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POSSIBILITIES FOR FINNISH HARVESTING MACHINERY IN CANADA

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During 1989-92, the Finnish Forest Research Institute and the Forest Engineering Research Institute of Canada exchanged two forest technology researchers. One of the objectives of the exhange was to study the possibilities of Finnish harvesting machinery in Canada. In this paper, a summary of the forestry conditions in each province is presented and the relevance of Finnish equipment, the problems expected and possible solutions to those problems discussed.

Due to the vast size of Canada, the site conditons are variable, and often very different from the Finnish conditions. Stands are usually unmanaged and they may be dense. Tree size within stands may vary widely and tree species are different. Forest management and harvesting practices are totally different from Finland in most parts of Canada. All this often results in operating conditions not found in Finland. In Canada, harvest systems are starting to change from a predominance of large clearcuts to smaller clearcuts and to an interest in partial cuts on a commercial scale. In most areas, however, clearcutting with full-tree or tree-length methods is still used almost entirely. The climate is more extreme in many areas of Canada, and thus more demanding.

When trying to introduce Finnish forest machinery in Canada more attention should be paid to the dissimililarities between the forests and forestry in respective countries. Because of lower level of operator training, the difference in operator attitude, climate and site conditions Canadian harvesting sets higher demands on machine durability than harvesting in Finland. Presently on the Canadian market, the key factors to a succesfull forest machine are reliability and productivity. Operators appreciate a quiet cab, good ergonomics and operator appeal but they are still secondary factors when purchasing a machine. More robust and less fancy machinery, than presently offered by Finnish manufacturers, would probably have a greater success, providing the price is right.

Keywords: forestry conditions, logging, forest machinery, Canada, Finland

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CONTENTS

1. BACKGROUND

In both Finland and Canada, forestry contributes to a major part of the national economy. Much of the forest conditions are similar, though the management and harvesting systems are different. Because of the similarity in forest conditions, Canadian harvesting equipment was tried in Finland in the 60's without much success. Now Finnish equipment has been introduced into Canada.

During 1989-92, the Finnish Forest Research Institute and the Forest Engineering Research Institute of Canada exchanged two forest technology researchers in an effort to promote understanding and cooperation in forest research between the two countries. Interest was shown by the Ministry of Industry and Trade in Finland, who offered to finance the transfer costs of the research personnel.

It is out of appreciation of their financial support that we are presenting this paper. Our objectives are to discuss aspects influencing the success of Finnish harvesting machinery in Canada on a province by province basis. Emphasis will be on machine suitability to integration with existing systems and introduction of new systems as influenced by forest infrastructure.

2. GENERAL LOGGING CONDITIONS AND PRACTICES IN FINLAND

Compared to Canada, Finland is a small country (Fig. 1). The total area of Finland is 0.337 mill. km^2, only 1/30 of the area of Canada. The terrain in Finland is relatively flat, and the variation in logging conditions in the different parts of the land small. About 30% of the land area is covered by peatlands. 50% of peatland has been drained (Aarne 1992), largely for forestry use. There are only three main tree species: Scots pine (*Pinus sylvestris*), Norway spruce (*Picea abies*) and birch (*Betula pendula* and *Betula pubescens*). The share of the standing volume in 1990 was 45.2% for Scots pine, 36.7% for Norway spruce and 18.1% for all the broadleaved species (Aarne 1992).

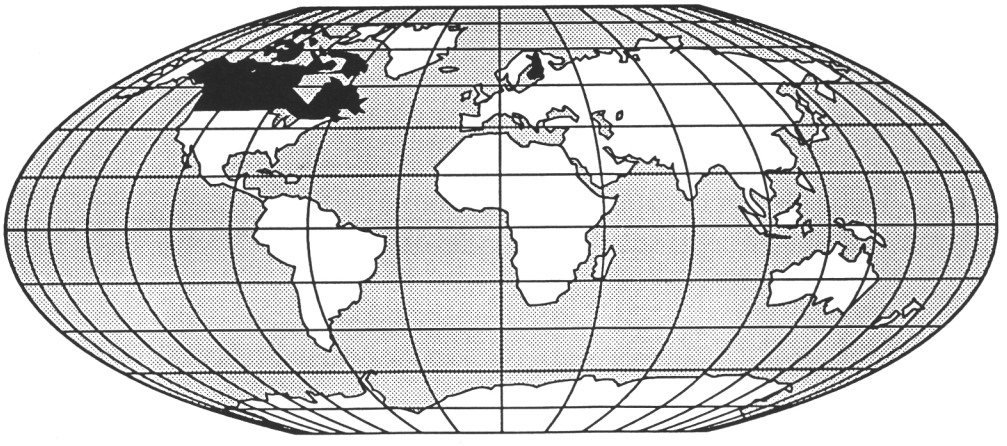


Figure 1. The total area of Finland is only 1/30 part of the area of Canada.

Finland has 20.1 mill. ha of productive forest land, 4.5 mill. ha of which is on drained peatland. Private citizens own 56% of the forest area, state 32%, forest industry companies 8%, and municipalities, parishes, and foundations 4%. The removal in 1991, which was an exceptionally quiet year on the roundwood market, was 39.4 mill. m^3 (1989: 52.0 mill. m^3). (Aarne 1992).

Stumpage prices have been higher than in most other forest industry countries. After roughly a 25% price reduction since the beginning of 1991, the stumpage prices were still around 85 FIM/m^3 (24 CAD/m^3, 10/1992: 1 FIM = 3.601 CAD) for pulpwood and 195 FIM/m^3 (54 CAD/m^3) for sawlogs in the spring of 1992 (Aarne 1992). In the late 1980's, stumpage price comprised 15% of the average export price of pulp and paper products, and 45% of that of coniferous lumber (Pellervon...1989).

Forest management systems are characterized by repeated selective thinnings from below. Less than 30% of all timber is harvested for thinnings (Hakkila 1989). Nearly all stands in Southern Finland are thinned twice or three times during the rotation period, which varies from 60 to 90 years. In the north of the country the rotation period is typically 100 to 120 years.

The tree size in thinnings varies form 0.05 to 0.12 m^3 (Lilleberg & Raitanen 1989), and in final cuttings usually between 0.2 to 0.7 m^3 (Hakkila 1989). The stem form of coniferous species is generally good, and usually the trees are not heavily branched. The trees are relatively sparcely located, the initial density of planted forests being about 2000 trees/ha.

The high season for logging has traditionally been wintertime, when the ground is frozen. This is still largely true on peatlands. The trend towards even and year-round logging on mineral soils is strong. Log-length method is used almost entirely. After harvesting the landowner is obliged to take care of regeneration.

Forest industry companies usually buy standing wood, and it is delivered to the road side with forwarders. Logging machines are almost entirely owned by private contractors. In 1991, 21.1% of commercial roundwood fellings was cut and extracted with chain saws and/or farm tractor-based machinery by self-employed forest owners (Aarne 1992).

In 1991, 43% of the commercial roundwood fellings was cut mechanically (Aarne 1992). The corresponding figure in the operations of the forest industry copmanies and the National Board of Forestry was 55% (Aarne 1992). The most common machine in mechanized cutting is one-grip harvester, with about 95% share of the cutting machine fleet (up to and including six year old machines) (Säteri 1992). All cutting machines sold in 1991 were of this type (Säteri 1992). Automated timber scaling by one-grip harvesters is advancing rapidly. In 1991, over two-thirds of mechanized cutting was scaled by the scaling devices of the cutting machines.

The average extraction distance is about 300 m. In 1989, the average secondary transportation distance was 137 km (Aarne 1992).

The training of chain saw operators and forest machine operator is on a relatively high level. The fact that the labour force of forestry has been continuously decreasing, has partly set requirements to the ergonomics of the machinery, in order to make forest work as attractive

as possible. Since the 1990 recession there has, however, been a surplus in the labour force of forestry.

In Finland, the forest and its intangible values are part of the way of life. The multiple use of forests and general environmental and ecological considerations put increasing pressure on forest management and logging operations. The condition of the site after logging must be good to keep the private forest owners willing to sell wood in the future.

3. GENERAL LOGGING CONDITIONS AND PRACTICES IN CANADA

31. General

Canada (Fig. 1) is an extremely large country with 10 provinces and 2 territories, each having a great deal of autonomy in forming their social and economic policies, including forest policies. Variations in terrain, climate, forest type, population density, population type, attitude, land ownership patterns, major industries, employment possibilities, and distance to markets across the country result in a many faceted and diverse forest industry.

32. Land ownership

Canada has 244 mill. ha of productive forest land, of which 80% are owned by the different provincial governments, 11% by the federal government and the remaining 9% by private

Table 1. Ownership of Productive Forest Land (Forestry Canada 1991a).

