METSÄTEHON katsaus

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LAKO GRAPPLE HARVESTER

By Ilkka Nissi

The Lako grapple harvester differs from the ordinary grapple processor in only one respect: a roll track is needed to move the multiprocessor unit from the delimbing-bucking position into the felling position. The Lako grapple harvester is technically simple and operationally reliable.

Due to the fact that the grapple harvester has a high output demand it should be mounted only on heavy forest tractors. It is best suited for use in clear cutting of medium-sized stems and in later thinnings.

When used as a grapple processor in spruce-dominated clear cutting, the effective times of the Lako per tree were 40 - 158 cmin for stem sizes of 0.05 - 1.00 solid m^3. When used as a grapple harvester, the Lako was 25 - 30 % slower for stem sizes up to 0.7 $m^3(s)$.

In thinning of spruce-dominated stands, the best effective times per tree, 41 - 70 cmin, the Lako achieved as a grapple processor for stem sizes 0.02 - 0.30 $m^3(s)$. As a combination grapple processor and grapple harvester the Lako was 20 % slower. In thinnings the Lako was slowest when used as a grapple harvester: it was approx. 35 % slower than when used as a grapple processor.

The accuracy of length measurement was average.

Manufacturer:	Lastusen Konepaja, Merimasku
Seller:	Metsätyö Oy, Jyväskylä
Price:	FIM 324,000; includes hydraulics without hoses and filters FIM 25,000 measuring automatics FIM 50,000 –150,000 mounting on the customer's basic machine, including modifications
Guarantee:	0.5 year
In use:	On December 31, 1982 5 Lako grapple harvesters and 3 Lako grapple processors.

STUDY

Metsäteho carried out a short test on a Lako grapple harvester in September 1982 on the Tehdaspuu Oy work sites at Kangasniemi. The object of the study was the Metsätyö Oy demonstration machine. The basic machine was a Kockums 875 forwarder (model year 1975) modified for the purpose. A Foresteri 1278 with a reach of 7.8 m and a gross lifting moment of 120 kNm was used as the loader. An experienced driver operated the Lako both as a grapple harvester and as a grapple processor.

Fig. 1. Lako grapple harvester. Foto Metsätyö Oy

TECHNICAL DATA

Technical data mainly received from the seller.

Main dimensions

Length	1,450 mm
Width	1,200 mm
Height	850 mm
Weight approx.	700 kg

Felling and bucking device

The multiprocessor unit is moved from the delimbing-bucking position into the felling position along a roll track. The bucking device is a hydraulic chain saw. The same saw is also used for the felling. Its output is 40 kW.

Delimbing device

Two spring-loaded mats of knives and one spring-loaded pre-limbing knife are used for delimbing. It can handle tree diameters of 5 - 50 cm.

Feeding device

The feeding device consists of 4 spiked rollers driven by hydraulic motors. During feeding the roller pressure varies according to the diameter of the tree: for diameters exceeding 16 cm the pressure is 10 MPa, for smaller diameters it is 6 MPa. During felling the pressure is 12 - 14 MPa.

Feeding speed 0.0 - 3.5 m/s
Feeding force 30 kN

Hydraulic system

The grapple harvester needs a dual-circuit hydraulic system. The output of the hydraulic pump is 2 x 160 l/min / 33 r/s. The highest working pressure is 20 MPa. The output of the basic machine must be no less than 105 kW.

Measuring automatics

The measuring equipment is microprocessor-based. The system consists of an electronic central unit, a keyboard unit, and a sensor located in the grapple. Length is measured with a toothed wheel, whose rolling movement is converted into electrical impulses. Five bucking lengths can be keyboarded. Each measurement can be individually adjusted with a code breaker to within 1 cm, adjustment accuracy ±127 cm. An indicator shows the length up to a maximum of 6 meters.

