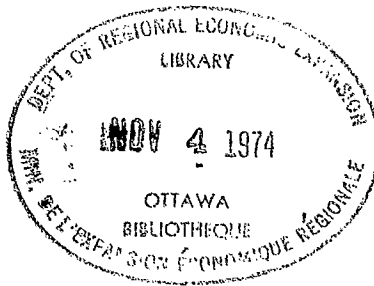


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PRELIMINARY FEASIBILITY STUDY OF TREE HARVESTERS ++++++



COMMERCIAL AND ECONOMIC RESEARCH AND
DEVELOPMENT
INTELLIGENCE SECTION
Canada DEPARTMENT OF REGIONAL ECONOMIC EXPANSION
= MAY 1973.

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SECTION A

PRELIMINARY FEASIBILITY STUDY OF TREE HARVESTERS

Summary and conclusions

For the purposes of this study, tree-harvesters have been divided into 3 types: feller-buncher, short-wood, and tree-length. Tree-harvesters are in the late development - early production stage. At present, tree harvesters are used in roughly 15% of logging operations in Canada. Due mainly to labour shortages and high wage rates, industry sources expect that harvesters will increasingly replace manpower in the next few years until the level of utilization of harvesters is between 50 and 80%. Consequently there will be an increase in demand for tree harvesters by woodlands operations.

At the present stage of development, tree-harvesters suffer from high levels of mechanical failure and require considerable maintenance. Further developmental work is required to bring mechanical availability and costs to levels desired by the forest industries.

The tree-harvester market in Canada is currently being supplied by both domestic manufacturers and imported machines. Several domestic manufacturers have tree-harvesters in the prototype stage. It is estimated that there are 276 tree-harvesters in use in eastern Canada. The potential, nation-wide market is approximately 3200 units.

Of the three types of harvesters, the tree-length harvesters seems to have the greatest potential for commercial development. The versatility of the tree-length harvester allows it to cut and process wood for pulp, sawing and veneer operations, while the short wood harvester can only cut wood for pulp operations. The feller-buncher is capable of harvesting for all three operations, however it lacks the de-limbing qualities of the tree-length harvester.

Of the companies in the tree-length harvester field, Tanguay Industries would appear to be the best candidate for assistance. Tanguay is a Canadian-owned firm, located in a designated area, with what appears to be a promising tree-length harvester, developed in Canada.

There seems to be a particular justification for supporting tree harvesters in designated areas such as Quebec and The Maritime provinces. In these areas, the forest industries are established and important. Therefore, tree-harvesters will have a market within the designated area, and will be supporting local forest industries.

SECTION B

DESCRIPTION AND TYPES OF HARVESTERS

Tree harvesters are employed in logging operations to fell, de-limb, slash (cut to size), bunch and transport trees. The harvester is a large self-propelled, tractor-like vehicle, either wheeled ^{or} tracked, and powered by a diesel engine. The vehicle has arms and attachments to perform the felling and harvesting operations. In this study, the term tree harvester refers to any type of machine that will at least fell and bunch trees. Different types of tree harvesters perform different degrees of harvesting.

Tree harvesters can be divided roughly into 3 types. The most simple type of harvester is the feller-buncher. This machine has extendable arms with scissor-like attachments at the end, which shear the tree trunk at the base. The arms also grasp and place the trees in piles on the ground. The second type is the short-wood harvester which fells, de-limbs, slashes and transports logs. Blade attachments on the arms remove limbs from the tree and additional blades cut the tree into eight foot lengths. Wood is then stored in a compartment on the harvester and later transported to the roadside. The third type of harvester is the tree-length variety. The tree length harvester fells and delimbs trees in a similar manner to the short-wood harvester. The main differences between tree length and short-wood harvesters is that with the former machine, the trees are not slashed into eight foot lengths or transported by the harvester to the road. Tree length harvesters deposit trees in bunches for transport to roadside by skidders.

The feller-bunchers have virtue in the simplicity of their operation, however they must be used in combination with processors, slashers and skidders. The short-wood harvester eliminates the need for processors, slashers and skidders. but can only produce pulp-wood since logs are cut into eight foot lengths. In addition, the short-wood harvester must interrupt the felling of trees

to transport logs to the road. It has also been suggested that the more operations a machine performs, the greater is the incidence of mechanical failure. The tree length harvester must be used with slashers and skidders. The greatest virtue of the tree length harvester lies in the versatility that it provides in woodlands operations. As with the feller-buncher, wood is cut in tree lengths and slashed in a different operation. Therefore, pulp-wood and saw-logs can be separated in the woods or at the mill, prior to slashing.

