T.N.# 14

FERIC

FOREST ENGINEERING RESEARCH INSTITUTE OF CANADA
INSTITUT CANADIEN DE RECHERCHES EN GÉNIE FORESTIER

ISSN 0381-7741

Technical Note No. TN-14
October 1977

The Timmins "Fel-Del" Harvester Head

(Supplement to FERIC Technical Report TR-5)

M.P. Folkema

Une traduction française de ce rapport est disponible.

245 HYMUS BLVD., POINTE CLAIRE, P.Q., CANADA H9R 1G6
2045 WEST BROADWAY, VANCOUVER, B.C., CANADA V6J 1Z5

FOREWORD

During the past 2 years FERIC has carried out a series of short-term studies aimed at evaluating new logging machines. Such evaluations are normally based on 1 to 2 weeks of detailed time studies. They are intended to describe the technical and operating characteristics of new machines and to estimate their potential productivity under measured operating and environmental conditions. The findings are normally published with a minimum of delay.

Some of the limitations of short-term studies include:

(i) They cannot fully explore the long-term production potential of machines which must often work under a broad range of conditions.

(ii) The productivity may be affected by the crew's limited experience on the machine and/or by their consciousness of the evaluating team.

(iii) The time period is too short to properly evaluate maintenance problems and the machine's mechanical availability.

Thus, FERIC has initiated a data collection system to provide additional information on machines that have already been the subject of their detailed time studies. This report on the Timmins "Fel-Del" harvester head is the first of a series of supplementary reports summarizing the results of longer-term data collection from several machines and from more than one operation.

For maximum usefulness, the results of longer-term data collection should also be released soon after a new machine is introduced. For logistics reasons this was not possible with the Timmins "Fel-Del". Also, at the time of writing, the Timmins "Fel-Del" faces an uncertain future due to the financial problems of the manufacturer. In spite of these limitations, the results of the study are considered to be of interest to Timmins "Fel-Del" owners and to others as:

(i) An opportunity to compare the long-term availability and productivity of tree-length and short-wood operations using the same harvester head.

(ii) An indication of the pertinence of the FERIC short-term machine evaluation studies to the longer-term potential of the machines.

Grateful appreciation is extended to company personnel of La Société Forestière Domtar Ltée., Dolbeau, Québec and Price (Nfld.) Pulp and Paper Limited, Grand Falls, Newfoundland.

The technical assistance provided by former FERIC employee J.Dymond is also acknowledged.

TABLE OF CONTENTS

SUMMARY

The results of this long-term study are intended as a supplement to the short-term study previously published in FERIC Technical Report TR-5, Evaluation of the Timmins "Fel-Del" Harvester Head.

Production data were collected for 6 months on five Timmins "Fel-Del" harvester heads. Two Timmins machines mounted on Liebherr 925 tracked carriers were employed on a one-shift-per-day basis on a company-run tree-length operation. The other three were mounted on Drott 40 tracked carriers and were employed on a two-shift-per-day basis on a contractor-run short-wood operation. All five Timmins heads were the 1975-76 model, which featured numerous improvements over the earlier model.

The tree-length operation gave consistent productivity results (averaging 76 trees or 3.4 ct (9.6 m^3) per PMH) very much in line with those obtained from an earlier intensive short-term study.

The short-wood productivity was approximately one-half that of the tree-length, averaging 1.6 ct (4.5 m^3) per PMH. The average tree size on the two operations was similar.

Problems with delimbing large branches and branch clusters were much more severe on the short-wood operation due to the loss of momentum which results from the stop/start delimbing action. This, plus the additional time required for repeated shearing, were considered to be the main reasons for the lower productivity on the short-wood operation.

Machine utilization on the short-wood operation (71%) was significantly higher than on the tree-length operation (55%). This large difference in utilization was mainly due to a higher level of carrier repairs on the tree-length operation. The repair times for the Timmins heads were similar (4% to 6% of SMH) on the two operations. Repairs to the carriers, however, differed widely, comprising 20% of the SMH for the Liebherr 925's on the tree-length operation and 6% of SMH for the Drott 40's producing short-wood. It should be noted that the Liebherr 925's had more major repairs of a once-a-machine-life-time nature during the 6-month period than the Drott 40's.

