Recommendations for working with power saws and brush cutters: economic and medical aspects

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Recommendations for working with power saws and brush cutters: economic and medical aspects

Part 1 Backgrounds

1.1 Introduction

Since the sixties, the use of one-man petrol power saws with saw chains has gained increasing acceptance in felling operations in the Netherlands. Originally they were only used to fell thicker trees and also for cross-cutting; trimming was done with the axe. Later on, hand tools were more and more displaced by the power saw, also for thin trees and for trimming. Because, during the felling operations, peeling is hardly ever done by hand, but mechanical later on, the number of revolving hours of the power saw per man per day has greatly increased since 1960. From about half an hour to about four hours a day. The revolving hours of power bow saws and brush cutters in tending operations even amount to about 5½ hours per man per day.

From the medical point of view great objections have been raised against such an intensive use, among others, because of the prolonged exposure to vibration and noise. Nor is such a use always essential from an economic point of view.

On the initiative of the Research Commission for Rationalization in Forestry ("CORB") of the Forest Research Station, efforts have in this respect been made to formulate the economic and medical criteria for working with power saws and brush cutters to adapt the use of these implements to these criteria as well as possible by working methods and work organization regulations.*) At the request of the Forest Safety Committee of the Forestry Board, this task was later on expanded by including criteria concerning the purchase of power saws and brush cutters in the study (e.g. noise and vibration production, convenience of handling) and concerning the use of individual means of protection.

The execution of this task has been taken in hand by the following persons:

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The findings of the group are given in the following pages.

*) Work is also being done on a project "Tree harvesting machines".

1.2 Economic aspects

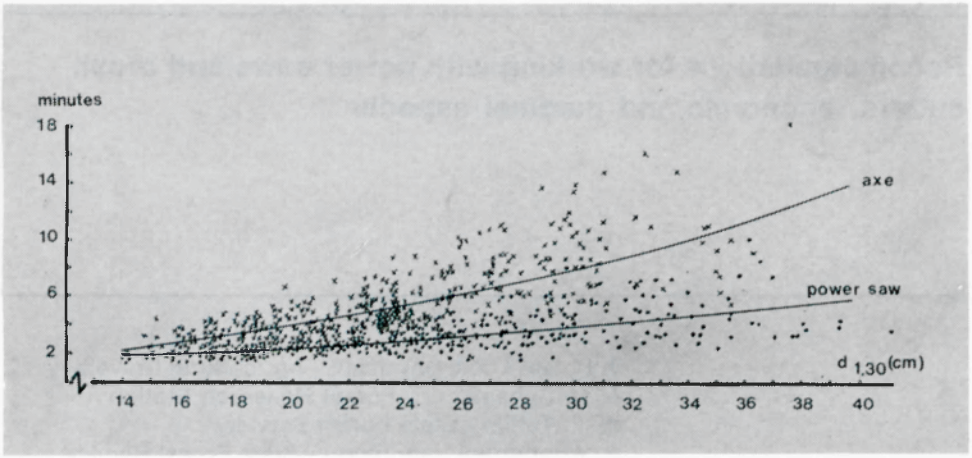
1.2.1 Power saws in felling operations

Felling The increasing use of the power saw is not without any more a result of an economic necessity. Researches have revealed that, considering the necessary hours of work, it is of no use felling trees thinner than 12 cm diameter at breast height with the power saw (1).
With working costs of Dfl. 10.— per productive man-hour and power saw costs of Dfl. 6.— per revolving hour, this would mean a maximum diameter of 13 to 14 cm.

Trimming On comparing the trimming of a common pine with an axe with a power saw in five stands (800 trees), it appeared that, over almost the entire tree diameter tract, the trimming time of the power saw lies below that of the axe (graph 1).
When we start from the above-mentioned cost again, this means that, in scots pine with "normal" branching, the trimming of all branches with motor saws is, financially, only useful when the diameter at breast height is more than 18 cm, corresponding with an average branch thickness of 17-21 mm and an average number of branches of 70-90 on timberwood length (graph 2).
With a further increase in working costs, compared with machine costs, this point of intersection will further move on to a smaller diameter.

1.2.2 Power bow saws and brush cutters in tending operations

The use of motor-driven hand tools (power bow saws, brush cutters) in cleaning operations will generally only save working time in the somewhat older stands (2). It appeared, for instance, that



Graph 1 Trimming time for axe and power saw in man-minutes per tree (excluding general allowances) with different tree diameter;
axe: $y = 0{,}92 + 0{,}00806\ x^2$
power saw:
$y = 1{,}50 + 0{,}002706\ x^2$
y = trimming time per tree in min.
x = diameter on 1.30 m. in cm.

application in an average tree height of Pinus stands smaller than 3 m (before treatment) does not save working time and is actually more expensive.
Hand tools (e.g. Sandvik slasher, Finnish slasher) are preferred here, whether or not in combination with systematic cleaning by tractor and rotary cutter.

