REDUCED IMPACT LOGGING AND SUSTAINABLE FORESTRY MANAGEMENT IN PAKISTAN

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Introduction

Forests in Pakistan cover 4.227 million ha, making only 4.8% of total land area of 87.98 million ha (Ashfaque *et al.*, 2000). However, forest percentage in different provinces/territories is different. The Azad State of Jammu and Kashmir (AJ&K) has the maximum forest area of 20.7%, followed by North West Frontier Province (NWFP) and Northern Areas (NA) having 16.6 and 9.5% of forest area, respectively. The province of Punjab and Sindh have almost similar forest area of round 2.8%. Forest area in Balochistan is the least, representing a minimum figure of 1.7% only.

About 32% of the existing forests are managed for production to supply timber and fuelwood and the rest 68% are meant for protection to fragile mountain ecosystems. In 1995-96, the state controlled forests supplied 0.250 million m^3 of timber (7.3%), import of wood and wood products was 1.494 million m^3 (43.9%), costing about Rs.6,660 million (Ashfaque *et al.*, 2000). The major contributors in the national wood supply were farmlands, making up the balance of 1.663 million m^3 (48.8%).

Logging and Sustainable Forestry Management

Forestry is a business in which Growing Stock (GS) is the capital/principal amount and the Mean Annual Increment (MAI) is the profit/interest and rotation is the investment period. Therefore, logging is the main event in forestry to realize profit of this business in the form of timber and fuelwood and the revenue earned from their sale. However, under the principles of sustainable forestry management and a good business, only a part of this profit (MAI) is to be utilized for all future investments and rest is to be kept to cover the risks without encroaching upon the principal amount/growing stock. This is to ensure sustainability, for the supply of forestry goods and services in perpetuity. Moreover, logging is also a very critical operation and if carried out improperly and negligently, may lead to serious economic and ecological consequences in the form of damages to the timber, forest, ground vegetation and environment. A forest, logged carelessly, may take considerable time to recover from the damages and impacts that accrued to it.

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Logging Systems

Logging is an important commercial and silvicultural operation in forestry and is carried out regularly in public forests and private farmlands. In public forest, logging is carried out under plan prescriptions, on the principles of sustained yield and silvicultural requirement. Logging in public forests is carried out by the semi-autonomous provincial bodies, such as "N.W.F.P. Forest Development Corporation" in the province of North West Frontier and "Azad Kashmir Logging and Sawmilling Corporation" in Azad State of Jammu Kashmir (Siddiqui, 1987). The provincial forest departments itself in the province of Punjab or through a separate intra-departmental set-up in the province of Sindh carry out logging (Ayaz, 1986).

Forest corporations work to log softwood species in the mountainous regions and purchase standing trees from the forest departments on negotiated rates. Tenders are floated by these corporations/departments to the private contractors for carrying out different logging operations (felling and conversion, minor and major transport of timber up to transit and sale depots). From the sale depot the timber is sold out by open auction to the consumers.

Logging operations are almost continuous throughout the year except May and June in the sub-tropical chir pine forest as a rule (fire season), while heavy snow restricts such activities from the months of December to March in temperate forests. In irrigated plantations the harvesting of timber is in progress from August to February, while all such works are to be completed up to April, before the onset of floods in riverain forests.

Forestry Workforce

There are about 600,000 workers employed in forestry and wood based industry in Pakistan (Amjad & Iqbal, 1982). In forestry alone 340,500 work to perform different operations both on state forests and private farmlands and about 290,000 carry out logging. Of these 19,000 work in state forest and 271,000 on private farms. The labour working in the forests, may be either local villagers, forest settlers (irrigated plantations), mountain forest labour (coniferous forests) or may be nomads of local and Afghan origin working in the irrigated plantations and riverain forests (Ayaz, 1986)). These work with different degree of perfection and skill. Mountain forest labour is comparatively better skilled and in addition to logging also carry out hand conversion of coniferous logs into scants for easy extraction. Labour of all types may perform forest operation as casual work to supplement their income from other resources mainly agriculture or rarely as family profession.