Measuring automatics function alongside the manual control. The operator's manual control overrides the automatic control. The automatic control is switched on when a measurement is keyboarded. A signal corresponding to the measurement lights up in the central unit. The operator starts feeding forward by a short push on the forward button. This switches on the automatic control, and the movement stops at the point of bucking. If the bucking point is passed under manual control, the tree can be moved back and the movement stopped at the bucking point by starting the automatic reverse control. The measurement data may be keyboarded at any time. Automatic control does not give the control command if the measurement key is not pressed. The meter shows, however, the length of the stem from the previous bucking, in other words, follows the movement forward and back. Thus, the operator can saw according to the showing on the meter. The meter is zeroed by pressing the sawing or zeroing button. The equipment does not measure the diameter of the stems.

Bucking accuracy of the measuring device

SAWLOGS		PULPWOOD	
Material 125 logs		Material 56 pieces (length 5.8 m)	
±3 cm	36 %	±3 cm	61 %
±5 cm	58 %	±5 cm	70 %
±10 cm	86 %	±10 cm	93 %

WORKING PRINCIPLES

The Lako grapple harvester differs from an ordinary grapple processor in one respect: a roll track is needed to move the multiprocessor unit from the delimbing-bucking position into the felling position (see Fig. 2). The felling position is achieved as follows:

- While delimbing and bucking, the multiprocessor unit is in the position of an ordinary grapple processor. After delimbing and bucking, the multiprocessing unit is laid on the ground. Thus the roll is freed from the slot at the end of the track. After that the roll can be moved along the track by turning the loader.

Fig. 2. The Lako roll track used for changing the multiprocessor unit from the delimbing-bucking position to the felling position. Foto Metsäteho

- By simultaneously lifting the multiprocessor unit, the roll moves by force of gravity to the other end of the track. Thus, the multiprocessor unit hangs almost vertically from the rotator, ready for positioning at the tree to be felled.
- The multiprocessor unit is placed at the tree in the desired felling direction. The tree is gripped by closing the mats of knives (= grapple) and sawn.

The tree is felled in the desired direction by the weight of the multiprocessor. The multiprocessing unit is carefully lowered on the ground as the tree falls, and the roll moves backwards on the track to the slot for the delimbing-bucking position. The multiprocessor unit is held in place under its own weight and that of the tree. The tree can then be processed as with a grapple processor. Technically, it is possible to use the Lako grapple harvester also as a grapple processor alone.

WORKING METHODS

The Lako was tested both in clear cutting and in thinnings, in both cases as both a grapple harvester and a grapple processor. In clear cutting, conventional working methods were used. In thinnings, three methods were applied:

1 As a harvester, strip road spacing 20 m

2 As a processor, strip road spacing 30 m

3 As a combination harvester-processor, strip road spacing 30 m. Trees near the strip road were processed with a grapple harvester, those further off, between the strip roads, were felled with a power saw (from about 7 meters back), toward the strip road, and processed with a grapple processor.

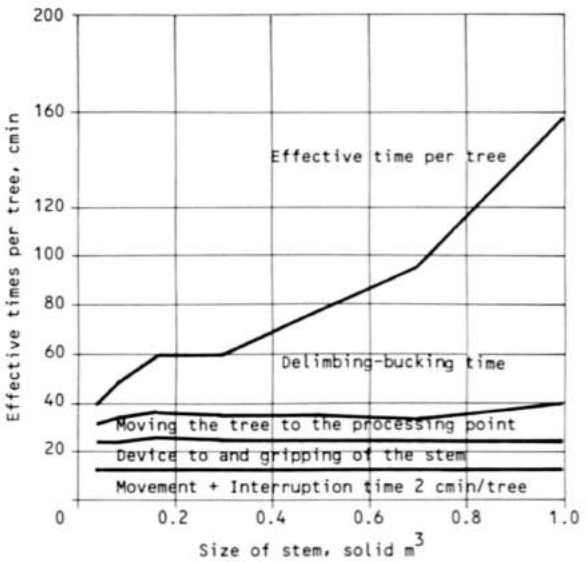
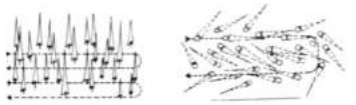