1.2.3 General conclusions

The conclusion is that, for economic reasons, the power saw, the power bow saw and the brush cutter should be used in many, though not in all circumstances.
Thin trees (diameter at breast height smaller than 13 to 14 cm) could be felled with a hand saw, but, what is of greater importance is that trimming with the power saw would, under present circumstances have to be confined to thicker trees (diameter at breast height larger than 18 cm). And, if desirable from a medical point of view, the use of the power saw for these thicker trees could even further be limited by not trimming the entire tree with the power saw but the thick branches only, e.g. branches thicker than 4 cm (measured at 2 cm from the branch joint, perpendicular to the branch axis) as already suggested before (3). The thinner branches can then be removed with the axe. The latter method would involve some financial disadvantage, approximately less than Dfl. 1.— per m^3 in trees with 30 cm diameter at breast height.
Stands could in general without further be cleaned with hand tools (possibly in combination with systematic cleaning with tractor and rotary cutter). Only with later, overdue cleaning can situations exist in which the use of motor-driven hand tools (power bow saw) is economically justified. With other tending operations too, such as the removal of thin, young brushwood, use of motor-driven hand tools (brush cutters) cannot always be avoided.

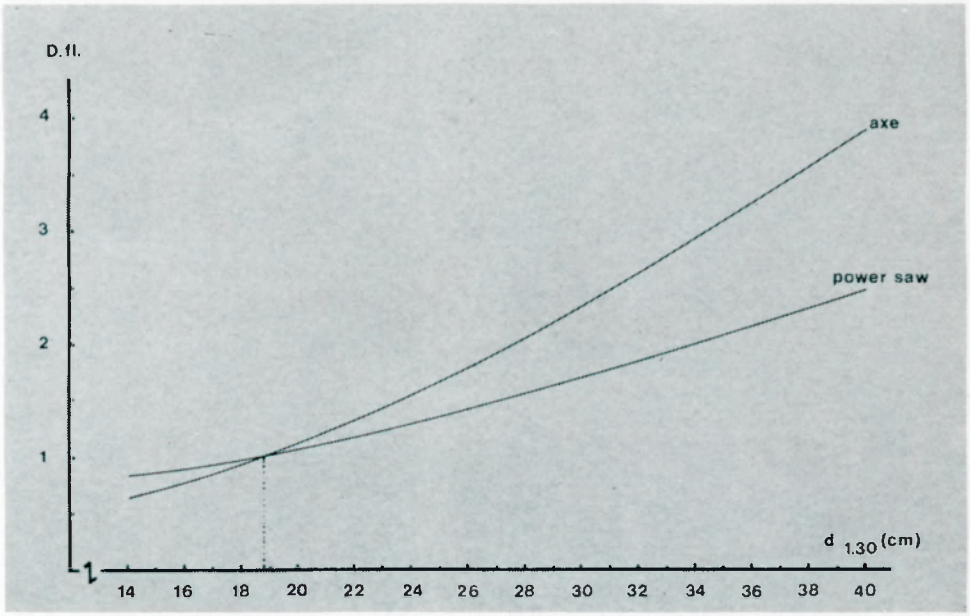
1.3 Medical and ergonomical aspects

This chapter is about power saws. There are not sufficient data about medical and ergonomic aspects available in literature to give a definite opinion about brush cutters. The source of noise and vibration is in outline the same. Still there are a few differences, however. The saw chain in the brush cutter has been replaced by a circular saw blade (noice), the distance from the operator to the source of the noise is smaller in using brush cutters and the transfer of vibration in the brush cutter is different (steering arm, supporting framework) from the power saw. All this is, for the present, not a reason to judge the brush cutter to be more unfavourable than the power saw.

1.3.1 Noise

When working with the power saw, forest workers are exposed to noise. It is known in industry that machine noise may cause damage in the inner ear of the workers, leading to hearing loss, which may stealthily and progressively develop into a certain degree of "noise deafness".
In order to judge industrial noise, the International Organization for Standardization has, in view of medical experiences, suggested that the 85 ISO curve in the octave band with the medium frequencies 500, 1000 and 2000 Hz should be taken as "Damage Risk Criterion", in other words as upper limit of permissible noise levels for continuous noise and permanent exposure during five hours per day and four days per week.

Graph 2 Trimming costs for axe and power saw in guilders per tree with different tree diameter; including an average of 48% and 56% resp. for general times for trimming with axe and power saw resp.



