Factsheet

Motor winches

FORMIN.FINLAND.FI
MINISTRY FOR FOREIGN AFFAIRS OF FINLAND

RECOFTC
THE CENTER FOR PEOPLE AND FORESTS

Motor winches

RECOFTC - The Center for People and Forests

Bangkok, Thailand

This publication has been generously funded by the Ministry for Foreign Affairs of Finland. The views expressed in this publication are those of the authors and do not necessarily reflect the views of RECOFTC and our donor organizations.

For more information about RECOFTC's ForInfo project, visit www.recoftc.org/project/forinfo

Motor winches

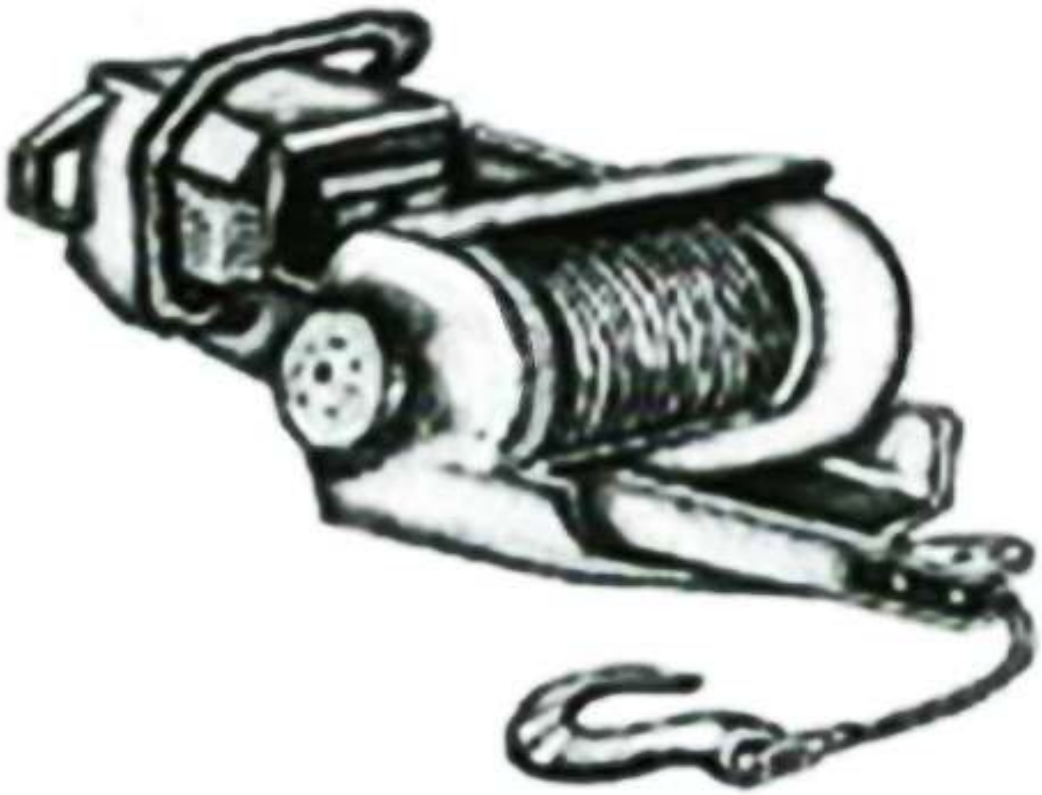
Table of contents

Figures

Tables

1. Introduction

Mobile motor winches play an important role in forest harvesting. They are used in situations where winches mounted on tractors and forwarders cannot reach logs or other objects to be moved. Larger winch types are also used in cable logging operations. However, they are not discussed in this factsheet as they fall outside the range of small-scale systems. Mobile winches used in forest-harvesting operations can be grouped as follows below.