INTRODUCTION

This report summarizes the results of 6 months of data collection from five Timmins "Fel-Del" harvesters operated by two companies in eastern Canada. At a company-run operation, two harvesters produced tree-lengths; at the other, a contractor-run operation, three harvesters produced 8 ft (2.4 m) short-wood bolts. In both cases, the operators had 1 year of experience prior to the 6-month study.

All of the Timmins heads were 1975-76 models which featured numerous improvements over the earlier (1972-74) models. These improvements were related more to better mechanical availability than to increased hourly productivity. A full description of the Timmins "Fel-Del" may be found in FERIC Technical Report TR-5.

The collection of field data for this study was carried out by company personnel according to uniform procedures developed by FERIC. Each harvester was equipped with a model K Servis recorder (or a Vibracorder) and a manually operated tree counter. Daily report forms for each machine, accompanied by the recorder charts,were forwarded to FERIC weekly for compilation and analysis. During the study, the co-operating companies and the manufacturer received copies of the interim results.

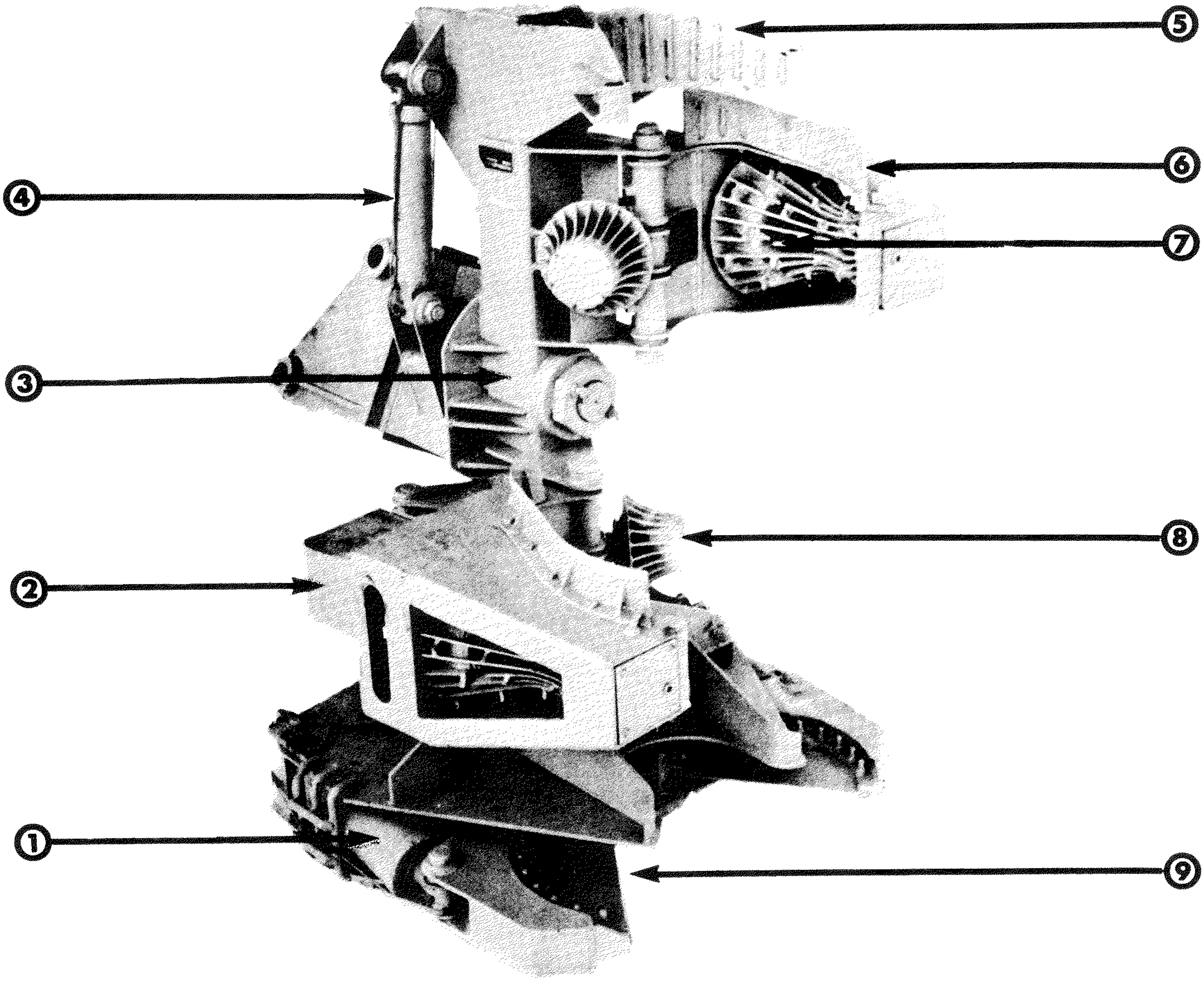

Fig. 1. Timmins "Fel-Del" Harvester Head. Main components are: 1) Shear cylinder. 2) Hydraulic motor for feed roller. 3) Main frame or post. 4) Tilt cylinder. 5) Limbing knife. 6) Holding/limbing arm. 7) Spiked feed roller. 8) Guide roller. 9) Shear blade assembly.

DESCRIPTION OF THE OPERATIONS

Tree-length Operation

This company-run operation was located in the region of Lac St. Jean, Quebec. Terrain in the cutting areas was flat to slightly rolling, with a few swampy areas. The stands averaged 375 merchantable trees per acre (927 per hectare) with an average tree volume of 4.3 ft^3 (0.12 m^3).

