COMPARISON OF TIMBER HARVESTING SYSTEMS IN THE FOREST AREAS OF HAZARA CIVIL DIVISION, N.W.F.P.

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1. Introduction

Tree harvesting aims at the removal of forest crops for the production of timber and firewood. It essentially consists of a set of definite operations of felling and conversion of trees to suit the subsequent extraction and transportation system. The methods and means of timber harvesting not only determine the magnitude of material to be extracted and economic gains of the operation but also the preservation of remaining stand and site.

The timber harvesting practices in Pakistan are very old and are performed manually with the use of simple traditional hand tools. Due to the lack of forest roads and mechanized means of timber extraction, the logs are often converted into scants by hand saws right at the stump with only 50% recovery of the log volume. The resulting timber is extracted out of the forest by dry and wet sliding (scants) or by rolling/sliding (logs). The scants may be further transported over long distances by animals or wet sliding. These methods of timber harvesting, besides being laborious and slow, also cause considerable damage to timber both in quantity and quality. These losses are breakage in felling, wear and tear in extraction/transportation and degradation due to weathering and biological agencies as a result of long time taken from forest to markets.

Pakistan is deficient in forest resources. The population of approximately 104 mill. consumed in 1986 2.50 mill. m^3 of timber out of which only 0.364 mill. m^3 could be supplied by state controlled forests (14.6%), 1.097 mill. m^3 by imports (44.0%) and the rest 1.039 mill. m^3 by farmlands (41.4%). While the country had to import in 1986/87 forest products amounting to Rs. 2,389.6 mill (US $ 136.5 mill.), while the annual export of wood and wood products is worth only of Rs. 383.3 mill (US $ 21.9 mill) (Amjad and Khan, (1988). Under these circumstances, it is extremely essential that the existing national forest resources of Pakistan should be utilized to their optimum to ease the timber supply situation in the country and to maximize the material and economic benefits of forestry.

2. Timber Production in Hazara Civil Division

Coniferous forests of Pakistan are the major source of timber in the country and provided in 1983/84 about 83% of timber supplies from the state forests. The province of N.W.F.P. contributes 30% of the total production of softwoods and about 65% of this is coming from the forests of Hazara Civil Division (Amjad & Khan, 1987). This situation calls for proper

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management of forests of Hazara Civil Division to increase the domestic timber production in general and of N.W.F.P. in particular.

This would necessitate adequate stocking/regeneration and new afforestation programmes for increasing the timber production. Improvement and choice of a proper timber harvesting system is also very essential to increase the quantity and quality of timber out-turn at much lower costs.

In the following study an analysis of timber harvesting systems is made for the choice of the most appropriate harvesting system for the forest areas of Hazara Civil Disivion. Due to the similarity of crop and terrain conditions, the chosen system can equally be applicable to the other coniferous forests of N.W.F.P., Azad Kashmir and Punjab.

3. Study Area

The study area consisted of the four timber harvesting lots in the Siran Forest Division, Hazara Civil Division. The detail of these lots is given as under:

Lot Nos.	Forest/Comartment
1S	Panjul 2 (iii)
225	Una 2 (i), 2 (ii), 2 (iii)
3S	Una 2 (iv), 3 (i), 3 (iv)
4S	Una 1 (ii)

The trees of different species in the above lots were marked under selection system. In total 1,367 trees were marked with a total standing volume of 12,762.3 m^3. The species-wise detail of marked trees and standing volume is given in Table 1.

TABLE 1: Number of trees and volume marked for felling

No. of trees/ volume	Species			
	Deodar (*Cedrus deodar*)	Kail (*Pinus wallichina*)	Fir/Spruce (*Abies pindrow*/ *Picea smithiana*)	Total
– No. of marked trees	45	290	1,032	1,367
– Standing volume (m^3)	612.2	2,151.4	9,998.7	12,762.3

4. Present Harvesting System

The traditional harvesting system of scants extraction was adopted in these lots. The timber was to be extracted from the forest by dry sliding and further transported by wet sliding through river Siran over an average distance of about 17.5 km upto the transit depot at Domel. The work was given to a forest contractor at the rate of Rs. 635.40/m^3 (Rs. 18/cft) of scants delivered at Domel. The forest contractor further sublet the work to petty contractors and to the labour on the following piece-rates:

- Felling, conversion and production of scants = Rs. 282.42/m^3 or Rs. 8/cft of scants.
- Dry and wet sliding upto Domel (17.5 km) = Rs. 211.80/m^3 or Rs. 6/cft of scants.

