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PRODUCTIVITY, QUALITY OF WORK AND COSTS ON MECHANIZED FOREST PLANTING

Bräcke and Ecoplanter planting machines and regeneration chain mounding and manual planting were surveyed and compared to each other in three different sites with and without slash removal. Work productivity of the Bräcke was, on average, 198 seedlings per effective hour without slash removal. After slash removal, the increase of work productivity (E_0) in mechanized planting was 18 per cent with the Bräcke. The productivity of Ecoplanter was, on average, 233 seedlings per effective hour with and without slash removal. Work quality was maintained with the Bräcke and regeneration chain mounding and manual planting, but worse with Ecoplanter. Mounding and manual planting was cheaper than machines, on average. However, on two sites with slash removal, the planting cost with the Bräcke was lower than cost of mounding and manual planting. The planting cost with the Ecoplanter was the most expensive method on all sites and with both slash treatments. The results show that mechanized planting is a competitive method in forest regeneration, especially after slash removal.

Keywords: planting, mechanized planting, Ecoplanter, Bräcke, slash removing

Магістр Велі-Матті Саарінен – Фінський ін-т лісових досліджень, Фінляндія

Продуктивність, якість роботи та витрати на механізоване садження лісу

Дослідження проводилися на трьох різних площах у хвойних лісах з використанням саджальних машин "Bräcke" та "Ecoplanter" і вручну. Продуктивність саджальної машини "Bräcke" в середньому склала 198 саджанців за годину, а після очищення площі від лісозаготівельних залишків зросла на 18 %. Продуктивність машини "Ecoplanter" склала в середньому 233 саджанців за годину з очищенням, чи без очищення лісосіки. За якістю роботи перевага надана машині "Bräcke". Що стосується витрат, то ручне садження виявилось набагато дешевшим, ніж машинне. Результати дослідження довели, що механізоване садження лісу є конкуруючим способом у лісовідновленні, особливо на площах очищених від залишків лісозаготівлі.

Ключові слова: садження, механізоване садження, Bräcke, Ecoplanter

Introduction

The mechanisation of forest planting has been an objective in Scandinavian forestry since the 1960's. The development of planting machines was originally been driven by increased labour costs, but nowadays a lack of forest workers is also an important reason for mechanisation.

During the 1970's and 1980's the main development trend in the mechanisation of planting work was the continuous improvement in machines [1]. At that time, site preparation and planting with a narrow working width was done continuously employing a fully automatic planting machine. The quality of the planting work was acceptable, but low cost-effectiveness meant that it was not competitive with manual planting [2].

The subsequent and current trend in mechanisation of forest planting in Scandinavian is intermittently advancing planting machines [1]. These boom-tip mounted machines with or without a site preparation mechanism can be attached to a harvester or excavator boom. The working width of boom-tip planting machines

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is quite wide. The operator determines planting points individually. The possibility to use harvesters and excavators for tasks outside the quite short planting season is an important factor in reducing capital costs. In a previous study [2], the work quality of planting with Bräcke and Ilves boom-tip mounted machines was at the same level as in manual planting, but manual planting was still the cheapest method.

Higher planting costs compared to manual planting is perhaps the main reason why mechanized planting is still uncommon in Finland. Only 1.5 percent of planting was carried out mechanically in 2003 [3]. In recent years conditions for the development of mechanisation of forest planting have improved. In 2002, the first Ecoplanter planting machine was imported into Finland. Compared to previous boom-tip planting machines it is equipped with double planting heads so that is possible to plant two seedlings simultaneously. Productivity should then be higher than using machines with a single planting head.

In addition, slash removal for forest chips for energy production has become quite common. The use of slash, mainly from regeneration areas, has tripled during the last three years [4]. In accordance with national target, the use of forest chips should be 2.5 times higher in 2010 than today [5]. After slash removal, mechanized planting is assumed to become more profitable. In a previous study [6], the increase of work productivity after slash removal was, on average, 20 percent in mechanized planting and the quality of work was slightly better.

