Appropriate forest harvesting technology: an overview

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Forests of Nepal have been harvested indiscriminately by both the local people and the government. While the former continue to use the traditional tools, the latter had introduced a mechanised system in harvesting operation in 1970. The present paper briefly discusses the *pros* and *cons* of both the forest harvesting technologies in the context of Nepal. Research outcomes of other countries have also been cited.

Keywords: Forest harvesting techniques, chain saw, crosscut saw, traditional tools, Nepal

Technology is a set of techniques that are currently in use or may be of potential use. Several definitions of technology exist (Merrill 1968). However the appropriate technology is the one, which is suitable for locally prevailing economic, social, and environmental conditions (Kantola and Harstela, 1991).

Harvesting experts have classified the forest harvesting technology in different names. However, Harstela (1993) catagorised appropriate technology into basic technology (for example: hand saw, animal or manual transport), intermediate technology (for example: chain saw, tractor transport), mechanised or advanced technology (for example, harvesters, forwarders) many factors such as productivity, socio-economic, ergonomics, forest types and site condition, and ecological aspect affect the choice for its adoption. And the technology, which is appropriate for one country or region, may not be suitable for another (Guangda and Murphy 1990).

Therefore, technology should be appropriate with regard to local conditions (FAO, 1981; Guangda and Murphy 1990; Heinrich 1987; and Knatola and Virtanen 1986). Besides, a political factor also plays an important role before adopting mechanization, as leaders in many developing nations are reluctant to have their countries classified as technologically second rate (Goulet, 1975). With these background the present paper analyses the forest harvesting technology in Nepal.

Forest harvesting system in Nepal

There are two streams of harvesting system exist in Nepal. The one is by villagers and the other is through government agencies, such as the Timber Corporation of Nepal (TCN) and the Forest Product Development Board (FPDB).

In 1970's, the TCN introduced mechanised system in harvesting operation. Chain saws, log lifters, uprooting dodgers, tractors with winch, trucks, and other capital-intensive machinaries were introduced. They were abandoned gradually due to lack of skilled labour, spare parts, and high production cost. Since then, hand tools such as two-man crosscut saw and simple traditional tools have been used to fell trees. Similarly, farm tractors are being used to transport logs from felling site to log-yard. This could be considered as a semi-intermediate technology.

Similarly, in 1980's, the FPDB imported chain saws from Germany to use in its project area, but were not frequently use because of unskilled manpower, lack of spare parts, soaring oil price, and unsuitability for cutting big hardwood trees. Now, local axe and Indian crosscut saws are the main felling tools in the project. However FPDP has again started using chain saw only for thinning of small trees. For cutting of big trees, FPDP hired Indian and local labours who use two-man crosscut saw, and farm tractor and trucks transport the logs. In hills, as villagers are more or less free to collect and use timber and fuelwood, no such appropriate harvesting technology has been tried. Villagers still adopt traditional or conventional tools and traditional harvesting system (plate).

People use local traditional tools like axe and sickle (khurpa). However, in few places, two-man crosscut saw is seen being used. In these regions, logs, timber, and fuelwood are manually transported.

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Plate: Traditional harvesting technology

Basic harvesting technologies

Almost all industrialised countries of the world have adopted mechanised harvesting technology whereas developing countries like Nepal is still under the basic or semi-intermediate technology system. There are several factors behind it.

Availability of labour is one of the major factors. It is said that the abundant and easy accessibility of labours means low cost of production. In this sense, mechanisation might be the burden for the nation as it is directly or indirectly linked with migration to the cities. The worst effects of this is slum housing and many other negative consequences; examples can be seen in many other developing countries.

Climatic condition is another factor. Tree harvesting occurs mainly in the Terai where there is similar to the tropical and sub-tropical climate. Due to dietary deficiencies and heat stress, labour-productivity as well as output is low in this region. In such cases, the introduction of machine could be appropriate. In the past, attempts were made to replace manpower with machines but it was not successful. Finally, basic technology was re-introduced as mechanisation could have a serious negative impact in the form of country's dependency on developed nations. It also continues transfer of mechanised harvesting system from industrialised countries to developing countries, which is unsustainable, anti-social and anti-ecological (Guangda and Murphy, 1990).

Fuelwood is the main source of energy in the country and timber for construction material. The price of fuelwood and timber should be kept as low as possible so that the poor people can also afford to buy it. Economical status of the people also governs the selection of the technology. To make the forest product cheaper, basic technology could be good option as low cost human resource is easily available. For example, Sundberg (1981) compared the costs of manual versus mechanised systems at two different labour costs, USD 5 and USD 15 per worker per day. When the labour cost was USD 5, the manual method became economic. A study carried out in Zimbabwe proved that for non-commercial thinning up to a DBH of 21 cm the use of saws instead of chain saws, reduced cost to about 40 percent.

