PRODUCTIVITY AND COST IN HARVESTING OF POPLAR WITH IMPROVED TOOLS

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ABSTRACT

Results of time studies carried out at Daphar Forest Plantation on the performance of peg-tooth crosscut saw, raker-tooth crosscut saw and power chainsaw in felling and conversion of poplar trees, show that power chain saw is very fast in cutting and demands only about 13% and 27% of the time/tree than with peg-tooth and raker-tooth crosscut saws, respectively. Power chainsaw also gives 4 and 7.2 times higher productivity of timber/hour at a cost which is about half and one fourth of the cost of work with raker-tooth and peg-tooth crosscut saws, respectively.

INTRODUCTION

Daphar forest plantation is one of the irrigated plantation in the province of Punjab. It was established during 1919 to 1936 in the district of Gujrat with a gross area of 5,050 ha (Afzal,1961). The main forest crop consists of Shisham (*Dalbergia sissoo)* with understorey of Mulberry (*Morus alba).* The rotation age for both these species is 20 years. Hybrid poplar (*Populus euroamericana* CV.I-214) was planted in some parts of the plantation in 1973 at a spacing of 5.5 x 5.5 m, and with a rotation age of 10 years (Hussain and Sheikh, 1981).

Harvesting of trees in forest plantations in Punjab is a regular operation lasting from August to January, and which is carried out through the employment of work contractors. Tools and methods used in these operations are traditional, such as conventional axe and peg-tooth crosscut saw and the workers work without any formal training. This results into high physical workload, low work output and high harvesting cost.

For the improvement of timber harvesting practices in forest plantations through the introduction of improved tools and methods, a study on the comparative efficiency of traditional peg-tooth crosscut saw, improved raker-tooth crosscut saw and power chainsaw, in felling and conversion of poplar, was carried out at Daphar forest plantation during normal felling operation. The basis of this comparison is the time demand/tree, volume of timber produced/hour (Technical Labour Productivity) and cost/m^3 of timber.

MATERIAL AND METHODS

Material

The time studies were carried out in compartment No.115-A of the plantation. The poplar crop was 10 years old, ready for final felling. The average height of the trees and DBH were 24 m and 31 cm, respectively.

In this study the following tools were used:

a. Traditional Saw:

- peg-tooth crosscut saw, 1.5 m long

b. Improved Saw:

- raker-tooth crosscut saw, 1.5 m long

(Traditional axe was used with both types of crosscut saws for undercut in felling and debranching).

c. Power Chainsaw:

- Stihl (038) with bar length of 45 cm.

Tools mentioned at "a", were owned by the workers, while at "b" and "c" belonged to the Pakistan Forest Institute, Peshawar.

d. Workers:

The workers had different origin. One group of professional fellers coming from Sargodha District of Punjab and the other "Gujars" from Dir District of N.W.F.P., who come to the plantation in winter and work in tree felling and conversion. The Work crew for all types of tools was of two persons. The workers from Sargodha were trained on the job in the use and maintenance of raker-tooth crosscut saw. Chain saw was used by the trained operators of the Pakistan Forest Institute. The timber pieces were cut in lengths varying between 1.25 to 1.50 m.

Methods

Time Study

Multimoment time study techniques were used to record the time of different work elements in tree felling and conversion, with an observation interval of 0.50 minute for work with crosscut saws and 0.25 minute for work with power chainsaw. The time study data were recorded in standard proforma.

Work Results

Timber pieces were measured by taking their middle diameter over bark and length. Volume of pieces was calculated with Huber's formula. Volume of timber pieces from a tree was summed up to get the timber volume/tree.

Cost of Work

Cost of work with different types of tools was calculated by taking into consideration capital cost of crosscut saws and power chainsaw (fixed, semi-variable and variable costs) and personal costs at the rate of Rs.60/- per man-day. Overhead cost and profit of the contractor have not been included in this cost calculation.