Opportunities exist for tree harvesters in woodlands operations due to low levels of mechanized felling and labour shortages. Industry sources estimate that between 80% and 85% of felling is still done by chain saws. At the same time labour is becoming increasingly difficult to obtain in the woodlands and wages have increased considerably. Individuals involved in logging operations foresee harvesters taking over the major portion of the felling and processing of trees. Industry estimates range between 50% and 80% for the harvester's ultimate share of felling operations. Rough terrain and soft ground, among other factors, limit the extent of the utilization of harvesters, with terrain being a greater limitation in some regions than in others.

Tree harvesters are, to a considerable extent, still in the development stage. Several makes are in use in the woodlands at present, and a number of other prototype and pre-production machines exist. High levels of mechanical failure have been experienced with production models of harvesters. Mechanical reliability is measured by the percentage of time that the harvester is available for felling and processing. Low levels of availability for a machine generally indicate the requirement for a considerable amount of operating maintenance. Levels of availability for machines presently in operation range from about 50% to 75%. Woodlands operators and other individuals in the industry are talking in terms of a desirable level of availability in the region of 80% to 85%.

SECTION C

CANADIAN PRODUCTION, COMPETITION AND

MARKET FOR TREE HARVESTERS

At present Canada is both producing and importing harvesters. It is estimated that 276 units were in use in eastern Canada in 1971, and of these 60 were built outside the country.¹ Probably the most widely used types of harvesters are the Koehring-Waterous short-wood harvester and The Drott feller-buncher. The Koehring machine is Canadian developed and made while The Drott machine is manufactured in the U.S. Koehring is producing at a rated 20 to 30 machines a year, and at present there are 53 or 54 of the company's short-wood harvesters in use in eastern Canada.² There are approximately 80 to 90 feller-bunchers in use across Canada and the Drott model appears to be the most popular.³ The Caterpillar company of the U.S. has recently begun to import their tree-length harvester into Canada and several woodlands operations that were contacted have indicated their intentions to purchase this model. Tanguay Industries of St. Prime, Quebec, have a prototype tree-length harvester that is scheduled to go into commercial production in 1974. Also in the tree-length harvester field are two Canadian machines planned by Clark Equipment and Eaton-Yale Ltd., and the Swedish ~~Logma~~ *Brunell-Jonsson AB* machine, marketed by Forano of Canada. Clarke Equipment has a prototype under test at present and Eaton-Yale has obtained a licence to build the Australian Windsor harvester in Canada.

¹ Source: Mr. C.R. Silversides, Chief, Logging Development Program, Forest Management Institute, Department of The Environment, Ottawa.

² Source: Mr. Huffaker, Koehring-Waterous.

³ Source: Mr. MacGregor, Director, Logging Group, Woodlands Section, Canadian Pulp and Paper Association.

Table one summarizes some of the available information on companies in the tree-harvester market in Canada. The levels of availability of the short-wood harvester and the feller-bunchers at 70-75% are quite respectable, and reported to be above that of the tree-length harvesters, which are largely in the development stage. Performance levels of feller-bunchers are shown to be higher than tree-length, and short-wood harvesters. However, it should be remembered that the feller-buncher performs the most limited operations with the degree of tree processing increasing with the tree-length and short-wood harvesters. Among the tree-length harvesters, the performance figures available show the Tanguay and Caterpillar harvesters to be quite close. Performance figures were not obtained for the other tree-length harvesters. The Caterpillar harvester is presently harvesting 4.5 units of wood per hour. The Tanguay harvester is processing 55 trees per hour, which, with a conversion of 12 trees per unit, amounts to roughly 4.5 units per hour. Tanguay hopes to up this rate to 85 trees per hour by the summer of 1973. One of the advantages mentioned for tree-length harvesters involved the fact that wood could be harvested for pulp-wood, saw-logs and veneer-logs. Since the larger diameter trees are generally used for saw-logs, and veneer-logs with smaller diameter trees becoming pulp-wood, the cutting capacity of tree-length harvester blades becomes important. A rough cut-off point could be: up to 10" diameter for pulp-logs; 10-14" for saw-logs; and 14" and up for veneer-logs. Generally the three types of harvesters intended for the Canadian market have a cutting capacity that will handle veneer-logs. Table one shows that the Koehring short-wood harvester has the capacity to cut trees 20" in. diameter. Of the feller-bunchers, the Warner and Swasey machine has the greatest capacity at 22". In the tree-length category the Eaton-Yale Machine is quite low with a capacity of 12", while the Tanguay harvester has the greatest capacity at 22". The cutting capacity of the Caterpillar harvester was not readily available.