Data were collected from June 1976 to December 1976 from two Timmins head harvesters. Topping was done by using the butt shears. The heads were mounted on Liebherr 925 tracked carriers and worked on a single-shift basis, 5 days per week. The tree-lengths were moved to roadside by cable skidders.

Short-wood Operation

This contractor-run operation was located in central Newfoundland. The harvesting area consisted mainly of upland flats and undulating terrain. The cutting area averaged 425 merchantable trees per acre (1050 per hectare) with an average tree volume of 4.0 ft^3 (0.11 m^3). Variation in tree size was minimal.

Data were collected from August 1976 to January 1977 from three Timmins heads mounted on Drott 40 tracked carriers. These were part of a fleet of six machines which produced 8' short-wood (2.4 m) on a two-shift/day basis, 5 days per week.

Short-wood was produced by advancing the tree through the Timmins head until the tree butt struck a steel plate on the carrier; at this point the hydraulic shear was used to sever the bolt. Later, wheeled forwarders were used to transport the short-wood bolts to roadside.

RESULTS

The results of the study are summarized in Figure 2 and in Table 1 and 2. In Figure 2, pie charts are used to show the time distribution on both the tree-length and the short-wood operation. The pie charts are based on total time, which is the scheduled time plus any out-of-shift time. For details regarding definitions of machine time elements see Appendix A.

Table 1 provides an operational summary of the results of the study. Table 2 summarizes the number of hours spent in repairing the components of the Timmins head and the tracked carriers.