2. Hand winches as chainsaw attachments

Chainsaw-mounted hand winches are great tools for hauling, dragging or lifting smaller logs or other heavy objects in forestry operations. A chainsaw-mounted hand winch is essentially a small chainsaw engine turned into a rope-pulling machine. There are two types of such winches:

2.1 Capstan or spill winch attachments

The capstan/spill winch design can use ropes of any length. Pulling power is usually restricted to about 1 000 kilograms (kg). A key advantage of the capstan design is that its pulling speed and pulling power are constant and the winch's full pulling force is available all the time. Moreover, the pulling length is not limited by the capacity of a spool or its housing because the capstan does not pull from the end like a standard-type winch.

Figure 1. STIHL chainsaw with capstan winch attachment

There are additional advantages to the capstan design. Because of the design's simplicity, it is never necessary to run a spool backwards or "free wheel" a spool of cable to let it out. It is also not necessary to run the winch to take up slack in the line and it is possible to begin a pull from any portion of the rope. The capstan design also makes it easy to gently start or stop a pull. The friction of the rope wrapped around the capstan determines how much slippage occurs. The number of wraps on the capstan and the rope tension being held behind it works like a clutch to control the force of the pull.

2.2 Cable winches with spools

The winch cable has a fixed length, normally up to 30 meters (m), due to the weight limitation of hand carrying the machine. However, the main and probably only advantage of spool winches, compared to the capstan system, is their higher pulling power, which can go up to 2 000 kg. A main problem with cable winches is the spool. Not only does the length of cable limit a pull, the cable also rarely fills the drum evenly when it is pulled in. It is common, moreover, for the cable to over-fill a portion of the spool, thus becoming too large for the operation to continue. This often happens when only a portion of the cable is retrieved, making it a key disadvantage in comparison to the capstan winch. On a cable winch, the spool will pull slower with more force when most of the cable is deployed. As the drum fills, its pulling speed increases and pulling force decreases. This is because the pulling ratio varies depending on how much cable is in the spool. As layers of cable stack up in the spool, the pulling speed increases and the pulling power decreases.

Figure 2. Husquarna chainsaw with Falknerspool winch attachment (http://www.mb-falkner.at/en/products#)

3. Portable winches with own engine

Similar to chainsaw attachments are portable winches with their own engines that come in a) capstan and b) spool models. Due to their specialized design, the pulling power of portable winches is usually higher and can reach up to 2 500 kg.

