covered.*

## Soil Disturbance

Mechanical site preparation can be defined as planned soil disturbance to achieve desired silvicultural objectives. Excessive soil disturbance, however, can lead to unwanted results such as removal of nutrients beyond seedling root systems, compaction, erosion, or even landslides. On the other hand, too little disturbance may not be sufficient to achieve the desired objectives, such as controlling competing vegetation. In general, the following quotation should be used as a working guideline:

"as much as necessary but as little as possible".

Different site preparation methods create different amounts and types of soil disturbance. When selecting the site preparation method, one must consider the sensitivity of the site to long-term degradation.

<table>
<thead>
<tr>
<th>Method</th>
<th>Area of ground surface disturbed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Spot scarification and mounding.</td>
<td>10–30 %</td>
</tr>
<tr>
<td>Disc trenching</td>
<td>25–50 %</td>
</tr>
<tr>
<td>Plowing</td>
<td>30–65 %</td>
</tr>
<tr>
<td>Mixing (e.g., bedding plow, Madge)</td>
<td>up to 100 %</td>
</tr>
</tbody>
</table>

* For information regarding these treatments see: Drag scarification in British Columbia and Guide for windrowing logging slash in the British Columbia Interior.
SITE PREPARATION METHODS

What makes a soil fertile?
Two of the most important factors are:

**Organic matter**
- contains the bulk of soil nutrients
- essential to biological activity in the soil
- helps retain moisture
- helps retain porous structure
- forest floor (duff) protects the underlying soil from structural damage and erosion

**Porous soil structure**
- encourages root growth
- permits the free movement of air and moisture into the soil
- necessary for good soil drainage
- necessary for healthy biological activity

What is detrimental soil disturbance?
Two types of soil disturbance that can be very damaging to site productivity are:

**Compaction**
Compaction can be the result of machine traffic that is excessive or poorly timed, or the inappropriate choice of equipment. Soils are most prone to compaction when they are moist (wet). Soils with a high clay content are the most sensitive.

**Extensive soil displacement**
Extensive soil displacement is the removal of forest floor and upper mineral soil layers beyond the seedling root system. Excessive soil displacement often results in the exposure of unfavourable material.

- Nutrients removed, surface soil exposed to compaction, erosion and increased moisture loss.
SITE PREPARATION METHODS

No Site Preparation
Mechanical site preparation is suitable for most sites. The following are three sites that are not suited to site preparation:

Dry, nutrient poor sites
These sites often have coarse-textured soils and a shallow duff layer. An example is SBSmco2, Pine-Huckleberry-Cladonia

Naturally regenerated sites
Sites where the new stand is established through natural regeneration from the old stand.

Small wet pockets
Some sites contain small sections of wet ground that would require different scarification equipment than that used on the remainder of the area. These sections are often quite productive; therefore, one has to decide whether the total area of such sections is large enough to justify the use of a different machine, or should remain untreated. One alternative is to use a more expensive but versatile machine (such as an excavator) which can provide a variety of treatments.

Manual and Motor Manual Site Preparation
Manual and motor manual site preparation should be used on areas where slope, ground roughness, or site sensitivity prohibit the use of machinery.

Manual site preparation is done with the planting shovel or by boot screeing.

Motor manual site preparation is done using modified brush saws or chain saws equipped with a site preparation blade. When performing motor manual site preparation, protective equipment, such as eye and ear protectors and leg guards, is required.
Mounding

Raised planting spots are usually good growing sites for seedlings, especially in cold, moist climates. Increased soil temperature, loose and oxygen-rich mineral soil, and good drainage promotes rapid root growth, seedling establishment, and early seedling performance. Mounds can control competing vegetation, retain nutrients of surface organic layers, increase light available to the crop seedlings and reduce the hazard of snow press and frost damage.

Mounds vary in size depending upon their composition and the objective of the mound treatment. On heavy, clay soils mounds require only 10–15 cm of mineral soil capping, while on wet organic soils mounds can be as large as required to elevate the seedling root system above restrictive high water tables. In most cases, mounds should not exceed 20–30 cm in total height after settling. Mounds must be wide enough to control competing vegetation. In all cases, mounds should be formed with flat to concave tops and gently sloping sides, and should have good contact with the humus or soil layers below. Concave tops are especially important on sites subject to seasonal drying as they help collect rainwater and prevent the mound from drying out. When forming mounds, care must be taken to avoid capping over slash or other debris, which would cause a barrier to root egress from the mound and increase the risk of the mound drying out.

Mounds may be composed of one of the following combinations:

- Mineral soil capping on inverted humus.
- Mineral soil capping on undisturbed duff.
- Mineral soil on mineral soil.
- Mixed surface organic matter and mineral soil.
- Well decomposed organic matter (peat soils) on organic matter.

Deep planting almost always applies when planting on mounds. Deep planting implies that the seedling is planted with the root collar buried at least 5 cm in mineral soil or humus. Inappropriate mounding or improper (shallow) planting can make the crop seedling vulnerable to drought and increase the risk of frost heaving. Deep planting also protects roots from being exposed due to weathering of the mound surface subsequent to planting.
SITE PREPARATION METHODS

Mounding Equipment
To obtain good results, the choice of equipment used must match the operating conditions of the site and the type and size of mound to be created.