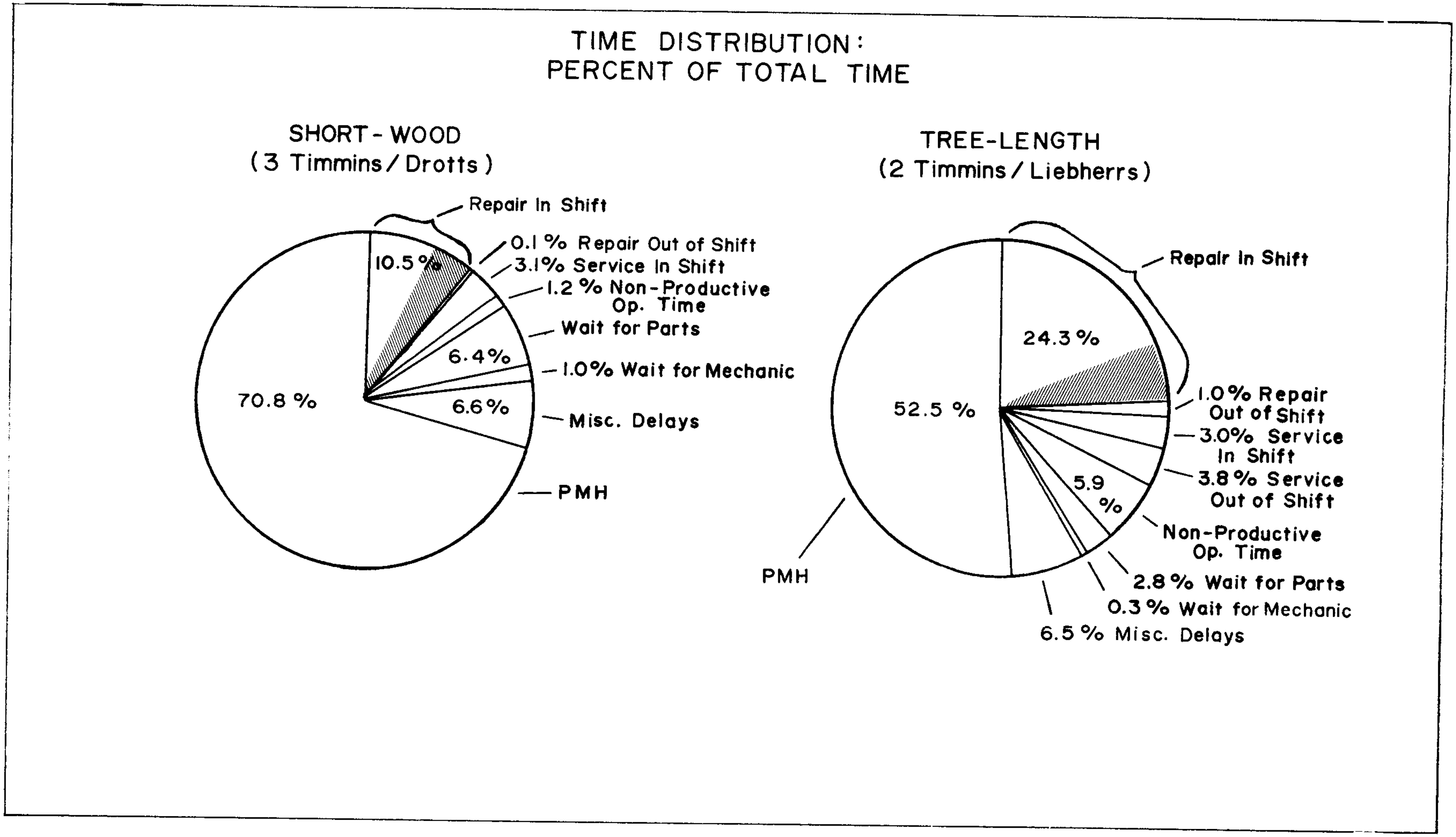

Fig. 2. Time distribution as a percent of total time. The shaded areas represent repairs to the Timmins "Fel-Del". All other repairs are to the carrier.