Fig. 3. Effective times per tree by work phase in clear cutting, when the Lako was used as a grapple processor

TIME EXPENDITURE

Clear cutting conditions

	AS A PROCESSOR	AS A HARVESTER
Time study material	95 stems	163 stems
Growing stock	spruce-dominated, 6 % pines	spruce-dominated, 26 % pines
Stand density	621 stems/ha	679 stems/ha
Timber assortment	sawlogs and pulpwood (target length 5.8 m)	
Sorting	sawlogs and pulpwood separately	
Terrain class	1	1
Branchiness class, average	3.1	2.4
Strip road spacing	approx. 6.5 m	approx. 15 m
Felling method	parallel	
Working method		
Movement	backwards while working	

Time analyses in clear cutting

AS A PROCESSOR		AS A HARVESTER	
Work phase	%	Work phase	%
Device to and gripping of the stem	16	Device to and gripping of the stem	15
		Felling	12
Moving the tree to the processing point	12	Moving the tree to the processing point	14
		Delimbing-bucking	32
Delimbing-bucking	57	Returning the multiprocessor into the felling position	11
Organising and interruption time	2	Organising and interruption time	1
Moving	13	Moving	15
EFFECTIVE TIME, total, %	100	EFFECTIVE TIME, total, %	100
-"- cmin/tree	79	-"- cmin/tree	80
Average stem size, m^3(s)	0.45	Average stem size, m^3(s)	0.20
Distance from one work point to another, m	4.6	Distance from one work point to another, m	4.5
Stems/work point	3.3	Stems/work point	2.5

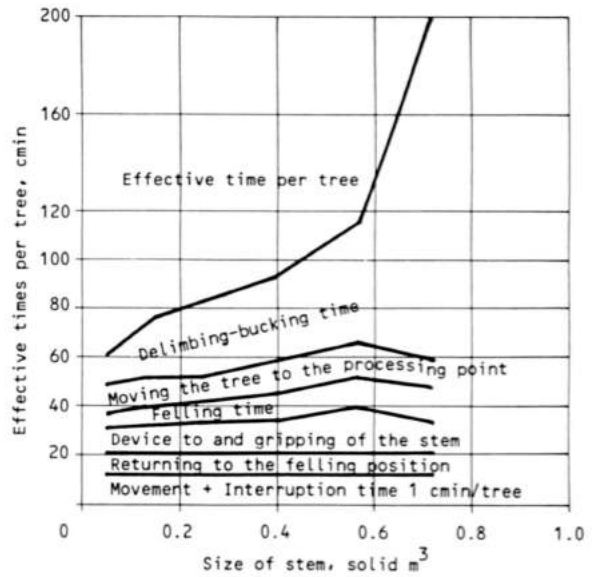
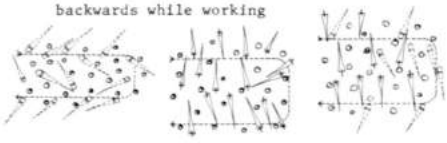


Fig. 4. Effective times per tree by work phase in clear cutting, when the Lako was used as a grapple harvester

Effective times per tree in clear cutting

Figures 3 and 4 (p. 3) present the Lako effective times per tree in clear cutting, both when using the Lako as a grapple processor and as a grapple harvester. When used as a grapple processor, the processing of stems was smooth. Delimbing and bucking slowed considerably only after the stem sizes exceeded 0.7 m^3(s). As a harvester the Lako was 25 - 30 % slower than as a processor. Returning the multiprocessor unit to the felling position takes approx. 10 cmin per tree.

