LIGHT-WEIGHT MECHANICAL TOOLS FOR SITE PREPARATION IN PLANTED OR NATURALLY-REGENERATED FOREST STANDS

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Introduction

Mechanical site preparation (MSP) methods are widely used for facilitating or allowing stand regeneration, mostly for artificial but sometimes also for natural regeneration. MSP methods in forestry are usually derived from agricultural methods: they typically involve large and heavy machinery; they prepare the soil according to classical agronomical concepts (tillage on the entire area, mixing of soil horizons, creation of a plough-pan) and are not always adapted to forest vegetation characteristics.

In many countries, forest soils have specific characteristics that one should maintain in order to ensure proper forest ecosystem functioning. MSP methods that mix (up and down) soil horizons or that destroy the structure of each horizon strongly modify soil functioning (water movements, microbial activity…). In addition, MSP tools mounted on heavy tractor induces unwanted soil compaction. All these effects on forest soil can be very long lasting.

MSP methods are often used to control competing neighbouring vegetation. Forest vegetation may strongly differ according to site characteristics, particularly in its root development. Some vegetation types that have deep or dense root systems are difficult to control with traditional MSP methods.

Recently, a series of MSP tools mounted on mini-excavators have been developed. Each tool is adapted to specific vegetation and soil types. The use of mini-excavators allows minimising the impact of MSP on environmental factors:

- The low weight of the machine (2.5 to 6 tons) together with the high contact surface area of the rubber caterpillars reduce the risk of soil compaction when operating.
- The various tools are not designed to work at high intensity the whole stand area. On the contrary, the tools are designed to work at low density according to an intermittent spatial design (patches or rows) or in a restricted number of suitable areas. The impacts on the soil, the vegetation and the remnants is therefore limited to the areas were the MSP is actually performed.

The objective of the study is to test these tools and evaluate their overall performance.

Materials and methods

Four tools were tested (see Table 1 for photos):

- A multifunction sub-soiler (Sous soleur multifonction®, Grenier-Franco, France) that decompacts the soil down to 60 cm, without reversing the soil horizons. It may also be used to create an additional 20-cm mound. The tool is used on sites with compacted and/or water-logged soil.
- A deep scarifier (Scarificateur Réversible®, Grenier-Franco) that removes the vegetation, extracts the root systems and fractures the soil structure down to 60 cm deep. The tool is particularly adapted to sites where bracken fern (*Pteridium aquilinium*), which has a deep and dense root system, is competing with the young trees.
- A herb-scalper (Razherb®, Grenier-Franco) that removes the above ground part and the first 5 cm of the root system of herbs. It is used in sites with dense herb coverage (e.g. *Molinia caerulea*).
- A hoe (Pioche Herse®, Grenier-Franco) that removes the vegetation and hoes the soil down to 25 cm deep. It is used on sites with small statured vegetation (e.g. *Vaccinium myrtillus*) where surface scarification is required.

Table 1. Description of the tested tools.

Name	Tool	Site preparation
Multifunction sub-soiler Sous soleur multifonction®		
Deep scarifier Scarificateur Réversible®		
Herb-scalper Razherb®		
Hoe Pioche-herse®		

Three networks of experimental sites (ALTER, PILOTE and WE-PP networks) were installed across a wide range of site conditions in France. Technical evaluation (analysis of their effects on soil properties, on vegetation dynamics and on young tree performance) and economical evaluation of their use are being performed. The technical and economical performances of the tools were compared to classical tools (subsoiler, scarifier, disc harrow…).

Results and discussion

The first results of these studies show that the various tools allow efficient vegetation control for 3 to 4 years after planting (Fig. 1). They create a soil environment suitable for the tree seedlings (large soil volume free of root competition and easily prospectable by the tree root system).

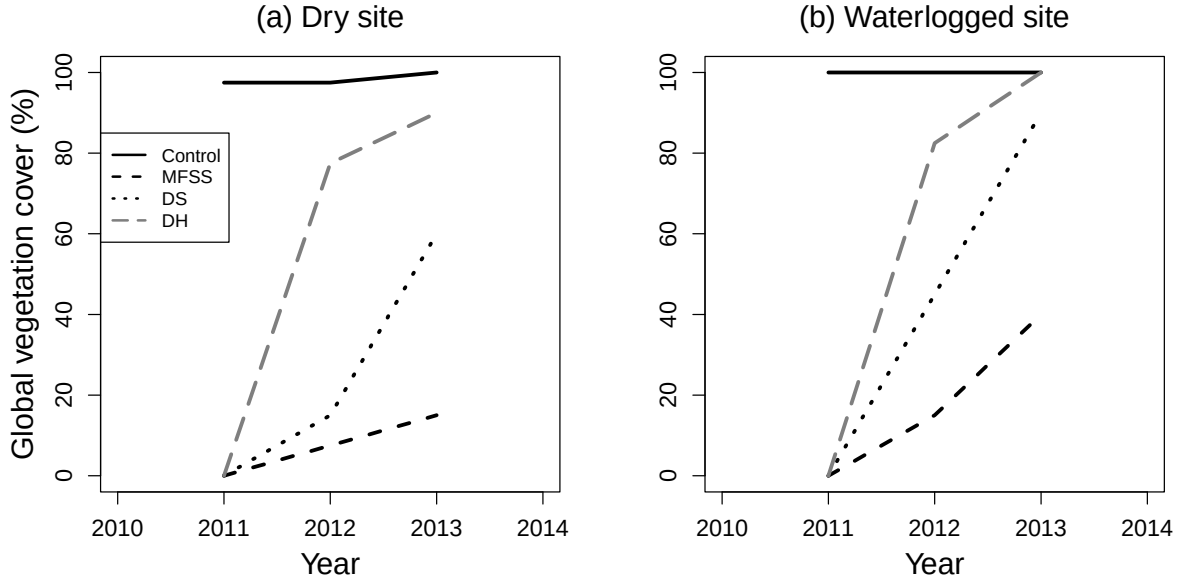

Figure 1. Vegetation cover during 3 years after treatment (a) in a dry site dominated by bracken fern or (b) in a water-logged site dominated by molinia. The two sites are located in Alsace (north-eastern France) and belong to the ALTER network. Treatments are: Control (no site preparation), MFSS (Multi function sub-soiler), DS (Deep scarifier), and DH (Disc harrow).

In most sites, in plantation or in natural regeneration, the various tools allowed high seedling establishment, survival and growth (results not shown).

The economical evaluation was performed in the plantation sites. It showed that the application of these tools is often more expensive than traditional MSP methods. However, when estimating the total costs over 2 or 4 years after planting and when taking into account additional operations that are required to ensure seedling survival, these methods appear to be less expensive than traditional MSP methods, but more expensive that methods requiring herbicides. The exact comparison depends on the tools taken into account and on the planting density.