

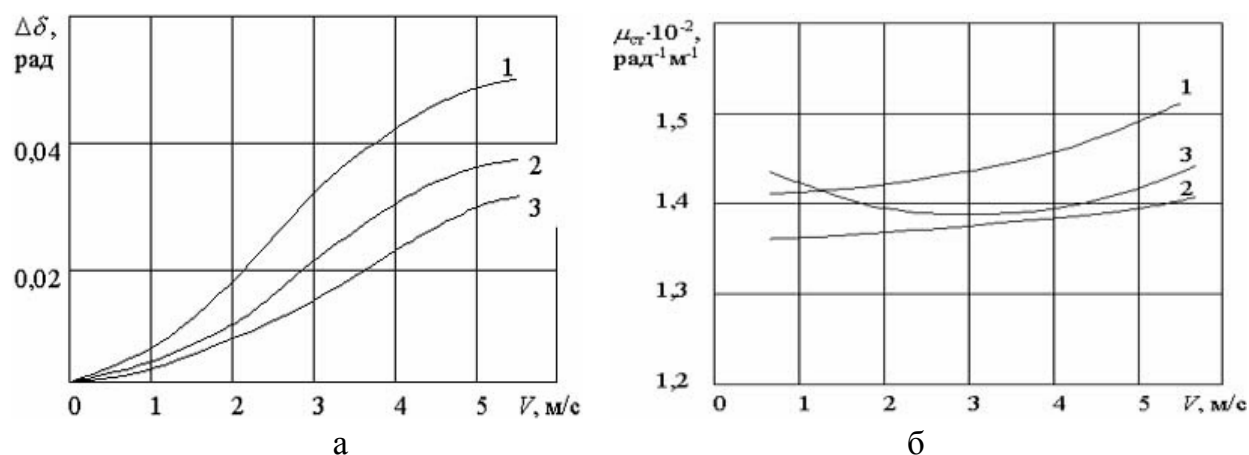


Рис. 5. Статичні характеристики керованості лісотransпортних машин з шарнірною рамою: а – поворотальність $\Delta\delta$; б – чутливість до керувальних впливів $\mu_{ст}$; 1 – двовісний тягач з розпуском і пакетом стовбурів; 2 – двовісний тягач з напівпричепом і пакетом деревини; 3 – двовісний тягач

Виконані дослідження та отримані результати свідчать про актуальність досліджень курсової стійкості та керованості руху колісних лісотransпортних машин з шарнірною рамою і необхідність пошуку оптимальних конструктивних рішень, які дадуть змогу підвищити безпеку їх руху та зменшити навантаження на оператора.

Висновки

1. Курсова стійкість лісотransпортних машин з шарнірною рамою в основному визначається стійкістю руху передньої напіврами тягача.
2. Найбільшою мірою на керованість руху таких машин впливає положення центру ваги тягача (розподіл повної ваги між мостами), а також швидкість руху та тиск повітря в шинах.

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DEVELOPMENT OF TECHNOLOGY FOR CLEANING OPERATIONS IN CONIFEROUS STANDS

The cleaning of secondary trees from young stands has remained a very laborious and expensive operation although unit costs in many other forest operations, such as timber

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harvesting, have markedly decreased during recent decades. This paper reviews some recent experiences, mostly from Finland and Sweden, concerning the development of cleaning operations. The mechanization of cleaning has been difficult, but traditional motor-manual methods of cleaning still have development potential. In the supervision of cleaning operations, geographical information systems for forest management can be used efficiently for locating stands needing tending if an appropriate survey of recently established stands is carried out.

Keywords: cleaning, cost-efficiency, mechanization, Finland, Sweden.

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Розроблення технології рубань прочищення в хвойних насадженнях

Рубання прочищення в молодих насадженнях є дуже трудомісткою і дорогою операцією, хоча вартість лісозаготівельних технологічних операцій в останні десятиріччя має тенденцію до зниження. У статті наведено огляд недавніх досліджень, виконаних, головню, в Фінляндії і Швеції, стосовно розроблення технології операцій прочищення. Механізація прочищення утруднена, водночас традиційні методи на базі ручних інструментів усе ще мають потенціал для вдосконалення. Для моніторингу виконання технологічних операцій прочищення лісових насаджень можуть ефективно використовуватись лісові геоінформаційні технології.