Analysis of Data

Time study data were compiled and accuracy of work cycle time was tested in test columns of proforma by comparing the multimoment points given and calculated. Multimoment points were changed to absolute time value in minutes for different work elements and for each tree felled and converted by different tools. Technical labour productivity (m^3/hour) was calculated by keeping 60 as numerator and minutes/m^3 of timber as denominator. For the purpose of comparison of time demand and productivity, simple arithmetic means were calculated. Significance of difference in the mean technical labour productivity by different tools was tested using "t" test (Freese, 1981). To find out the relationship between total work time/tree with different tools (dependent or Y-variable) and tree parameters like DBH, timber vol./tree, No. of timber pieces/tree and average timber piece vol.(independent or X-variables), multiple linear regression analysis was carried out with the help of computer.

RESULTS AND DISCUSSION

In all 132 trees of poplar were felled and converted by different tools (Table 1) with an average DBH of 32.3 cm, a timber volume of 0.72 m^3/tree and 8.3 timber pieces/tree each having an average timber piece volume of 0.09 m^3.

Table 1 Data of poplar trees felled and converted with different tools.

Tools	No. o trees	Average DBH (cm)	Av. Timber Vol/tree (m^3)	Av. No. Timber pieces	Av. Timber piece Vol. (m^3)
1. Peg-tooth crosscut saw.	44	33.3	0.81	8.0	0.10
2. Raker-tooth crosscut saw.	30	30.4	0.70	10.6	0.07
3. Power Chainsaw	58	32.6	0.67	7.4	0.09
Average	32.3	0.72	8.3	0.09	

Out of total number of trees, 44 were felled and converted by peg-tooth crosscut saw, 30 by raker-tooth crosscut saw and 58 by power chainsaw.

Time Study

Table 2 shows the results of time studies and the average time demand in felling and conversion of a poplar tree with different tools. As shown in this table, peg-tooth crosscut saw takes maximum total work time of 65.35 minutes/tree. Time taken/tree by raker-tooth crosscut saw and power chain saw is much less as 31.71 and 8.47 minutes/tree and only 48.5 and 13% of the time taken by peg-tooth crosscut saw. Similarly effective time/tree is also very small with power chainsaw and raker-tooth cross cut saw and and is 4.7 and 28.82 minutes/tree when compared with 56.07 minutes/tree with peg-tooth crosscut saw.

Table 2. Tools and average work times/tree

Times	Tools					
	Peg-tooth		Raker-tooth		Power Chainsaw	
	Minutes	Index No.	Minutes	Index No.	Minutes	Index No.
Effective time	56.07	100	28.82	51.4	4.70	8.4
Delay time	9.28	100	2.89	31.1	3.77	40.6
Total work time	65.35	100	31.71	48.5	8.47	13.0

Power chainsaw proved to be much efficient in felling and conversion of poplar trees and was faster by about 12 and 6 times in effective time/tree than peg-tooth and raker-tooth crosscut saws, respectively. In total work time power chainsaw works by about 7.7 and 3.7 times faster than peg-tooth and raker-tooth crosscut saws, respectively. In total work power chainsaw is not as efficient as in effective work because of comparatively higher delay times.

Higher performance of raker-tooth crosscut saw and power chainsaw in felling and conversion of trees was also reported in many other studies. Ayaz, (1987) found out that raker-tooth crosscut saw demanded about 17% less time than peg-tooth crosscut saw in felling and conversion of mulberry and shisham trees in Changa Manga forest plantation. In an investigation carried out by Ayaz and Siddiqui, (1982) it was observed that power chainsaw was 4 to 11 times faster in cutting of mulberry and shisham trees than peg-tooth crosscut saw.

Work Times and Tree Parameters

Table 3, shows the relationship between total work time/tree (dependent or Y-variable) and tree parameters as DBH, timber volume/tree and timber piece volume (independent or X-variables). In work with peg-tooth crosscut saw only the timber volume/tree is the highly significant determinant of total work time as depicted by a very high "F" value, but correlation in this case remained weak with a R^2 value of 0.442. In work with raker-tooth crosscut saw and power chainsaw both DBH of trees and average timber piece volume appear to have a very high significant effect on total work time/tree. In case of raker-tooth crosscut saw correlation between work time and tree parameters is very strong (R^2=0.913), while for work with power chainsaw this correlation remains weak (R^2 =0.356).

Table 3. Relationship between total work time/tree (dependent variable) and tree parameters (independent variables) in felling and conversion of poplar trees with different tools.