By permissible level is not meant that there could not be any car damage but only that, in the long run, possible damage will not be so serious as to influence the capacity to understand speech unfavourably. There are also indications of unfavourable influences of noise of lower intensity upon human organism, for instance, reactions of the vegetative nerve system, which are manifested in changes in the blood circulation, metabolism etc. From an ergonomical point of view, the suggested 85-line is actually still too high for a justified permissible limit. The Dutch working group "Relation between noise and noise deafness" of the CARGO-TNO therefore advises to use the 80 ISO line as "Damage Risk Criterion".

It has become clear from measurements of the sound level in various brands and types of power saws, that the noise of the present saws actually differs only slightly and that with values of 100 dB and more, they lie, in the critical frequencies, far above the given limits. In spite of the fact that, in power saw activities, the noise exposure is mostly not continuous and permanent, the risk of damage still seems to be great.

Measurements of the hearing threshold among power saw workers have shown that a considerable percentage of the forest workers who have been exposed to power saw noise for one to five years, have been affected by damage which is manifested in the characteristic hearing looses. A favourable effect of individual ear protectors was not observed, possibly because they were not used consistently or because of the inefficiency (damping value, fitting) of the applied methods.

These findings lead to the following conclusions. The noise of the presentday power saws may indeed cause serious ear damage. Therefore the noise will have to be reduced drastically. As far as this has not been sufficiently realized everywhere, the harmful influence must be limited as much as possible, especially by a consistent use of ear protectors with sufficient damping value and by a limited exposure. Besides, power saw workers should be subject to a periodic audiometric control.

1.3.2 Vibration

During his work with the power saw, the forest worker is further exposed to mechanic vibration. This vibration will be more intensive as the worker holds the saw more firmly, for instance, during the different movements during trimming. It is known that also this vibration has a damaging effect. Muscles, bones, nerves and arteries etc. may be effected stealthily and progressively, to start from the hands to go further to the rest of the body. A remarkable symptom is, for instance, "dead fingers".

The medical experiences in this field are still limited, however. Only very little is for instance known about the relation between the vibration characteristics, the exposure pattern and the risk of damage. No clear indications are therefore yet available about the permissible limit for this vibration. Researches hitherto published suggest that vibration should be avoided to have a frequency of 50 to 500 Hz, an amplitude of more than 80 micron and an acceleration of more than 0.5 g. Besides, cold seems to be an important aggrarating factor.

Felling with power saw. Individual means of protection: polyester helmet reinforced with glass fibre, ear caps with neck strap, soft leather working gloves, nylon safety-overall, rubber boots with steel toe-cap, profiled rubber soles and ankle strengtheners.

Measurements of vibration in various brands and types of power saws have made it clear that the vibration of the presentday power saws lie on harmful level. This is confirmed by the increasing number of characteristic affections among power saw workers.

These findings lead to the following conclusions. The vibration of the presentday powersaw may cause serious physical damage, this vibration therefore will have to be drastically reduced. As long as this has not been effected sufficiently, the damaging influence will have to be restricted by limiting the exposure time as much as possible. This restriction specially applies to the unfavourable operations (trimming). It is also recommendable to avoid cold hands in winter.

1.3.3 Exhaust gases

During his work with a power saw, the forest worker is exposed to exhaust gases. In this, the power saw does not actually differ from other combustion engines. These gases contain different constituents, among which carbon monoxyde, which, when

breathed in, may cause toxic symptoms. This danger is not imaginary, especially in unfavourable conditions of weather and terrain, where some cases of intoxication have been reported - consequently, also concerning exhaust gases protective measures are desirable; they must first of all be found in "cleaner" exhaust gases and further, for instance, in a favourable position of the exhaust.

1.3.4 Accidents

Those who work with a power saw are in many respects liable to accidents with serious injuries. Arms or legs may be heavily injured when the saw slips or is kicked back. Some of the injuries are caused by parts flying off (branches, wood chippings and splinters) which may injure one's eyes. If we consider protective measures, we should first of all think of the power saw itself, in other words, a good balance in different positions and a good stability and control during the operations. This includes a good working method instruction with special training for "safe work" and the use of good individual means of protection.

1.3.5 Other ergonomical factors

Felling with a power saw means heavy physical labour and quite a great deal of static muscular load. This may cause different muscle and joint complaints. We can try to avoid this by using a light saw with a good balance, stability and control. But here, too, it is necessary to limit the exposure time with a favourable variation of the usual operations and an adequate scheme of breaks.

The advice given about vibration, namely, to limit "trimming with a power saw" involves: "more trimming with the axe". The latter may require some more energy though this need not be regarded as a disadvantage, because this measure does not only reduce the effect of vibration but substitutes also a more dynamic muscular activity for a mainly static load.