Work and Payments

The forest labour who carry out nursery work, regeneration operations and construction and maintenance of engineering structures work directly for forest department and are paid on time basis (daily wage). The labour who carry out logging, work either direct for forest department or for the forest contractor in riverain forest and irrigated plantations, or solely for the forest contractor in high hill forests of conifers (Ayaz, 1986). They work on piece-rate, which is verbally decided between employer and labour, directly or through a labour contractor (mait) in visual consideration of crop and work conditions. Some units of work for the purpose of piece-rate are given below:

- felling/tree, according to a maximum of 2-3 dbh classes.
- per cft or per log converted, including debranching, debarking, cross-cutting and engraving of number and identification marks.
- for hand sowing in the forest, per cft of sawn timber irrespective of size and per side cut, with two length classes.
- per stack of firewood converted.
- likewise transportation and stacking rates (manual, animal and motor transport)

There is no formal vocational training for the forest workers, in work methods, use and maintenance of tools and personal safety. They know the use of axe, pickaxe and saw as a requirement of agriculture and common village life and are further trained on the job. Those who inherit forest work as their family profession, on the job training starts from early youth by their seniors (Ayaz, 1986).

The tools used by the forest workers are simple hand tools made from the used parts of vehicles and old rails, without any strict design and quality considerations. The most commonly used logging tools are as under:

- Axes: Various shapes and weight classes.
- Crosscut saws (peg-tooth): 5 feet length
- Frame saws: 4-5 feet in length with 10 cm blade width for hand conversion of logs in the forest
- Hammers: Steelhead, 5 - 10 kg in weight
- Wedges: Steel, of various sizes
- Bill hooks: For conversion of small firewood and cleaning operations

Traditional Logging

The traditional logging comprises a set of activities, like felling, debranching, debarking, crosscutting and extraction of timber up to transit depot. In those coniferous

forests which are remote and inaccessible by forest road, hand conversion of logs into scants is carried out, at the stump, for extraction with pack animals or by sliding (Trotter, 1940). Brief description of logging activities, in order of traditional their occurrence, is given as under:

Felling

Felling of trees is carried out mostly with axe. If trees are large, two persons work on the same tree at a time. Crosscut saw (peg-tooth) is also used in felling of large trees, especially conifers.

Impacts

- axe work is wasteful and strenuous.
- no control over the direction of fall.
- damage to felled and standing trees in the form breakage.
- damage to young regeneration.
- high chances of personal injury.
- releasing of hung-ups demand much work, time and is also a very risky.
- low labour productivity.
- high physical workload.

Debranching

The felled trees are cleared of branches. The branches may be thick or thin depending upon the species and size of trees. The operation of debranching is performed purely with axe. In principle the branches should be removed as near to main stem as possible, which is very difficult to accomplish with the tool used.

Impacts

- work is very strenuous
- output is low
- down grading of logs

Debarking

Debarking of full lengths or converted logs is carried out in the forest of conifers, to quicken the process of drying, reduction in volume and weight and minimize the chances of degradation due to insect and fungal attack. The tool used in this work is axe.

Impacts

- work output and quality is very low.

Crosscutting

Before crosscutting the full tree length is measured and log lengths marked. Log lengths are decided in consideration to market, size of the tree and means of extraction and transportation. Crosscutting is carried out with 2-men crosscut saw (peg-tooth). Identification marks are engraved on the cross ends of logs.

Impacts

- faces of logs are often oblique, lengths are inaccurate logs may split during crosscutting.
- volume losses and downgrading of logs.
- work output is low.
- work is very strenuous.

Hand conversion of logs into scants

Hand conversion of coniferous logs into scants, of various dimensions, is carried out in those forests which are remote and inaccessible by forest roads. Mostly, two workers perform this operation with a frame saw. Prior to sawing, the logs are squared with axe and then scaled.

Impacts:

- method is very wasteful and about 50% of the valuable timber is left inside the forest as chips and sawdust
- net return from the sale of scants is lower than logs

Extraction of Timber

Extraction of timber especially in the mountain forests, except for few examples, is carried out by traditional manual means. These timber extraction methods in addition to being slow also result in timber degradation due to wear and tear, weathering and attack of biological agencies. Traditional timber extraction methods are briefly described as under:

i. Dragging

Manual dragging of small wood and scants is rarely practiced for the extraction of timber. However, in dry sliding, scants are manually dragged to cross those parts of the slide where the gradient is low and the motive force of gravity can not overcome natural friction.

Impacts:

- difficult and expensive.
- wear and tear of the timber pieces.

ii. Rolling

Rolling is practiced for the extraction of round timber. In rolling, the advantage of gentle and falling gradient is taken and, hence, is difficult on flat ground and against the gradient. Operation of rolling is performed by a party of manual workers, equipped with wooden levers and is done on properly prepared rolling paths or on the forest roads, wide enough to accommodate the length of logs. The rolling is carried out in batches and the system works only for short distances.

