PIECE-RATES IN TREE FELLING AND CONVERSION IN KAGHAN VALLEY: PART-I

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ABSTRACT

In the presence of contractor system of forest work in Pakistan, the possibilities of improvement of forest operations, through the introduction of improved tools, techniques, mechanization and vocational training of forest workers, are very low. Replacement of contract system is only possible when the forestry works are done departmentally, through the direct engagement and payment of forest workers. For this work an appropriate wage system is an important pre-requisite. At present there is no incentive oriented wage system (piece-rates) in forestry, which is developed on time and productivity principles. To develop a piece-rate on the basis of time demand and productivity considering tree variables and work place factors, time studies were carried out in Kaghan Valley on felling and conversion of deodar (*Cedrus deodara*) and fir/spruce (*Abies pindrow/Picea smithiana*) trees. Piece-rates so developed are presented in this article.

INTRODUCTION

Timber harvesting in Pakistan is done through the forest contractors. Tools and techniques used by these contractors are very primitive with low productivity, high wastage of the product and strenuous work for the forest workers. This system of forest work offers very low scope for the replacement and improvement of the traditional tools and techniques. This is because the contractors are under no obligation for operational improvement and serve merely as middlemen making a handsome profit and taking away a bulk share of the worker's income employed by them. Under such system, besides the high harvesting cost, improvement of forest work and the worker through the introduction of improved tools, mechanization and vocational training are also not foreseeable. For the introduction of modern technology in timber harvesting, workers training, reduction of cost and better wages for the forest workers, it is important that the contract system be replaced with departmental working and employment of more or less permanent labour force working directly for the forestry organizations. This is only possible when there in a good and incentive oriented wage system (piece-rates) for different forest operations, developed not merely by estimation and experience, but on the principles of time demand and productivity and in relation to tree species, sizes and ground conditions of work places.

For the development of a piece-rate in timber harvesting for the trained workers of Kaghan Intensive Forest Management Project, time studies were started during 1989-90. In 1990-91, due to incomplete number of observations, an interim and collective piece-rate was developed for felling and conversion of deodar *(Cedrus deodara)*, kail *(Pinus wallichiana)* and fir/spruce *(Abies pindrow/Picea smithiana)* trees [1]. The productivity and standard time for Deodar, Kail and Fir/Spruce is expected to vary because of differences in tree characteristics. Therefore, during 1992-93, more data were collected and separate piece-rates for Deodar and Fir/Spruce are developed.

MATERIAL AND METHODS

The details about material and methods used for the development of piece-rates in felling and conversion of Deodar and Fir/Spruce trees are given below.

Material

- Study Sites: Compartment No. Noori-3(a) and 17 and Kamalban-12, Upper Kaghan Forest Division.

- Workers: Workers worked in a party of 4 persons. Before work they were trained at the "Malkandi Forest Workers Training Center "Kaghan Intensive Forest Management Project (KIFMP), Kaghan Valley.

- Tools: Peg-tooth crosscut saw and axe

Tree felling and conversion comprises all activities related to tree felling, debranching, crosscutting, debarking, snipping, engraving of numbers and identification marks on the logs.

Methods

- Time study Multimoment (Observation interval of 1 minute) method: [2] The data on total work time/tree with respect to different work elements in tree felling and conversion, species, DBH and slope of work sites of each tree are recorded on 273 trees as detailed in Table 1.

Table 1 Detail of trees of time studies

Species	No. of trees	Average DBH of trees (inches)	Average timber * Vol/tree (C.ft
1. Deodar	141	25.72	125.53
2. Fir/Spruce	132	28.52	155.05
Total	273	27.1	139.8

* Volume of timber pieces(u.b) of each tree was recorded by Quarter Girth formula and summed up to get the timber volume/ tree.

For the development of piece-rate three tree size (DBH) and slope classes are used as detailed below in Table 2.

Table 2 Tree size (DBH) and slope classes of work sites

	DBH (inches)		Slope (%)		
Class	Range	Mid value	Class	Range	Mid.value
I	16-22	20	I	0-30	15
II	23-30	26	II	31-60	45
III	31 & above	33	III	61 & above	75

Analysis of Data

Species-wise data on total work time/tree, DBH of trees and slope of the work site were fed to a computer. Simple linear regression analysis was performed between timber volume/tree as dependent (Y) variable and DBH of trees as independent (X) variable for deodar and fir/spruce separately. Least square multiple linear regression analysis between dependent variable of total work time and independent variables of tree DBH and terrain slope (in percent) was also carried out. The general form of these regression models is:

- Simple Linear Regression: $Y = a + bX$

Where

Y is dependent variable,
a is intercept,
b is slope of the regression line and
X is independent variable.

- Multiple Linear Regression:

$$Y = b_0 + b_1.X_1 + b_2.X_2 + \ldots + b_i.X_i + error$$

Where

Y is dependent variable,
b_0 is regression constant and b_1, b_2 and b_i are regression coefficients for independent variables of X_1, X_2 and X_i, respectively.