Assuming that tree harvesters, with given terrain limitations, will be able to perform 70% of all timber felling and processing in Canada, the total present market for tree harvesters is estimated by dividing the productive capacity of a tree-length machine into the total logging production in 1970. An average productivity figure of 4.5 units is used on an 8 hour day and 200 day year. Using these figures it is estimated that there is a potential market in Canada for 3176 tree harvesters.⁴ This estimate is based upon the use of a tree-length harvester. In terms of feller-bunchers, with their more limited operations, and higher productivity, the market would be somewhat less. Conversely with short-wood harvesters, there would be market potential for a greater number of machines than the estimated figure.

4

To calculate the market potential for tree-harvesters, the following sources were used. From conversations with industry sources, a figure of 70% was arrived at as the potential percentage of felling which could be performed by tree-harvesters. The average productivity per tree-harvester is taken from performance figures of the Tanguay and Caterpillar tree-length harvesters. The number of operational hours and days of a tree-harvester in a year is based on an estimate by Mr. C.R. Silversides of the Department of the Environment.

TABLE ONE

SUMMARY OF COMPANIES PRODUCING AND MARKETING

TREE HARVESTERS

COMPANIES	TYPE	LEVEL OF AVAILABILITY %	PERFORMANCE (CUNITS PER HOUR)	STAGE OF DEVELOPMENT	COUNTRY OF MANUFACTURE	PRICE	CUTTING CAPACITY DIAMETER
KOEHRING-WATEROUS	SHORT-WOOD	70-75	2.3	COMMERCIAL PRODUCTION	CANADA	\$152,000	20
TANGUAY INDUSTRIES	TREE-LENGTH		55 TREES/HR.	PRE-PRODUCTION	CANADA		22
DROTT MANUFACTURING	FELLER-BUNCHER	75	10.5	COMMERCIAL PRODUCTION	U.S.A.	\$ 47,000	18
EATON-YALE LTD.	TREE-LENGTH			PRE-PRODUCTION	CANADA		12
LOGMA	TREE-LENGTH			COMMERCIAL PRODUCTION	SWEDEN		
FORANO	FELLER-BUNCHER		3 TREES/MIN.	COMMERCIAL PRODUCTION	CANADA		20
CATERPILLAR AMERICAS	TREE-LENGTH		4.5	COMMERCIAL PRODUCTION	U.S.A.		
CAN-CAR DIV. (HAWKER-SIDDELEY)	FELLER-SKIDDER			COMMERCIAL PRODUCTION	CANADA		
CLARK EQUIPMENT	TREE-LENGTH			PRE-PRODUCTION	CANADA		
WARNER & SWASEY	FELLER-BUNCHER	75 (UTILIZATION)	7.9	COMM. PRODUCTION	U.S.A.	\$ 65,100	22
SICARD INC.	FELLER-SKIDDER			COMM. PRODUCTION	CANADA		
J.I.CASE	FELLER-BUNCHER			COMM. PRODUCTION			
ESCO LTD.	FELLER-BUNCHER			COMM. PRODUCTION			
FRANKLIN EQUIPMENT	FELLER-BUNCHER			COMM. PRODUCTION			
INTERNATIONAL HARVESTER	FELLER-BUNCHER			COMM. PRODUCTION			
NORTHERN ENGINEERING	FELLER-BUNCHER			COMM. PRODUCTION			
POCLAIN CANADA	FELLER-BUNCHER			COMM. PRODUCTION			

MACHINE AND COMPANY COMPARISON :