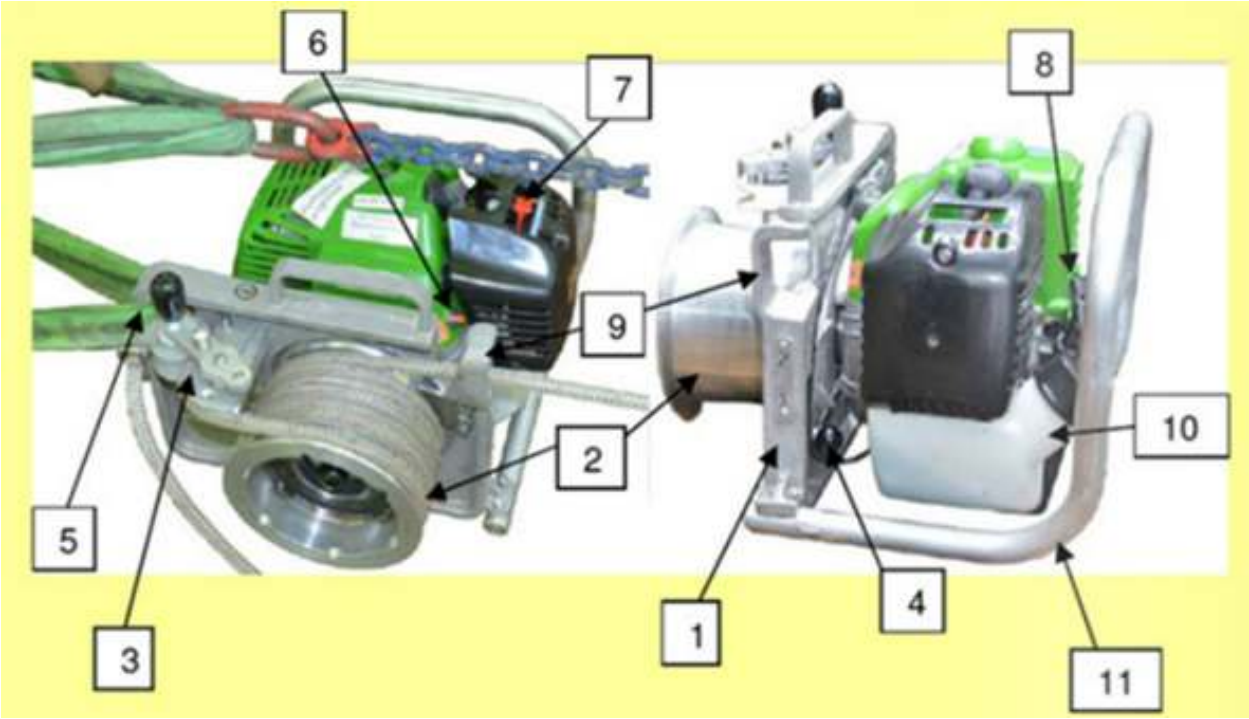


Figure 3. Nordforst 1800 Capstan hand winch with 1.8 ton pulling power (www.Nordforst.com)

1. Aluminum base plate for attachment of capstan spool
2. Capstan spill drum
3. Speed control and rope break
4. Gear control
5. Attachment for rope and chain anchors
6. Emergency stop
7. Choke
8. Starter rope
9. Rope guide bar
10. Fuel tank
11. Carrying and protective handle

Both chainsaw winch attachments and winches with their own engines are ideal for use in combination with chainsaw felling, which provides aid in directional felling, removing hung-up trees and removing entangled stems or bamboo poles from clumps. The forwarding capacity of such motored winches for bunching smaller-sized materials, however, is normally restricted to a maximum extraction distance of 25-30 m.

4. Winches on two-wheel chassis

Due to weight limitations posed by manually carrying winches and the subsequent reduced pulling power, two-wheel chassis were designed for situations when heavier spool-type hand winches can be mounted. These systems also allow for the use of spools with increased cable lengths up to 100 m.

Figure 4. Dominicus FKS Compact 13 motor winch

4.1 Self-propelled motor winches on sledges

Self-propelled motor winches were developed to transport winches on difficult (sloping) terrain. The chassis come in two types: closed shield or open bottom sled. Forward pulling of the machine is done by anchoring the winch rope at the target point and pulling the machine by its own rope. The engine capacity of these systems ranges from two to 10 horsepower (hp).

Figure 5. Ackja sledge winch (Model KMF 42)

Winches used for agriculture can also be used in forestry operations. Winches developed for ploughing steep terrain for wine cultivation are particularly useful (see Figure 6). Presently, RECOFTC – The Center for People and Forests is testing such systems for use in extracting bamboo in northern Lao PDR.

Figure 6. Werner Ziehmax vineyard sledge winch used in bamboo extraction, Bokeo province, northern Lao PDR.

Sled winches with closed bottom and complete outer shelter are stronger and heavier models that are still considered small-scale equipment. These systems can be used on extremely difficult terrain. Sled winches are equipped with petrol or turbo diesel engines of up to 32 hp, hydraulic gear systems and can reach pulling powers of up to six tons. They are operated using remote control systems to provide maximum safety since the operator can keep a reasonable distance away from the rope and payload during extraction. Such systems make possible the extraction of timber from difficult sites where other systems cannot efficiently operate.