Basic wage as Rs./minute of total work time was also calculated on the basis of daily wage rate in tree felling and conversion and in consideration to slack work season in Kaghan Valley.

Results

The results of various calculations and development of piece-rates are reported below:

- Regression Analysis

The results of regression analysis are given in Table 3.

Table 3   Results of regression analysis

Regression	Spp.	Dependent Variables	Independent Variables	Regression Constants	Regression Coefficients	R^2	df	F-Value
Simple Linear Regr.	Deodar	Timber Vol./tree	DBH	-142.11	10.40	0.61	139	**210**
	Fir/Spruce	Timber Vol./tree	DBH	-135.94	10.21	0.56	130	**136**
Multiple Linear Regr.	Deodar	Total Work Time	DBH Slope	6.164	6.270 2.442	0.28	138	**27**
	Fir/Spruce	Total Work Time	DBH Slope	4.251	5.163 1.192	0.32	129	**30**

The results of regression analysis as given in Table 3, show that in simple linear regression analysis there exists a strong correlation between the dependent (Y) variable of TIMBER VOLUME/TREE and independent (X) variable of DBH with R^2 values of 0.61 and 0.56 for Deodar and Fir/Spruce, respectively. In case of multiple linear regression, dependent variable of total work time/tree shows a very weak correlation with the independent variables of DBH of the trees and SLOPE of the ground with R^2 values of 0.28 and 0.32 for Deodar and Fir/Spruce, respectively.

The correlations between dependent and independent variables in both the above regressions remained highly significant as shown by very high values of F.

-Timber volume/tree (corrected)

The corrected timber volume/tree calculated with the help of regression equations are given in Tables 4 and 5 below.

Species-I: Deodar (Cedrus deodara)

Regression Equation: Timber vol./tree = $-142.11 + 10.40(DBH)$

Table 4   Corrected timber volume(u.b)/tree of Deodar (cft)

DBH Class (inches)	Mid. value	Corrected timber
I. (16-22)	20	65.9
II. (23-30)	26	128.3
III. (31 & above)	33	201.1

. Species-II: Fir/Spruce (*Abies Pindrow/Picea smithiana*)

Regression Equation: Timber vol./tree = $-135.94 + 10.21 \times (DBH)$

Table 5.   Corrected timber volume(u.b)/tree of Fir/Spruce (cft)

DBH Class (inches)	Mid. value	Corrected timber
I. (16-22)	20	68.3
II. (23-30)	26	129.5
III. (31 & above)	33	201.0

As shown in Tables 4 and 5, timber volume/tree increases with increasing diameters with a linear relationship. In the highest DBH class the timber volume/tree is the same for deodar and fir/spruce. But in Deodar the timber volume/tree, in lower DBH classes, is slightly less than that in Fir/Spruce.

-Corrected Total Work Time/Tree (TWT)

The corrected total work times (minutes/tree) with the help of regression equation are given in Tables 6 and 7 below:

. Species-I: Deodar

Regression Equation: TWT = $6.164 + 6.270 \times (DBH) + 2.442 \times (Slope)$

Table 6 Corrected Total Work Time (TWT)/tree of Deodar
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  DBH Class       Slope class      TWT
                                   (min.)
-------------------------------------------------------------

    I               I              168.19
                    II             241.45
                    III            315.06

    II              I              205.81
                    II             279.07
                    III            352.63

    III             I              249.70
     .              II             322.96
                    III            396.57
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. **Species-II:**   **Fir/spruce**

Regression Equation: TWT = 42.251 + 5.163 (DBH) + 1.192 (slope)

Table 7 Corrected Total Work Time (TWT)/tree of Fir/Spruce
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-------------------------------------------------------------
  DBH Class         Slope Class         TWT(Min.)
-------------------------------------------------------------
    I                 I                  163.39
                      II                 199.15
                      III                234.91
    II                I                  194.37
                      II                 230.13
                      III                265.89
    III               I                  230.51
                      II                 266.27
                      III                302.03
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- Basic Wage Calculation:

. Daily wage rate for felling   = Rs. 60/-
  and conversion of trees in
  Kaghan Valley

. Slack season in most parts of
  Kaghan Valley   = About 4 months

. Adjusted daily wage in = Rs. 90/-
  Kaghan Valley on the basis

of 8 months of working season

Basic Wage on the basis of Rs. 90/- day and 7 hours of daily work.

- for one person = Re. 0.21/min.
- for a work party of 4 persons = Re.0.84/min.

- Development of Piece-rates

Making use of corrected volume/tree (Tables 4 and 5) and corrected total work time/tree (Tables 6 and 7), total work time in min./c.ft is calculated. Minutes/c.ft are multiplied by basic wage as Rs./min to get the piece-rates as Rs./c.ft and are given in Tables 8 and 9.