Province	Federal Crown	Provincial Crown[1]	Private[2]	Total
		mill. ha		
British Columbia	0.47	48.65	1.98	51.10
Alberta	1.75	22.75	0.94	25.44
Saskatchewan	0.46	15.03	0.39	15.89
Manitoba	0.34	13.49	1.09	14.92
Ontario	0.25	32.39	5.66	38.29
Quebec	0.22	47.97	6.61	54.79
New Brunswick	0.15	2.96	2.98	6.09
Nova Scotia	0.11	1.02	2.71	3.85
Prince Edward Island	-	0.02	0.26	0.28
Newfoundland	0.06	10.71	0.40	11.17
Yukon & North West Territories	21.88	-	-	21.88
CANADA, total	25.71	194.99	23.02	243.70

1) includes unclassified land
2) includes municiple land

industry, private individuals or other. Ownership patterns are different between provinces as shown in Table 1. Not all of the productive forest land is available for harvest. About 8.9 million hectares (3.6%) is reserved including parks and other areas where harvesting is not permitted; a further 1.6 mill. hectares (0.7%) is unclassified but not available for harvest. Only half of the remaining 233 mill. hectares is considered commercially viable; the other half may be in isolated areas without transportation links or in harsh terrain where access is difficult and harvesting is too expensive (Forestry Canada 1991a).

33. Tenure and timber pricing

Most provincial governments lease their land to forest companies granting them the right to cut timber for a specified period of time. Agreements differ across the land but there are basically 3 types (Forestry Canada 1991a):

1. Long-term leases of land area are commonly granted for 20 to 25 years and are renewable indefinitely provided that the company satisfies the terms of agreements. The lease grants exclusive cutting rights to the timber but generally requires that forest protection, regeneration and management are carried out by the lease holder.

2. Medium term leases based on a volume allotment of timber generally are for a period of 15 to 20 years but may or may not be renewed depending on the province or the lease. Forest management, regeneration, and protection are often the responsibility of the province but may be the responsibility of the lease holder or may be a shared responsibility.

3. Short-term agreements based on small volumes of timber or small parcels of land carry no management obligations. They are used to allocate the timber or land for such purposes as Christmas tree farming, fuelwood harvesting or provisioning a small sawmills.

In all types of forest leases, the lease holder pays a fee known as the stumpage rate to the province. Methods of calculating the stumpage payment differ between provinces and between types of leases. The rate varies from a high of 18.55CAD/m^3 for coniferous and 26.70CAD/m^3 for deciduous on certain agreements in Quebec down to virtually nothing in Newfoundland. British Columbia has the highest average stumpage rates at 11.04CAD/m^3 on the coast and 8.59CAD/m^3 in the interior (Haley & Luckert 1990).

34. Wood drain

The annual wood drain by natural causes is nearly equivalent to industry's cut. Table 2 shows the breakdown. In 1989, the losses due to forest fires were worst in 80 years.

Table 2. Canadian annual wood drain.

Roundwood production in 1986 [1]		177 mill. m^3
	Atlantic provinces	9%
	Quebec	21%
	Ontario	17%
	Prairie provinces	9%
	British Columbia	44%
Insect and disease conditions 1984-87 [2]		
	Annual mortality	60 mill. m^3
	Growth reduction	22 mill. m^3
	Wood destruction	25 mill. m^3
	Total	107 mill. m^3
Fires [1],	avg. 1983-88	1 000 000 ha
	1989	7 300 000 ha

Sources: 1 = Forestry Canada 1991a
2 = Canadian Forestry Service 1988

35. Tree species

About 10 major forest types are found in Canada with many commercially important tree species. The boreal forest is one of the largest forest types, extending across most of the northern forested area in Quebec, Ontario, Alberta and the Territories (Figs. 2 and 3). It is quite similar to Finnish forests. Major species include black and white spruce (*Picea mariana* and *Picea glauca*), balsam fir (*Abies balsamea*), jack pine (*Pinus banksiana*) and birch (*Betula alleghaniensis* and *Betula papyrifera*).

Tree sizes in areas scheduled for clearcutting vary considerably between provinces, species and circumstances. In Newfoundland, the average tree-size in a budworm-damaged fir stand may be as low as 0.06 m^3/tree whereas an old growth stand in B.C. may have Douglas-fir stems averaging 3 m^3 or more. Even on the same site, tree size may vary considerably in unmanaged, intermediate or climax forests. On the other hand, pioneer forests of jack pine on sand flats may be dense but very homogeneous. Many species have poor form. Crooks, double tops and thick branches are not unusual for most species.

36. Logging season

Though there is no longer a high season for logging, there is a low season in many places across Canada. Logging is often stopped for 4 to 6 weeks in the spring when ground conditions are soft. During hot summers, there is always a chance that operations may be shut down or required to run on reduced hours because of a high fire hazard. This may account for 1 to 3 weeks per year.

37. Forest management systems

Both forest management objectives and systems are changing rapidly across Canada. There is a general trend to managing the forest also for recreation, wildlife and ecological values in addition to the traditional supply of commercial timber. The result is that harvest systems are changing from a predominance of large clearcuts to smaller clearcuts and to an interest in partial cuts on a commercial scale. However, there are still places where large areas, up to 250 ha, are clearcut. Many Canadian forests are catastrophy forests, e.g. they grow out of a major catastrophy such as a fire or a widespread blowdown, and clearcutting is a valid silvicultural prescription in these circumstances.

Most of the timber currently harvested off crown land is from unmanaged forests, whereas many private forests have been managed for the past 30 to 100 years. A major planting program on crown lands started only in the 70's and continued through the 80' s assuring regeneration success. However, many of those stands have not been touched since establishment. A new trend in the 90's is to use harvesting methods which protect the advance regeneration. A cleaning (pre-commercial thinning) is carried out 5 to 15 years after the harvest to space the regeneration, sometimes favouring one species over another.

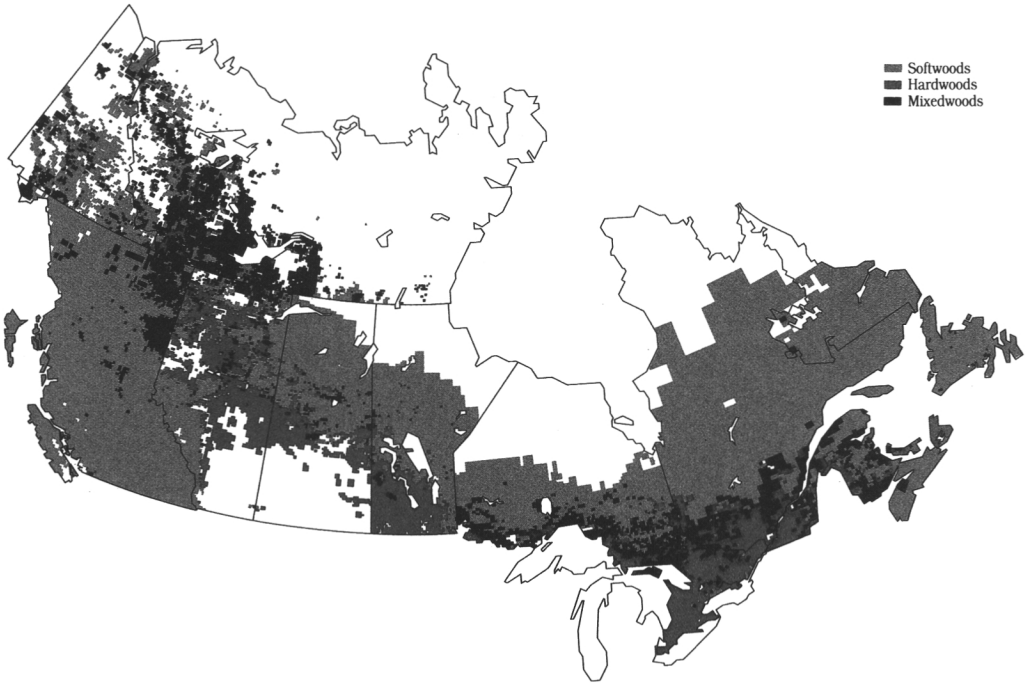
The first stands established by large-scale planting are just starting to need thinning but the majority won't be ready for 10 or more years. The first stands established by protection of natural regeneration and subsequent cleaning will not likely need commercial thinning for 20 years or more.

38. Harvest systems

General trends in harvest systems according to FERIC data bank (FERIC 1992) are shown in Fig. 4. As the cost of woodrooms are increasing, pulp companies are more and more interested in receiving chips rather than roundwood. Thus, delimber-debarker-chippers are gaining in popularity. There are now 12 working in eastern and central Canada, up 200% from 1990.

Nordic style harvesters/processors or heads which can be mounted on excavator-type carriers are the only other type of machinery which has shown substantial growth over the last year.

Results from a FERIC Eastern Division survey of member companies in eastern and central Canada, show an overall increase in the number of harvesters of 94% over the 1990 figures in the FERIC (1992) data bank (Table 3). The number of processors increased by 11%, while the forwarder population grew by 5%. Member companies surveyed accounted for 57% of the wood harvested in eastern and central Canada in 1990 and 50% in 1991. Forwarders in Table 3 include North American and Nordic models.