Thinning conditions

	AS A HARVESTER	AS A PROCESSOR	AS BOTH HARVESTER AND PROCESSOR
Time study material	185 stems	121 stems	129 stems: 63 as processor; 66 as harvester
Growing stock	spruce-dominated, 5 % pines	spruce-dominated, 13 % pines	
Drain	380 stems/ha	561 stems/ha	
Residual growing stock	650 stems/ha	700 stems/ha	
Timber assortment	sawlogs and pulpwood (target length 5.8 m)		
Sorting	sawlogs and pulpwood separately		
Terrain class	1	1	1
Branchiness class, average	2.8	2.5	2.5
Strip road spacing	20 m	30 m	30 m
Movement	backwards while working		
Working method			

= separate felling + use as a processor

= use as a harvester

Time analyses in thinnings

AS A PROCESSOR (Strip road spacing 30 m) Work phase	%	AS A HARVESTER (Strip road spacing 20 m) Work phase	%
Device to and gripping of the stem	28	Device to and gripping of the stem	16
		Felling	9
Moving the tree to the processing point	22	Moving the tree to the processing point	19
		Delimbing-bucking	21
Delimbing-bucking	34	Returning the multiprocessor into the felling position	11
Organising and interruption time	4	Organising and interruption time	3
Moving	12	Moving	21
EFFECTIVE TIME, total, %	100	EFFECTIVE TIME, total, %	100
-"- cmin/tree	51	-"- cmin/tree	80
Average stem size, m^3(s)	0.11	Average stem size, m^3(s)	0.10
Distance from one work point to another, m	5.4	Distance from one work point to another, m	3.0
Stems/work point	2.0	Stems/work point	4.3

Effective times per tree in thinnings

In thinnings the Lako achieved the best effective times per tree as a grapple processor (Fig. 5). The Lako was 20 % slower when used as a combination grapple processor and grapple harvester. As a grapple harvester the Lako was clearly slowest: approx. 35 % slower than as a grapple processor.

DAMAGE TO THE GROWING STOCK IN THINNINGS

In thinnings the residual growing stock was damaged only slightly. The Lako caused the most damage when used as a grapple processor (strip road spacing 30 m): eight instances of damage to stems and two to roots along a 150 m stretch of strip road. When used both as a grapple harvester and as a combination grapple processor and grapple harvester the damage caused was less than half of the above. Damage to roots was effectively prevented by the branches and tops left on the strip road. Damage to stems is largely dependent on the skill and care of the operator.

OUTPUT AND MECHANICAL AVAILABILITY AS A GRAPPLE HARVESTER IN CLEAR CUTTING, as followed up by vibration recorder

Stem size 0.224 m^3(s), stand density 679 stems/ha, terrain class 1 and cutting quantity 121.6 m^3(s). Sawlogs and pulpwood; gross-effective-hour output 16.6 m^3(s) and mechanical availability 83 %.

Stem size 0.155 m^3(s), stand density 834 stems/ha, terrain class 1 and cutting quantity 155.2 m^3(s). Sawlogs and pulpwood; gross-effective-hour output 14.5 m^3(s) and mechanical availability 83 %.

Stem size 0.135 m^3(s), stand density 1,491 stems/ha, terrain class 1 and cutting quantity 160.9 m^3(s). Sawlogs and pulpwood; gross-effective-hour output 11.1 m^3(s) and mechanical availability 89 %.

ECONOMIC ANALYSIS

The true mechanical availability for the Lako grapple harvester is probably about 80 %. Gross-effective-hour costs in that case are FIM 240 - 300, depending on the basic machine (age, state of repair, price). On the basis of the above and the previously presented effective times per tree, the Lako is economically competitive with manual work both in clear cutting and in thinnings. In clear cutting, the Lako was more economical as a grapple harvester than as a grapple processor when the stem sizes exceeded 0.3 m^3(s). In thinnings, the Lako achieved the most economical results as a grapple processor when the strip road spacing was 30 meters.