Ключові слова: прочищення, вартісна ефективність, механізація, Фінляндія, Швеція.

Introduction

It is widely agreed that cleaning (tending or clearing) is an important operation in growing coniferous stands. Growth and yield studies indicate that by removing secondary stems from a coniferous stand the volume increment of the main stems is markedly improved [1]. The secondary broad-leaved trees may also touch the coniferous tree-tops and damage apices [2]. The density of the main tree species may also be too high and thus cause slower diameter growth of individual trees. Such stands are often established naturally or by direct-seeding. The first commercial thinning cutting is also difficult to carry out if the stand has been grown too dense.

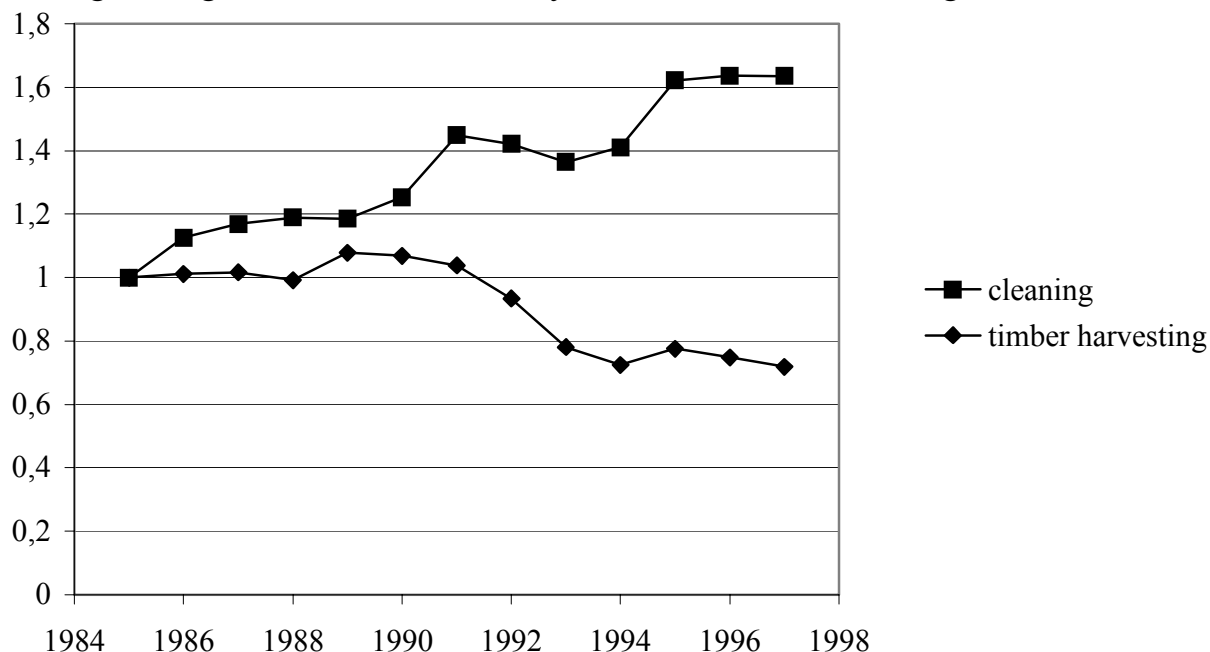


Figure 1. Unit cost indexes of timber harvesting (e.g. €/m³) and cleaning (e.g. €/ha) in Finland from 1985 to 1997. The unit costs in 1985 equal 1

In Finland, the unit costs in silvicultural operations, such as stand establishment and cleaning, have increased markedly compared to the unit costs of timber harvesting. The unit cost indexes of cleaning and timber harvesting (cutting and forest hauling) are shown in Figure 1 [3]. The costs in the Figure are deflated by the wholesale price index. The development of cleaning costs is partly affected by delays in tending young stands. These are more difficult to clean than they would have been in earlier phases of development. Such delays in tending of stands were increasingly common until 1996 when a national programme for the treatment of young forests was established. Since then, the balance between necessary and enforced cleaning areas has been fairly good.