FOREST RESOURCE

TOTAL AREA	997 million ha
FOREST LAND	453 million ha
RESERVED FOREST LAND	12.5 million ha
PRODUCTIVE FOREST LAND	244 million ha
AREA REGENERATED (1988)	823 thousand ha
AREA HARVESTED (1988)	1 million ha
DEFOLIATION BY INSECTS (1989)	19 million ha
AREA BURNED (1989)	7.3 million ha

OWNERSHIP OF PRODUCTIVE FOREST LAND

80% PROVINCIAL
11% FEDERAL
9% PRIVATE WITH 430 000 WOODLOT OWNERS

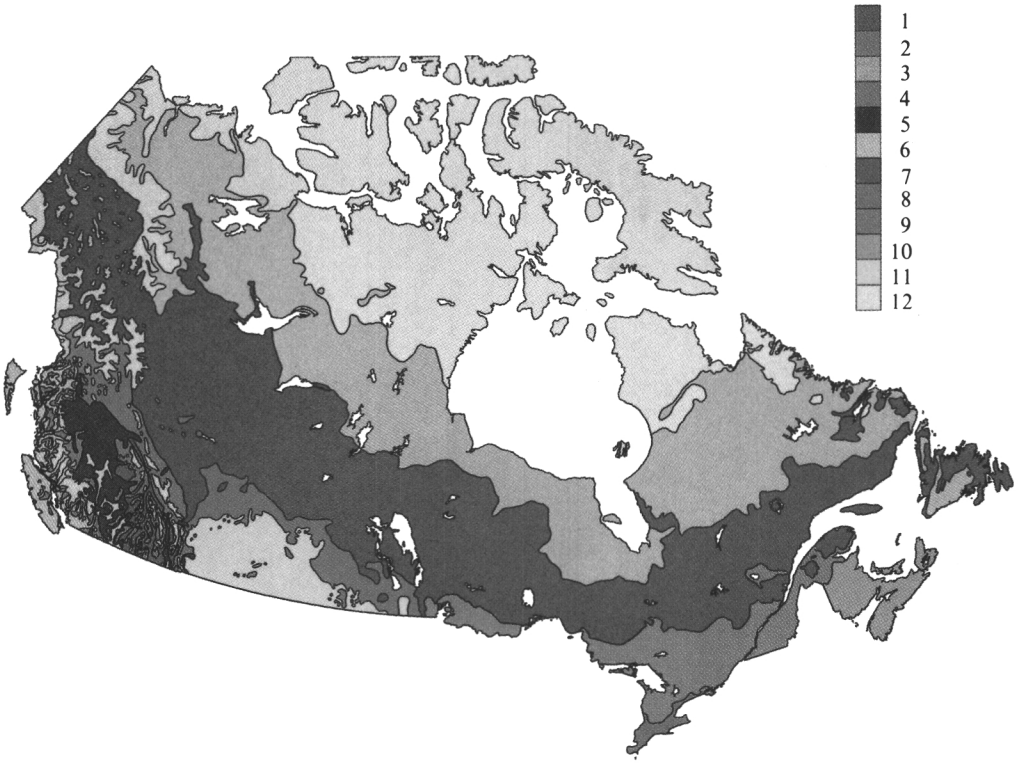
TRADE (1989)

VALUE OF EXPORTS	$22.8 billion
17% of all Canadian exports, 21% of world trade in forest products	
MAJOR VALUE OF PRODUCTS EXPORTED	
wood pulp (30%), newsprint (25%), softwood lumber (24%)	
MAJOR EXPORT MARKETS	
United States (65%), EEC (15%), Japan (11%), others (9%)	
BALANCE OF TRADE	$+19.5 billion

INDUSTRY PROFILE

TOTAL VALUE OF SHIPMENTS (1988)	$49 billion
54% sold domestically, 46% exported	
CONTRIBUTION TO ECONOMY (1989)	$20 billion
NUMBER OF ESTABLISHMENTS (1988)	14 944
Logging: 10 587, wood industries: 3 639, paper and allied industries: 718	
FORESTRY-DEPENDENT COMMUNITIES	348
EMPLOYMENT (1989)	888 000 jobs
348 000 direct jobs, 540 000 indirect jobs, 1 job in 14	
WAGES AND SALARIES (1988)	$9.6 billion
NEW INVESTMENT (1989)	$8.9 billion

Figure 2. An overview of Canadian forestry (Forestry Canada 1991a).



Forest Region No.	Name	Principal Tree Species
1	Boreal-Predominantly Forest	White Spruce, Black Spruce, Balsam Fir, Jack Pine, White Birch, Trembling Aspen
2	Boreal-Forest and Grassland	Trembling Aspen, willow
3	Boreal-Forest and Barren	White Spruce, Black Spruce, Tamarack
4	Subalpine	Engelmann Spruce, Alpine Fir, Lodgepole Pine
5	Montane	Douglas fir, Lodgepole & Ponderosa Pine, Trembling Aspen
6	Coast	W. Red Cedar, W. Hemlock, Sitka Spruce, Douglas fir
7	Columbia	W. Red Cedar, W. Hemlock, Douglas fir
8	Deciduous	Beech, maple, Black Walnut, hickory, oak
9	Great Lakes-St. Lawrence	Red Pine, E. White Pine, E. Hemlock, Yellow Birch, maple, oak
10	Acadian	Red Spruce, Balsam Fir, maple, Yellow Birch
11	Grassland	Trembling Aspen, willow, Bur Oak
12	Tundra	-

Figure 3. The forest regions of Canada (Forestry Canada 1991a).

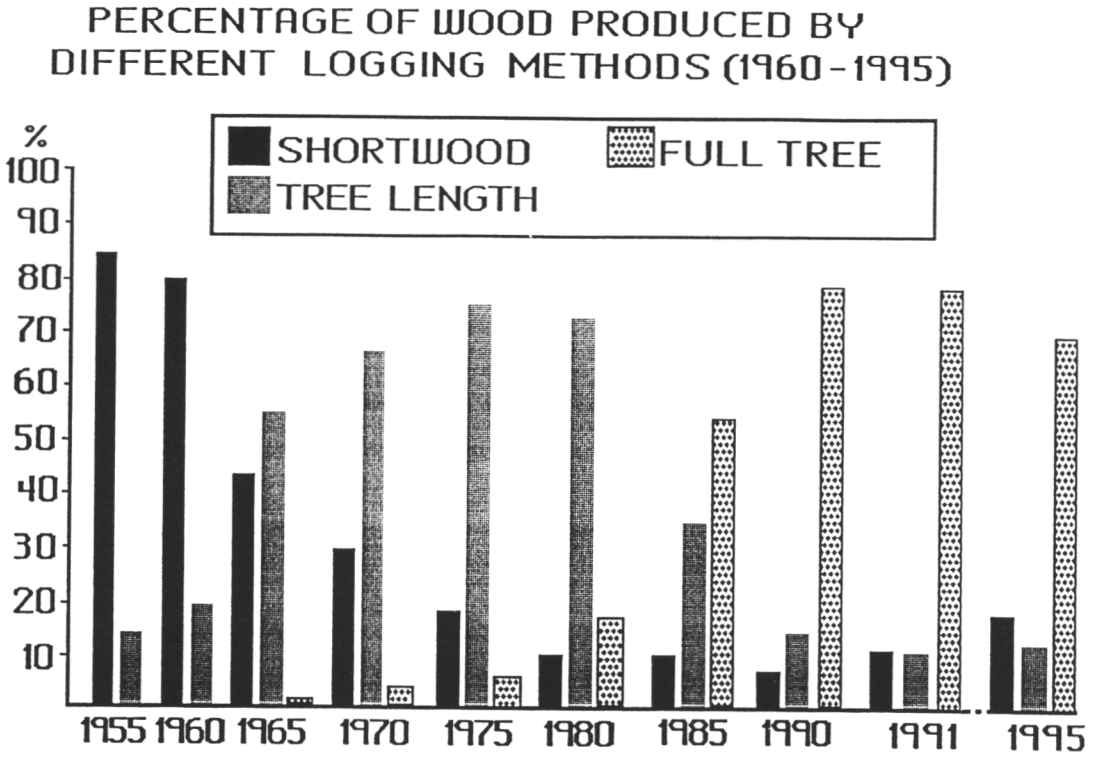


Figure 4. General trends in harvest systems in eastern and central Canada on Crown Lands and large private lands (does not include systems used on small private woodlots) (FERIC 1992).

Table 3. Machine populations in eastern and central Canada according to FERIC' s (1992) logging data bank in 1990 and 1991.