Figure 7. Interior of the Waldrapp 32-hp motor sled winch

Figure 8. Waldrapp motor sledge winch in use during steep-slope harvesting

Performance studies with mobile motor winches

LeDoux et al (1987) carried out detailed studies with the Radio Horse, a remote-controlled winch, testing it on several forest types in the United States (Table 1). The techniques with which the radio-controlled winch is similar to those for using tractors; however, the equipment's remote radio control component facilitates only one-man operations. Since the portable winch is sled-mounted and rests on the ground, it is more stable than a tractor-mounted unit and slightly more difficult to move. The portable winch uses approximately 100 m of 0.5-inch wire cable, but winching is typically limited to 30-40 m. The long cable permits the machine to be set-up at a central point with a work pattern of up to 60 m in the trail in each direction and 25 feet into the stand (roughly 30 m in a diagonal corridor) on either side of the trail road. Therefore, one winch setting services an area of approximately one hectare (ha). Winching distances of up to 45 m are feasible, though 30 m is the recommended maximum.

Table 1. Productivity of radio controlled mobile winches in various forest types

Stand type	Average DBH cm	Average volume removed m^3/ha	Average slope %	Productivity m^3/hr	Stand treatment
White pine natural	24	16	0	6.8	Release cut partial removal
Oak hardwood	19	15.5	47	6.8	Improvement cut Downhill extraction
Spruce plantation	20	7	22	1.4	Single tree selection cut bunching across hill
Red maple swamp	21	16	0	7.2	Thinning
Hemlock hardwood	20	12.5	37	3.7	Improvement cut Downhill extraction

Production rates of up to 100 m3/person day have been achieved with radio-controlled winches. Crews for these winches have exceeded 80 m3/man day thinning pole-sized softwoods. As shown in Figure 9, production rates are highly dependent upon tree or load size. Slope, stand structure and understory density play minor roles.

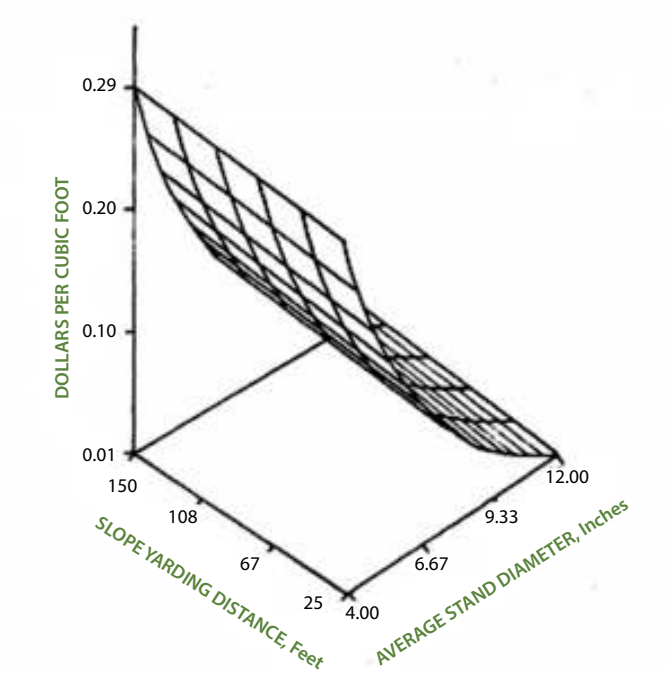


Figure. 9. Effect of slope and mean diameter on extraction costs with radio-controlled motor Radio Horse 9 sled winch (from LeDoux 1987)

Tusk (1989) carried out similar performance studies using mobile winches during thinning operations in young conifer stands in New Foundland. He tested the log ox winch, which is based on the Radio Horse used in the LeDoux (1987) study discussed above. Tusk tested extraction with maximum distances reaching 70 m of 1.25 m fuelwood, 2.5 m logs (Figure 10) and whole trees (Figure 11) for chipping.

Results of the trials, adjusted to an extraction distance of 24 m, are shown in Table 2. It is interesting to note that relatively high daily performances could be reached in extracting such small-sized material. In comparison to tractor-based systems, these results are very encouraging and suggest further development as an appropriate harvesting tool for Southeast Asia, particularly in the area of bamboo harvesting or the harvesting of other small-sized materials for fuelwood of biomass energy production.