1.3.6 General conclusions

Considering all the medical and ergonomical objections we must say that working with a power saw involves a complex of unfavourable factors. This makes it almost impossible to give a simple practical advice to improve the work situation or it should be: to avoid working with a power saw as much as possible and trying to replace it by a quite different felling method.

As long as the work still has to be done with a power saw, however, it is of importance to choose the best possible solution. Above we have made a few suggestions for different aspects and these could serve as directives. If, however, we want to combine all these separate indications into one advice, we shall be faced in practice with inconsistencies which make clear recommendations impossible and lead in different respects to a choice or compromise as an emergency solution.

This particularly applies to the power saw itself. A decrease in weight may be at the cost of a more unfavourable noise. The reverse may also be the case: improved noise absorption may lead to a heavier saw. Reduction of vibration may decrease the stability and the control ability.

These inconsistencies make it almost impossible for the producer to make an ideal saw, they make it exceedingly difficult for the consumer to choose, out of the present assortment, the kind of saw which, where health and safety are concerned, would be the least unfavourable.

A universal aid to improve the situation, which has frequently been mentioned, is the "restriction of the exposure time", in particular the total sawing time per man per day. The main reason is the limitation of the exposure to vibration, because any other effective protection against vibration is hardly possible. For the current power saws, some authors give the advice not to work more than 2 hours per day with a power saw and to do this preferably

Trimming thick branches with the power saw (thicker than 4 cm at the base)

during a few short periods, spread all over the day and not for hours in succession. With frequent intervals, the harmful influences will be weakened and have less effect.

About the use of individual means of protection it has to be noticed that these can greatly contribute to the safety of the forest worker, provided these means are reliable and effective and do not give difficulties or raise objection. Here too, it appears that, in practice, the realization of these requirements on the one hand, leads to disadvantages on the other. This limits the importance of these aids as a solution for the power saw problem, considerably.

Finally we want to urge the importance of good instructions, advice and guidance for the power-saw workers, both where a good and safe working method is concerned and the use of means of protection. The practical aspects of all this will be further worked out in part 2.

Part 2 Recommendations

2.1 Recommendations for the working method and work organization

The following calculations have been based upon a working time of 8¼ hours per day (two shift-quarters included). The "general times" (two shift-quarters included) have been given in percentages of the true working time. The calculations have been based upon the times measured during the felling and tending operations in Pinus stands.

2.1.1 Power saws in felling operations

Further to what has been said in "Economic aspects" in chapter 1.2, calculations have been made about the use of the power saw per man per day in a number of working situations, classified according to: *average stand diameter,* thin wood (average diameter at breast height 15 cm), thinning; thick wood (average diameter at breast height 27 cm), clear cutting.
manufacturing, felling and trimming; felling and trimming and cross cutting.
trimming, axe; power saw, power saw (branches thicker than 4 cm) + axe.
gang, one-man gang: one-man, one power saw; *)
two-men gang: two men, one power saw; **)
mainly one-man job;
changing the power saw after felling a number of trees

*) In practice several more one-man gangs have to work in the same stand for security reasons;
**) Because waiting times can sometimes not be avoided, the tree-times in all two-men gangs may, in practice, be somewhat higher than indicated in the following calculations, and the exposure time of the power saw may be a little lower.

Trimming thin branches with the axe (thinner than 4 cm at the base)

Thin trees (average diameter at breast height 15 cm), thinning

felling + trimming (tree length method); felling with power saw, trimming with axe
- one-man gang; tree-series size 1;

use power saw	1 × 1.2 min.	=	1.2 min.
other operations	1 × 4.0 min.	=	4.0 min.
time per tree, excluding general allowances (53%)			5.2 min.
time per tree, including general allowances (53%)			8.0 min.
number of trees per day $\frac{495}{8.0}$		=	62
use power saw per day	62 × 1.2 min.	=	74 min. ***)

- two-man gang; tree series size 3;

use power saw	3 × 1.5 min.	=	4.5 min.
other operations			
operator power saw	1 × 4.0 min.	=	4.0 min.
assistant	2 × 4.0 min.	=	8.0 mm.
time per 3 trees excluding general allowances		about	17.0 man-min.
time per 3 trees including general allowances (45 %)			24.6 man-min.
number of series of 3 trees per man per day $\frac{495}{24,6}$		=	20
use power saw per man per day	20 × 4.5 min.	=	90 min.
use power saw per gang per day		=	180 min.

felling and trimming and cross-cutting (short wood method); felling and cross-cutting with power saw, trimming with axe; carrying and stacking of 2 m assortment over 5 m
- one-man gang; tree-series size 1; measuring out/cross-cutting after trimming in one gang;

use power saw	1 × (1.2 + 1.2) min.	=	2.4 min.
other operations	1 × (3.7 + 1.4) min.	=	5.1 min.
time per tree excluding general allowances			7.5 min.
time per tree including general allowances (58%)			11.8 min.
number of trees per day $\frac{495}{11.8}$		=	42
use power saw per day	42 × (1.2 + 1.2) min	=	101 min.

