

A NOTE ON THE COMPARATIVE EFFICIENCY OF POWER CHAIN SAW AND HAND TOOLS FOR FELLING AND CONVERSION IN IRRIGATED PLANTATIONS

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INTRODUCTION.

Tree felling and conversion in Pakistan is done by hand tools; axes and saws. These, besides being primitive are inefficient, thus causing low labour productivity, and delays in exploitation and subsequent regeneration operations in the forests. Introduction of power chain saws for felling and conversion of trees is essential to speed up timber harvesting operations so that enough time is available for regeneration work as well as to increase the labour productivity. It has been observed in many countries that power chain saws are more than three times efficient in timber production during felling and conversion than hand tools (Pearce and Stenzel, 1972). Hence their use is quite common in the developed countries. However, considerable research is needed to determine the suitability and economics of working of these tools in different countries and forests in view of the varied socio-economic conditions prevailing in them.

Irrigated forest plantations in the plains of Pakistan constitute a valuable wood resource. Because of their easy terrain and accessibility, as well as size of annual coupes and composition of tree crop and regularity in schedule of different forestry operations, power tools can conveniently be used to replace hand tools for the intensive management of these plantations. With this object in view, a preliminary study was carried out in Changa Manga plantation in December 1979 and Daphar plantation in January 1981 to compare the efficiency and economics of chain saws with hand tools in felling and conversion operations. Though the results of this study are preliminary and limited, still, these could serve as useful guideline for future research planning and operational work.

MATERIAL AND METHODS.

The study was conducted in compartment No. 68 in Changa Manga and Compartment No. 24 in Daphar Forest Plantation, where final felling and conversion of trees was in progress. A one man "Solo-642" power chain saw with 75 cm bar length, having 13.2 kg weight and 106 c.c. piston displacement was used for felling and conversion of trees. The crew consisted of two persons, one chain saw operator and one helper. Hand felling crew consisted of 2-9 persons with average daily employment of 4 persons using axes and crosscut saws. A total of 92 trees of shisham (*Dalbergia sissoo*), mulberry (*Morus alba*) and semal (*Salmalia malabarica*) were felled and converted by these two methods. The details are given below:

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Species	Av. dia. cm	No. of trees felled		Total number of trees for each species
		Hand tools	Chain saw	
Shisham	41-61	24	52	76
Mulberry	28	—	10	10
Semal	39	—	6	6
Grand Total:				92

Felling and cross cutting time was recorded with the help of a stop watch for trees of different species for both power chain saws and hand tools. Total amount of fuel and lubricants consumed by the chain saws was also recorded. Average felling and cross cuttings efficiency was calculated as area cut in $\text{cm}^2/\text{minute}$ both for hand tools and chain saw for different species. The volume of converted timber and firewood was calculated in cubic meters by Huber's formula. Total work time was also recorded for both types of tools. Crew size and work duration for hand tools was more, therefore, for comparison purposes, timber production by hand tools was reduced to the work duration and crew size of power chain saw. Further, it was assumed that proportion of firewood and timber is of the same order for both the methods, therefore, timber volume was only considered for the calculation of cost of production as Rs./m^3 of timber. The cost of production per cubic meter was calculated by adding different costs, e.g., (a) depreciation, (b) labour wages and (c) cost of fuel, lubricants and repairs. The details of cost analysis are given in Appendix I and II for both types of tools.

RESULTS.

The results of this study are given in Table 1 and 2. As shown in Table 1, average felling efficiency of power chain saw is $843 \text{ cm}^2/\text{min.}$ for an average d.b.h. of 41 cm, $513 \text{ cm}^2/\text{min.}$ for an average d.b.h. of 28 cm and $1221 \text{ cm}^2/\text{min.}$ for an average d.b.h. of 49 cm, for shisham, mulberry and semul trees respectively. The average felling efficiency of hand tools for shisham is $76 \text{ cm}^2/\text{min.}$ for an average d.b.h. of 61 cm. No such data was recorded for mulberry and semul. It is clear from these figures that a power chain saw is 11 times more faster in felling a shisham tree than hand tools. It takes 2 minutes to fell a shisham tree of 46 cm diameter by chain saw while the same tree will take 22 minutes to be felled by hand tools. The felling efficiency of power chain saw for mulberry trees is rather low, but is very high for semul trees which is probably due to low density of its wood.

Table 1

Average felling efficiency of power chain saw and hand tools for different species.

