SINGLE TREE SELECTION SYSTEM IN MOIST TEMPERATE FORESTS OF PAKISTAN: A REVIEW

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ABSTRACT

This paper examines the effectiveness of single tree selection system applied in the Himalayan moist temperate forests of Pakistan. It argues that though the single tree selection system is very suitable to Himalayan moist temperate forests due to their nature and location, the system has not been successful in sustainable management of the forests due to anthropogenic factors such as illegal logging, grazing and clearance of forestland for agriculture. The management of moist temperate forests has always been a challenging job for forest managers due to conflicting interests of different stakeholders and the crucial location of these forests. These forests are managed under selection system to achieve the twin objectives of watersheds protection and generation of revenue for the state and local right holders. Single tree selection system is the most appropriate sivicultural system for managing the Himalayan moist temperate forests. If properly practiced, single tree selection system can protect the steep slopes from erosion and produce timber and other forest products on sustainable basis. Single tree selection system can be safely applied in the forests where REDD+ projects are implemented as it allows for limited extraction of timber and non-significant reduction in carbon stock in the forests.

INTRODUCTION

Mountain forests are home to a great diversity of plants and animals, which provide wood and non-wood forest products and services that mountain peoples depend on for their livelihoods (Price, 2005). Himalayan temperate forests are the most important forest type of Pakistan because they house the valuable timber species, rich biodiversity and protect the upland watershed areas. These forests receive a lot of precipitation in the form of monsoon rains in summer and snowfall in winter (Sheikh, 1993). The forests are dominated by evergreen coniferous species with local admixture of oak and other broad-leaved trees (Siddiqui et al., 1999). Most of the species are shade tolerant and thus adopted to single tree selection system. These forests are located in high hills and protect the otherwise highly erodible slopes in these areas. This is why only single tree selection system can be applied in these forests.

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The management of moist temperate forests has always been a challenging job for forest managers due to conflicting interests of different stakeholders and the crucial location of these forests. These forests are managed under selection system to achieve the twin objectives of watersheds protection and generation of revenue for the state and local right holders (Hasan, 2007). However, the management is largely failed to achieve the objectives due to several reasons. The ownership of these forests is disputed between the state and local communities. These forests are under tremendous pressure due to high population pressure, overgrazing, clearance of land for pasture and food crops, illegal logging for timber and fuelwood (ICIMOD, 2000). Only 50% of these forests are managed by the forest department under prescribed management plans (Siddiqui, 1997). Rests of the forests are treated as common property resources by the local communities where no management is applied. Most of the forests have very low tree cover and indeed present a gloomy picture of the tragedy of commons.

Single-tree selection felling is the most common silvicultural system extensively practiced throughout temperate forests (Troup, 1966). This harvesting system has evolved from technical and logistical constraints posed by temperate forests and the socio-economic conditions of local communities who prefer best trees for felling. This may however, lead to a selective and concentrated removal of elite trees - a practice known as “creaming” and “high-grading” leading to dysgenic selection (Moktan, 2008).

This paper examines the effectiveness of single tree selection system in the Himalayan moist temperate forests of Pakistan and identifies options for improving the efficiency of the system. It argues that though the single tree selection system is very suitable to Himalayan moist temperate forests due to their nature and location, the system has not been successful in sustainable management of the forests due to anthropogenic factors such as illegal logging, grazing and clearance of forestland for agriculture.

MATERIAL AND METHODS

The current research article on “Single Tree Selection System in Moist temperate forests of Pakistan: A Review” is based on the compilation, analysis and synthesis of available literature on the subject. An extensive literature review was conducted to gain insights into the technical details of the selection system used for harvesting of trees in moist temperate forests of Pakistan. Peer reviewed journals and technical reports of different government agencies and international research organizations are the main sources of the data used in this article.