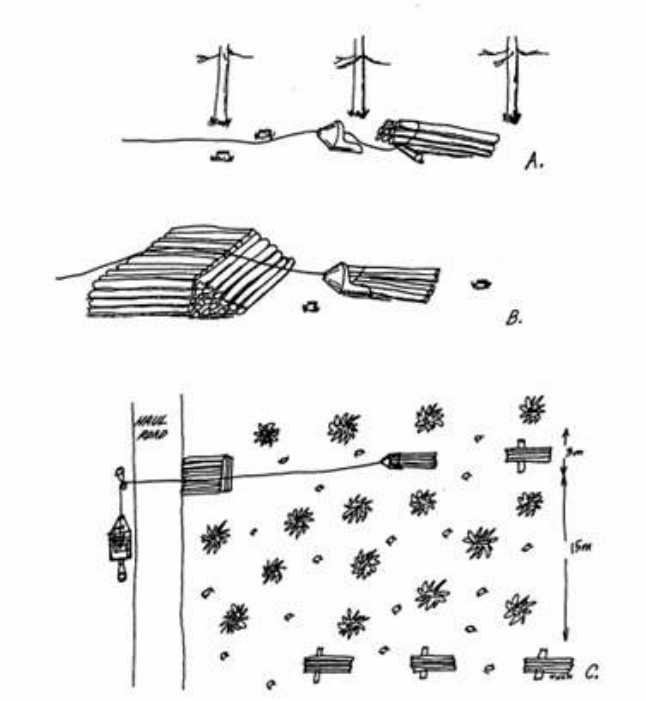


Figure 10. Mobile winch harvesting system for 2.5 logs and use of logging cone. Logs in front of stack act as a ramp

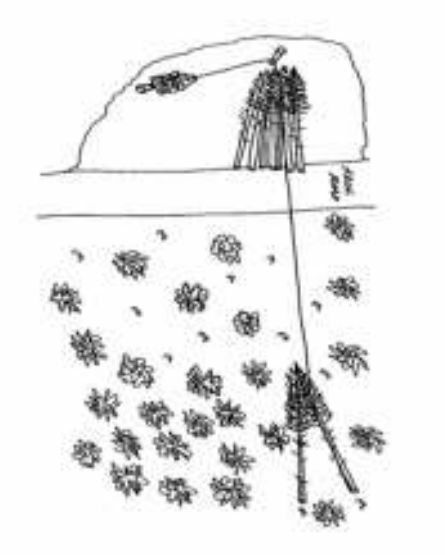


Figure 11. Whole tree harvesting system with portable winch

Table 2. Results of the log ox extraction trials, from Tusk (1989)

	Harvesting system		
	2.5 meter logs (fig. 10)	1.25 meter logs	Whole tree (fig. 11)
Mean number of logs/stems per load	10	18	2
Mean mid diameter	12	11	10
Mean log length	2.5	1.25	9
Mean volume per load (m^3)	0.29	0.21	0.14
Time per cycle (min)	3.62	3.08	2.28
Cycles per hour	16.59	19.49	22.01
Productivity per hour (m^3/hr)	4.76	4.17	3.10
Productivity per day (m^3/day)	38.1	33.7	24.8

Salakka (2014) studied several small-scale technologies in the energy biomass extraction of secondary bamboo in northern Lao PDR. The study included two mobile winch types: a portable hand-held spill winch and a vineyard sledge winch for skidding both used in combination with chainsaw felling.

1) A portable hand-held spill winch similar to Figure 3 was applied in felling and stacking of highly entangled bamboo culms, both in U-shaped clump thinning and clear felling and in the subsequent downhill stacking. During the U-shape felling trials, average cycle time was 31.3 minutes with an average extraction volume of 60.6 kg.