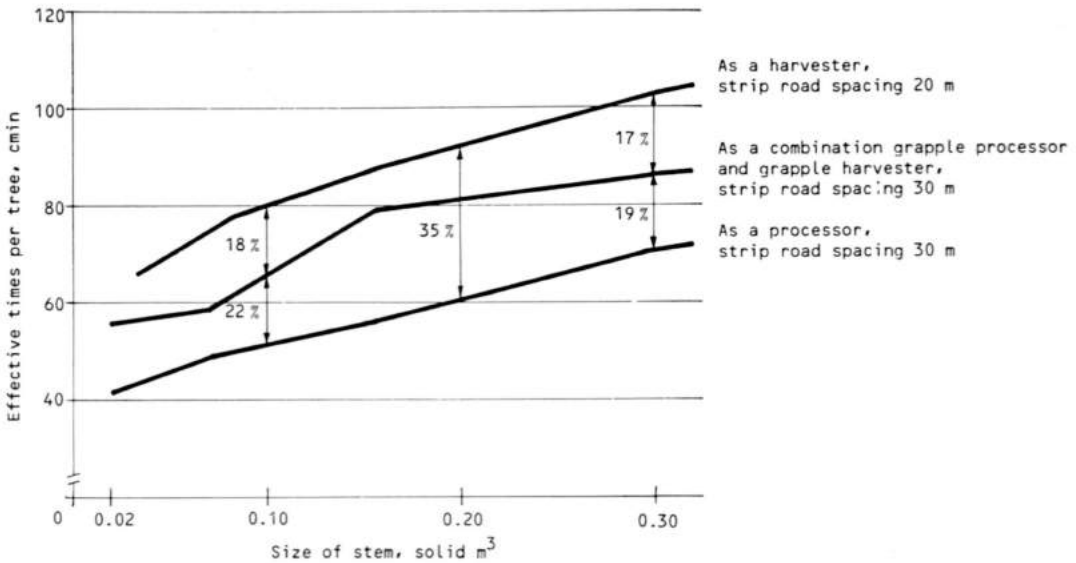


Fig. 5. The dependence of effective times per tree on stem size with different thinning methods

CONCLUSIONS

Changing the Lako from a grapple processor to a grapple harvester is technically simple and operationally reliable. The modification adds 110 kg to the weight of the unit and costs FIM 20,000.

For each tree to be felled, the multiprocessor unit must be changed from the delimbing-bucking position to the felling position. The time required for the change is almost constant (approx. 10 cmin); the time is not affected by the size of the stem. The felling-sawing and felling is smooth except for the largest trees, when the felling must be done from several positions. On unfrozen ground the stump is 5 - 10 cm shorter when felling with a grapple harvester than when done with a power saw. The Lako is most suitable for clear cuttings of medium-sized stems, both when used as a grapple processor and as a grapple harvester.

In thinnings, when the Lako was used as a grapple harvester and when the strip road spacing was 20 meters, the loader with a reach of 7.8 meters did not reach every tree. Therefore, short side-trips had to be made from the strip road to fell the most distant trees. The reach should be a minimum of 9.5 - 10.0 meters to allow all trees to be felled from a strip road with 20 meter spacing. When used as a grapple processor, the reach of the loader was sufficient when the strip road spacing was 30 meters. Fairly little damage was done to the residual growing stock in thinnings.

The delimbing result was generally good. There were difficulties only in the case of large pines and crooked birches. When delimbing trees with a lot of thick branches, the delimbing mats of knives seemed to need greater feeding force than the ordinary delimbing knives. The bucking result was good. The damage caused by the spiked feeding rollers was slight if the tree was delimbed without interruption. When delimbing pines with thick branches the feeding rollers tended to dig into the stem when feeding stopped. The sorting results were good due to the careful operator. The bucking accuracy of the measuring device was mediocre.

The output demand is great for the Lako. Therefore, only heavy forest tractors are suitable as the basic machine. A heavy basic machine is not the most suitable unit for thinnings due to its dimensions (width, weight, height). On the other hand, the Lako used as a grapple processor or grapple harvester, possibly with a long-reach loader, requires a heavy basic machine for sufficient stability.

METSÄTEHO

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