Table 8   Piece-rates for Deodar

DBH Class	Timber vol./ Tree (c.ft)	Slope class	Total Work time/ tree (min)	Total Work time/ c.ft (min)	Total Work (Rs./ min)	Basic Wage (Rs./ c.ft)	Piece rates
I	65.9	I	168.19	2.55	0.84	2.14
		II	214.45	3.66	0.84	3.07
		III	315.06	4.78	0.84	4.02
II	128.3	I	205.81	1.64	0.84	1.38
		II	279.07	2.18	0.84	1.83
		III	352.63	2.75	0.84	2.31
III	201.1	I	249.70	1.24	0.84	1.04
		II	322.96	1.61	0.84	1.35
		III	396.57	1.97	0.84	1.65

Table 9   Piece-rates for Fir/Spruce

DBH Class	Timber vol./ Tree (c.ft)	Slope class	Total Work time/ tree (min)	Total Work time/ c.ft (min)	Total Work (Rs./ min)	Basic Wage (Rs./ c.ft)	Piece rates
I	68.3	I	163.19	2.39	0.84	2.01
		II	199.15	2.92	0.84	2.45
		III	234.91	3.44	0.84	2.89
II	129.5	I	194.37	1.50	0.84	1.26
		II	230.13	1.78	0.84	1.50
		III	265.89	2.05	0.84	1.72
III	201.0	I	230.51	1.15	0.84	0.97
		II	266.27	1.32	0.84	1.11
		III	302.03	1.50	0.84	1.26

As shown in Table 8 and 9, total work time as min/c.ft decrease with increasing diameter classes and increase with increasing slopes classes. On the same basis piece-rates as Rs./c.ft decrease with increasing DBH classes and increase with increasing slope classes.

- Adjustments in Piece-rates

As the work place conditions differ with the distance from the main valley road in terms of climate, food supply, medical facilities and evacuation and hospitalization in case of accident and disease therefore, as a compensation for these difficulties a monetary incentive is provided to motivate the workers to work deep into the forest, when necessity arises. For this purpose an allowance for distance on the forest road from the main valley road up to the entry point in the felling coup is provided. The distance classes and adjustment (allowance) in the piece-rates are given in Table 10.

Table 10   Distance classes and percentage increase in piece-rates

Distance class	Distance (Km)	% age increase in the piece-rates
I	0 - 3	–
II	3 - 6	5
III	6 - 9	10
IV	9 & above	15

The piece-rates for Deodar and Fir/Spruce as given in Tables 8 and 9 are adjusted on the basis of allowance provided in Table 10 and the adjusted piece-rates are given in Table 11 below.

Table 11 **Adjusted Piece-rates for Deodar and Fir/Spruce**

DBH Class	Slope Class	Distance class	Piece-rates (Rs./c.ft) Deodar	Fir/Spruce
I	I	I	2.14	2.01
		II	2.25	2.11
		III	2.35	2.21
		IV	2.46	2.31
	II	I	3.07	2.45
		II	3.22	2.57
		III	3.38	2.70
		IV	3.53	2.82
	III	I	4.02	2.89
		II	4.22	3.03
		III	4.42	3.18
		IV	4.62	3.32
II	I	I	1.38	1.26
		II	1.45	1.32
		III	1.52	1.39
		IV	1.59	1.45
	II	I	1.83	1.50
		II	1.92	1.58
		III	2.01	1.65
		IV	2.10	1.73
	III	I	2.31	1.72
		II	2.43	1.81
		III	2.54	1.89
		IV	2.66	1.98
III	I	I	1.04	0.97
		II	1.09	1.02
		III	1.14	1.07
		IV	1.20	1.12
	II	I	1.35	1.11
		II	1.42	1.17
		III	1.49	1.22
		IV	1.55	1.28
	III	I	2.65	1.26
		II	1.73	1.32
		III	1.82	1.39
		IV	1.90	1.45

CONCLUSION AND RECOMMENDATION

The following conclusions can be drawn from results of the study:

1. Piece-rates developed are first of their kind in Pakistan, therefore have been made simple by using only three DBH and slope classes.

2. Piece-rates decrease with increasing tree size and increase with increasing slope of the terrain.

3. Guarantee equal income to all the workers working on different tree sizes, species and terrain slopes.

4. Take into consideration the slack work season in Kaghan Valley in calculation of basic wage.

5. Are flexible in nature, subject to revision on technical grounds as well as on the basis of changes in basic wage.

6. Preferably applicable to a work crew of 4 persons.

7. All volume calculations are based on Quarter Girth.

8. These piece-rates pave the way for full departmental working and introduction of mechanization, improvement of tools, work methods and vocational training of forest workers.

On the basis of the above conclusions, it is recommended that the above piece-rates may be introduced in felling and conversion of conifers and to replace the forest contract system for full departmental working. These piece-rates are ideal for making payments direct to the forest workers engaged in felling and conversion of Deodar and Fir/Spruce trees. As the piece-rates for Kail (*Pinus wallichiana*) are under preparation therefore, for this species interim piece-rates developed earlier for felling and conversion of all the coniferous trees in Kaghan Valley [1] may be used, by the time separate piece-rates for Kail are finalized.

Primarily these piece-rates are based on the time and productivity data collected in Kaghan Valley, but due to the similarity of species and terrain conditions these piece-rates are equally workable in the other coniferous forests of Pakistan.

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