TABLE 1: OPERATIONAL SUMMARY

		TREE-LENGTH		SHORT-WOOD		
		MACHINE No. 1	MACHINE No. 2	MACHINE No. 3	MACHINE No. 4	MACHINE No. 5
SCHEDULING						
Days Reported	DY	117	117	125	125	122
Scheduled Time	HR	936	936	1973	1915	1890
Out-of-Shift Time	HR	46	48	8	6	6
Total Time	HR	982	984	1981	1921	1896
Shifts/Day	SH/DY	1	1	2	2	2
MACHINE						
Repair In-Shift	HR	212	266	279	164	167
Repair Out-of-Shift	HR	6	13	3	0	4
Service In-Shift	HR	30	28	64	51	66
Service Out-of-Shift	HR	39	35	0	1	0
OPERATIONS						
Non-Prod. Oper. Time	HR	80	36	30	27	16
Wait Parts	HR	6	50	254	68	48
Wait Mechanic	HR	0	6	20	23	12
Miscellaneous Delays	HR	79	49	133	108	140
MACHINE AND OPERATIONS						
PMH	HR	531	500	1191	1474	1442
Mechanical Availability	%	65	59	77	87	86
CPPA Availability	%	64	56	66	83	83
Utilization	%	57	53	60	77	76
Total Time Utilization	%	54	51	60	77	76
PRODUCTION						
Total Production	ct (m^3)	1790 (5066)	1674 (4737)	2201 (6233)	2175 (6157)	2125 (6015)
Trees / ct (m^3)	TR/ct (TR/m^3)	23 (8.1)	23 (8.1)	25 (8.8)	25 (8.8)	25 (8.8)
Trees / PMH	TR/PMH	77	76	45	37	36
Productivity	ct/PMH (m^3/PMH)	3.4 (9.6)	3.4 (9.6)	1.8 (5.1)	1.5 (4.2)	1.5 (4.2)

TABLE 2. REPAIR SUMMARY

COMPONENT	TREE-LENGTH		SHORT-WOOD		
HARVESTER HEAD REPAIRS	MACH. 1 (hrs)	MACH. 2 (hrs)	MACH. 3 (hrs)	MACH. 4 (hrs)	MACH. 5 (hrs)
FABRICATED STEEL STRUCTURE					
Main Frame			19.0	8.5	72.5
Brackets and Mounts	3.5		.5		
Removable Panels					.5
Limbing Knives					
Holding Arms					
Other	16.0	3.0	1.5	1.5	.5
HARVESTING DEVICES					
Shearing Devices					
Butt Shear Blades		.5	6.0		
Feed Rollers					
Hydraulic Powered	8.5	3.0	2.0	.5	
Idlers					.5
Other	5.5	1.0			.5
HYDRAULICS					
Cylinders					
Seals, Rings, Packings					
Butt Shear			31.0	20.0	
Holding Arms	4.0	7.0			
Tilt	4.0				2.0
Crowd	5.0			.5	
Other Cylinder Repairs					
Butt Shear			.5	5.5	
Holding Arms		2.0			
Tilt		.5			
Crowd					
Feed Roll Motors		10.0	.5		
Flexible Hoses	18.5	23.0	23.0	13.0	15.0
Fittings	1.0	2.0	4.0	1.0	3.0
Other Hydraulics	2.0	2.5	4.5	10.0	3.5
CARRIER REPAIRS					
Track, Track Frame	.5	24.0		9.5	3.5
Booms (Structure)	8.0	24.0		45.5	12.0
Hydraulics	46.5	20.5	2.0	2.0	
Power Unit	6.5	131.5	116.0	11.0	18.0
Electrical	11.0	6.0	38.0	21.0	23.0
Other	77.5	18.5	33.5	13.0	16.5
SUMMARY					
Total Harvester Head Repairs	68.0	54.5	90.5	62.0	97.5
Total Carrier Repairs	150.0	224.5	191.5	102.0	73.5
Total Repairs	218.0	279.0	282.0	164.0	171.0

DISCUSSION OF RESULTS

Productivity

(a) Tree-length

Earlier short-term studies of the Timmins "Fel-Del" were reported in FERIC Technical Report TR-5. Case Study II (TR-5) had many similarities with the 6-month tree-length study. For example, in both studies Liebherr 925/Timmins harvesters were used; trees per acre and average tree size were also similar.