The size of the tree is another factor that decides the choice of technology. For trees with small diameter, the manual method is more economical than the mechanised one. A study done in the Philippines showed that the working unit cost of a bow saw was USD 34.50 per thousand stems and USD 35.27 when chain-saws were used for the same work (Larrman *et. al.* 1981). Similarly, Kant and Sood (1975) did a comparative study of power chain saw and two men crosscut saw in felling of sal (*Shorea robusta*) trees. Two-man crosscut saw was more economical in 10 to 20 cm diameter classes by 33% to 100% as compare to power chain saw.

Not only in cutting of trees but also in terrain transportation, basic technology can be cheaper in Nepal. At present, farm tractor and bullock cart are being used in the Terai, and manual force is being used in the hills. It is not known which method is cheaper, because no such studies have been done in the country. Studies carried out in other developing countries show that productivity of agricultural tractor in terrain transportation is three times higher than animal logging. Cost-wise however animal logging can be 37 times cheaper than the agricultural tractor (Heinrich, 1987). Similarly, a study carried out by Rodrguez (1986) showed that wood extraction with tractor was expensive. The cost per m^3 using tractor was USD 0.92 whereas the cost per m^3 was USD 0.48. Mitra and Sood (1980) have shown that for terrain transportation animal cart was more economical up to 4 km than truck and 9 km than tractor.

The productivity of mechanical tools is obviously high, but to a certain extent, manual tools are also productive and economic. Mitra and Sood (1977) compared bow saw, crosscut saw, and chain saws as used in eucalyptus plantation in India. The results showed that bow saws were cheapest in cross cutting, and crosscut saws were best for felling and chain-saws were more productive while using. But their effective cutting times were only 49 percent of the total working time compared with 86 and 76 percent for crosscut and bow saws respectively. In addition, availability of skilled manpower also plays important role to gain high productivity. The productivity of mechanised tool is very low in developing countries. Guanda and Murphy (1990) has mentioned that the productivity in Northeast China, where forest operations have been mechanised, is only 260 to 290 cu. m. per year because of the lack of trained personnel.

Mechanisation is intended to speed up forest work and reduced human effort, but it affects workers' health due to excessive noise, vibration and carbon monoxide emission, etc. This has been shown in a study in which bow saws, crosscut saws and chain saws were compared. It was revealed the chain saws were faster and less energy consuming than manual tools, but its physiological load on the worker was high. Similarly, tree felling with a handsaw and a power saw in three Dutch workers. His results showed that the average heart-rate in felling with a hand-saw was 127 beats per minute as compared to 142 when using a power saw. People who operate mechanised tools will suffer from different occupational diseases. Regarding this, a study from Nigeria revealed that 38 percent of chain saw operators had painful or swollen hands and 18 percent had numbness of fingers. A similar study carried out in the Philippines in 1984 showed that 13 out of 16 had symptoms of vibration induced white fingers.

Gender issue, which is getting stronger in every developmental activities can not be neglected in forestry operation. In Nepal, men and women work together in harvesting operation. If men fell trees, women support them in making bundles of fuelwood, and carrying them, and so on. Womens' participation is equally important for better management and utilisation of the forest products. Mechanisation means, in one way, to stop participating in harvesting operation. For example if chain saw is used, then women will be excluded from the team and loose valuable social function.

Occurrence of accident is low in manual logging in compare to mechanical logging. A study carried out in Switzerland (ILO, 1981) showed that percentage of accidents by tractor skidding was 45 whereas by manual sliding of logs on steep slopes using sample was 20. Similarly, accident rate is high in the chain-saw operator in compare to manual tool operators. Chain-saw operators and helpers account 61% of the identified wood accidents (ILO, 1977).

In the hills, use of heavy machine causes soil compaction and soil erosion that affects and forest regeneration. A study carried out by Shishiuchi, (1990) showed that influence of soil compaction and disturbance to growth of the planted seedling was high during first growing seasons. In tropical and sub-tropical countries, topsoil is very much fragile. It can be easily eroded if exposed to heavy rains. Compared with heavy equipment, labour-intensive methods is less harmful for the forest environment (Kantola and Virtanen, 1986).

Mechanised technology means highly sophisticated machines. It needs highly trained manpower. Developing countries such as Nepal can not afford to provide expensive training to its manpower to adopt the such technology, whereas untrained manpower causes less production rate. Therefore, Guangda and Murphy (1990) have said that due to the lack of trained personnel, the productivity and economic efficiency of forest operations are very low in developing countries.

Conclusion

Each of the three harvesting technologies has its own merit that depends on various factors. The most important thing is to have a clear vision of the technology to be adopted. Nevertheless, based on several studies done in other developing countries, basic technology is appropriate for Nepal.

Appropriate harvesting technology, if followed, will give high production rate with low input. However, while selecting the appropriate technology, the three factors whether it is socially acceptable, economically viable and physically feasible should be always considered.

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