Impacts:

- slow, laborious and risky work
- wear and tear to the logs
- risk to personal safety

iii. Skidding

Skidding is comparable to dragging, but performed with animals (buffaloes, oxen, horses and camels) or machines (common agricultural tractors). Both animal and machine skidding is carried out on specially aligned skidding paths made by clearing of vegetation and ground working, wide enough for the easy movement of animals or machines. Skidding is easy on gentle gradient or flat ground. Skidding is not recommended along steep gradient.

Impacts:

- tractor tyres cause soil compaction.
- tyres and hoofs of the animals dislodge soil, which becomes more prone to water erosion on sloping grounds.
- cause damage to the ground vegetation and young regeneration.

- tree roots and stumps are damaged, which provide gateways for the entry of pathogens causing rotting and death of trees.
- smoke of tractor cause environmental pollution and noise disturbs the wildlife.

iv. Timber Chutes

Timber chutes are used for the extraction of round and converted timber over short distances. These chutes are simply troughs scooped out of the ground with steep gradient.

Impacts:

- wear and tear to the timber.
- disturbance to the soil and soil erosion.
- damage to the ground vegetation, roots and stumps of standing trees.

v. Timber Slides

- Dry slide

Dry slide (Pathru) is a trough shaped structure in cross section, several kilometers long, made from mostly scants placed end to end and side to side. A dry slide is constructed in or along a nullah bed with steep gradient. Slide construction starts from above, construction proceeds with timber pieces slided over the completed section and ends up at the delivery point. When sliding work is complete, slide is dismantled from top end and the timber pieces, once used in its construction, are slided down to the lower end on the remaining section of the slide. This practice continues till whole of the slide is finished at the delivery point usually a transit depot. The motive force in dry sliding is the force of gravity. In Pakistan, converted timber (scants) is mostly extracted by dry sliding where no other mean is workable.

Impacts:

- skilled labour is required for construction and sliding work.
- process is slow and laborious.
- timber losses as wear, tear and breakage.

- Wet-slide

As the name denotes, a wet slide (Mohan) works with the motive force of water. A wet slide is constructed from scants in or along the bed of a mountain stream

with perennial flow of water. In cross section wet slide is a rectangular trough. Rest of the construction process is the same as for a dry slide, but with watertight joints. Water and scants are charged in the slide at the top end. Water moving down takes the scants along. Wet slide works only on gentle gradient.

Impacts:

- much skill is required for construction and maintenance of a wet slide.
- high risk of damage from flood.
- require high degree of repair and maintenance.
- timber losses in the form of wear and tear.

4.7 Transportation

Transportation may be minor or major depending upon distance covered and ultimate destination (transit or sale depot). Minor transport starts from the forest and ends up at the forest/transit depot. Pack animals or motor transport running over forest roads may be used in this operation. Major transport starts from the transit depot and ends up at the sale depot.

i. Minor Transport

- Pack-animals

The animals used in minor transport of timber are mules in mountains and camels in the plains. Mules are used for scants carrying at the average 6 cft of timber over 5 to 10 km. Camels are used in plains for round logs of hardwoods and fuelwood. This system of timber and fuelwood transport is disappearing fast due to introduction of more quick and economic mean of motor transport.

- Motor Transport

The vehicles used for minor transport of timber (scants/logs) are usually small and strong (4x4) trucks capable of negotiating steep gradients of forest roads. Common agricultural tractors with trolleys are also used. Jeeps are used for the minor transport of scants over narrow and steep forest roads. A truck may carry at the average 250 cft of round timber (Ayaz, 1990).

ii. Major Transport

- Water Transport

Timber and fuelwood is transported by boats, up- and down streams, in the riverain forests (Vistro, 1996). Floating of coniferous timber (scants/logs) is carried out by directly lodging the pieces in the river when passing in the hilly areas. This process

is known as rafting when river enters plain areas, lose speed and become wide (Trotter, 1940). Floating ends at specially constructed booms across the river. Timber pieces are collected at the boom and tied together to make rafts for further transport down stream. Transportation by boats has considerably declined. The practice of floating and rafting has been abandoned for about last three decades due to construction of Mangla and Tarbela dams.

Impacts:

- timber degradation due to wear and tear.
- high timber losses, on way, due to theft.

ii. Motor Transport

Common trucks are used for long distance timber transport. A truck may carry about 600 to 1,000 cft of timber. At present this is the cheapest mean of long distance timber transport.