Amongst the three harvesters, the tree length harvester would appear to be the best alternative for promotion. As mentioned previously, the tree-length harvester is capable of harvesting veneer-logs, saw-logs and pulp-logs, while the short wood harvester can only harvest pulp-logs, since part of the operation of the short-wood harvester involves the slashing of logs into 8 foot lengths, thus precluding their use as saw or veneer-logs. Logging statistics⁵ show that 45% of logs cut in Canada are used as pulp-wood and thus may be harvested in short-wood fashion. The remaining production is harvested in tree lengths. While the short-wood harvester can only produce pulp-wood, the tree-length harvester allows the separation of pulp-logs and other types after felling. The versatility of the tree-length harvester would be useful in operations where pulp-logs and other types of logs are being harvested. Thus the tree-length harvester, with the help of a slasher, is capable of felling and processing logs for all uses while a short-wood machine, such as the Koehring harvester is limited to pulp-wood. It would seem, then, that the most desirable type of machine would be one which is capable of harvesting in tree-lengths. The feller-buncher cuts in tree lengths, but lacks the de-limbing capacities the tree-length harvester. To de-limb for skidding to road-side would require another large, mobile, machine operating around the stumps. Therefore the de-limbing feature of the tree-length harvester

⁵ Source: Statistics Canada, Catalogue Number 25-201, Logging 1970.