Av. felling efficiency as cm ² /minute cut.					
Shisham		Mulberry		Semul	
Chain saw	Hand tools	Chain saw	Hand tools	Chain saw	Hand tools
843	76	513	—	1221	—

Average cross-cutting efficiency of power chain saw for shisham, mulberry and semul trees is 1438 cm²/min., 1607 cm²/min. and 3516 cm²/min. respectively, while the average cutting efficiency of hand tools for shisham and mulberry is 260 cm²/min. and 401 cm²/min. respectively. No such data could be recorded for semul. It is clear from these results that a power chain saw is 5½ times faster in cutting of shisham, 4 times faster in cutting of mulberry trees as compared to hand tools. This efficiency is quite higher than the reported figures of 2-3 times for different forest species (Sundberg, 1955). The cutting efficiency of the power chain saw is very high in semul trees because of its low wood density and soft nature of its wood.

Table 2

Average cross cutting efficiency of power chain saw and hand tools for shisham, mulberry and semul trees.

Cross-cutting efficiency as cm ² cut per minute.					
Shisham		Mulberry		Semul	
Chain saw	Hand tools	Chain saw	Hand tools	Chain saw	Hand tools
1438	260	1607	401	3516	—

The total timber produced by power chain saw and hand tools is 66.11 and 19.14 cubic metres respectively (Table 3). Power chain saw produced more timber (3.5 times) than hand tools. This value is quite comparable to the reported figures in the literature (Pearce and Stenzel, 1972). The cost of production per

cubic meter of timber was found to be Rs. 11.69 and 15.57 for power chain saw and hand tools respectively. Therefore, power chain saw is about 25% more economical than hand tools. The low cost difference is due to high cost of fuel and lubricants, which are used in power chain saw operation.

Table 3

*Total timber production and cost of timber production/m³
for power chain saw and hand tools.*

Tools used	Work duration hrs-min.		Total fuel consumed litres	Total lubricant consumed litres	Total cost of timber conversion Rs.	Total timber produced m ³	Cost of conversion per m ³ Rs.
Chain saw	81	30	34.2	6.6	773.09	66.11	11.69
Hand tools	81	30	--	--	298.06	19.14	15.57

SUMMARY AND CONCLUSION.

The study reported here was conducted on a limited number of trees. However, it was found that power chain saw is more efficient than hand tools in all respects. It was 11 times more efficient than hand tools in felling a shisham tree of 46 cm stump diameter, 4-5 times more efficient in cross-cutting of mulberry and shisham trees and 3.5 times more faster in timber volume production than hand tools. Cost of timber production was Rs. 11.69 m³ for chain saw and Rs. 15.57 for hand tools, thus the former was about 25% more economical in cost of timber production as compared to hand tools.

Literature Cited

1. PEARCE, J.K. and G. STENZEL. 1972. Logging and Pulpwood Production. Ronald Press Company, New York, 1972.
2. SUNDBERG, V. 1955. The use of power chain saws in forest operations. 2nd report for the joint FAO/ECE Committee on Forest Working techniques and Training of Forest Workers, Geneva, Nov. 1955.

APPENDIX -- I

Cost Analysis of Timber Production with Hand Tools.

Total timber produced	=	19.14 m ³
Crew size	=	2 men
Work duration	=	10.1 days
Tools:		
Axes	=	2
Cross-cut saw	=	1
Wedges	=	2
Cost of 2 axes	=	Rs. 150.00
Cost of cross cut saw	=	Rs. 150.00
Cost of two wedges	=	Rs. 50.00
	Total:	Rs. 350.00

Cost Analysis

(a) *Fixed cost*

Depreciation of tools taking 2 years as their service life, for 10.1 days = Rs. 4.84

Compound interest on Rs. 350 at the rate of 10% for 10.1 days = Rs. 1.02

(b) *Dependent cost*

Wages of two workers at Rs. 12/- day for 10.1 days = Rs. 242.02

(e) *Operating cost*

Cost of fuel and lubricant. = Nil

Repairs and maintenance. = Rs. 50.00

Total cost. = **Rs. 298.06**

Cost/m³ of timber = Rs. 15.57

APPENDIX -- II

Cost Analysis of Timber Production with Power Chain Saw

Total timber produced	=	66.11 m ³
Crew size (One operator and one helper)	=	2 men
Work duration	=	10.1 days
Tools:		
Power chain saw	=	1
Price of power chain saw	=	Rs. 9730.00
Cost Analysis		
(a) Fixed cost		
Depreciation of machine for 10.1 days taking two years as its service life.	=	Rs. 134.62
Compound interest on cost of machine (Rs. 9730) at the rate of 10% for 10.1 days.	=	Rs. 28.27
(b) Dependent cost		
Wages of the workers for 10.1 days (Operator Rs. 20/- and helper Rs. 12/- day)	=	323.20
(c) Operating cost		
Cost of 34.2 litres of fuel at Rs. 5/- litre.	=	Rs. 171.00
Cost of 6.6 litres of lubricant at Rs. 10/- litre.	=	Rs. 66.00
Repairs	=	Rs. 50.00
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	Total cost:	= Rs. 773.09
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Cost/m³ of timber	=	Rs. 11.69