The harvesting operation was started in May 1987 and is expected to finish in November, 1988 (18 months). On the basis of timber out-turn upto July, 1988 the anticipated out-turn at the end of operation is given in Table 2.

TABLE 2: Out-turn of logs and scants

Logs/Scants	Species			Total
	Deodar	Kail	Fir/Spruce	
– Out-turn of logs (o.b.) (m^3)	574.9	1,738.3	7,869.0	10,182.2
– Recovery of logs (o.b.) as % of standing volume (o.b.)	93.9	80.8	78.7	79.8
– Out-turn of logs (u.b.) average bark 20% (m^3)	459.9	1,390.6	6,294.4	8,144.9
– Out-turn of Scants (m^3)	245.5	1,025.6	3,895.2	5,166.3
– Recovery of Scants as				
% of log vol. (o.b.)	42.7	59.0	49.5	50.7
% of log vol. (u.b.)	53.4	73.8	61.9	63.4

(All the volume calculations are made on basal area)

Source: Office record of Forest Development Corporation (FDC), Mansehra

The low timber out-turn of 79.8% in the log form was mainly because of decay of over mature trees. Low out-turn of scants in deodar as 42.7% of log volume (o.b.) was because of high taper in deodar logs.

The scants were further transported by FDC to Goharabad Sale Depot on contract at a rate of Rs. 59.65/m^3 (Rs. 1.69/cft) over a distance of 87 km.

5. Timber Harvesting Alternatives

Under Pakistani conditions, four different timber harvesting systems/alternatives can be foreseen. These different alternatives are denoted as A,B,C, and D and differ from each other in methods and degree of mechanization as indicated in the flow chart in fig. No. 1.

Fig. 1: Flow-chart of Timber Harvesting Alternatives/Systems

Operations	Timber Harvesting Alternatives A	B	C	D
(i) Felling and Conversion	Hand Tools (traditional)	Hand Tools (traditional)	Hand Tools (improved)	Power Chainsaws
(ii) Scants/logs	Hand Sawn scants	Logs	Logs	Logs
(iii) Extraction	Dry sliding	Rolling and sliding	Cable-crane logging	Cable-crane logging
(iv) Minor Transport	Wet sliding	Gattu and Forest Road	Gattu and Forest Road	Gattu and Forest Road
(v) Major Transport	Truck and Public Road	Truck and Public Road	Truck and Public Road	Truck and Public Road
	Goharabad Sale Depot			

The system currently being practiced in different lots falls under *alternative-A*, which is the felling and conversion of trees into logs and their sawing at the stump by hand saws, extraction of scants from the forest by dry sliding over an average distance of about 1.5 km to river Siran. Scants further transported by wet sliding through river Siran upto Domel over an average distance of about 17.5 km.

In timber harvesting *alternative-B,* the trees are to be felled and converted in logs by conventional hand tools, debarked with axe, extracted out of the forest by rolling/sliding and transported by Gattu on the forest road upto Domel.

In timber harvesting *alternative-C,* the trees were to be felled and converted to logs by improved hand tools, debarking with bark spades, extraction of logs with long distance cable-cranes, and transportation of logs by Gattu on forest road upto Domel.

Timber harvesting *alternative-D,* differs from alternative-C, only that in alternative-D, felling and conversion of trees is carried out by power chain saws.

Ideally, different harvesting alternatives should be tried under the similar conditions of crop and terrain for their comparative efficiency with respect to losses, timber out-turn and cost. But in this case such study was not possible due to time and many other technical constraints, therefore, other harvesting alternatives designated as B, C, and D, were superimposed on A and their comparative efficiency was calculated by simultation. For the purpose of calculation of losses, timber out-turn and cost, data collected from other forest areas as Dewli Guzara (Siran Forest Division) and by FDC in Kaghan Valley were used.

6. Cost Benefit Analysis

6.1 *Harvesting cost and losses*

The harvesting costs varied between Rs. 370.61 and Rs. 695.05/m^3 for alternatives B and A, respectively (Tables 3 to 6). The average timber volume recovery by different alternatives ranged between 93% (alternative C and D) and 42.4% (alternative A). The final volume delivered at Goharabad Sale Depot varied between 4,060 m^3 (alternative A) to 7,737.7 m^3 (alternative C and D) (Table 8).