S. No.	Tools	Dependent variable (Y)	Independent variables (X)	b_i	s_i	$b_i \times s_i$	R^2	"F" value
1.	Peg-tooth crosscut saw	Total work time	Timber volume	24.732	0.38	9.398	0.442	34.01***
2.	Raker-tooth cross-cut saw	Total work time	BDH	2.432	6.68	16.242		
			Av.timber piece vol.	166.948	0.02	3.339	0.913	142.12***
3.	Power chainsaw	Total work time	DBH	0.820	5.25	4.305		
			Av.timber piece vol.	246.389	0.02	4.928	0.356	142.12***

*** Highly significant
b_i = regression coefficient
s_i = standard deviation

Technical Labour productivity

Table 4. gives the results on technical labour productivity (m^3 of timber/hour) with different tools. Technical labour productivity with peg-tooth crosscut saw, raker-tooth crosscut saw and power chainsaw is calculated as 0.73, 1.32 and 5.26 m^3/hour, respectively. Technical labour productivity of raker-tooth crosscut saw and power chainsaw is higher by about 1.8 and 7.2 times than with peg-tooth crosscut saw. Increase in technical labour productivity of power chainsaw is highly significant over peg-tooth and raker-tooth crosscut saws.

Table 4. Technical labour productivity in total work time (m^3 of timber/hour) in felling and conversion of poplars with different tools.

Tools	m^3/hour	Index No.	df	"t" value
1. Peg-tooth crosscut saw	0.73	100		
2. Raker-tooth crosscut saw	1.32	181	72	1.028
3. Power chainsaw	5.26^{***}	721	100	16.799

*** Highly significant

Studies carried out by Ayaz, (1987) also indicated about 24% higher productivity of raker-tooth crosscut saw over peg-tooth crosscut saw in felling and conversion of mulberry and shisham trees in Changa Manga forest plantation. It was also reported that power chainsaw was by about 3.5 times faster in timber production in comparison to peg-tooth crosscut saw in forest plantations (Ayaz and Siddiqui, 1982).

Cost of Felling and Conversion

Table 5 gives the cost of felling and conversion of poplar timber as Rs/m^3 with different tools. The cost of timber is 20.81, 11.55 and 5.47 rupees/m^3 with peg-tooth crosscut saw, raker-tooth crosscut saw and power chainsaw, respectively. Power chainsaw works at a very low cost of timber production which is about half to one fourth of the cost with raker-tooth and peg-tooth crosscut saws, respectively. The cost of timber production with raker-tooth crosscut is higher than power chainsaw and lower when compared with peg-tooth crosscut saw. Maximum cost of timber production is with peg-tooth crosscut saw, mainly because of its slow cutting and low work output.

Table 5. Cost of felling and conversion of poplar with different types of tools.

Tools	Cost/hour (Rs.)	Technical labour productivity (m^3/hour)	Cost/m^3 (Rs.)	Cost Index
1. Peg-tooth crosscut saw	15.19	0.73	20.81	100
2. Raker-tooth crosscut saw	15.25	1.32	11.55	55.5
3. Power chainsaw	28.79	5.26	5.47	26.2

Ayaz and Siddiqui, (1982) and Ayaz, (1986 & 1987) reported that tree felling and conversion work in irrigated plantations was 25% and 17% more economical by power chainsaw and raker-tooth crosscut saw, respectively than with peg-tooth crosscut saw. Higher cost effectiveness of power chainsaw in this study is because of different nature of tree species. The reported studies were carried out on shisham and mulberry which have harder wood to cut than the wood of poplar in this case.

Conclusions and Recommendations

Power chainsaw is more than 7 times faster in poplar timber production at a cost only 26.3% of that with traditional peg-tooth crosscut saw. This is followed by raker-tooth crosscut saw being 1.8 times faster in timber production at about half the cost with traditional peg-tooth crosscut saw. These results form the basis of following recommendations:

1. Poplar plantations offer a good possibility for the introduction of improved tree felling and conversion tools for higher productivity at a lower cost.

2. In the initial stages traditional peg-tooth crosscut saws be replaced with raker-tooth crosscut saws and then gradually with power chainsaws.

3. Introduction of improved tools demand proper training of workers in the use and maintenance of these tools. Use of power chainsaw in felling and conversion of trees need even more intensive training of workers for the safe and efficient work with this tool.

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