***) the exposure time of the power saw is that for the operator. As regards sound, there is still an extra exposure at a distance. This is, in the one-man gang, the noise produced by the power saw and effecting the second felling worker, who, for security reasons, works in the same stand; in the two-men gang for the assistant who, because of the limited tree series size, generally works at a shorter distance (5-15 m).

- two-man gang; tree series size 3; measuring out/cross-cutting before trimming in one gang;

use power saw	3 × 2.9 min.	=	8.7 min.
other operations			
operator power saw (stacking)			3.5 min.
assistant (trimming and stacking)			12.1 min.
time per 3 trees excluding general allowances			24.3 man-min.
time per 3 trees including general allowances (47%)			35.7 man-min.
number of series of 3 trees per man per day $\frac{495}{35.7}$		=	14
use power saw per man per day	14 × 8.7 min.	about	122 min.
use power saw per gang per day			244 min.

N.B. Sometimes there may be other situations in practice, for instance, a separate field gang (see situation felling + trimming), while measuring out and cross cutting takes place on the forest road, after skidding (tree length method):
- measuring out and cross-cutting of several trees simultaneously up to 2 m assortment including stacking; mainly one-man job.

use power saw			5.7 min.
other operations			15.4 min.
time per 10 trees excluding general allowances			21.1 min.
time per 10 trees including general allowances (50%)			31.6 min.
number of series of 10 trees per day $\frac{495}{31.6}$		=	16
use power saw per day	16 × 5.7 min.	=	91 min.

Thick trees (average diameter at breast height: 27 cm), clear cutting

felling + trimming + branchwood on ridges (tree length method); felling with power saw
- one-man gang; trimming exclusively with power saw; tree series size 1;

use power saw	1 × 6.0 min.	=	6.0 min.
other operations	1 × 2.8 min.	=	2.8 min.
time per tree excluding general allowances			8.8 min.
time per tree including general allowances (67%)			14.7 min.
number of trees per day $\frac{495}{14.2}$		=	34
use power saw per day	34 × 6.0 min.	=	204 min.

- one-man gang; trimming with power saw and axe; tree series size 1;

use power saw	1 × 3.0 min.	=	3.0 min.
other operations	1 × 7.1 min.	=	7.1 min.
time per tree excluding general allowances			10.1 min.
time per tree including general allowances (57%)			15.9 min.
number of trees per day $\frac{495}{15.9}$		=	31
use power saw per day	31 × 3.0 min.	=	93 min.

- two-men gang; trimming with power saw and axe; tree series size 3;

use power saw	3 × 3.2 min. =	9.6	min.
other operations			
operator power saw		5.6	min.
assistant		15.1	min.
time per 3 trees excluding general allowances	about	30.3	man-min.
time per 3 trees including general allowances (49%)		45.1	man-min.
number of series of 3 trees per man per day $\frac{495}{45,1}$	=	11	
use power saw per man per day	11 × 9.6 min. =	106	min.
use power saw per gang per day		212	min.

felling + trimming + cross cutting + branchwood on ridges (short wood method)
felling and cross cutting with power saw; saw logs and piles; stacking of 2 m assortment; mainly one-man job; measuring out and cross cutting in separate gangs

- one-man gang; trimming exclusively with power saw; tree series size 1;

use power saw	1 × (4.7 + 0.9 + 1.3) min. =	6.9	min.
other operations	1 × (2.8 + 1.4 + 1.8) min. =	6.0	min.
time per tree excluding general allowances		12.9	min.
time per tree including general allowances (67%)		21.5	min.
number of trees per day $\frac{495}{21.5}$	=	23	
use power saw per day	23 × (4.7 + 0.9 + 1.3) min. =	159	min.

- one-man gang; trimming with power saw and axe; tree series size 1;

use power saw	1 × (3.0 + 1.3) min. =	4.3	min.
other operations	1 × (8.1 + 1.8) min. =	9.9	min.
time per tree excluding general allowances		14.2	min.
time per tree including general allowances (62%)		23.0	min.
number of trees per day $\frac{495}{23.0}$	=	22	
use power saw per day	22 × (3.0 + 1.3) min. =	95	min.