Research and development efforts in timber harvesting have resulted in more efficient methods of operation, mostly due to mechanization. Parallel developments have not existed in silvicultural operations, which are still mostly carried out using methods created over 30 years ago. Indeed, the only silvicultural operation in which a good cost efficiency has been achieved by mechanization is direct-seeding i.e. sowing. Direct-seeding machines can be attached to soil preparation machines for effective operation. In Nordic conditions, the cost-efficiency of mechanized planting is also approaching the cost-efficiency of manual planting. Although there have been a number of innovations in the development of cleaning operations, especially involving mechanization, motor-manual methods using the brush-cutting saw have clearly remained predominant.

Recent developments and stand cleaning in the near future

The annual cleaning area has been about 140,000 ha in Finland and 200,000 ha in Sweden [3]. The targets have been somewhat higher, as high as 275,000 ha in Sweden [4]. On such a large scale, even small relative improvements in the efficiency of operations can have considerable effect on output at the national level.

In addition to the rather poor cost-efficiency, the silvicultural quality of mechanized operations has often failed to reach the desired standards. For example, breakage occurs under the machine in stands with over 1 m by height because saplings are no longer pliable. As a result, strip roads are opened to the stand already before commercial wood is harvested. Damage to remaining trees in the stand has also been a larger problem in mechanized cleaning than in motor-manual cleaning.

At most, there were 20 cleaning machines working in Sweden in 1991. After some years of operation they were all withdrawn from service. The cost-competitiveness of mechanized cleaning compared with motor-manual cleaning was also not as good as expected. Those machines were mostly mounted on forwarders and the operating principle was a hydraulic-driven circular saw. Current research in Sweden is concentrating on a combination of mechanized geometric cleaning and motor-manual cleaning [5]. In such a concept, the stand is first treated using a mechanized cleaning tool, that creates totally cleaned strips in the stand. The rest of the stand is then cleaned by forest workers with brush-cutting saws. This combined method is not yet used in practice but intensive studies are ongoing.

Similar machines to those used in Sweden have also been tested in Finland, but the role they have played in practice has been negligible. It is technically possible to mechanically clean over half of the cleaning areas with such machines is in

most regions of Finland [6]. The productivity of mechanized cleaning operations, the cleaned area per working day, is already fairly good. The problem is the high fixed cost of the base machine, and this raises the unit costs above the costs of motor-manual cleaning.

Cleaning in two steps instead of one has been proposed as a method for growing good quality coniferous trees. The first step, early cleaning, has often been point cleaning, i.e. removing only the secondary stems closer than a given distance from the main stems. A typical cleaning radius for such a method has been one metre. The rest of the secondary stems are left to grow in the stand and removed later when they achieve a given height – in some guide-lines, 6 to 8 meters. Early cleaning is especially necessary in stands where the secondary stems quickly overtake the main stems and thus restrict the growth of the main stems.

Advanced applications of information and communication technologies can also be successfully utilized in the supervision of cleaning operations. An example from northern Sweden [7] is a company providing silvicultural services with 120 forest workers in planting and cleaning teams and only 2 supervisors. The supervisors utilize modern methods of ICT in everyday practice. Their customers are mostly large forest companies whose regeneration areas are larger than in non-industrial private forestry.

In a recent study [8], the importance of the timing of operations on the working time consumption has been assessed. In early cleaning, a delay by two years increased the working time consumption by 44 % (Figure 2).