TABLE 3. PRODUCTION COMPARISON

	Case Study II FERIC TR-5		6-Month Study	
Av. vol./tree, ft^3 (m^3)	3.7	(0.11)	4.3	(0.12)
Trees/PMH	83		76	
Productivity, ct (m^3)/PMH	3.0	(8.5)	3.4	(9.6)

The 6-month productivity was very much in line with the earlier short-term data from Case Study II (see Table 3).

Figure 3 indicates that on the tree-length operation there was a slight increase in trees/PMH from the beginning to the end of the 6-month period. A company official attributed the slight increase to a change in operating areas in September. Although the tree size was similar, the new stand was more densely stocked, resulting in higher productivity.

(b) Short-wood

Productivity on the short-wood operation was 1.6 ct (4.5 m^3) per PMH. This was approximately one-half that for the tree-length operation (see Table 4). Of course, the practicability and cost of slashing should also be considered when evaluating the two methods.

TABLE 4. PRODUCTIVITY, TREE-LENGTH vs. SHORT-WOOD

	Tree-length Operation	Short-wood Operation
Trees/PMH	76	39
Productivity/PMH	3.4 ct (9.6 m^3)	1.6 (4.5 m^3)

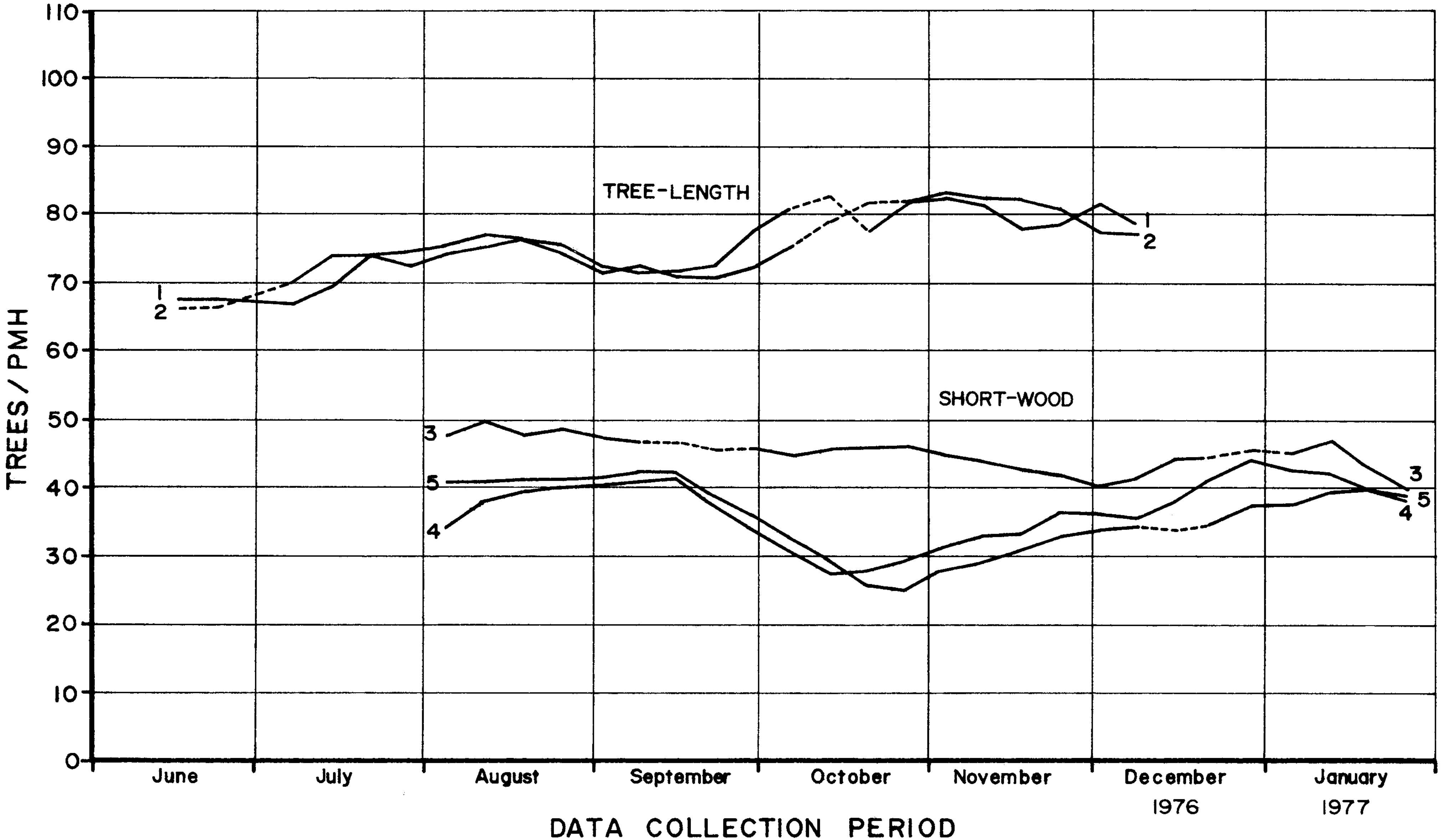

Fig. 3. Average number of trees harvested per PMH. A 6-week floating average is used for all the machines in the study. The dotted lines represent periods of extended downtime during which no production occurred or periods of incomplete data. Machines 1 and 2 worked on the tree-length operation; machines 3, 4 and 5, on the short-wood operation.

The average tree size, the stocking, and several other key factors were similar on the two operations.

Short-wood production with the Lajoie "Fibre-Flow" harvester head (FERIC Technical Report TR-3) required only about 30% longer than for tree-lengths, depending on tree size. One possible reason for better short-wood production with the Lajoie compared to the Timmins is that the Lajoie has four powered feed rollers; the Timmins, two.

The main reasons for the lower productivity for the Timmins "Fel-Del" head when producing short-wood, as compared to tree-lengths, are:

1. Short-wood production requires that the butt shears be opened and closed four to five times for each tree compared with a single cut for tree-length. This adds 20 to 25 cmin per tree.

2. The repeated start/stop processing of the tree to make the short-wood bolts often does not allow the feed rollers to accelerate the tree within the harvester head. If the tree has large branches or clusters of branches, their removal usually requires that the operator reverse the feed roll motors and then repeat the infeed action several times.

Table 1 and Figure 3 indicate that machines 4 and 5 had relatively similar performance, while machine 3 had a consistently lower mechanical availability but higher productivity. The contractor-owner attributed the difference for machine 3 to faster operators who spent less time in servicing and preventive maintenance.

<u>Utilization</u>:

Utilization on the short-wood operation (71%) was significantly higher than on the tree-length operation (55%). The main reasons for the lower utilization on the tree-length operation were higher levels of repairs to the tracked carriers and longer servicing time. Time spent in waiting for parts or mechanics and in non-mechanical delays was the same on both operations (about 15% of the total time).

<u>Repairs</u>

(i) <u>Timmins Head vs Carrier Repairs</u>

Repairs on the tree-length operation comprised 24% of the total time, compared to 11% on the short-wood operation.

The main cause of higher repair levels on the tree-length operation was the large amount of repairs carried out on the Liebherr 925 carriers (see Tables 2 and 5). It should be noted that the Liebherr 925's had more repairs of a once-a-machine-life-time nature during the 6-month period than the Drott 40's.

TABLE 5. SUMMARY OF REPAIR HOURS PER PMH

		Repair hours per PMH
Tree-length (2 machines)	Timmins "Fel-Del"	.12
	Liebherr carrier	.36
	TOTAL	.48
Short-wood (3 machines)	Timmins "Fel-Del"	.06
	Drott carrier	.09
	TOTAL	.15

(ii) Repair Characteristics

Table 6 indicates that the marked difference in total repair hours per PMH between the two operations was more a result of breakdown frequency than time required to make the repair.