Province	Harvesters		Processors		Forwarders	
	Number of machines					
	1990	1991	1990	1991	1990	1991
Newfoundland	8	12	1	2	74	76
Nova Scotia	16	20	5	6	99	94
New Brunswick	8	22	12	12	80	100
Quebec	0	7	0	0	7	2
Ontario	1	3	0	0	0	1
Manitoba	0	0	0	0	0	0
Saskatchewan	0	0	0	0	0	0
Total	33	64	18	20	260	273

About 75% of large logging equipment (excluding farm woodlot-type machinery) is owned by contractors who are paid by volume or weight. The trend is towards contractor operations away from company-owned machinery which predominated in the early 70's. Operators may be paid hourly wages when the machines are complex and need careful maintenance (e.g. harvesters). They are usually paid a piece rate for operation of more simple machines (e.g. skidders). Shift lengths in Canada vary from 8 to 12 hours and the number of shifts per day vary from 1 to 3. Typically operators work long shifts resulting in 50 to 55 hours per week. Machines may be operated from a low of 1 800 hours per year for a single shift operation to about 4 600 hours per year for a double shift operation in favourable conditions.

39. Education and training of forest workers

The education and training of forest workers in Canada is extremely diverse. However, the majority have not completed high school (grades 11 to 13). The level of schooling of workers in the logging industry in 1986 is presented in Table 4.

There is very little training once a person has entered the work force. Companies have their own training programs which usually are focused on safety, periodic maintenance and operation of the machines but not on the mechanics of the machines. These courses are not continuous and well-organized. Machine dealers organize on-job training for contractors. The training, which is tailored according to the needs, usually consists of a two-week period after the delivery of the machine and a follow-up later. The success of this type of training depends much on the level of the basic training of the students, and the results are often poor.

An extensive FERIC survey on Future Equipment Needs highlights the need for training on particular machines (Gingras 1992). This is especially acute for machines with newer technology such as Nordic-style harvesters and processors. Survey respondents indicated their preference for equipment dealers or manufacturers to conduct this training.

Table 4. Level of schooling within the logging industry in 1986 (Forestry Canada 1991b).

Level of schooling	Number of employees	Share of employees, %
Less than secondary school graduation	31 400	59
Secondary school graduates	5 985	11
Some post secondary schooling	4 115	8
Trade vocational graduates	6 925	13
Post-secondary non-university graduates	3 120	6
Undergraduate	1 815	3
University graduates	245	<1
Total	53 605	100

4. LOGGING CONDITIONS AND PRACTICES BY PROVINCE

Canada is so vast, spanning an entire continent, and so variable, that it is difficult to comprehend most subjects on a national level. However, by studying a problem on a provincial basis, the conditions and the solutions are more easily defined. Therefore, a summary of the forestry conditions in each province will be presented and the relevance of Finnish equipment, the problems expected and possible solutions to those problems discussed.

Newfoundland

The harsh moist climate of Newfoundland and shallow rocky soils support mainly black spruce and balsam fir species. Softwood stems are generally small and straight. The terrain is rough, rocky and often steep. Natural regeneration is prolific (20 000...100 000 stems/ha) and dense stands are a major concern. Forestry statistics for Newfoundland are shown in Fig. 5.

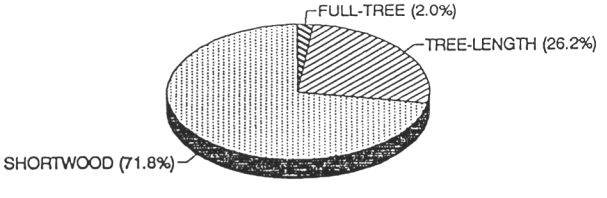
OWNERSHIP OF PRODUCTIVE FOREST LAND
96% PROVINCIAL
4% PRIVATE WITH 4 500 WOODLOT OWNERS

Black spruce

FOREST RESOURCE	
TOTAL AREA	40.6 million ha
FOREST LAND	22.5 million ha
RESERVED FOREST LAND	120.5 thousand ha
PRODUCTIVE FOREST LAND	11.2 million ha
AREA REGENERATED (1988)	17.5 thousand ha
AREA HARVESTED (1988)	17 thousand ha
DEFOLIATION BY INSECTS (1989)	10 thousand ha
AREA BURNED (1989)	68.2 thousand ha

TRADE (1989)	
VALUE OF EXPORTS	$377 million
MAJOR VALUE OF PRODUCTS EXPORTED	
newsprint (67%), book and writing paper (32%)	
MAJOR EXPORT MARKETS	
EEC (36%), United States (29%),	
South and Central America (22%)	
BALANCE OF TRADE	$+371 million

INDUSTRY PROFILE	
TOTAL VALUE OF SHIPMENTS (1988)	not available
NUMBER OF ESTABLISHMENTS (1988)	193
Logging: 130, wood industries: 56,	
paper and allied industries: 7	
FORESTRY-DEPENDENT COMMUNITIES	15
EMPLOYMENT (1989)	10 000 jobs
6 000 direct jobs, 4 000 indirect jobs,	
1 job in 20	
WAGES AND SALARIES (1988)	not available
NEW INVESTMENT (1989)	not available



Harvesting systems used on Crown Lands or large private lands

Figure 5. Forestry statistics for Newfoundland (Forestry Canada 1991a, FERIC 1992).

Virtually all of the 2.4 mill. m^3/year (1986 figures) of wood harvested is destined for the pulp and paper markets (Forestry Canada 1990). Traditionally, wood was manually felled, delimbed, bucked to 4 foot lengths and manually piled in the stand (trail cutting). Since the 70's forwarders have been used for extraction to roadside. Another popular harvest method in Newfoundland has been to fell and delimb manually in the bush. Skidders then drag the tree-length stems to roadside where slashers are used to cut them into 4 or 8 foot pieces.

In 1988, the Abitibi-Price company, one of two large pulp companies in the province, introduced Nordic harvesters. They felt that the one-grip harvesters would fit well into their existing system as their transportation and mill handling systems were designed for 4 or 8 ft wood. They wanted to switch from manual felling for several reasons: less labour cost which leads to a lower administration cost and lower camp costs, less labour turnover, possibilities for double shifting and possibilities for working in the deep snow in winter.

In 1991, there was 12 one-grip harvesters and 2 six-wheel forwarders in the province according to FERIC's (1992) logging data bank.

Potential markets

When equipped with tracks Nordic forwarders have better tractive effort on the steep slopes than the traditional 4-wheel North American models. On the steep and rough terrain they are more productive. Thus, there is a market for them if the cost-benifit ratio is positive.

One-grip harvesters have been well accepted at Abitibi-Price after some introductory problems. There are now some skilled operators and skilled mechanics. The company bought the harvesters as a way to introduce them. They would now like to sell them to contractors as all their other operations are run by contractors.

The other large pulp company in the province has 1 harvester and 2 processors. However, the market potential with them is low because they are phasing out their wood room and receiving more and more of their wood in the form of chips.

A potential market for harvester heads exists among small contractors and woodlot owners for mounting on inexpensive carriers such as small excavators or converted forwarders.

Potential problems

Unions in Newfoundland have a history of being very strong. A contractor cannot choose which operator will run his machine. The operator will be chosen by union hierarchy and will not necessarily be the person the most suited for the job.

There is a very high unemployment rate in the province and, therefore, labour saving systems may not be encouraged.

The level of education in the province is low.

The temperatures in Labrador can be extremely cold (-30°C for many days in a row). Nordic machinery is not designed for the extremely cold temperatures enjoyed in some parts of Canada.

Nova Scotia

The climate in Nova Scotia is mild and humid. Temperatures seldom go below -10°C. The Acadian forest type predominates. There are no mountains in Nova Scotia, just hills and valleys. The ground undulates from boggy and soft to steep and rocky. Natural regeneration is usually more than adequate. Some general forestry statistics for Nova Scotia are presented in Fig. 6.

Much of the forest is privately owned and the purchase wood system is somewhat similar to that practiced in Finland. In Nova Scotia, about 3.9 mill. m^3 were harvested in 1986 (Forestry Canada 1990). There are some small lumber mills in the province and about 30% of the wood volume is first delivered there. The rest of the wood is divided up between 4 pulp and/or paper mills.

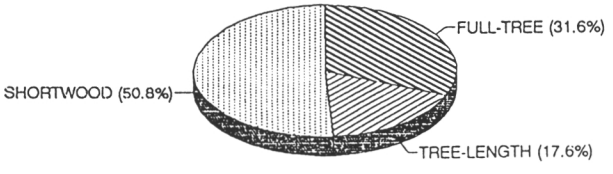
OWNERSHIP OF PRODUCTIVE FOREST LAND
27% PROVINCIAL
3% FEDERAL
70% PRIVATE WITH 31 000 WOODLOT OWNERS

Red spruce

FOREST RESOURCE	
TOTAL AREA	5.6 million ha
FOREST LAND	4.0 million ha
RESERVED FOREST LAND	96.4 thousand ha
PRODUCTIVE FOREST LAND	3.9 million ha
AREA REGENERATED (1988)	32.7 thousand ha
AREA HARVESTED (1988)	42 thousand ha
DEFOLIATION BY INSECTS (1989)	not available
AREA BURNED (1989)	462 ha

TRADE (1989)	
VALUE OF EXPORTS	$524 million
MAJOR VALUE OF PRODUCTS EXPORTED	
newsprint (44%), wood pulp (44%)	
MAJOR EXPORT MARKETS	
United States (68%), EEC (19%)	
BALANCE OF TRADE	$+499 million

INDUSTRY PROFILE	
TOTAL VALUE OF SHIPMENTS (1988)	$1.0 billion
NUMBER OF ESTABLISHMENTS (1988)	516
Logging: 389, wood industries: 112, paper and allied industries: 15	
FORESTRY-DEPENDENT COMMUNITY	1
EMPLOYMENT (1989)	15 000 jobs
9 000 direct jobs, 6 000 indirect jobs, 1 job in 25	
WAGES AND SALARIES (1988)	$198 million
NEW INVESTMENT (1989)	not available



Harvesting systems used on Crown Lands or large private lands

Figure 6. Forestry statistics for Nova Scotia (Forestry Canada 1991a, FERIC 1992).