is desirable. A further feature of the Koehring machine which detracts from its desirability involves the forwarding of processed wood by the harvester to the roadside. This means that an expensive, complex machine spends part of its time performing the role of a skidder or forwarder. Tree-length harvesters and feller-bunchers can devote all their time to felling and processing since felled trees are deposited in bunches for later hauling to the roadside by skidders.

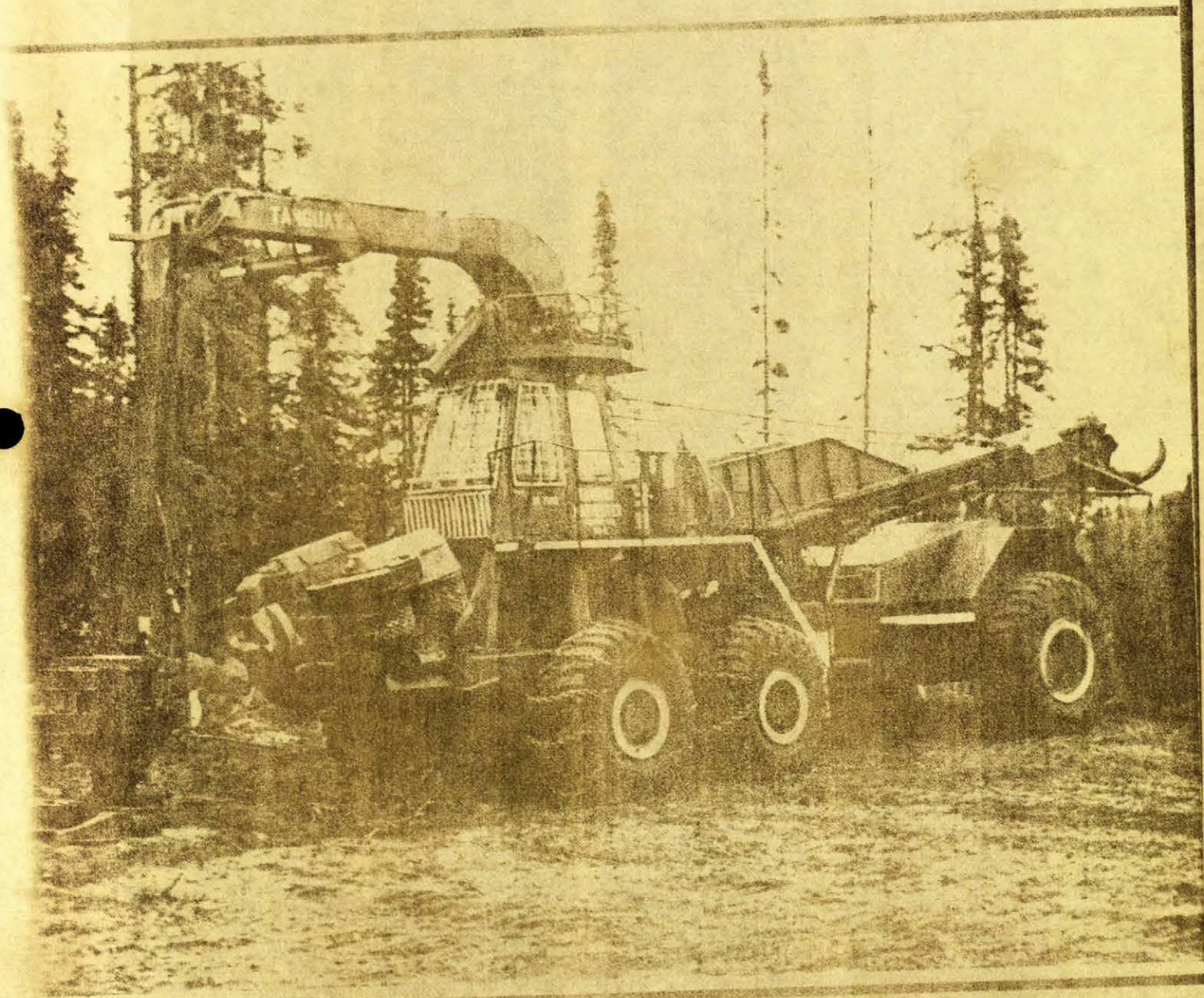
There are five makes of tree-length harvesters that are or will be marketed in Canada. Of the five, two companies, Tanguay Industries and Clarke Equipment Ltd., appear to be the most interesting for promotional purposes. Tanguay would be the first choice, being a Canadian owned company, located in a designated region in St. Prime, Quebec. Tanguay's prototype tree-length harvester has been fully developed in Canada with the assistance of an industrial incentive grant from the Department of Industry, Trade and Commerce. Tanguay's location, surrounded by the wood industries in Quebec, is also a favourable feature for the company since it is close to potential customers and sources of information as to trends in the woods industries. Clark Equipment, a U.S. subsidiary, is interesting as a second choice in that the company appears to be developing a tree-length harvester in Canada. Eaton-Yale of Canada, another U.S. subsidiary, is building under licence in Canada an Australian designed tree-length harvester. The other competitors in the tree-length harvester field are both foreign-made machines: Caterpillar (U.S.), Logma (Sweden).