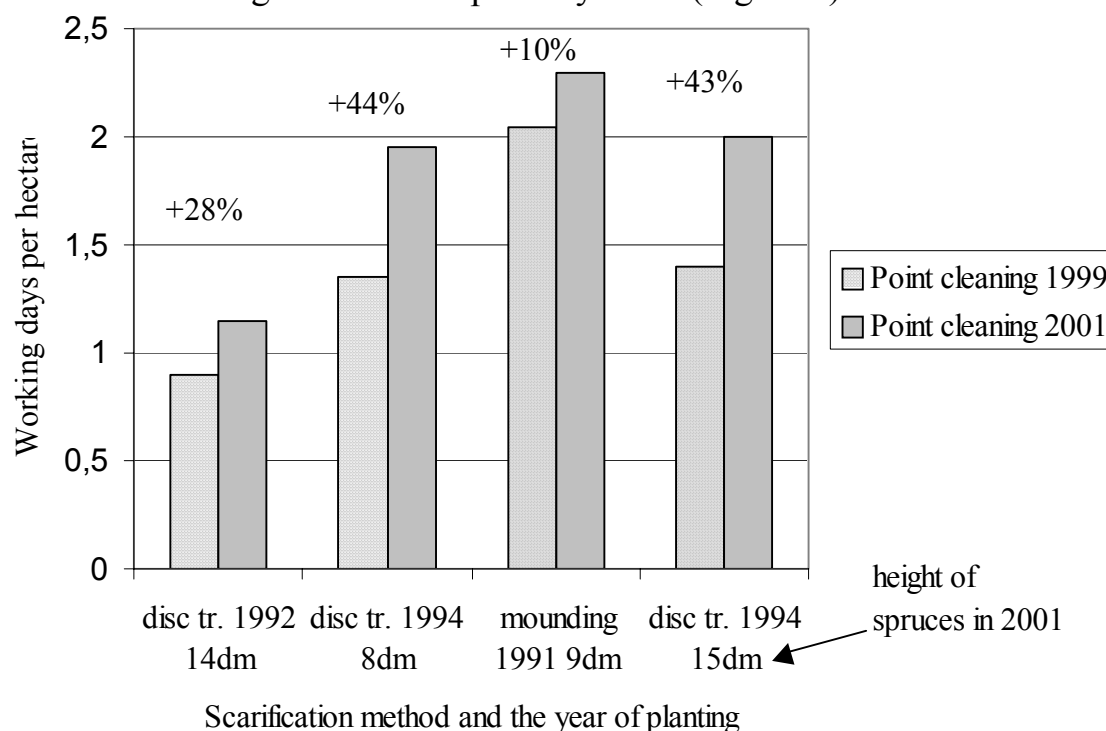


Figure 2. The effect of delaying early tending by two years on the working time consumption in spruce stands. Site preparation method, year of planting and the average height of spruces are also indicated. (disc tr. = disc-trenching)

Early cleaning carried out as point cleaning has been fairly successfully mechanized. Some point cleaning machines have been in practical use in southern Finland. The major innovation in this machine is that it does not try to imitate

brush-cutting saws but operates in a different way. The cutting itself is done by hydraulically operated knives in a circle. They are well-protected and not sensitive to obstacles on the ground. A limiting factor for operating this machine is the height of the trees. Sporadic larger trees can be cut with an additional blade attached to the machine. This method has been found to be competitive with motor-manual work if the number of removed secondary stems exceed 10,000 stems per hectare.

In some Finnish forestry organizations, all regeneration areas are inventoried 3 to 5 years after the stand establishment. Such an inventory is carried out for quality assurance purposes, but at the same time the need for early cleaning during subsequent years is assessed. The information is put on a forest resource GIS system. The GIS system expresses the need for tending what is expected to occur and a map is produced for the forest worker in order to check and clean the most important areas of the stand. Where surveys of young stands are not carried out, the use of remote sensing information may provide a tool for determining appropriate the timing of operations.

The use of herbicides in cleaning has decreased drastically since the 1980s despite of their efficiency [3]. This development has occurred because of environmental pressures rather than poor results. The research into herbicides in cleaning has recently been limited to the compulsory testing by governmental authorities of new preparations. The number of herbicide products for forestry use has decreased because of the expensive but compulsory registration of products. The same products may be available for agricultural purposes but the manufacturers do not register them for the small forestry market.

The development of sprouts in cleaned stands can be prevented by using fungi to rot the stumps of the cut broad-leaved trees. Such preparations of fungus spores are already commercially available, for example in Canada [9]. The effect of those preparations, however, is somewhat weaker than traditional herbicides used for the same purpose. Active research and development on the use of fungi has also been carried out in Finland. The most interesting fungus species in this context is *Chondrostereum purpureum*. The species is very common in all boreal forests and there is no risk of introducing foreign species into ecosystems. Spreading the preparation of spores should be fairly easy to combine with mechanized cleaning.