5. Some Pre-requisites for Reduced Impact Logging

Coniferous forests in high mountains of Pakistan are very important for their production, protection and environmental value. To introduce reduced impact logging to advance sustainable forestry management in these areas, different technical and work organizational measures are suggested. These measures are briefly described as under:

5.1 Vocational training of forest workers

Forest work in Pakistan is casual with least instances and chances of permanent employment (Ayaz, 1986). The workers work mostly for forest contractors, who go for making maximum profit and are least interested in the improvement of forestry operations. As a result, the forest works are performed by use of traditional techniques, tools and without formal training of workers in proper work methods, use and maintenance of tools and personal safety. This makes the logging operation very strenuous with low work output, income and poor socio-economic condition of the workers. Moreover, the methods and tools used cause much wastage of timber during logging. Because of casual work the rate of turnover of experienced workers is also very high.

It is emphasized that the workers training in proper work methods, use and maintenance of tools and personal safety must be initiated. The workers should directly be engaged by the forestry organizations rather than through forest contractors. To streamline the wage system, scientifically developed piece-rates must be introduced.

5.2 Improved Tools

Improved tools both in quality and design and properly maintained, not only have a positive impact on work productivity, but also reduce physical workload on the workers (Ayaz, 1986 & 1990b). Studies on the use of improved tools with training of workers, in many countries including Pakistan, revealed that in logging new tools and techniques gave higher productivity and less energy demand and workload as compared to traditional tools and techniques. Among hand tools the advantages of raker-tooth crosscut saws are higher than the peg-tooth crosscut saws.

Power chainsaw is an efficient tool in felling and conversion of trees. Results of the studies on the efficiency of power chainsaw in many countries indicate that power chainsaw give higher work performance and less energy demand in felling and crosscutting as compared to other cutting tools. Higher performance of power chain saw in logging is also supported by results of studies carried out in plantations in Pakistan (2.6 to 3.5 times higher). Introduction of improved tools to reduce impacts of logging to advance sustainable forestry management is strongly emphasized.

5.3 Mechanization

Human capacity to perform physical work is limited, but the demand for higher productivity is always surpassing (Ayaz, 1986). Therefore, mechanization of work operations is the only mean to bridge the gap between human limits of physical work and higher productivity demand. Mechanization is the most effective tool to increase technical labour productivity, but full labour productivity of mechanization is highly variable because of difference in machine and labour cost among the countries. The industrial countries are the self-manufacturers of machines and the machine cost seldom exceed 50% of the total cost. In developing countries machine cost is 80% of the total cost of the operation. Therefore, mechanization in developing countries is expensive than manual work.

Another aspect of mechanization is its effect on employment due to substitution of manual work. Developing countries are already facing a chronic problem of unemployment. Mechanization means more people without job. Therefore, the option for mechanization should only be made under very special conditions, otherwise well-trained workers, with better tools, techniques and work conditions is a suitable compromise between employment problems and labour productivity demand.

5.4 Forest Accessibility

Forests in the north and northwest of Pakistan are very productive and are the sole source of coniferous timber in the country. The accessibility of these forest areas,

with adequate and good standard forest roads, is very poor. While, forest roads are a pre-requisite to improve logging and introduce reduced impact aerial extraction of timber. At present a forest road density of 2.9 m/ha is estimated for the coniferous forests of Pakistan (Siddiqui, 1987). Recommended minimum density for efficient management of these forests is 10 m/ha (Pfister, 1987). To achieve this figure, a forest road network of about 13,582 km needs to be built. However, this is a tremendous task to accomplish and beside technical inputs also involve substantial financial outlays estimated at R.4.075 billion.

6. Application of Reduced Impact Logging to Advance Sustainable Forestry Management

Reduced impact logging to advance sustainable forestry management is the logging with least negative impacts on the remaining site, forest stand and maximization of material, economic and environmental benefits of forestry in perpetuity. In this regards research and development efforts always remained underway to devise ways and means of logging forests to achieve these objectives. Different logging operations with reduced impacts are briefly described as under:

6.1 Felling and conversion

Felling and conversion of trees is the most critical logging operation and if properly carried out is highly beneficial in term of quantity and quality of timber and preservation of remaining stand, site and environment. Healthy and trained forest workers working with modern, improved, well-maintained and adequate tools can greatly reduce the impacts of logging in the following manner.

Reduced impacts:

- least wastage of timber in felling losses as chips.
- least losses as breakage of felled trees, standing trees and regeneration, due to control over the direction of felling.
- high quality of timber logs with respect to perfection in debranching, debarking and crosscutting.
- higher economic returns due to high prices of timber in the market.
- least workload on the forest workers.
- maximum safety of forest workers with good income due to higher productivity.