SECTION E

U.S. MARKET

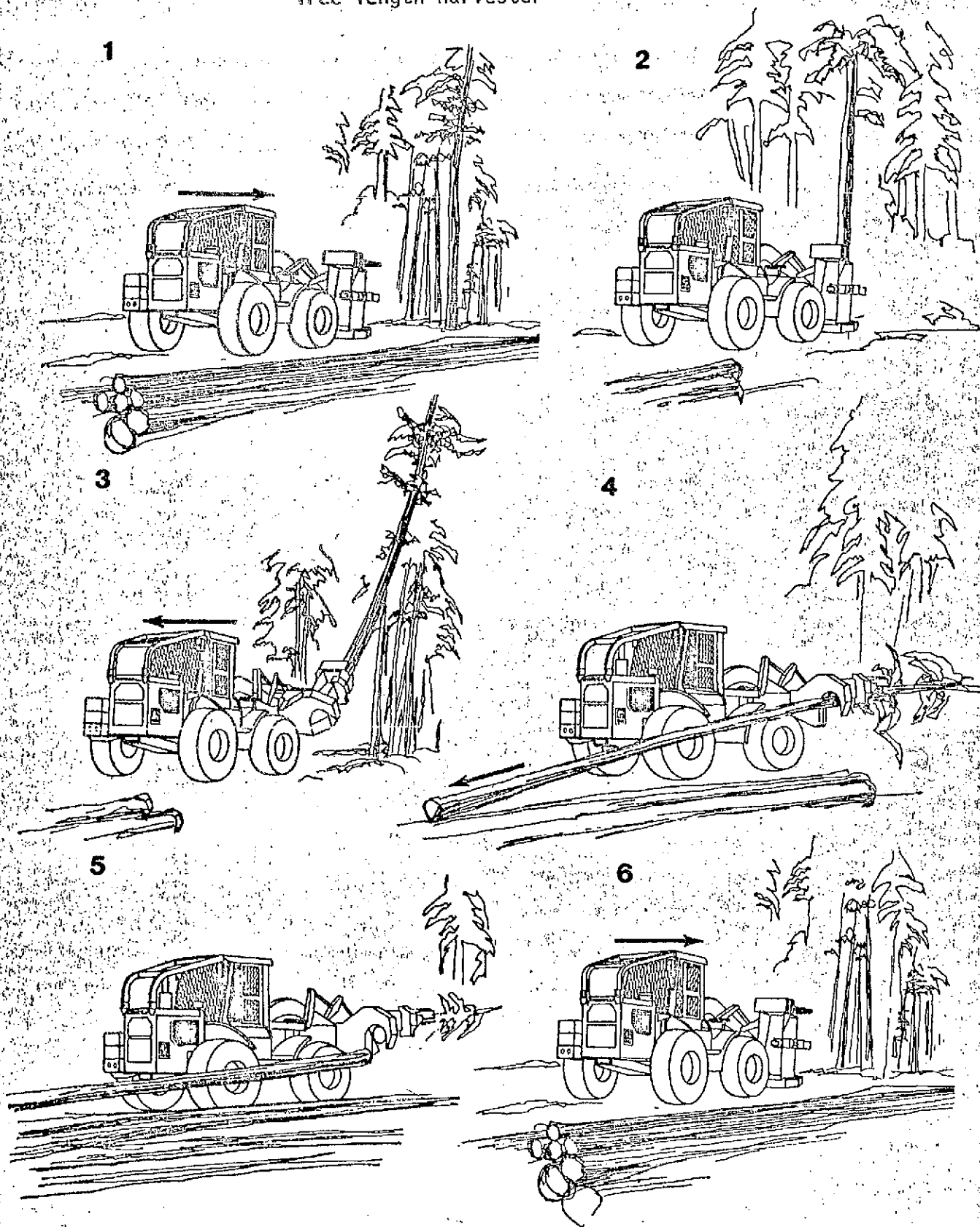
The development of tree-harvesters is in its infancy in the U.S. as in Canada. There are at least three U.S. manufacturers of harvesters. No production or trade figures are available for tree-harvesters in the U.S. The U.S. market is possibly limited in two areas of the country. In the mountainous west coast area, as in British Columbia, the use of tree-harvesters will be limited due to the predominance of very large trees, which cannot be cut by harvesters. In the southern U.S., the present organization of the forest industry is not conducive to the sale of harvesters. Logging in this area is done mainly by small contractors who supply the pulp and paper mills and saw-mills. In general these small contractors do not have the means to purchase sophisticated forestry machinery such as tree-harvesters. At present, felling, limbing and topping of trees is done primarily by chain-saws with some feller-bunchers being used. Apparently the forest industry in the southern U.S. is interested in retaining the present logging arrangements since they help to avoid problems of unionization. In combination, the west-coast and southern areas account for the majority of the timber cut in the U.S. It would seem that the areas most receptive to tree-harvesters in the U.S. would be the north-east and north-central areas. Since tree-harvesters are still in the developmental stage and presuming that most logging operations are being carried out in the traditional manner