TABLE 3: Harvesting cost and losses for alternative-A

Operations	Cost/m^3 (Rs.)	Losses (%)	
		Volume	Quality
1. Felling and conversion (traditional hand tools)	82.96*	5	–

	Operations	Cost/m^3 (Rs.)	Losses (%) Volume	Quality
2.	Scants production (Hand Sawing)	199.44*	37.6	5 Irregular cuts
3.	Extraction (Dry sliding) (1.5 km)	35.30*	5 Wear & tear	10
4.	Minor Transport (Wet sliding) to Domel (17.5 km)	176.50*	5 Wear & tear	15
	Contractor Rate**	(635.40)		
5.	Major Transport (by Truck) Domel to Goharabad (87 km)	59.65***	5 Losses due to partial seasoning	
	Total	695.05 (US $ 38.19)	57.6	30

* Petty Contractor rate (piece-work rate)
** Rate of forest contractor for timber upto Domel
*** FDC rate

TABLE 4: Harvesting cost and losses for alternative-B

	Operations	Cost/m^3 (Rs.)	Losses (%) Volume	Quality
1.	Felling and Conversion (FDC experiences in Kaghan Valley)	31.06	5	–
2.	Debarking (axe) (FDC experiences in Kaghan Valley)	14.12	–	–
3.	Extraction by Rolling and Sliding (1.5 km) (Dewli Guzara Rates)	30.26+	5 Wear & tear	16 Weathering, seasoning & biological agencies

	Operations	Cost/m^3 (Rs.)	Losses (%) Volume	Quality
4.	Minor Transport by Gattu Dewli Guzara Rates (17.5 km)	102.90 (Rs. 5.88/m^3/km)	1	2
5.	Major Transport by Truck Domel to Goharabad (87 km)	192.27 (Rs. 2.21/m^3/km)	5 partial seasoning	–
	Total	370.61 (US $ 20.36)	16	18

\+ Contractor rate

TABLE 5: Harvesting cost and losses for alternative-C

	Operations	Cost/m^3 (Rs.)	Losses (%) Volume	Quality
1.	Felling and conversion (Improved hand tools and methods)	31.06	2	–
2.	Debarking (Debarking tool)	14.12	–	–
3.	Extraction by Cable-cranes (1500 m) (Stöhr et al.)	198.00	–	
4.	Minor Transport by Gattu Dewli Guzara Rates, (17.5 km)	102.90 (Rs. 5.88/m^3/km)	2.5 partial seasoning	2 Weathering Seasoning
5.	Major Transport by Truck Domel to Goharabad (87 km)	192.27 (Rs. 2.21/m^3/km)	2.5 partial seasoning	
	Total	538.35 (US $ 29.58)	7	2

TABLE 6: Harvesting cost and losses for alternative-D

	Operations	Cost/m^3 (Rs.)	Losses (%) Volume	Quality
1.	Felling and conversion (Power chainsaw) (PFI, 1986)	41.40	2	–
2.	Debarking (Debarking tool)	14.12	–	–
3.	Extraction by Cable-cranes (1500 m) (Stöhr et al.)	198.00		
4.	Minor Transport by Gattu Dewli Guzara Rates (17.5 km)	102.90 (Rs. 5.88/m^3/km)	2.5 partial seasoning	2 Weathering Seasoning
5.	Major Transport by truck Domel to Goharabad (87 km)	192.27 (Rs. 2.21/m^3/km)	2.5 partial seasoning	
	Total	548.69 (US $ 30.15)	7	2

TABLE 7: Comparison of harvesting costs and losses in volume and quality for different alternatives

Alternatives	Cost/m^3 (Rs.)	Losses (%) Volume	Quality	Volume Recovery (%) (for all 4 stages)
A	695.05	57.6	30	42.4
B	370.81	16	18	84
C	538.35	7	2	93
D	548.69	7	2	93

TABLE 8: Quantity of timber received at Goharabad Sale Depot (m^3 u.b.)*

Alternatives	Final out-turn (m^3 u. b.)			Total
	deodar	kail	fir/spruce	
A	208.7	871.8	2,979.8	4,060.3
B	409.3	1,237.6	5,602.0	7,248.9
C	436.9	1,321.1	5,979.7	7,737.7
D	436.9	1,321.1	5,979.7	7,737.7

* (based on the log out-turn (u.b.) under alternative-A minus losses during conversion and extraction as well as transportation upto Goharabad Sale Depot).