RESULTS AND DISCUSSION

Himalayan Moist Temperate Forests

Himalayan temperate forests of Pakistan are located in the northern mountain ranges between the elevations of 1,500 and 3,000 meters. These forests are mixed coniferous forests with *Pinus wallichiana* (Kail), *Cedrus deodara* (Deodar), *Abies pindrow* (Fir) and *Picea Smithiana* (Spruce) as the dominant species varying with changes in site conditions and elevation. The broad leaved associates are *Quercus dilatata, Q. incana, Juglans regia, Populus celiata Aesculus indica* and *Alnus nitida* (Sheikh, 1993). The broad leaved species are found singly scattered or in groups in deep and moist sites. Mid storey is usually dense and consists of evergreen and deciduous species including *Vibernum cotonifolium, Cotoneaster microphylla, Cotoneaster nummalaria, Sarcococca saligna, Berberis lycium, Indigofera heterantha, Rubus fructicousus* and *Rosa moschata*. Ground flora consists of *Paeonia emodi, Fragaria nubicola* and *Viola* species (Haq, et al., 2010). The wood of all tree species is highly valued as timber while the undergrowth provides medicinal plants, mushrooms, and fodder.

Himalayan moist temperate forests receive precipitation between 630mm to 1500 mm per year. Most of the precipitation occurs in the form of monsoon rains from July to September (Sheikh, 1993). An appreciable amount of precipitation is derived from winter rains and snowfall. Being wet and cold, Himalayan moist temperate forests are largely protected from fire. These forests are characterized by the extensive growth of conifers mainly kail, deodar, fir and spruce. The canopy formed by these species is 24 m to 36 m high whereas the individual tree diameter may reach up to 1.5 m (Sheikh, 1993). Though the exact estimate of the area covered by moist temperate forests in Pakistan is not available, it is clear that these forests constitute the major share of coniferous forests covering 1.913 million ha area (Government of Pakistan, 1992). The growing stock of coniferous forests was 185 million m3 with an average of 145 m^3 per ha in 1992 (Siddiqui, 1997).

Moist temperate forests can be divided into lower and upper zone forests, each with different species of conifers and/or oaks as dominant vegetation. In the lower zone, *Cedrus deodara*, *Pinus wallichiana, Picea smithiana* and *Abies pindrow* are the chief conifer species in order of increasing altitude. In this zone *Quercus incana* occurs at lower altitudes and *Q. dilatata* occurs above 2130 m. In the upper zone *Abies pindrow* and *Q. semecarpifolia* are the dominant tree species (Siddiqui, 1997). There may be pockets of deciduous broad-leaved trees, occurring in moist and deep sites in both the zones. Alder (*Alnus* species)

colonizes new gravels and sometimes *Pinus wallicihina* is the first colonizer. Degradation forms take the shape of scrub growth and in the higher reaches, parklands and pastures are subjected to heavy grazing by cattle, goat and sheep (Shaheen *et al*., 2011).

Importance of Moist Temperate Forests in Pakistan

Pakistan is a forest deficient country with the lowest forest cover in South Asia. Out of its total 87.98 million hectare (m ha) area only 5.2% (4.51 m ha) is under forest cover (Bukhari et al., 2012). Most of the forests (40%) are located in the Himalayan mountains which constitute the catchment of the major rivers of the country (Figure 1). These mountainous forests are dominated by coniferous species with local admixtures of broad-leaved associates. Though the forest resource is meager, it plays an important role in Pakistan's economy by protecting the upland watersheds against erosion, regulating waterflow in rivers and reservoirs, employing half a million people, providing 3.5 million cubic feet of wood and fulfilling one third of the nation's energy requirements (Govt. of Pakistan 2002). Thus, forests are important for security of livelihood and maintenance of a sound ecological balance in the country.

In addition to production of timber and fuelwood, the location of Himalayan temperate forests is of critical importance for the agro-based economy of Pakistan. These forests protect the watershed areas of the Indus Basin irrigation network-the lifeline of agricultural production (Ali and Shah, 2005). These lands are highly fragile due to their weak geological formations, steep slopes and occurrence of high intensity showers in monsoon and heavy snowfall in winter (ICIMOD, 2000). The denudation of these areas causes severe erosion and land degradation leading to siltation of water reservoirs, rivers and canals in the downstream areas. The removal of vegetation cover also causes damage to life and property due to landslides and periodic flash floods (Azhar, 1993).