- two-men gang; trimming with power saw and axe; tree series size 3;

use power saw	3 × (3.2 + 1.5) min. =	14.1	min.
other operations			
operator power saw		9.8	min.
assistant		20.9	min.
time per 3 trees excluding general allowances	about	47.8	man-min.
time per 3 trees including general allowances (55%)		74.1	man-min.
number of series of 3 trees per man per day $\frac{495}{74.1}$	=	7	
use power saw per man per day	7 × 3 × (3.2 + 1.5) min. =	99	min.
use power saw per gang per day		198	min.

N.B. Sometimes there may also be other situations in practice, for instance, a separate field gang (see situation felling + trimming + branch wood on ridges), a separate person to measure out and finally a separate gang for cross-cutting and stacking at the felling site.

- cross-cutting per tree up to four assortments (saw logs, poles and two other assortments of 2 m in length) including stacking of 2 m assortments; two-man gang, mainly one man job; tree series size 7;

use power saw	7×1.5 min.	=	10.5 min.
other operations	7×1.7 min.	=	11.9 min.
time per 7 trees excluding general allowances			22.4 min.
time per 7 trees including general allowances (54%)			34.5 min.
number of series of 7 trees per man per day	$\frac{495}{34.5}$	=	14
use power saw per man per day	14×10.5 min.	=	147 min.
use power saw per gang per day			294 min.

Cross cutting with the power saw

Tending stands (cleaning) with hand tools

2.1.2 *Power bow saws and brush cutters in tending operations*

The use of motorized hand tools in tending operations leads to a very high exposure period; during the cleaning of Pinus cultures, for instance, from 5 to 5½ hours per day. This is far above the granted criterion of 2 hours per man per day and therefore not permissible even if, for the operator, the noise and vibration level of brush cutters would be lower than that of power saws.

2.1.3 *General conclusion*

With felling operations in thin wood of an average diameter of 15 cm breast height (and a comparable exposure applies to thinner wood), both the one-man gang and the two-men gang method (with a change of the power saw per tree series) are acceptable.

For the operator the exposure time therefore remains within the medical criterion of two hours per day. Considering the present cost relations, the two above-mentioned methods, in which the trimming axe is used, are, also economically, the most favourable.

The greatest variation and the shortest exposure time in a one-man gang is per time and in total. The two-men gang leads to lower power saw expenses.

In the two-men gang the tree-series size must remain limited because otherwise the exposure time will be too high. The exposure time during the separate cross-cutting of long logs along the forest road, is also acceptable, provided the operator of the power saw also measures out and stacks.

With cross-cutting only, the daily exposure per man would be unacceptable.

With felling operations thick wood of an average diameter of 27 cm at breast height, power saw trimming leads to an exposure time of 2½ to 3½ hours per day, far above the criterion of 2 hours applied here.

The combined use of the power saw and axe for trimming gives an acceptable exposure time, both in the one-man and the two-men gang (with a change of the power saw per tree series). This, however, will slightly increase the cost of felling with approximately less than Dfl. 1.— per m^3 for trees with a maximum diameter of 30 cm at breast height.

The greatest variation and the shortest exposure period in the one-man gang is per time. The two-men gang leads to lower power saw costs. In the two-men gang, the tree series size must remain limited to about 3 trees to avoid a too high exposure period per time.

With separate cross-cutting and stacking of long logs in a two-man gang, the exposure time will be too high, also when the power saw is changed per tree series.

In tending operations the use of motorized hand tools lead to an unacceptable exposure period of 5 to 5½ hours per day. It has already been stated in chapter 1.2 "Economic aspects" that, from an economic point of view, there is generally no evident necessity to use motorized hand tools. Hand tools, such as e.g. the Swedish Sandvik slasher and the Finnish slasher are recommended, either or not in combination with a tractor and rotary cutter. If we want or must use the motorized hand tools (e.g. the brush cutter to remove thin brushwood or the power bow saw for later, greatly overdue cleaning) it would be recommendable, considering the available information, to aim at an exposure of not longer than 2 hours per man per day and thus limiting the use to at most 3 working hours per man per day. Other work can then be done during the rest of the day.

2.2 **Recommendations for purchases**

2.2.1 *Recommendations concerning vibration, noise etc.*

It has been indicated in chapter 1.3 "medical and ergonomic aspects" what requirements concerning noise, vibration, exhaust gases, safety, weight etc. a power saw must primarily satisfy to be acceptable in medical and ergonomic respect. (A list with additional ergonomic wishes concerning convenience of handling is given below). It has been stated that, in so far as the data of the research institutes give information, none of the power saws, now available, seems to meet the conditions, not even approximately.

