TIMBER HARVESTING TOOLS AND WORK STRESS
IN IRRIGATED FOREST PLANTATIONS

by

M. Ayaz[*]

Abstract

A study was carried out in Changa Manga forest plantation in 1984-85 for the comparison of conventional and improved tools in timber harvesting on the basis of technical labour productivity under an equal and maximum work stress. Results of the study reveal that the technical labour productivity of conventional and improved tools at maximum work stress is 0.47 and 0.61m^3 of timber and firewood per man hour respectively. Improved tools were found to have (30%) higher productivity than conventional tools in tree felling and conversion and therefore were recommended for introduction in timber harvesting in Pakistan.

INTRODUCTION

Improvement of work techniques and tools are the strongest factors affecting labour productivity in timber harvesting. It is also essential that before making any decision, the performance of new means and methods should be tested on the basis of output and workload under the local conditions of work, labour and tree species. An earlier study carried out in Changa Manga on the performance of tools in timber harvesting under normal work stress, revealed that the improved tools gave a significant increase in the labour productivity and reduction in workload of the workers in comparison to conventional tools, (Ayaz, 1987).

The present study likewise was carried out in Changa Manga during winter of 1984-85, to estimate the maximum performance of conventional tools (axe and peg-tooth crosscut saw) and improved tools (bow saws and raker-tooth crosscut saw) under an equal and maximum work stress. No doubt the labour productivity at maximum work stress can never be maintained in continuous work, however, it gives the maximum limits of productivity and also a bias-free comparison of performance of tools.

* Logging Officer, Forest Products Research Division, Pakistan Forest Institute, Peshawar.

MATERIAL AND METHODS

Material

Tree crop

The study was carried out in compartment No.12, Changa Manga irrigated plantation. The crop consisted of mature trees of mulberry (<u>Morus</u> <u>alba</u>) and shisham (<u>Dalbergia</u> <u>sissoo</u>). The study was conducted for two days. On each day, 6 trees (3 mulberry + 3 shisham) having an average DBH of 30 - 31 cm were felled and converted with conventional and improved tools. The trees were very carefully selected to keep each group of 6 trees, as far identical as possible in all tree parameters.

Tools

The conventional tools consisted of two locally made axes and one peg-tooth crosscut saw while improved tools comprised of 2 bow saws and one raker-tooth crosscut saw. The local axes were used with both types of tools, and their use however, with improved tools was confined only to the undercut during felling of trees. Both types of tools had proper maintenance before use.

Workers

The study was conducted with a work party of three professional wood cutters of the plantation, with an average 9 year's work experience, 22 years age, 57 kg of body weight and 172 cm height. These workers were trained in the use of improved tools for two weeks.

Methods

Incentives

To keep the workers at maximum and equal work stress for both types of tools, the incentive provided was to fell and convert a group of 6 trees which normally appeared to be the task of 3 to 4 hours. It was also understood that they will get the wages for full day as soon as the work is over. It proved to be a very powerful motivation and the workers worked under a maximum and equal stress with both types of tools.

Data Recording

Recording of times for different work elements in tree felling and conversion, heart rate as an indicator of work stress and work

results were carried out by the methods described by Ayaz (1987). Time study data were recorded on standard proforma.

ANALYSIS OF DATA

Time study

The multimoment points were changed to their absolute time values for different work elements and work cycles by the method described by Ayaz (1986). Average work cycle time (time/tree) and the average time of different work elements was calculated for both types of tools.

Technical Labour Productivity (TLP)

The technical labour productivity (TLP) as m^3/man hour was calculated by keeping 60 as numerator and time in min/m^3 of timber and firewood and work party size as denominator:

$$TLP = \frac{60}{Time\ (min(/m^3\ x\ work\ party\ size}$$

The average technical labour productivity for total production (timber+firewood) and total work time, timber production and crosscutting time and firewood production and firewood conversion time was calculated for both types of tools. The differences between the corresponding mean values of times and labour productivity for both types of tools was changed to percentages for comparison and their significance was tested by two small samples "t" test (FREUND, 1984).

RESULTS AND DISCUSSIONS

Work stress

The data of average heart rate (average total pulse/min) of the workers during felling and conversion of mulberry and shisham trees with conventional and improved tools and as an indicator of work stress are given in Table 1. This shows that the average total pulse of the workers in total work with conventional and improved tools was 112 and 111 pulse beats/minute, respectively. In case of improved tools total pulse in total work was higher by only 1 pulse beat/min. but this change was very negligible and insignificant. However, in effective work the average heart rate of the workers with conventional and improved tools remained equal as 116 pulse beats/min. This shows that the work stress on the workers with both types of tools remained maximum and equal.