The object of this study is to survey the work productivity, quality and costs of mechanized and manual planting. Two boom-tip-mounted planting machines equipped with site preparation mechanism (mounding) and regeneration chain mounding and manual planting were compared in three different conditions. At the same time, the effects of slash removal were surveyed. Only preliminary results are reported at this juncture.

Methods and materials

Three regeneration areas of Norway spruce (*Picea abies* (L.) Karst) with different soil types and stoniness (work difficulty factors) were selected in the southern part of Finland (Table 1). The experimental design was split-plot in three blocks (replications) with planting methods as main plots (0,30 ha/block) and slash as subplots (0,15 ha/block). This design was replicated on each site (Table 1). The use of excavator-mounted Bräcke (Figure 1) and harvester-mounted Ecoplanter (Figure 2) planting machines and manual planting were compared in summer 2002.

Table 1. Description of the sites.

	Site Jäppilä	Site Kangasniemi	Site Karttula
Forestry land	Mire, transforming	Mineral soil	Mineral soil
Soil type	Peat	Till	Till
Stoniness index, %	Class 1. (0 – 20 %)	Class 3. (55 – 75 %)	Class 4. (>80 %)

The machines differ in the mounding principle they employ. The Bräcke planting machine is equipped with a mounding blade and a mound compaction system (Figure 1). The Ecoplanter is equipped with two rotavator-wheels and two planting heads without a mound compaction system (Figure 2).

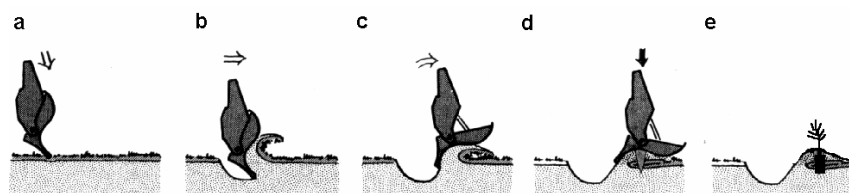


Figure 1. The Brücke planting machine and its mounding method. (Photo: Kari Kautto)

Time studies were conducted during planting (containerised Norway spruce). After planting, the density and the quality of site preparation and planting was analysed with measurements of the seedlings. Mound classification was based on the main material of the mound surface layer.

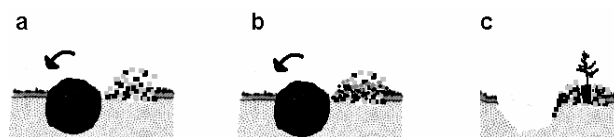


Figure 2. The Ecoplanter planting machine and its mounding method. (Photo: Ecofräsen Ab)

The condition and the height increment of the seedlings were surveyed after the first and the second growing seasons. The condition of the seedlings was analysed subjectively based on health. The classes employed were: health, weakened, dying and dead.

Planting cost calculations for the machines were made using a four month planting or mounding season with a two-shift routine. Outside the planting season, harvesters worked on logging and excavators on excavation work. The annual operating costs for planting (labour, fuel and lubricants, repair and maintenance, transport) and capital costs of the planting period were included. Wages of the forest workers in manual planting was based on piece-rates and work difficulty factors from collective agreements including supervision supplements.

Results

There was little difference in the productivity of the surveyed machines. The removal of slash improved the work productivity of planting only in the case of the Brücke. The productivity per effective hour (E_0) with the Brücke was on average 198 seedlings with slash and 233 with slash removed (Figure 3); that is to say, an improvement of about 18 per cent.

The productivity of the Ecoplanter was on average 223 seedlings per effective hour (E_0) in both slash treatments (Figure 3). The productivity was surprisingly low, although it is possible to plant two seedlings simultaneously with the Ecoplanter. On the other hand, the Bräcke operator was much more experienced in mechanised planting than the Ecoplanter contractor.