Traditionally, the trail cut method of manually felling, delimbing, bucking and piling stems has been used especially in the pulp wood stands of small dimension softwood. All of the pulp mills were designed to accept 4 ft lengths, upgrades have allowed them to accept 8 ft lengths and chips. One mill also accepts random lengths. The cut-to-length method of harvesting is the most predominant method at present.

Primarily because of population distributions, road networks and ownership patterns, more forest management over the full rotation of a stand is practiced than in most other places in Canada. The trend is towards more partial cuts, more multiple-use forestry and more environmentally soft logging.

There were 20 one-grip harvesters in the province in the 1991 FERIC logging data bank. About 80% of the heads and about 55% of the carriers were Nordic. Six processors and 6 Nordic forwarders were also in the data bank. It is estimated that about an equal number of smaller contractors using small heads mounted on light-weight carriers are working for private woodlot owners.

Potential markets

The market for machines for commercial thinning applications will likely increase. This will include both one-grip harvesters, harvester heads and forwarders.

Six- and eight-wheel Nordic machines offer the opportunity to reduce ground pressure by using tracks on the soft soils in N.S.

Potential problems

Because of an imbalance in the age class distribution caused by a major insect infestation in the past, there is an over supply of wood at present and predicted for the next 5 years which has resulted in a low raw wood price. A period of shortage may follow in 5 to 10 years.

Stems may be crooked, deformed or with thick branches. White spruce may be especially problematic for delimbing with harvester or processor heads.

New Brunswick

The maritime climate prevails in New Brunswick. Temperatures generally are not as extreme as those in the mid-continent. The forest is predominantly Acadian with three spruce species and balsam fir as the major commercial species. The terrain is gentle. Though there are some steep slopes, this province is characterized by low hills, long ridges and flats. Natural regeneration is usually adequate although many seedlings have been planted in the past 20 years. Selected forestry statistics for New Brunswick are presented in Figure 7.

The annual harvest in New Brunswick was 8.7 mill. m^3 in 1986 (Forestry Canada 1990). Forestry is a very important industry in the province supporting around 300 establishments including logging firms, sawmills, shingle mills, pulp and paper mills and others.

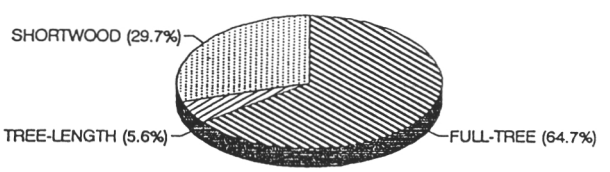
OWNERSHIP OF PRODUCTIVE FOREST LAND
49% PROVINCIAL
2% FEDERAL
49% PRIVATE WITH 35 000 WOODLOT OWNERS

Balsam fir

OREST RESOURCE	
OTAL AREA	7.3 million ha
OREST LAND	6.3 million ha
ESERVED FOREST LAND	31.6 thousand ha
RODUCTIVE FOREST LAND	6.1 million ha
REA REGENERATED (1988)	61.8 thousand ha
REA HARVESTED (1988)	87.2 thousand ha
EFOLIATION BY INSECTS (1989)	398 thousand ha
REA BURNED (1989)	343 ha

TRADE (1989)	
VALUE OF EXPORTS	$1.5 billion
MAJOR VALUE OF PRODUCTS EXPORTED	
wood pulp (48%), newsprint (16%),	
other paper and paper board (24%)	
MAJOR EXPORT MARKETS	
United States (55%), EEC (23%), Japan (12%)	
BALANCE OF TRADE	$+1.4 billion

INDUSTRY PROFILE	
TOTAL VALUE OF SHIPMENTS (1988)	$2.7 billion
NUMBER OF ESTABLISHMENTS (1988)	1 124
Logging: 948, wood industries: 154,	
paper and allied industries: 22	
FORESTRY-DEPENDENT COMMUNITIES	41
EMPLOYMENT (1989)	30 000 jobs
18 000 direct jobs, 12 000 indirect jobs,	
1 job in 9	
WAGES AND SALARIES (1988)	$458 million
NEW INVESTMENT (1989)	not available



Harvesting systems used on Crown Lands or large private lands

Figure 7. Forestry statistics for New Brunswick (Forestry Canada 1991a, FERIC 1992).

Both cut-to-length and tree-length harvesting methods have been used in the last 30 years. Presently, there is a wide variety in systems and equipment being used for commercial harvesting across the province ranging from tree-length thinning with horses and, traditional cut and skid tree-length with cable skidders, to mechanized full tree extraction to a flail delimber/debarker/chippers and, to cut-to-length harvesting with Nordic one-grip harvesters and forwarders.

Two-grip processors were first introduced to New Brunswick by two Swedish contractors in 1983. Their success as contractors and subsequent success as equipment distributors because of their drive, and commitment to customer service and satisfaction, has led to an overall acceptance of Nordic machinery in the province.

One of the largest companies in the province has recently forced its contractors to convert from using full-tree harvesting methods and equipment to using cut-to-length methods. Thus, the number of harvesters has almost tripled since 1990 to 22. There are 12 processors and 9 Nordic forwarders.

Potential markets

Many in the province believe that the government will disallow burning as a means to treat roadside slash piles produced from full-tree operations. As most other methods of treatment are more costly, logging companies must start considering methods which leave the slash spread out over the site rather than at roadside.

One-grip harvesters have been well accepted as have processors for use in clearcuts. One-grip harvesters may become popular, for thinning applications as some of the earliest plantations will soon be ready for a first thinning. Also, companies are experimenting with partial cuts in buffer zones and in deer wintering areas where one-grip harvesters and light-weight forwarders may be employed.

There are over 35 000 private woodlot owners and, therefore, small operators abound. Some of these are interested in Nordic one-grip heads to mount on low cost carriers.

Potential problems

A lot of businesses have gone bankrupt since the 1990 recession. It may be difficult to find a reliable dealer for any new product.

Stem form is often poor and some species may have thick branches which may reduce productivity and reduce quality.

Quebec

Quebec has the second largest harvest of all the provinces. Relevant information is presented in Fig. 8. Though, some areas experience a maritime climate, most of Quebec's forest lands are situated on a continental climate zone with extreme cold in the winter and possibilities of hot dry summers where the fire hazard can be prohibitive to operations. All types of terrain can be found in the province varying from mountainous, to extremely rocky and rough, to gentle and flat, and to very soft peatlands.

Quebec has sawmills, pulp and/or paper mills, shingle mills, veneer and plywood mills and others. Of the 38.1 mill. m^3 harvested annually (1986 figures), less than half goes directly to the pulp mills (Forestry Canada 1990). For many years, the manual cut and skid tree-length to roadside has been the dominant harvesting system. However in the boreal forest zone, mechanical full-tree clearcutting has been the accepted system for the past 2 decades.

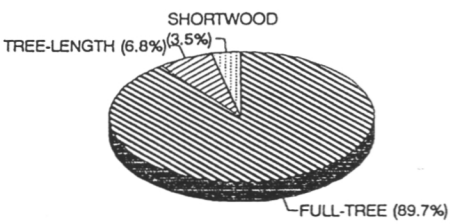
OWNERSHIP OF PRODUCTIVE FOREST LAND
87.6% PROVINCIAL
0.4% FEDERAL
12% PRIVATE WITH 120 000 WOODLOT OWNERS

White elm

FOREST RESOURCE	
TOTAL AREA	154 million ha
FOREST LAND	94 million ha
RESERVED FOREST LAND	378 thousand ha
PRODUCTIVE FOREST LAND	54.8 million ha
AREA REGENERATED (1988)	256 thousand ha
AREA HARVESTED (1988)	315 thousand ha
DEFOLIATION BY INSECTS (1989)	1.1 million ha
AREA BURNED (1989)	2.1 million ha

TRADE (1989)	
VALUE OF EXPORTS	$5.1 billion
MAJOR VALUE OF PRODUCTS EXPORTED	
newsprint (49%), wood pulp (15%), other paper and paperboard (18%)	
MAJOR EXPORT MARKETS	
United States (80%), EEC (13%)	
BALANCE OF TRADE	$+4.4 billion

INDUSTRY PROFILE	
TOTAL VALUE OF SHIPMENTS (1988)	$13.3 billion
NUMBER OF ESTABLISHMENTS (1988)	4 171
Logging: 2 735, wood industries:1 218, paper and allied industries: 218	
FORESTRY-DEPENDENT COMMUNITIES	126
EMPLOYMENT (1989)	210 000 jobs
110 000 direct jobs, 100 000 indirect jobs, 1 job in 14	
WAGES AND SALARIES (1988)	$2.7 billion
NEW INVESTMENT (1989)	$2.2 billion



Harvesting systems used on Crown Lands or large private lands

Figure 8. Forestry statistics for Quebec (Forestry Canada 1991a, FERIC 1992).