Table 1 Average total pulse of workers at maximum
work stress

Attributes	Average total pulse		Difference
	Conventional tools	Improved tools	
Total work	112	111	1
Effective work	116	116	0

Time study

The data of work time during felling and conversion of
mulberry and shisham trees at maximum work stress are given in
Table 2, which show that the average total work time/tree was 32.10
and 23.30 min. for work with conventional and improved tools,
respectively. Improved tools proved to be faster than conventional
tools in cutting of trees giving a total work time saving of 8.80
min. (27%) per tree as compared to conventional tools. Similarly
the effective time per tree was also less by 6.24 min. or 29% for
work with improved tools than that for conventional tools. When
tested statistically, the reduction in work times/tree with the use
of improved tools at maximum work stress was insignificant because
of limited number of observations and large standard deviations.

Ayaz, (1987) in his study on the performance of tools, under
comparable conditions of work, but at normal work stress, reported
an average effective time per tree of 49.5 and 42.7 min. for
conventional and improved tools respectively, which in all cases
are higher by more than 100% of the times in this study.   This
shows that at maximum work stress the workers could work at more
than double the speed of work at normal work stress.

Table 2   Average total and effective work time/tree with
conventional and improved tools at maximum work
stress

Work time	Tools		Reduction in the work time/ tree with improved tools	
	Conventional	Improved	Min.	%
Total work time/tree(min)	32.10	23.30	8.80	27
Effective work time/tree(min)	21.68	15.44	6.24	29

Technical Labour Productivity

Table 3, shows the average technical labour productivity (TLP) in the form of total volume (timber+firewood) in total work time at maximum work stress of 0.47 and $0.61m^3$/man hour in felling and conversion of trees with conventional and improved tools, respectively. Improved tools proved to be very efficient and produced $0.14m^3$ or 30% more timber and firewood per hour per worker.

Table 3   Technical Labour Productivity of Tools at maximum stress

Productivity	m^3/man hour		TLP increase with improved tools	
	Conventional tools	Improved tools	m^3/man hour	%
Total volume/ total work time	0.47	0.61	0.14	30
Timber volume/ crosscutting time	1.49	2.75	1.26	86[++]
Firewood volume/ firewood conv.time	0.55	0.74	0.19	35

++ Significant at 95% level.

Similarly, in case of timber production with respect to crosscutting time the average labour productivity with improved and conventional tools was 1.49 and $2.75m^3$/man hour, respectively. The rate of timber conversion with improved tools was significantly higher by $1.26m^3$ or 86%/man hour than with conventional tools. A higher performance of improved tools is partly due to higher cutting efficiency of raker-tooth crosscut saw than peg-tooth crosscut saw (AYAZ, 1986). The firewood production was estimated as 0.55 and $0.74m^3$/man hour with conventional and improved tools, respectively. Improved tools were quicker in firewood cutting and gave a productivity increase of $0.19m^3$/man hour or 35% as compared to conventional tools.

Except for timber production, all productivity differences with improved tools were insignificant because of limited number of observations and high standard deviations.

Performance of Improved Tools at Normal and
Maximum Work Stress

As shown in Table 4, the labour productivity increased from
23 to 30% with improved tools from normal to maximum work stress.
Similar trend was observed in both timber and firewood production
which was however, more pronounced in the latter than the former.

Table 4   Productivity increase at normal and maximum work
stress

Productivity variables	%age increase in technical labour productivity with improved tools		%age increase for maximum work stress
	Normal work stress+	Maximum work stress	
Total volume/ total work time	23	30	30
Timber volume/ crosscutting time	40	86	115
Firewood volume/ firewood conversion time	3	35	1067

+ AYAZ (1986)

Technical labour productivity with improved tools in firewood
production with respect to conversion time was higher by 3 and 35%
for work at normal and maximum work stress, respectively. The
difference is very high and the performance of improved tools in
firewood production and at maximum work stress was as high as 10.6
times the work at normal work stress.   This is probably due to
difference of incentives between the two studies. The productivity
of improved tools at normal work stress was assessed when the
workers were paid on daily wage basis (AYAZ, 1986). Therefore,
workers worked very slowly which was highly reflected in their work
of firewood conversion.

CONCLUSION

The results of the study have shown that improved tools give
a high work performance at maximum as well as normal work stress

and under different incentives when compared to conventional tools. This indicates that introduction of improved tools with training of workers is essential to increase the labour productivity in timber harvesting.

Performance of tools changes positively with the difference in work stress, but to a maximum limit. Further, productivity of tools at maximum work stress can never be maintained in continuous work, but it provides a bias-free comparison for the performance of tools.

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