But, in practice, a choice will nevertheless have to be made out of the available assortment. The basis of the choice should be the reports of institutes specialized in testing power saws, such as the Swedish Statens Maskinprovingar and the Finnish Vakola institute and one can try to judge these data by means of the directives mentioned above.
The noise can be judged by taking the dB(A), dB(C) and N values (noise rating number) as a basis. It is a little more complicated to judge vibration, but, this can be indicated relatively easy to.
In principle, saws are preferred with the lowest possible noise and vibration values, though the other qualities already referred to above, must also be included in the judgement.
When, for instance, a good vibration damping leads to a low vibration value on the one hand but leads to a decrease in stability and controlability on the other, with, as a result, an unfavourable load on the muscles and a higher accident risk, it is doubtful if the saw in question can be classified under the most favourable ones. Weighing off the pros and cons is not a simple task. This applies to the power saw and to the brush cutter.

Now if we consider the publications of the above-mentioned Statens Maskinprovingar (5), they suggest that the Swedish power saw brands are among the least unfavourable of the series of power saws examined.

For different reasons we shall not mention any concrete brand here. The differences are not great and have not the same tendency. Moreover, not all available saws have been examined. And, considering the rapid developments, a better saw may have come on the market meanwhile.

On purchase, the users of power saws would do well to follow the developments closely and, in case of new purchases, to consider the latest data. Test reports are on view and obtainable from the Section Forest Work and Technique of the Forest Research Station in Wageningen.

2.2.2 *Recommendations concerning manageability*

Power saws

Front handle frame

a the front handle frame should have such a place and form that the engine can be kept well in balance, with the guide bar almost horizontal or turned slightly upwards for a good operation and safety.
b thick enough (not thicker than 2½ cm); no profiles preventing the hand to move.
c smooth enough.
d sufficient grip in different positions.
e preferably lined (to prevent cold fingers).

Back handle

a such a thickness, form and profile that the hand has sufficient grip.
b preferably lined with a light profile.
c wide enough to put one's foot into it when starting.

Operating equipment

The operating equipment should be easily to operate without moving the hands. Remember: the ignition switch, oil pump, locking button for "start" position, choke or air flap.

Position exhaust

Preferably on the front side of the engine block beside the saw blade with the opening for the exhaust gases longitudinally of the guide bar.

Starting device

The starting device should be of a sound quality, dependable in operation to prevent misstarts (safety).

Design

A design with the least possible protrusions will be preferred. The bottom plate of the engine should preferably be smooth enough for the saw to slide over the bark during trimming and be wide enough for the stability of the engine when started.

Tending the forest with tractor and rotary cutter (systematic cleaning)

Safety

a the engine should have an ignition switch, if possible, within reach of the fingers and not immediately to be reached by branches etc. (countersunk).
b preferably equipped with a dual safety device for the gas handle (key knob).
c sound petrol tank-air venting.
d sufficiently large filling opening of petrol and oil tank.
e equipped with kick-back guard for the leading hand upon the front handle frame; this to prevent the hand to slip off the carrying joke at the risk of injuries by the saw chain.

Brush cutters

Carrying set

Preferably a leather shoulder belt (one point of suspension) with sufficient possibilities for adjustment so that the brushcutter will hang in the right position (balance) and the weight is equally divided over both shoulders.

Steering arm

a there should be a rubber filling between the steering arm and the saw spindle to avoid as many vibrations as possible.
b the ends of the steering arm should have soft rubber grips with some profiles; the grips shall not be thicker than 2 to 3 cm.

Operating equipment

The operating equipment should be easy to operate. Remember the gas control handle, the choke or air flap, and the locking button for "start" position.

Position exhaust

Preferably on the back side of the engine block with the opening for the exhaust gases turned backwards.

Starting device

The starting device should be of a sound quality, dependable in operation to prevent misstarts (safety).

Safety

a the engine should be equipped with an ignition switch, if possible, within reach of the hands and not immediately to be reached by branches etc. (countersunk).
b sound petrol tank-air venting.
c sufficiently large filling opening of petrol and oil tank.
d panic bolt in carrying set.

2.3 Recommendations for the use of individual means of protection

Accurate registrations of the accidents in forestry during the last ten years have revealed what parts of the body are most liable to injuries. Especially the legs, the feet and the ankles seem to be vulnerable in this respect; they account for 50% of the total number of accidents. There are also frequent head and eye injuries, just as hand injuries.

The registrations have also given an idea of the kind of injuries and the tool which inflicted them. The use of individual means of protection can greatly limit the number of accidents, while the severity of the injuries will also be reduced considerably. These means of protection must satisfy certain standards.

They may not be a danger to the user or give him any trouble.

Head protection

During felling operations (felling, trimming and cross-cutting) a safety helmet should be worn to protect against falling branches.
The helmet should meet the following conditions:

a good quality e.g. polyester reinforced with glas fibre.
b of good fit, e.g. by adhesive tape fastener.
c not too heavy in weight, about 300-350 gm.
d inner work of good quality.