TABLE 6. REPAIR CHARACTERISTICS

	Tree-length Operation (2 machines)	Short-wood Operation (3 machines)
Total no. of repairs	188	273
Mean time to repair	2.6 hours	2.3 hours
Mean time between repairs (based on PMH)	5.5 hours	15.0 hours

(iii) Repair Highlights

All repairs carried out during the 6-month study are summarized in Table 2. Some notable repairs are discussed below:

Flexible Hoses - Timmins - The repair/replacement of hydraulic hoses occurred repeatedly on all the machines in the study. The frequency (and cost) of these repairs indicate that this remains a major problem for Timmins users.

Main Frame - Timmins - During the study the main frame (column) of Machine 5 broke in two. Less severe structural problems occurred on machines 3 and 4. Additional gusseting and welding were necessary on the main frames of these three machines.

Swing Bearing - Liebherr - Major repairs were required to the swing bearing on both Liebherr 925 carriers. (This was also a problem with the Drott 40 carriers prior to the study).

APPENDIX A

DEFINITIONS OF MACHINE TIME ELEMENTS

NORMAL SHIFT LENGTH: Nominal statement of intent for regular machine activity (e.g., 8-hour shift, 9-hour shift). It usually corresponds to operator's paid on-job time.

OVERTIME: The hours of productive work, non-productive operating time and/or active maintenance carried on outside usual shift hours.

TOTAL MACHINE TIME: The sum of Normal Shift Length and Overtime. It is the total time associated with the machine for a given shift.

PRODUCTIVE MACHINE TIME (or PRODUCTIVE MACHINE HOURS, PMH): That part of Total Machine Time during which the machine is performing its primary function.

ACTIVE REPAIRS: Repair is mending or replacement of part(s) due to failure or malfunction. It also includes modifications and improvements to the machine.

SERVICE: Service is fuelling, etc., and preventive maintenance performed to retain the machine in satisfactory operational condition.

DELAY: That part of Total Machine Time during which the machine is not performing its primary function for reasons other than active maintenance. Delay time is divided into:

NON-PRODUCTIVE OPERATING TIME: That part of Total Machine Time during which the machine's engine is running but the machine is doing something other than its primary function.

WAITING FOR MECHANIC(S) ($\geq$ 4 hours): Extended period of in-shift time ($\geq$ 4 hours) during which the machine is broken down and is not under repair due to the unavailability of mechanic(s). "Waiting for mechanic(s)" time of less than four hours will be incorporated into "Miscellaneous Delay".

WAITING FOR PART(S) ($\geq$ 4 hours): Extended period of in-shift time ($\geq$ 4 hours) during which the machine is broken down and is not under repair due to the unavailability of part(s). "Waiting for part(s)" time of less than four hours will be incorporated into "Miscellaneous Delay".

MISCELLANEOUS DELAY: The unexplained difference between Total Machine Time and the sum of Productive Machine Time, Active Maintenance, Non-Productive Operating Time and Waiting for Mechanic(s) and Part(s) ($\geq$ 4 hours).

TOTAL MACHINE TIME FORMULAS

$$\text{Utilization} = \frac{\text{Productive Machine Hours (in shift)}}{\text{Scheduled Machine Hours}} \times 100$$

$$\text{Total Time Utilization} = \frac{\text{Productive Machine Hours}}{\text{Total Machine Hours}} \times 100$$

$$\text{Mechanical Availability} = \frac{\text{Productive Machine Hours}}{\text{Productive Machine Hours} + (\text{Repair \& Service})} \times 100$$

("Repair and Service" includes both in - and out-of-shift.)

$$\text{CPPA Availability} = \frac{\text{SMH} - (\text{Repair} + \text{Service} + \text{Wait (Parts} + \text{Mechanic}))}{\text{SMH}} \times 100$$

("Repair and Service" includes only in-shift)

CPPA Availability, by definition, is influenced not only by machine characteristics but also by operational factors (i.e. waiting for parts, or waiting for mechanic). Mechanical Availability, by definition, excludes these operational factors.

For details regarding definitions of machine time elements see "Shift Level Availability and Productivity: Manual for Collecting and Reporting Field Data". September 1976.