Pulled or Skidder Mounted Mounders
These are recommended on most sites with good trafficability and gentle slopes, however, they should not be used where any of the following conditions are present:
- Sites with heavy slash loading.
- Sites with a thick humus layer.
- Extremely wet sites.
- Sites with slopes greater than 20%.

Crawler Mounted Mounders
These units have the ability to work on a wider range of sites and on slopes up to 25-30%. The added power of a crawler, combined with a slash parting V-plow or rake, can successfully mound on sites with moderate to heavy slash loadings.
Mounding Equipment

*Excavator Mounding Attachments*

Excavators are the most versatile, but costly, type of mounding equipment. They are recommended for all sites, but are especially cost competitive on sites with the following conditions:

- Sites with heavy slash loading.
- Sites with high stumps and many obstacles.
- Sites with a thick humus layer.
- Sites with a slope > 25%.
- Brushy sites.
- Wet sites.
- Sites where a variety of mound sizes and types are required.

---

On extremely wet sites, mounding can be combined with ditching. However, ditching must be approached with caution, and carefully planned to avoid mineral soil erosion and stream sedimentation.
SITE PREPARATION METHODS

Scalping

During scalping, patches of mineral soil are exposed in a systematic pattern. Scalps should only be deep enough to remove unfavourable litter and duff layers, and expose well-decomposed organic or favourable mineral soil horizons. **Care must be taken to avoid scalping too deep or too wide,** especially on nutrient poor sites with a thin humus layer. Removing nutrients beyond seedling roots or exposing unfavourable soil substrates can lead to poor seedling performance. However, scalps must be large enough to reduce the influence of competing vegetation.

Scalping is recommended for sites with the following conditions:

- Dry sites.
- Sites with a thin humus layer.
- Sites subject to grazing (rangeland or wildlife).
- Sloped sites where erosion due to water channelling is a concern.
- Sites where continuous trenches would encourage the spread of unwanted vegetation.

**Scalping should not be done on wet sites, where planting in scalped spots can place seedling roots in saturated soil. Scalping on fine-textured soils places seedlings at risk for frost heaving.**

Depending upon the equipment used, scalping can produce a range of planting spots. Often a small mound of inverted humus, or sod, with some mineral soil is formed. On most sites, seedlings should be planted on the shoulder of the exposed mineral soil, adjacent to the inverted humus. On dry sites the seedling may be planted in the bottom of the scalp. **Scalping should not be done on sites prone to frost heaving.** Rather, on these sites seedlings need to be planted in the inverted humus with sufficient mound capping.
SITE PREPARATION METHODS

Scalping Equipment

*Pulled or Skidder Mounted Implements*

These are recommended on most sites with good trafficability, gentle slopes, and moderate humus depths. Skidder mounted implements are characterized by high productivity and low treatment costs.

*Brücke two-row scarifier*

*Leno scarifier*

*Excavator Attachments*

Standard buckets with teeth, or rakes, are all that is required for scalping. Excavators have generally low productivity and high treatment costs, and are used for scalping only on sites with steep slopes, heavy slash or high stumps, or where a variety of site preparation treatments is required.
**Disc Trenching**

The results of disc trenching vary, depending upon site factors, the type of disc trencher and what machine settings are used.

Disc trenchers are recommended for a wide range of sites, for natural regeneration or planting. They should not, however, be used on wet or steep sites. On rangeland (domestic or wildlife), or sloped sites where erosion from water channelling is a concern, disc trenching should only be performed intermittently.

Disc trenching can produce 3 distinct planting positions:
- Trench position for dry sites.
- Hinge position for medium sites.
- Berm position for moist sites.

The trench profile can be adjusted by changing the disc angle, down-pressure, and travel speed. A disc angle more perpendicular to the direction of travel produces a wider, flatter trench, while a disc angle more parallel to the direction of travel produces a deeper, narrower trench. By increasing the down-pressure and decreasing the travel speed, a deeper trench and a well formed berm are produced.
SITE PREPARATION METHODS

Disc Trenching Equipment

Disc Trenchers
Disc trenchers can be grouped into three distinct categories: passive trenchers, trenchers with hydraulic down-pressure but passive discs, and trenchers with hydraulic down-pressure and powered-discs. The most common trenchers used in Western Canada have hydraulic downpressure and powered-discs. They are recommended for sites with heavy slash or a relatively deep humus layer, or any other application requiring good disc penetration or berm formation. For proper operation, disc trenchers should never be operated at travel speeds greater than 5 km/h (3 mph). On sites with heavy slash, a v rake can be used to align the slash immediately prior to trenching.

Some powered-disc trenchers have the ability to trench intermittently. These trenchers are recommended for trenching slopes that are too steep to treat by contouring.

Prime Movers
Disc trenchers have been mounted on a variety of prime movers. When selecting the prime mover the following considerations are important:

- Match the prime mover to the site conditions (i.e., slopes, slash loading, trafficability).
- Meet the hydraulic requirements of the disc trencher.
- Match the transmission to high drawbar pull requirements at slow travel speeds (especially if a slash parting device is to be used as well).