6.2 *Sale Value of Timber*

Table 10 indicates that the total revenue as based on the average prices of table 9 ranged between Rs. 14.3 mill. for alternative A and Rs. 16.7 mill. for alternative C and D. If we assume that the average sale value includes already a quality loss of about 20% for the whole of the timber stock at Goharabad, the range of the actual sale values of the timber would increase for the alternatives C and D and decrease for the alternatives A and B (Table 11) earning actual sale values of Rs. 12.9 mill. and Rs. 19.7 mill. for alternative A and C and D, respectively.

TABLE 9: Average sale prices of different timber species in Goharabad Sale Depot (FDC. 1988) (July, 1988).

Type of Timber	Timber prices (Rs./m^3).		
	deodar	kail	fir/spruce
– scants	5,295	4,624	3,071
– logs	3,565	2,859	1,906

TABLE 10: Average sale value of timber harvested by different alternatives at Goharabad Sale Depot (Rs.)

Alternative	deodar	kail	fir/spruce	Total
A	1,105,067	4,031,203	9,150,966	14,287,236
B	1,459,155	3,538,298	10,677,412	15,674,865
C	1,557,549	3,377,025	11,397,308	16,731,882
D	1,557,549	3,777,025	11,397,308	16,731,882

TABLE 11: Actual Sale Value after reduction in the average sale value of timber due to quality losses by different harvesting alternatives.

Alternative	Total sale value of timber (Rs.)	Quality loss (%)	Change in price (%)	Actual sale value (Rs.)
A	14,287,236	30	−10	12,858,512
B	15,674,865	18	− 2	15,361,368
C	16,731,882	2	+18	19,743,621
D	16,731,882	2	+18	19,743,621

The net sale revenue (Table 13) considering only harvesting costs (Table 12) and actual sale price (Table 11) reaches with alternative C (improved hand tools + cable crane logging) its highest value (Rs. 15.6 mill) and with alternative A (traditional scantling system) its lowest value (Rs. 10.0 mill).

TABLE 12: Total cost of timber harvesting by different alternatives

Alternatives	Timber volume (m^3)	Cost/m^3 (Rs.)	Total cost (Rs.)
A	4,060.3	695.05	2,822,112
B	7,248.9	370.61	2,686.515
C	7,737.7	538.35	4,165,591
D	7,737.7	548.69	4,245,597

TABLE 13: Net sale value after deduction of harvesting cost.

Alternatives	Actual sale price (Rs.)	Harvesting cost (Rs.)	Sale Revenue (Rs.)
A	12,858,512	2,822,112	10,036,400
B	15,361,368	2,686,515	12,674,853
C	19,743,621	4,165,591	15,578,030
D	19,743,621	4,245,597	15,498,024

6.3 *Investments in the operations*

– Alternative – A = Nil

– Alternative – B,C and D necessitate the proper opening-up of the forest area with a good quality forest road of about 23.5 km. Presently, there exist a jeepable road of about 4.5 km from Domel to Mandaguccha. To reach the farthest point of the forest, a new road of about 19 km needs to be constructed between Mandaguccha and compartment No. U 3 (iv). The entire length of road of 23.5 km needs to be improved/constructed to open-up the forest and to work it with the harvesting alternatives B,C and D. Besides the road investment, one can consider also the cable cranes as a bigger investment in order to run these operations.

6.3.1 Road improvement/construction

Improvement/construction of 23.5 km of forest road from Domel to Comptt. No. U3 (iv) to a good standard road, 3.5 m wide, with proper surfacing, camber and drainage

• cost/km of road improvement from Domel to Mandaguccha	Rs. 0.350 mill.
• Total cost of improvement of road from Domel to Mandaguccha	4.5x0.350 1.575 mill.
• cost/km of construction of road from Mandaguccha to Comptt. No U3 (iv)	0.500 mill.
• Total cost of construction of road from Mandaguccha to Comptt. No U3 (iv) (19 km).	9.500 mill.
– Total cost of construction/improvement of 23.5 km of road	11.075 mill.
– Maintenance cost for 23.5 km (3%)	Rs. 0.332 mill/a
– Depreciation of road (25 years)	Rs. 0.443 mill/a

If we assume that the same volume transported through this road will be harvested at least every 5 years, the cost for construction to be depreciated and for maintenance would be only Rs. 3.875 mill. or Rs. 500.87/m^3.