Hearing protection

Both the operator and the assistant worker (working within a distance of 10 m around the source of the noise) should wear ear defenders during their operations with the power saw, power bow saw or brush cutters.

The best hearing protection is given by:
a ear muffs with neck straps; preferably no ear muffs with oil filling for fear of damage by branches;
b "Billesholm" glasswool plugs which can especially serve as a temporary solution; on no account medicated cotton wool and faty cotton wool, as they give no attenuation enough.

The table below shows the noise reduction (dB) of some ear defenders measured in a recent research (6) *).

ear defender	measured frequency	
	500	2000 Hz
Willson 258 ear muffs	26.1	31.7
Willson 153 ear muffs	15.0	24.4
MSA, Mk IV ear muffs	26.0	34.0
AO 1275 ear muffs	18.4	30.4
Billesholm glass wool	11.0	21.7

*) According to a very recent report (7) the Willson 360 ear muffs with foam plastic filling gives a noise reduction of 30.6 and 37.2 dB with 500 and 2000 Hz resp.

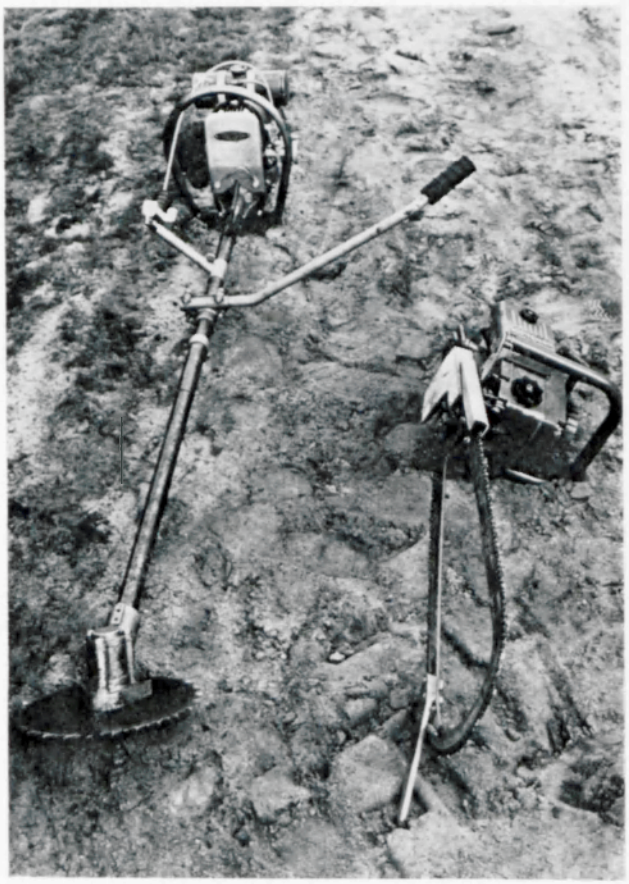
Eye protection

During the felling and tending operations, the eyes should be protected against rising saw dust, needles and sweeping branches.
For protection can be used:
a spectacles with preferably unbreakable glasses e.g. hardened plano glass
b face screen (the disadvantage is that it is rapidly damaged because the material is soft).

Hand protection

During a great many frequent operations, e.g. felling and tending work, it would be recommendable to wear gloves, for instance, against injuries. Besides, gloves can give a direct (deadening) and indirect (to prevent cold fingers) protection against the effect of vibration.

The gloves must preferably be of soft, supple leather, be as thin as possible so that the operator of the power saw or brush cutter can still feel the machine.



Tending the forest with motorized hand tools (brush cutter, for instance, to remove thin, young seedlings, and power bow saw, for instance, for greatly overdue cleaning later on.)

Leg protection

During the felling and tending operations, the legs should be protected against injuries, preferably by leg protectors and in combination with the nylon safety-overall, or else sewn up in the working-trousers.

Foot protection

During the felling and tending operations, the feet should be protected against injuries. Recommended are: soft, leather work shoes or rubber boots, both with a steel toe-cap, profiled rubber soles and ankle strengthener.

Summary

Recommendations for working with power saws and brush cutters: economic and medical aspects

From a medical point of view serious objections can be raised against working with the power saws and brushcutters used nowadays. For the forest worker there is a risk of e.g. loss of hearing, "dead fingers" and serious accident injuries. To restrict unfavourable effects as much as possible some protective measures are necessary. Recommendations are given. Exposure time with power saws and brush cutters should be limited. This can be achieved by work organization and by using certain working methods. At purchase, attention should be paid to noise, vibration and other ergonomic qualities, to promote the use of the best possible saws and brush cutters.

Finally, the use of good individual means of protection, such as ear defenders, safety helmet and safety glasses are important.

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