Table 3. Cycle time elements in bamboo harvesting with hand-held winch

Element	U-shape	Clear cutting	
		Chainsaw	Winch
Preparatory work	1.7	2.2	1.3
Clearing area around the clump	0.7	0	0
Removing undesired material	3.8	13.2	0
Chainsaw cutting	2.3	3.9	0
Bundling the culms	2.9	2.8	4
Extraction with winch	2.7	1.6	10.1
Delimbing	14.1	12.5	24.8
Stacking	2.0	0	4.5
Delays	1.0	3.9	1.8
Waiting	-	8.6	6.2
Overall time, min	31.2	50.7	50.7

Overall productivity for one person was 0.1 tons/ha covering an extraction distance of 20 m. Productivity during clear cutting trials was considerably lower with 50.7 minutes cycle time and extraction volume of 112.2 kg. Overall productivity remained at around 0.1 tons/hr/person. One objective during the clear cutting trials was to test the winch's maximum extraction limit without risking the breaking of the remaining culms. Because of thi s trial, average extraction volume was increased from 60 kg to 112 kg. However, overall productivity declined since the bunched material became too heavy for the hand winch, which made extraction more time consuming. The extended extraction distance, from 20 to 35 m, also had a significant impact. The chainsaw operator spent almost 10 minutes more per cycle "removing undesirable material." Variations in operator work skills could be the reason behind the chainsaw productivity result. Larger bundle size also has a negative impact on delimbing, especially when machetes were used. In addition to large bundle size, the work environment was more challenging in terms of excess logging residues. Stacking of delimbed stems gave higher productivity due to easier handling, compared to culms with branches. A productivity value of 1.8 tons was achieved when stacking distance was less than 10 m and logging waste did not slow the work.

Table 4. Productivity rates in hand-held winch extraction

Productivities	U-shape	Clear cutting	
Chainsaw	0.592	0.393	t/h
Winch	0.640	0.426	t/h
Delimbing (machete)	0.258	0.181	t/h
Stacking	1.827	1.494	t/h

2) Chainsaw felling combined with a **vineyard sledge winch** extraction was tested in U-shape thinning and clear cutting cycles with extraction distances of 30-40 m and 80-100 m. Overall productivity with the 30-40 m extraction distance was 0.1 tons/ha/person. Average extraction volume at this distance was 96 kg with a cycle time of 53.4 minutes. When distances were extended to 80-100 m, overall productivity remained similar at 0.01 tons/ha/person due to the increase in payload from 60 kg to 100 kg, giving an average cycle time of 53.3 minutes. Clear cutting trials gave better results with productivity at 0.125 tons/ha/person. Average extraction volume increased to 168 kg because of a higher pulling capacity, comparable to the hand winch when extraction distance was 35 m. Delimbing was not carried out in these trials.

Table 6 illustrates productivity numbers in greater detail during the vineyard winch trials. Winch productivity dropped from 0.564 tons/ha to 0.403 tons/ha when the extraction distance was extended from 35 m to 80-100 m. The stacking phase had a relatively low productivity rate even though the operators were working with already delimbed culms. This result indicates the impact when stacking distance is 20 m and the ground is full of logging residue in contrast to a stacking productivity of 1.8 tons/ha during the hand winch trials when the distance was much lower – at less than 10 m – and no logging waste was present to interrupt the work. Chainsaw productivity was increased from 0.55 tons/ha to 1.30 tons/ha in the clear cutting trials. An explanation is the omitted delimbing component, which results in heavier stems because biomass is not reduced. Excluding the delimbing results in poor stacking productivity, which was 0.347 tons/hr and required 52.63 percent of the winch operator's total time and 19.78 percent of the chain saw operator's. Winch performance increased from 0.564 tons/ha to 0.630 tons/hr. The productivity of 0.4-0.6 tons/hr or 3.2-4.8 tons/day for winching is quite satisfactory, given the small average piece weight of 11 kg of bamboo in these trials.