Recently, several large companies have become interested in the cut-to-length system using Nordic machinery. There are a few different reasons for that. One of the companies has many small pockets of wood requiring much movement of machinery. Two machines are easier and cheaper to transport than 4 or 5. In Quebec, a lot of emphasis is put on the protection of natural regeneration and the companies may switch to a cut-to-length system if it is cost competitive with full-tree harvesting when calculating in the cost of silviculture to bring the forest to a free-to-grow state.

Potential markets

The potential market in Quebec is very large. This market has barely been touched. There are only 7 Nordic harvesters or harvester heads, no processors and no Nordic forwarders entered into the FERIC logging data bank.

The province has legislated that buffer zones where machines cannot enter must be left around most bodies of water but that 1/3 of the stems must be removed from these zones. Many companies are having difficulties meeting this criteria. Perhaps, a very long reach boom with a harvester head could be used, or perhaps the government could relax its machine entry restrictions for very small, tracked, lightweight harvesters and forwarders such as the Farmi-Trac, Nokka Jokeri or Terri.

Roadside slash from full-tree operations will no longer be allowed to remain untreated. One way to eliminate these piles is to use a system where stems are delimbed in the bush such as a cut-to-length system and thus, roadside slash piles are not created.

In Quebec, the emphasis is put on the protection of natural regeneration. The cut-to-length system where stems are carried with a forwarder over designated trails is one of the best harvesting systems for minimizing damage to the existing regeneration (Gingras 1990).

About 120 000 private woodlots accounting for 12 % of the province's productive forest land base produce 33 % of the wood (Forestry Canada 1990). Thus, small, productive machinery of low cost such as attachments for farm tractors is of interest for forest owners. There are many cooperatives and private-land contractors who would be interested in larger machinery if the price were right.

The merchandizing capability in a Nordic system is superior to the merchandizing capability of any fully mechanized North American system.

Potential problems

All manuals must be written in French and all instructors must know how to speak French.

Northern Quebec is extremely cold, temperatures of approximately -30 to -40°C often prevail for up to two months. Harvesting machinery is operated continuously despite of the cold. Most Nordic machinery is not designed for the extreme cold; hydraulic oil used normally is too viscous, making start-up difficult, causing high pressure drops in the lines and thus reducing delimbing power. Speeds of sequences are slowed down and the timber scaling device becomes inaccurate as the resistance to movement is high. Piston pumps are sensitive and will break if the machines are not warmed up thoroughly. Metal cracks easily in such cold and machines should be over-designed for normal temperatures to be able to remain intact during the cold. On the other hand, summers can be extremely hot, up to +40°C. Because of the large glass area of the cabins, heavy duty air conditioners in the machinery is essential.

Nordic machinery is usually not robust enough. The terrain can be very rough, and rocky, the slopes may be steep and the visibility can be less than 1 m. The stems may grow in clumps. These factors, especially when combined with poor visibility, influence the amount of breakage and downtime a machine experiences.

Stems are not homogeneous in size, may have poor stem form and may have large branches. This can effectively reduce productivity especially of lower-powered harvesters and may also reduce quality.

Though measurement with automatic timber scaling devices is not accepted as the official measurement, some contractors may get advances based on the machines' computer printout. However, the accuracy of the devices has been poorer than what is common in Finland for the following reasons:

-The measurement systems are usually designed according for the Nordic conditions. In Canadian conditions the stems generally are more crooked and branchy. This causes inaccuracy in volume measurement (Ala-Ilomäki 1992), and the breakdown of assortment may be incorrect if the stems have to be dropped and then picked up farther up along the bole.

-Most operators and contractors do not know how to calibrate the timber scaling device.

-The know-how of the dealers is not sufficient.

Ontario

Ontario has much the same climate and forest conditions as Quebec except there are not the extreme rough conditions nor the extreme slopes. Statistics for the province are shown in Fig. 9.

The annual harvest in 1986 equalled 30.2 mill. m^3 (Forestry Canada 1990). Over half of the wood is shipped directly to the pulp and paper mills. The rest goes to sawmills, veneer and plywood mills and others. Their residues are sold to the pulp mills.

Many Ontario logging camps still boast large cut and skid operations though most now pull full trees to roadside. Mechanical operations employing feller-bunchers, and grapple skidders in the bush, stroke delimbers and, in some cases, slashers at roadside have been slowly replacing the manual operations.

The FERIC logging data bank shows that only one member company employs Nordic equipment: 3 harvesters and 1 forwarder. These were bought primarily to salvage wood from an extensive blowdown area.

There are a few more Nordic machines found in the private forests in southern Ontario and possibly some working for non-member companies.

Potential markets

Like Quebec, Ontario also has a large potential market. Because of the pressure from environmental groups, logging companies have to think about their harvest prescriptions and objectives especially near urban centres. Companies are opting to conduct partial cuts, strip cuts and patch cuts. Clearcut sizes are being reduced. These types of changes make the Nordic machinery seem more attractive than in large clearcut settings where they could not compete economically.

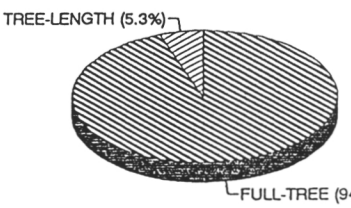
OWNERSHIP OF PRODUCTIVE FOREST LAND
84% PROVINCIAL
1% FEDERAL
15% PRIVATE WITH 169000 WOODLOT OWNERS

Eastern white pine

FOREST RESOURCE	
TOTAL AREA	107 million ha
FOREST LAND	80.7 million ha
RESERVED FOREST LAND	1.7 million ha
PRODUCTIVE FOREST LAND	38.3 million ha
AREA REGENERATED (1988)	181 thousand ha
AREA HARVESTED (1988)	237 thousand ha
DEFOLIATION BY INSECTS (1989)	14.5 million ha
AREA BURNED (1989)	404 thousand ha

TRADE (1989)	
VALUE OF EXPORTS	$3.9 billion
MAJOR VALUE OF PRODUCTS EXPORTED	
newsprint (37%), wood pulp (24%), other paper and paperboard (21%)	
MAJOR EXPORT MARKET	
United States (95%)	
BALANCE OF TRADE	$+2.0 billion

INDUSTRY PROFILE	
TOTAL VALUE OF SHIPMENTS (1988)	$12 billion
NUMBER OF ESTABLISHMENTS (1988)	2 983
Logging : 1 727, wood industries: 926, paper and allied industries: 330	
FORESTRY-DEPENDENT COMMUNITIES	41
EMPLOYMENT (1989)	169 000 jobs
84 000 direct jobs, 85 000 indirect jobs, 1 job in 29	
WAGES AND SALARIES (1988)	$2.4 billion
NEW INVESTMENT (1989)	$1.7 billion



Harvesting systems used on Crown Lands or large private lands

Figure 9. Forestry statistics for Ontario (Forestry Canada 1991a, FERIC 1992).

In southern Ontario where there is a wide diversity in species with many high value hardwoods and older softwood plantations, and most of the land is privately owned, much of the harvest is conducted under a partial cut prescription. In some situations, the Nordic machinery is the most environmentally friendly and has the least adverse impact on the residual stands. The merchandizing capability in a Nordic system is superior to that of any fully-mechanized North American system.

There are 169 000 private woodlots on 15% of the land base producing 38% of the wood for the province (Forestry Canada 1990). Many would be interested in forestry attachments for their farm tractors. Medium sized operators on private land would also be interested in equipment especially if it did a neater or more environmentally soft job than their present equipment.

The Nordic harvesters are better adapted than most North American feller-bunchers to operate in blowdowns or insect kill salvage jobs because of the geometry of the interface of the head and boom.

Potential problems

The cold and the heat are a problem causing machines to over heat in the summer if the hydraulics and the engine are not cooled adequately, and to break in the winter.

Some companies have wood rooms and a secondary transportation system designed for tree-length wood and would not be willing to change.

Stems are often crooked, of poor form or have large branches.

Manitoba

Forestry is of limited importance in this prairie province. Only 1.7 mill. m^3 were harvested in 1986 (Forestry Canada 1990). Other forest statistics for Manitoba are presented in Fig. 10. The climate is dry and the temperature can fluctuate wildly. Natural regeneration is not assured.