In the U.S., there would appear to be export opportunities for a competitive Canadian harvester in this market.



**A giant of the forest:
Langway's tree-length harvester**

Tree-length harvester



The operating cycle of the Caterpillar 950 tree harvester begins as the machine (1) approaches tree with felling and processing head in the vertical position with grapple arms open. Next (2) the grapple grasps the tree and the felling head shears it at the butt, following which (3) the tree is lowered to the horizontal position as the machine backs up to the pile. Then (4) the tree is propelled through the delimiting arms by a drive mechanism and (5) the shear tops it to the desired length. As the tree is placed on the pile, the harvester moves forward (6) with the harvesting head returning to the vertical position and the grapple arms opening as the machine approaches the next tree.

SIDE VIEW, KOEHRING HARVESTER

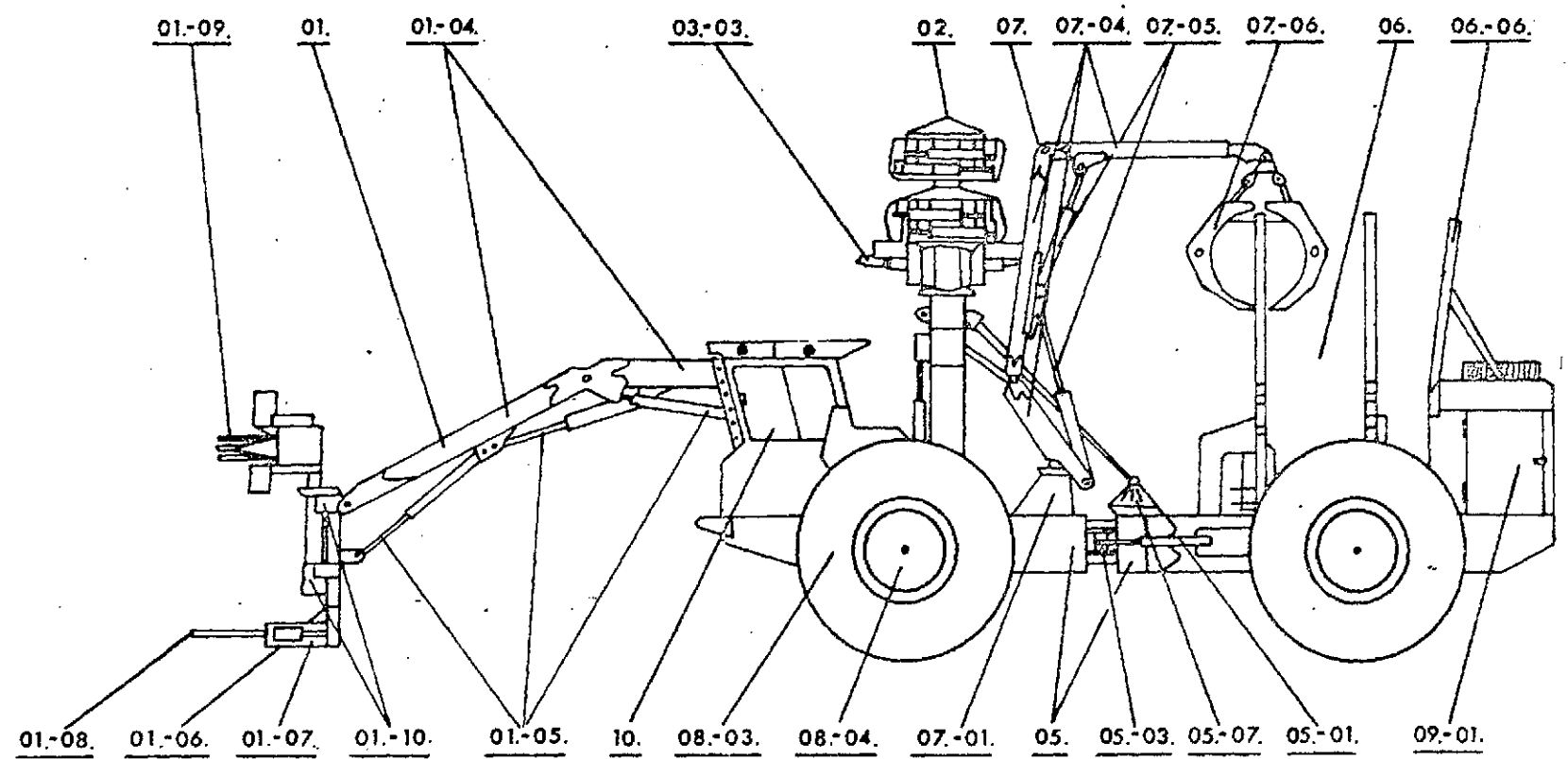


FIG. D-1.

- 01. TREE BOOM
- 04. Booms
- 05. Boom Cylinders
- 06. Shear Cylinders
- 07. Shear Frame
- 08. Shear Blades
- 09. Grabber Arms
- 10. Shear Swing Assem.
- 02. PROCESS TOWER

- 03. PROCESS SHEAR & KICKER
- 03. Shear Cylinders
- 05. MAIN FRAME
- 01. Steering Cylinder
- 03. Articulating Hinge
- 07. Transfer Rollers
- 06. STUFFER & CRADLE
- 06. Back Guard

- 07. LOG BOOM
- 01. Loader Base
- 04. Booms
- 05. Boom Cylinders
- 06. Grapple
- 08. DRIVE SYSTEM
- 03. Tires
- 04. Wheels
- 09. POWER UNIT
- 01. Engine
- 10. CAB

Short-wood harvester

DROTT FELLER-BUNCHER

The Drott Feller-Buncher is built by Drott Manufacturing Company, Wausau, Wisconsin, U.S.A. One of the two machines operating on the limits of the Ontario Paper Company Ltd., Heron Bay, Ontario, Camp 70, was studied by PPRIC during 2 weeks of June 1970.

TECHNICAL INFORMATION

For logging operations, the usual excavator attachments of the Drott 35YC and 40YC crawlers are replaced by a feller-buncher unit, designed to fit directly on to the "Y" boom. The feller-buncher unit consists of two hydraulic shear blades and two hydraulic grab arms. These are all mounted on a short column, which is attached to the end of the "Y" boom (see Figure 1).