6.3.2 Cable-cranes

In order to transport the timber in one year and get better prices for fresh logs at least

four cable-cranes would be needed. The investment for this purpose would be Rs. 6.40 million. The lifetime of this equipment is about 10 years or 10,000 hours. Therefore, it would not be correct to charge this felling operation with 100% of the depreciation of this investment. The cable logging cost of Rs. 198/m^3 (for timber harvesting alternative C and D) already includes the depreciation. Therefore, there is no need to charge the depreciation cost separately. Experiences in Kaghan Valley have proved that cable cranes are extremely useful to extract logs from difficult terrain upto distances of 1500 m. Therefore, the requirements of road density are quite low.

6.4 *Net Revenue*

The alternative-C (felling and conversion with improved hand tools, extraction with cable-cranes and transportation over the road including road construction and maintenance) gives the maximum net revenue of Rs. 11.703 million which is Rs. 1.667 million (16.6%) higher than alternative-A (traditional scant system and extraction/transportation by dry/wet sliding). Second most favourable system was alternative-D (felling and conversion with power chain-saws, extraction with cable-cranes and transportation over the forest road including road construction and maintenance) giving a net revenue of Rs. 11.623 million which is higher by Rs. 1.587 million (15.8%) than alternative-A. Least economical was the alternative-B (felling and conversion with traditional hand tools, extraction of logs by rolling/sliding and transportation over the road including road construction and maintenance) producing a net revenue of Rs. 8.818 million, which is 1.219 million (12.1%) less than alternative-A.

TABLE 14: Net revenue of different alternatives after deducting the costs for road (Rs. million)

Alternative	Sale Revenue of Timber each 5 years	Road costs each 5 years	Net Revenue each 5 years
A	10,036,400	–	10,036,400
B	12,674,853	3,857,000	8,817,853
C	15,578,030	3,875,000	11,703,030
D	15,498,024	3,875,000	11,623,024

In timber harvesting by alternative B, C and D, the quantity of timber out-turn was 79% to 91% higher as compared with alternative-A. This fact would help to reduce the pressure on the conifer forests as supplier of timber.

In the presence of a good standard forest road, timber transportation with Gattu will become more speedier and economical, thereby causing further reduction in transportation cost and enhancement of net revenue.

Alternative-C and D besides higher net revenue, leave behind a good standard forest road of about 23.5 km length. This road in the long run shall also have several direct and indirect effects on the forest and local people:

(1) Good and adequate forest roads are a pre-requisite for intensive forest management with the following advantages:
- quick and easy access to the forest
- speedy inflow of material, equipment and personnels
- economic extraction of forest products
- increase in the timber out-turn
- proper control and protection of the forest
- better management and effective silviculture
- successful regeneration and afforestation

(2) Due to the inaccessibility of the forest area, the logging residues are left inside the forest. In presence of good forest roads, these residues can economically be extracted for their utilization in the manufacture of constituted wood products or at least used as fuel by the local inhabitants.

(3) Timber yarding with cable-cranes cause least ecological disturbances with maximum preservation of remaining site and stand.

(4) Good and adequate forest roads also help in the socio-economic uplift of rural areas near to and inside the forest by providing an easy and economic inflow of goods and services from other areas, thereby, reducing their dependence on the forest.

(5) Forest road construction is a labour intensive operation and provides additional job opportunities to the local inhabitants in addition to harvesting of timber.

(6) The development of accessibility of forest areas with road will also contribute to the improvement of living and working conditions of forest workers.

7. *Conclusion*

On the basis of above facts and under present forestry conditions, the economic analysis showed that felling and conversion of trees with improved hand tools, extraction of timber with cable-cranes and proper opening-up of forest with roads and transportation of timber by trucks is the most economic alternative of timber harvesting, both with respect to net revenue and quantity and quality of timber produced. This policy of timber harvesting should be adopted not only for the forest of Hazara Civil Division, but also for the other coniferous forests of N.W.F.P., Azad Kashmir and Punjab.

Due to the use of cable-cranes in timber yarding, departmental working on the lines of

Kaghan Valley is suggested with due attention to the proper training of workers and staff in the efficient use and maintenance of improved hand tools and cable-cranes.

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