Two thirds of the wood volume harvested is channeled directly to the 3 pulp and paper mills. The rest of the wood is divided up between 12 sawmills and 96 other mills (Forestry Canada 1990, Canadian Forestry Service 1988).

The two FERIC member companies use a mechanized full-tree system or semi mechanized tree-length system to roadside where stems are converted to 8 ft lengths or chips.

Potential market

The market potential is lower than in most of the other provinces.

Potential problems

The forest is in the north. There would be problems with timely parts delivery and with the cold temperatures.

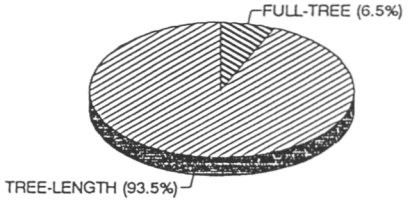
OWNERSHIP OF PRODUCTIVE FOREST LAND
90% PROVINCIAL
2% FEDERAL
7% PRIVATE WITH 3 500 WOODLOT OWNERS

White spruce

FOREST RESOURCE	
TOTAL AREA	65.0 million ha
FOREST LAND	34.9 million ha
RESERVED FOREST LAND	863 thousand ha
PRODUCTIVE FOREST LAND	14.9 million ha
AREA REGENERATED (1988)	5.6 thousand ha
AREA HARVESTED (1988)	12.4 thousand ha
DEFOLIATION BY INSECTS (1989)	383 thousand ha
AREA BURNED (1989)	3.3 million ha

TRADE (1989)	
VALUE OF EXPORTS	$221 million
MAJOR VALUE OF PRODUCTS EXPORTED	
wrapping paper (32%), softwood lumber (30%), newsprint (29%)	
MAJOR EXPORT MARKET	
United States (73%)	
BALANCE OF TRADE	$+99 million

INDUSTRY PROFILE	
TOTAL VALUE OF SHIPMENTS (1988)	$613 million
NUMBER OF ESTABLISHMENTS (1988)	241
Logging: 117, wood industries: 99, paper and allied industries: 25	
FORESTRY-DEPENDENT COMMUNITIES	4
EMPLOYMENT (1989)	10 000 jobs
6 000 direct jobs, 4 000 indirect jobs, 1 job in 50	
WAGES AND SALARIES (1988)	$123 million
NEW INVESTMENT (1989)	not available



Harvesting systems used on Crown Lands or large private lands

Figure 10. Forestry statistics for Manitoba (Forestry Canada 1991a, FERIC 1992).

Saskatchewan

The forest industry is not very important in this prairie province either. In 1986, 3.5 mill. m^3 were harvested mainly from crown land (Forestry Canada 1990). The climate is dry and regeneration is not assured. Selected statistics for the province are shown in Fig. 11.

In 1987, there were 12 sawmills, 1 pulp mill, 1 plywood mill and 51 other mills (Forestry Canada 1990). Only 36% of the wood is channeled directly to the pulpmill (Canadian Forestry Service 1988).

Wood is either felled manually or with feller-bunchers and skidded full-tree or tree-length to roadside. There is no Nordic equipment working in this province.

OWNERSHIP OF PRODUCTIVE FOREST LAND
95% PROVINCIAL
3% FEDERAL
2% PRIVATE WITH 15 000 WOODLOT OWNERS

White birch

FOREST RESOURCE	
TOTAL AREA	65.2 million ha
FOREST LAND	23.7 million ha
RESERVED FOREST LAND	1.3 million ha
PRODUCTIVE FOREST LAND	15.9 million ha
AREA REGENERATED (1988)	10.9 thousand ha
AREA HARVESTED (1988)	22 thousand ha
DEFOLIATION BY INSECTS (1989)	826 thousand ha
AREA BURNED (1989)	471 thousand ha

TRADE (1989)	
VALUE OF EXPORTS	$275 million
MAJOR VALUE OF PRODUCTS EXPORTED	
wood pulp (52%),	
other paper and paperboard (37%)	
MAJOR EXPORT MARKETS	
United States (79%), Japan (18%)	
BALANCE OF TRADE	$+257 million

INDUSTRY PROFILE	
TOTAL VALUE OF SHIPMENTS (1988)	not available
NUMBER OF ESTABLISHMENTS (1988)	214
Logging: 143, wood industries: 65,	
paper and allied industries: 6	
FORESTRY-DEPENDENT COMMUNITIES	7
EMPLOYMENT (1989)	8 000 jobs
5 000 direct jobs, 3 000 indirect jobs,	
1 job in 56	
WAGES AND SALARIES (1988)	not available
NEW INVESTMENT (1989)	not available

Figure 11. Forestry statistics for Saskatchewan (Forestry Canada 1991a, FERIC 1992).

Potential Market

Unknown

Potential problems

The winters are extremely cold. There could also be problems with timely parts delivery and good service.

Alberta

In 1986, the annual drain in Alberta was 10.4 mill. m^3. It has increased dramatically since then as several new aspen pulp mills have been opened. Other forestry statistics for Alberta are shown in Fig. 12. Though some of the wood is bound for the 45 saw mills or 5 veneer and plywood plants, a growing proportion is slated for use in the pulp and paper mills.

In Alberta, the climate is unpredictable. Winter temperatures range from -40°C to + 20°C. Summer temperatures also vary, but seldom fall below 0°C. The terrain changes between flatlands, the foothills, and the Rocky Mountains.

OWNERSHIP OF PRODUCTIVE FOREST LAND
89% PROVINCIAL
7% FEDERAL
4% PRIVATE WITH 7 500 WOODLOT OWNERS

Lodgepole pine

FOREST RESOURCE	
TOTAL AREA	66.1 million ha
FOREST LAND	37.8 million ha
RESERVED FOREST LAND	4.4 million ha
PRODUCTIVE FOREST LAND	25.4 million ha
AREA REGENERATED (1988)	39.1 thousand ha
AREA HARVESTED (1988)	40 thousand ha
DEFOLIATION BY INSECTS (1989)	1.3 million ha
AREA BURNED (1989)	6.4 thousand ha

TRADE (1989)	
VALUE OF EXPORTS	$731 million
MAJOR VALUE OF PRODUCTS EXPORTED	
wood pulp (59%), softwood lumber (23%)	
MAJOR EXPORT MARKET	
United States (92%)	
BALANCE OF TRADE	$+683 million

INDUSTRY PROFILE	
TOTAL VALUE OF SHIPMENTS (1988)	$1.6 billion
NUMBER OF ESTABLISHMENTS (1988)	602
Logging: 346, wood industries: 227,	
paper and allied industries: 29	
FORESTRY-DEPENDENT COMMUNITIES	10
EMPLOYMENT (1989)	18 000 jobs
10 000 direct jobs, 8 000 indirect jobs,	
1 job in 67	
WAGES AND SALARIES (1988)	$326 million
NEW INVESTMENT (1989)	not available

Figure 12. Forestry statistics for Alberta (Forestry Canada 1991a).

Harvesting systems currently used in this province include mechanical full-tree logging, cable logging, traditional cut and skid, and cut-to-length with Nordic machinery.

Potential markets

There is a huge potential market for Nordic machinery. With the new mills coming on stream, more contractors will be needed and established contractors will want to expand. One and two-grip harvesters have already made a successful debut at delimbing aspen and pine in this province and forwarders were used to extract log lengths of up to 6.5 m. A company spokesman from Millar Western Industries who first tried the Nordic machinery in 1989 says that the Nordic system is more economical than their conventional tree-length machines in wood smaller than 0.33 m^3/stem (Anonomous 1989).

The amount of rot arriving at a mill could be reduced with the Nordic cut-to-length system.

Due to a larger load size, the economic extraction distance is greater with forwarders than with skidders. This could lead to a less dense road network resulting in a substantial cost savings.

Good mobility over soft ground is important for continuous operation. Track-equipped 6- or 8-wheel Nordic machines exert lower footprint pressure than traditional North American 4-wheel machinery. The one-grip harvesters can also pile the slash and tops in front of the machine creating a mat to improve trafficability.

A new provincial regulation will limit the maximum transportable lengths. They will ban the transport of tree-length wood and encourage transporting cut-to-length wood.

Potential problems

The cold may be a problem in some areas.

British Columbia

British Columbia has the largest harvest of all the provinces at 77.5 mill. m^3 in 1986 (Forestry Canada 1990). Statistics on forestry in the province are found in Fig. 13.

Logging in British Columbia is roughly divided into two areas, coastal and interior. On the coast the climate is warm, temperate and very moist. Most forests grow on the steep slopes of the coastal mountains, Vancouver Island, the mountainous Queen Charlotte islands or other islands. Tree size in old-growth stands may be huge with stand volumes of up to 1000 m^3/ha.

Interior B.C. is dryer. Temperatures fluctuate but seldom reach the extreme cold found in some parts of the country. Terrain varies from flat to steep. Softwood stems are long, tall and straight with few thick branches. These stems may vary in size from about 0.2 to 1 m^3 at final fell.