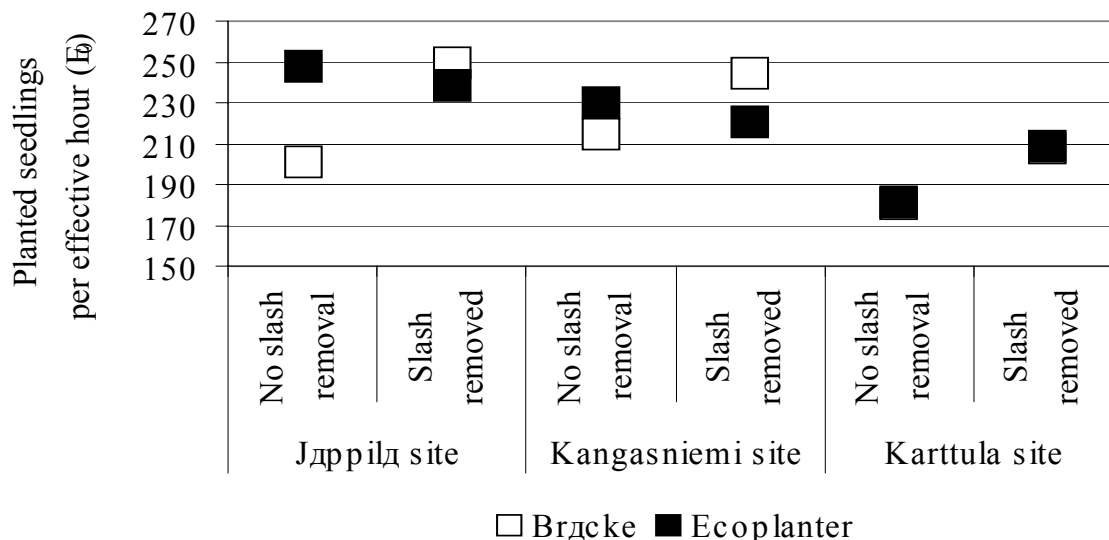


Figure 3. Work productivity (E_0) of the planting machines.

The quality of the mounding phase differed between the planting machines. The proportion of ideal mineral soil mounds and good mineral soil-humus mounds was quite low, especially in the Ecoplanter plots. The quality of mounds was higher both in the mounding (manual planting) and Bräcke plots. The proportion of mineral soil and mineral soil humus mound types was under 20 per cent in the Ecoplanter plots and about 40 per cent in the mounding and Bräcke plots. The effects of slash removal were slight in all treatments.

The quality of the planting phase also differed between the methods. For example, sweeping the seedlings immediately after planting was clearly higher on mechanized planted plots. One fifth of mechanized planted and under one tenth of manual planted seedlings were at the angles of 15 degrees or greater. Sweeping effects from mechanized planting were less when slash was removed.

The condition of the seedlings after the second growing season was the same for both manual planted and Bräcke plots, but worse for Ecoplanter plots. The proportion of dead seedlings by the second growing season was, on average, 10 percent on Ecoplanter plots, 3 percent on Bräcke and manual planted plots. The proportion of weakened and dying seedlings was also the highest on Ecoplanter plots. The main reasons for lower results with the Ecoplanter were the rotovated and uncompacted mounds. Pine weevil damage was worse on the Ecoplanter plots than elsewhere. Differences in the condition and height increment of the seedlings between planting or slash treatments were not observable.

The planting cost in mechanized planting was, on average, higher than in manual planting (Figure 4). The Bräcke planting machine was the cheapest planting method after slash removal on two sites. Planting costs with the Ecoplanter were about 20 per cent higher than with the other methods. Planting costs of Ecoplanter were quite high because of high capital and operational costs and low productivity.