6.2 Use of Cable-cranes

Cable-cranes and cableways are means of aerial extraction of timber (Stoehr *et*

al., 1988) and comprise a system of cables (SWR), pulleys and power winches. Cable-cranes have different designs, working mechanism, working length, load carrying capacity and mobility. A cable-crane can pick up loads all along its length and to a certain lateral distance and deliver at its tail or head (downhill or uphill yarding) located usually on a forest road. Cable-ways are permanent installations working for longer distances and unlike cable-cranes can transport timber between two fixed points (loading and delivery point) and could be served, at loading point, with one or more means of timber extraction, including cable-cranes.

Reduced Impacts:

- quick and economical.
- least wastage of material due to wear and tear and degradation in the forest on account of weathering and biological agents.
- least disturbance to ground/soil, vegetation and maximum preservation of biodiversity.
- least damage to the remaining stand.
- high timber quality and recovery.
- high revenue due to higher timber prices fetched in the market.
- less strenuous for the forest workers.

6.3 Other Methods of Aerial Transport

In North America and some tropical countries balloons (Lambert, 1988) and helicopters (Hui, 1996) have been tried as means of aerial extraction of logs. Despite of favourable ecological impacts these methods could not find larger recognition in timber transport. In addition to many technical constraints and heavy initial investments, these methods are expensive due to very high operating cost per unit volume and therefore, have limited application only for very expensive timber species and high quality logs. Balloon and helicopter logging have least application for timber transportation in Pakistan. However, these methods have the following reduced impacts:

Reduced Impacts:

- quick and speedy.
- least wastage of material due to wear and tear and degradation in the forest on account of weathering and biological agents.
- no disturbance to ground, vegetation and biodiversity.
- least damage caused to the remaining stand.

6.4 Forest Roads

A certain density of forest roads in very essential, as a major means of forest opening up and, for working with any of the above mentioned reduced impact extraction methods, except use of balloons and helicopters. The state of present forest road density and future need has already been discussed under chapter 6.4 above. However, the positive impacts of forest roads are given as under.

Reduced Impacts:

- quick and easy access to the forest.
- economic extraction of forest products and utilization of logging residue.
- increase in the timber out-turns.
- Proper control and protection of the forest.
- better management and effective silviculture.
- successful regeneration and afforestation.
- Preservation of environment with the introduction cable-crane extraction for reduced impacts on the remaining stands and site.
- Socio-economic uplift of rural areas.
- generation of job opportunities due to forest road construction activities.

6.5 Optimum Reduced Impacts Logging System

In a system analysis study carried out in the forests of Upper Siran, Hazara Civil Division, four logging systems have been recognized for coniferous forests of Pakistan and compared for their economic and ecological benefits (Ayaz & Stoehr, 1988). These logging systems or alternatives are briefly described as under:

- **Alternative-A**

Felling and conversion with conventional tools and techniques, sawing with frame saws at the stump (scanting), extraction by chutes and sliding (20 km) to the transit depot.

- **Alternative-B**

Felling and conversion with conventional tools and techniques, extraction by rolling/sliding and transport by small trucks on the forest road (17 km) upto transit depot.

- **Alternative-C**

Felling and conversion by improved tools and techniques with training of forest

workers, extraction with cable-cranes and transport by small trucks on the forest road (17 km) upto transit depot.

- **Alternative-D**

Felling and conversion by power chainsaw and training of forest workers, extraction with cable-cranes and transport by small trucks on the forest road (17 km) upto transit depot.

Results of this simulation analysis reveal that Alternative-C (*Felling and conversion with improved tools, techniques and training of forest workers, extraction with cable-cranes and transportation by small trucks on the forest road (17 km*) upto transit depot) is the best logging system, under Pakistani conditions. This gave maximum recovery of high quality logs and higher revenue than the rest of the three logging alternatives. In addition, this method of logging left behind about 17 km long forest road.

This system of logging must be adopted for reduced impacts to advance sustainable forestry management in Pakistan. Reduced impacts of this logging system are given as under:

Reduced Impacts:

- least timer losses and maximum recovery of sound wood.
- quick and easy access to the forest.
- economic extraction of forest products and utilization of logging residue.
- proper control and protection of the forest.
- better management and effective silviculture.
- successful regeneration and afforestation.
- preservation of environment with the introduction cable-crane extraction for reduced impacts on the remaining stands and site.
- socio-economic uplift of rural areas.
- generation of job opportunities due to forest road construction.

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