Table 5. Cycle time elements for chainsaw vineyard winch extraction

Element	U-shape		Clear cutting	
	30-40	80-100	Chainsaw	Winch
Preparatory work	3.0	3.2	3.2	3.0
Clearing area around the clump	2.3	2.6	0.0	0.0
Removing undesired material	8.0	7.5	5.0	0.0
Chainsaw cutting	3.0	2.7	2.6	0.0
Bundling the culms	4.4	4.9	5.0	3.0
Extraction with winch	6.0	9.4	0.7	7.4
Delimbing	19.3	15.8	0.0	0.0
Stacking	6.9	5.8	8.0	21.2
Delays	0.5	1.4	2.5	2.3
Waiting	-	-	13.3	3.5
Overall time, min	53.4	53.3	40.3	40.3

Table 6: Productivity rates during vineyard winch trials

	U-shape		Clear cutting	
Productivities	30-40 meters	80-100 meters	30-40 meters	
Chainsaw	0.534	0.566	1.322	t/h
Winch	0.564	0.403	0.630	t/h
Delimbing chainsaw	0.305	0.365	Omitted	t/h
Stacking	0.855	1.004	0.347	t/h

References

Anonymous 1986, "The Radio Horse: a new machine for thinning without damage," January-February Issue, Alabama Forests Newsletter, Alabama, United States.

Belyea, B 1984, "Radio-Tir 740 portable remote control winch and Skogma grapple," Progress Report to the Technology Transfer Committee, N.B.: S.N.B. Wood Cooperative, Ltd.

Hathaway, FM and Hoffman, BF 1986, "A comparison of small single- and double-drum cable systems for pre-bunching and partial cuts." Bulletin. 815, Maine Agricultural Experiment Station, University of Maine, Orono, Maine, United States, p. 32.

Hoffman, BF and Christensen, TE 1980, "Appropriate technology fuel wood harvesting," Forestry Notes, Maine Cooperative Extension Service, University of Maine, Orono, Maine, United States, Joint publication with the Forestry Extension Service, Department of Natural Resources, N.B., pp. 14.

Hoffmann, BF 1982, "A two stage transportation system for woodlot harvesting," University of Maine College of Forest Resources, Orono, Maine, United States, Technical Note 87.

KwF 2011, "Prüfbericht Spillwinde (Report on performance testing of Nordforst Capstan winch)," , p. 4

LeDoux, CB and Butler, DA 1982, "Pre-bunching results from simulation," Journal of Forestry, Vol. 80. p. 5.

LeDoux, CB, Kling, BW and Harou, PA 1987, "Predicting bunching costs for the Radio Horse 9 winch," NE-RP-595, Broomall, Pennsylvania, United States: U.S. Department of Agriculture, Forest Service Northeast Forest Experiment Station.

Salakka J 2014, "Unit cost calculation for bamboo harvesting supply chain in unmanaged bamboo stands in Lao PDR," Karelia University of Applied Sciences, Degree Program in Forestry, Joensuu, Finland, pp. 60, annexes.

Trzesniowski, A 1977, "Use of the 'ackja' winch in forests," Forstarchiv Vol. 48, No. 8, pp. 167-169.

Tulk, D 1989, "Portable winch systems for commercial thinning in Newfoundland – productivity, costs and comparisons," University of Newfoundland Department of Forestry and Agriculture, Forest Products and Development Division, Forest Resources Development Agreement Report 53, p. 44.

RECOFTC

THE CENTER FOR PEOPLE AND FORESTS

RECOFTC's mission is to enhance capacities for stronger rights, improved governance and fairer benefits for local people in sustainable forested landscapes in the Asia and the Pacific region.

RECOFTC holds a unique and important place in the world of forestry. It is the only international not-for-profit organization that specializes in capacity development for community forestry. RECOFTC engages in strategic networks and effective partnerships with governments, nongovernmental organizations, civil society, the private sector, local people and research and educational institutes throughout the Asia-Pacific region and beyond. With over 25 years of international experience and a dynamic approach to capacity development – involving research and analysis, demonstration sites and training products – RECOFTC delivers innovative solutions for people and forests.

RECOFTC – The Center for People and Forests
P.O. Box 1111
Kasetsart Post Office
Bangkok 10903, Thailand
Tel (66-2) 940-5700
Fax (66-2) 561-4880
info@recoftc.org
www.recoftc.org

Printed on recycled paper