Two very important issues concerning the relation between the method of cutting and the ability to sprout are:

- the more the stump is destroyed, the fewer and smaller are the sprouts;
- traditional disc-cutting creates a smooth cross-cut that sprouts easily.

Such issues should be fairly easily to take into account when designing cleaning machines.

The timing of cleaning according to the season may have strong effect on the growth of sprouts. At least in Nordic conditions, cleaning in summertime results in considerably lower height increments of sprouts than if cleaning is done in winter. Unfortunately, in summer in very dense stands, the poorer visibility due to leaves makes cleaning work slower. In motor-manual cleaning, the effect in very dense stands is 20 to 30 % decrease in productivity. The effect may have even stronger in mechanized cleaning.

A major challenge in developing cleaning regimes for young stands is the great variation between and within stands. Optimizing regimes for later thinning cuttings is easier because increment models and growth simulators are available that provide reliable results. Such a simulator for young stands has been developed in Finland, but its reliability has to be improved before its wider application in practice. The increment models used in the simulator have not been reliable in conditions of great variation.

Experiences from practical management have revealed considerable differences in work productivity between forest workers in similar conditions. A tacit knowledge of operational practices and working methods concerning the most productive forest workers should be transferred to the others. Such a research and development project has recently been carried out with harvester operators [10].

Discussion

The greatest challenge to the development of cleaning operations is to grow wood raw material of good quality using cost-efficient methods. In the Nordic countries, the stumpage prices of coniferous trees have been fairly high on average compared to Europe. There may exist some pressure on the stumpage prices, which creates pressure to get the costs of wood production lower, to ensure the profitability of forestry business. There is also a threat of shortage of labour for forest operations. This is particularly acute in the case of laborious silvicultural operations, but affects are already being felt also in mechanized timber harvesting. Research and development into mechanization will most likely be further increased in the future, but simultaneously the output of traditional motor-manual cleaning methods can be improved. Nevertheless, it is to be hoped that there will be soon a breakthrough in mechanization. The main issues of developing motor-manual cleaning from organizational viewpoint are at least [11]:

- training forest workers and forest owners actively working in their forests;
- developing wage systems;
- arranging year-round work opportunities.

The development of cost-efficiency in mechanized cleaning operations seem to be rather difficult. It also seems that there still is unused potential in developing motor-manual operations. The key issue in developing traditional methods is timing. To manage and supervise large-scale cleaning activities and to optimise timing, applications of ICT may provide considerable advantages.

It is sometimes forgotten that the amount of work and costs of cleaning can be controlled already at the stand establishment stage. In Nordic conditions, spruce plantations on disc-trenched sites gather considerably more secondary broad-leaved stems than those planted on mounded sites in otherwise similar conditions [8]. Mounding is a more laborious and expensive method of soil preparations than disc-trenching, but the subsequent management of the stands is easier on mounded sites. The chain of sequences in growing young stands should be considered as a whole from stand establishment until the final commercial cuttings. Using more expensive methods in one phase, for example stand establishment, may bring greater cost-advantages in a subsequent phase. There is a great challenge for research and development activities to recognize the most cost-competitive chains for the management of young stands in order to take account of all relevant issues.

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WATER IN HYDRAULIC OIL – ITS EFFECT AND CONTROL

In some industries and environments, water is a far more damaging contaminant than solid particles and is often overlooked as a primary cause of component failure. For certain applications, even a small amount of water may have damaging effects on production or equipment. In the field conditions the oil contamination monitoring was accomplished by static extracting samples. The oil servicing and cleaning of the loader were done by the portable filtration system.

Keywords: Water, hydraulic oil, Karl Fischer titration, loader, filtration.

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Вода в гідравлічній оливі – її вплив і контроль

У деяких середовищах вода є значно шкідливішим компонентом, ніж тверді частинки і часто – першопричиною складної відмови механізму. В окремих випадках навіть невелика кількість води може шкідливо впливати на створювану продукцію чи обладнання. У робочих умовах контроль забруднення оливи здійснювався за відібраними пробами, а її очищення – мобільною фільтрувальною системою.

Ключові слова: вода, гідравлічна олива, фільтр Карла Фішера, навантажувач, фільтрування.

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