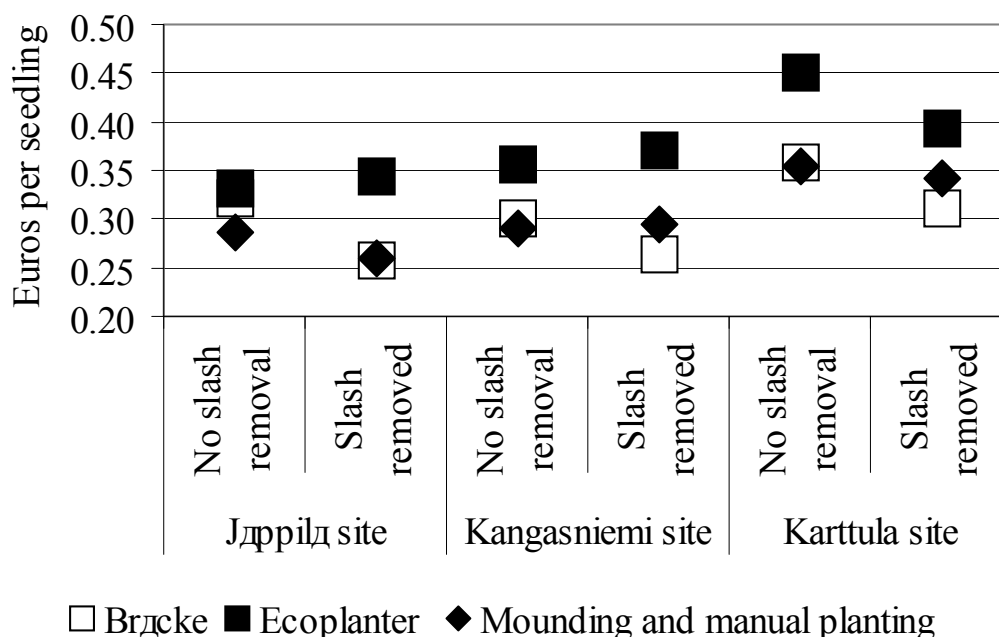


Figure 4. Planting costs by planting methods and slash treatments. Mounding cost in manual planting is included

Conclusion

Bräcke and Ecoplanter planting machines and regeneration chain mounding and manual planting were surveyed and compared to each other in three different sites with and without slash removal.

These preliminary results and a previous study [6] show that slash removal will increase the work productivity and quality of forest regeneration. The comparison between this and earlier studies is difficult, because in practical conditions, machines and operators skills vary considerably.

The work productivity (E_0) of Bräcke planting machine without slash removal was now (on average, 198 seedlings/h E_0) higher than in the other study (148 seedlings/h E_0) [2]. Very high figures for the Bräcke (254 seedlings/h E_0) have also been published [7]. The increase of productivity with slash removal for the Bräcke machine (18 %) was at the same level than in the previous study (20 %) [6], but then the machine was equipped with an automatic feed system. The work productivity of the Ecoplanter without slash removal has been higher (460 seedlings/h E_0) [8] than now (on average 223 seedlings/h E_0), but similar results (230 seedlings/h E_0) [9] have also been reported.

As before [2], these results show that work quality of Bräcke planting machine approaches that of manual planting. In addition, after slash removal, planting costs were even lower than in chain mounding and manual planting. Work quality with the Ecoplanter was clearly poorer than with the other methods. At the same time, the planting costs of Ecoplanter were the highest.

The effects of slash removal, which is becoming more common, are to the advantage of mechanised planting. In addition, new technology and a worsening labour shortage in forestry will increase the competitiveness of mechanized planting.

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THE SITES WITH FULL-AREA GROUND PREPARATION BY DOZER AND DREDGER, ITS CURRENT STAGE AND REVITALIZATION IN 7TH FOREST ALTITUDINAL ZONE OF ORE MOUNTAINS, CZECH REPUBLIC

The full-area ground preparation by dozer, with apposition to rampart composed by top holorganic and partly mineral horizons and also after logging remainders, were leaded to significant degradation of soil environment. Mainly the sites with overburden to mineral layers of sponclck horizons showed contrary values of particular soil characteristics especially humus and basic saturation. Conversely important predisposition factor for revitalization of dozer enclaves was high potential reserves of nutrition and organic substances with favourable amount of ration C: N and higher amount of mineral N in organic mineral ramparts. Today full-area application of organic mineral material with long-term exposition and fermentation especially after logging remainders from ramparts could ensure optimal nutrition and minimal immobilization of N.

Keywords: full area ground preparation, Ore Mountains, nourishment balance

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Ґрунтові ділянки, суцільно оброблені бульдозером та землечерпалкою, їх сучасний стан та відновлення у 7-й лісовій висотній зоні гір Оре, Чеська Республіка

Мета даної наукової роботи – вивчити вплив органічних речовин на стан ґрунту та на лісовідновлення.

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