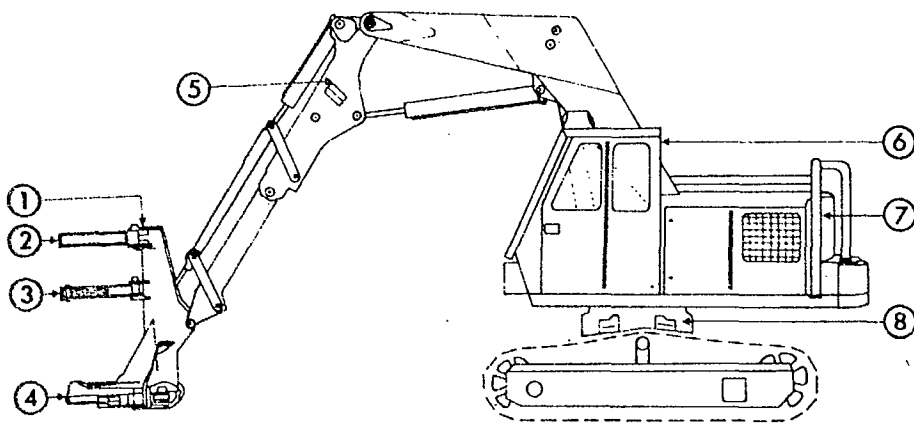


FIG. 1. Drott Feller-Buncher. The main components are: (1) Feller-buncher unit (2) Upper grab-arm (3) Lower grab-arm (4) 18" hydraulic shear (5) "Y" boom (6) Cab (7) 114-h.p. Cummins diesel engine (8) Turntable leveler.

The machine studied was a basic model 35YC crawler with the following modifications:

1. replacement of the model 35YC boom with the tool boom and tool-boom extension from a model 40YC for additional strength;
2. replacement of the model 35YC final drive shafts with the stronger drive shafts, standard on model 40 and 50 size crawlers;
3. the addition of optional logging equipment (see Appendix A);
4. increased capacity of the hydraulic oil reservoir to assist in cooling of the oil (This modification was made without the manufacturer's knowledge).

The machine studied weighed approximately 29,000 lb., complete with feller-buncher unit. The price of the machine, with the optional logging equipment was C\$47,000 f.o.b. Montreal. More detailed manufacturer's specifications are presented in Appendix A.

SECTION G

MANUFACTURERS OF TREE-HARVESTERS

Koehring-Waterous Ltd.
P. O. Box 490
Brantford, Ontario

Tanguay Industries Ltd.
St. Prime
Roverval County, Quebec

Drott Manufacturing Company
Wausau, Wisconsin, U.S.A.

Timberjack Division
Eaton Yale and Towne Canada Ltd.
P. O. Box 160
Woodstock, Ontario

Logma A.B.
Solna, Sweden
(Distributed in Canada by Vulcan Machinery and Equipment Limited
915 Memorial Avenue,
P.O. Box 810
Thunder Bay, Ontario)

Forano Ltd.
7000 Park Avenue
Montreal, 303 Quebec

Caterpillar of Canada Ltd.
1550 Caterpillar Rd.
Mississauga, Ontario.
Parent company: Caterpillar Tractor Co.
Peoria, Illinois, U.S.A.

Canadian Car Division of Hawker Siddeley Canada Ltd.
P. O. Box 67, Station F
Thunder Bay, Ontario

Clark Equipment of Canada
Division of BLH Canada Ltd.
Michigan Blvd.
St. Thomas, Ontario

Warner and Swasey Canada, Ltd.
P.O. Box 37
Guelph, Ontario

Parent Company: Warner and Swasey Company Ltd. (con't)
Woodlands Equipment Division
Solon, Ohio, U.S.A.

Sicard Inc.
10 Sicard St.
P. O. Box 600
Ste. Therese, Quebec.

J. I. Case Co.
Construction Equipment Division
17 Vickers Road
Islington, Ontario

Esco Ltd.
1855 Kingsway
Port Coquitlam, B.C.

Franklin Equipment Co. (Canada) Ltd.
Industrial Road, Box 1210
Elmira, Ontario

International Harvester Co. of Canada Ltd.
208 Hillyard St.
Hamilton, Ontario

Northern Engineering and Supply Co. Ltd.
114 Miles St.
Fort William, Ontario

Poclain Canada
8400 Cote de Liesse
Montreal, 376 Quebec