The large stem size contributes to an important lumber and veneer industry although, the recent economic climate has forced some reductions in the veneer production and some increases in the pulp and paper sector.

OWNERSHIP OF PRODUCTIVE FOREST LAND
95% PROVINCIAL
1% FEDERAL
4% PRIVATE WITH 21 000 WOODLOT OWNERS

Western red cedar

FOREST RESOURCE	
TOTAL AREA	94.8 million ha
FOREST LAND	60.3 million ha
RESERVED FOREST LAND	2.4 million ha
PRODUCTIVE FOREST LAND	51.1 million ha
AREA REGENERATED (1988)	209 thousand ha
AREA HARVESTED (1988)	244 thousand ha
DEFOLIATION BY INSECTS (1989)	299 thousand ha
AREA BURNED (1989)	25.4 thousand ha

TRADE (1989)	
VALUE OF EXPORTS	$10.2 billion
MAJOR VALUE OF PRODUCTS EXPORTED	
softwood lumber (40%), wood pulp (36%), newsprint (10%)	
MAJOR EXPORT MARKETS	
United States (45%), Japan (22%), EEC (21%)	
BALANCE OF TRADE	$+9.7 billion

INDUSTRY PROFILE	
TOTAL VALUE OF SHIPMENTS (1988)	$16.8 billion
NUMBER OF ESTABLISHMENTS (1988)	4 864
Logging: 4 036, wood industries: 763, paper and allied industries: 65	
FORESTRY-DEPENDENT COMMUNITIES	103
EMPLOYMENT (1989)	194 000 jobs
99 000 direct jobs, 95 000 indirect jobs, 1 job in 7	
WAGES AND SALARIES (1988)	$3.1 billion
NEW INVESTMENT (1989)	$3.0 billion

Figure 13. Forestry statistics for British Columbia (Forestry Canada 1991a).

Potential markets

While there is virtually no potential market for Nordic equipment in old-growth douglas fir on the coast, new growth may be thinned using the Nordic cut-to-length system. There is at least one contractor on Vancouver Island with such machinery.

Environmentalists and other green groups are very active in B.C. They are trying to force the industry to stop clearcutting and to use more environmentally friendly equipment in partial cuts.

Some stands in the interior are ideal for clearcutting with mechanized cut-to-length system. The Nordic machinery could directly compete economically with the other mechanical systems in use.

The cut-to-length system offers a chance to merchandize in the bush and to cut out rot on the site thus boosting the trucking and the mills' productivities.

Potential problems

Contractors may try to use the machines in over-large wood.

In some parts of the country the snow accumulation is deep.

Prince Edward Island (PEI), Yukon and Northwest Territories

The amount of logging in Prince Edward Island, Yukon and Northwest Territories is small. In PEI, 0,5 mill. m^3 per year is harvested, all of it on private land (Forestry Canada 1990). Most operations are very small scale and equipment is generally farm tractor-based. There could be some interesting possibilities for the smallest of Nordic equipment.

The territories are in the North where much of the land is above the tree line. Logging is limited to the valleys in the southern regions. Annual harvest in the Nortwest Territories is 60 000 m^3 and in Yukon 140 000 m^3, all on public land (Forestry Canada 1990). There are virtually no possibilities for Nordic equipment as the infrastructure necessary to service such a vast area would be out of proportion with any profits that could be made.

5. RECOMMENDATIONS

51. General

From the harvesting mechanization point of view, Finland is in the fortunate position of having relatively gentle terrain and a long tradition in forest management. If early thinnings and peatland forest harvesting are excluded, it can be said, that the problem of mechanization of harvesting has been solved quite satisfactorly in Finland. This appears to have led the forest machine manufacturers to think, that the same technology would automatically also be suitable elsewhere.

In Finland, Canadian forests are traditionally thought to be relatively similar to Finnish forests. In some areas this is true, although none of the main tree species are commmon. Forest management and harvesting practices are totally different from Finland in most parts of Canada.

When trying to introduce Finnish forest machinery in Canada more attention should be paid to the dissimililarities between the forests and forestry in respective countries. The climate is more extreme in many areas of Canada, and thus more demanding. The site conditons can also be very different. Stands are usually unmanaged and they may be dense. Tree size within stands may vary widely and tree species are different. All this often results in operating conditions not found in Finland.

In Canada, partial cuts have only recently started to be an alternative harvesting method. In most areas, clearcutting with full-tree or tree-length methods is used almost entirely. Changing over to Finnish machinery and harvesting methods would mean a big change. Such change may be questionned and/or resisted in many areas where the industry tends to be conservative. With the increase of the share of partial cuts the Nordic machinery is likely to be more in demand.

52. Marketing and after-sales

Starting to market cut-to-length harvesting machinery in Canada is not easy. Canadian contractors are not very eager to purchase machinery that is not proven in the local conditions, i.e. they have to be able to ask someone already operating a similar machine. Selling the first machine in a particular area may thus prove to be difficult.

A much more sizeable investment into marketing is necessary than in countries where cut-to length systems are used predominantly and which have extensive basic forestry education. Sales costs in Canada are higher than in Finland, especially so for one-grip harvesters.

The presence of the manufacturer is necessary in Canada. This can take the form of own subsidary or fully committed dealer with top notch service personel. Good dealers are, however, scarce and getting their attention to your product may be difficult as they usually have a variety of products already. Dealers are also hard to train and they tend to give up easily in the beginning.

Distances are deceiving in Canada. 500 km is considered a short distance, and many logging camps and operations are situated 100 to 300 km away from the nearest civilization linked by a dirt road. The vast distances and low density of population result in a low level of infrastructure in the remote areas. In many cases, the operators can not use cellular telephones to call for help simply because they are out of range of the network. All this sets very high demands on after sales services.

The importance of contractor and operator training and after-sales services can not be over-emphasized. Contractors and operators must be given training by the manufacturer or distributor on how to operate the machines, how to troubleshoot and how to repair them. Service is the other essential ingredient in selling machines in Canada. Equipment should be introduced only when proper backup support can be provided. Many Canadian distributors

offer 24h part delivery guarantees. Contractors can not afford to wait a week while the parts are being shipped from overseas. The success of Swedish Rottne machines in New Brunswick can be mentioned as an example of well-organized after-sales.

Proper manuals in English and French explaining the hydraulics, electrical system, engine and transmission etc are important. Also essential is a knowledgeable staff who can provide technical expertise to the contractors over the telephone and who will travel quickly to someone who needs on-site help. The technical back-up of the manufacturer is needed in Canada for quite a long period.

53. Machinery

Because of lower level of operator training, the difference in operator attitude, climate and site conditions Canadian harvesting sets higher demands on machine durability than harvesting in Finland. Canadian machine operators are used to simple and durable machinery. Sometimes machines are running around the clock, resulting in a maximum of about 4 500 machine hours per year. Operations do not normally shut down because of cold or heat.

Finnish forest machinery is highly developed and reliable in Finnish conditions. Presently most of the the machine designs are either a compromise between the requirements for thinnings and for clearcuts, or in some cases primarily intended for thinnings. The level of ergonomy in Nordic machinery is superior. In Canada, the emphasis in design has been on highly reliable, high production machinery for clearcutting.

As a result of the design criteria of Nordic machinery, the greater log length and the tendency of harsh operating, the stability of Nordic machinery in Canadian operating conditions is often considered inadequate. Attention should be paid to maximise machine width in clearcuts and to adequate extensions of wheelbase and load space. Low ground pressure is desireable in many areas. High engine output is also welcome. Some redesign of harvester heads better suited to Canadian conditions is recommended, as indicated in detail in the potential problems section of each province.

Presently on the Canadian market, the key factors to a succesfull forest machine are reliability and productivity. Operators appreciate a quiet cab, good ergonomics and operator appeal but they are still secondary factors when purchasing a machine. More robust and less fancy machinery, than presently offered by Finnish manufacturers, would probably have a greater success. In Canada, Finnish machinery does not necessarily enjoy the same good reputation it has in the Nordic Countries.

Because of the introduction of Nordic harvesters on the Canadian market, the ergonomic standard of all forwarders will likely be forced to improve. This will make North American forwarders more expensive and thus Nordic models more competetive.

Selecting components made or readily available in North America would help in selling the machines and in organizing after-sales services. The operators in the remote logging camps like to have similar equipment to each other to minimize the spare parts on inventory and to increase the combined expertise.

6. CONCLUSIONS

Forest management and harvesting practices in Canada have been changing providing a good potential market for Nordic machinery. In the last few years Nordic machinery has become popular. The newest invasion started in the east and is slowly making its way westward. The merchandizing capability of a Nordic cut-to-length system is superior to that of any fully-mechanized North American system and its environmental impact is less. Both factors are of increasing importance in Canada. Popularity for Nordic machinery should continue to grow as new niches for their use are found and especially if they are redesigned for various Canadian conditions.

Finnish forest machinery has all the possibilities for success on the Canadian market, providing the reliability is good and the price right. However, rather than searching a market for an existing machine, a manufacturer should search a machine for an existing market.

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