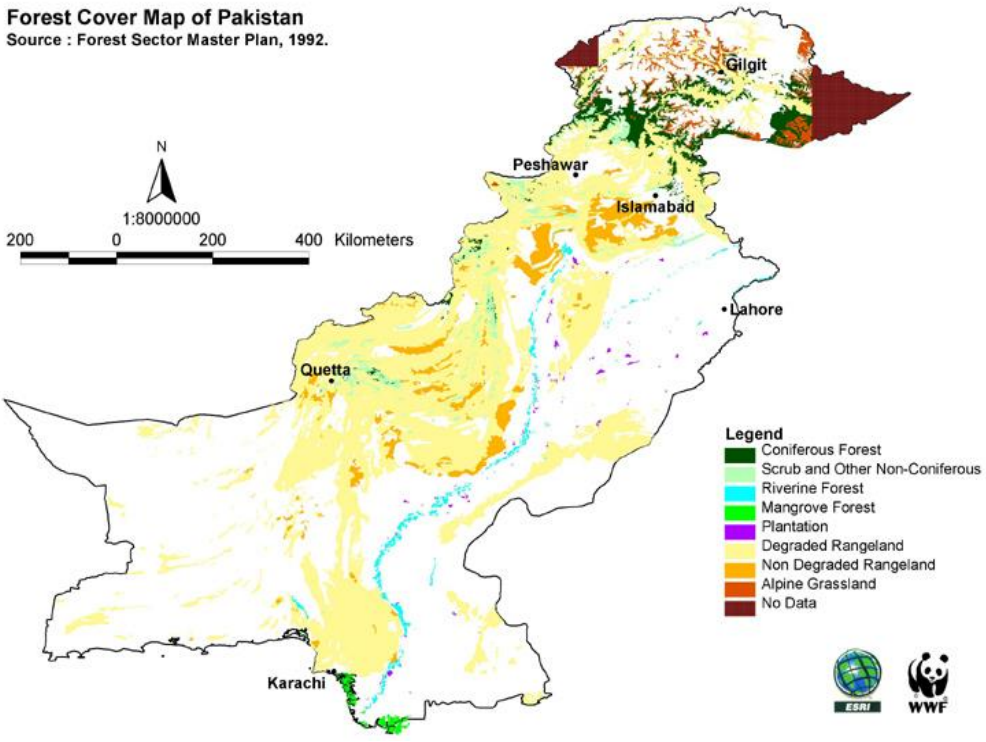

Fig.1. Distribution of forests in Pakistan

Source: Reproduced from Government of Pakistan, Forestry Sector Master Plan,1992

Deforestation and forest degradation in moist temperate forests of Pakistan

In many mountain areas of the world in general and the Himalayas in particular, mountain forests are under tremendous pressure due to increase in human and livestock populations, illegal logging, unsustainable agricultural practices (Wakeel, 2005) and excessive grazing of forests (Moktan et al., 2008), leading to accelerated deforestation and forest degradation. In Pakistan, deforestation is mainly caused by illegal commercial logging and cutting of trees for fuelwood. Illegal logging is widely practiced in the moist temperate forests in the country because these forests have highly valuable timber species like deodar and kail which fetch highest prices in the market (Fischer et al, 2010). The people involved in illegal logging are mostly local or have partnership with local people and sometimes they also get the support of officials of Forest Department to conduct their illegal activities in the forests. Exclusion of local communities from the forest management makes illegal logging possible (Hasan,

2007). Uncontrolled grazing and clearance of forestland for cultivation and pastures are other main reasons of deforestation.

The moist temperate forests of Pakistan were subjected to illegal logging on one hand and selective felling by the Forest Department on other hand. Good quality trees were removed through single tree selection and whatever left were felled by illegal loggers (Hasan, 2007). This resulted in extensive deforestation and forest degradation. Consequently, the government imposed a complete ban on all logging operations in the forests and suspended the so called forest management in 1993 (Fischer et al., 2010). However, deforestation is going unabated and the forests are continuously being degraded. It is feared that if nothing is done and the current management system goes on the remaining forests will soon be diminished (Ali and Shah, 2005).

Single Tree Selection System

In selection system individual trees or small group of trees are felled all over the forest, creating small gaps to stimulate regeneration. This results in the development of an uneven-aged forest in which trees of different age classes are distributed over the whole area of the forest (Troup, 1966). Theoretically a forest managed under selection system should contain trees of all age classes distributed over the whole area of the forest in proper proportions (Figure 2). However, this regularity is seldom found in actual conditions (Troup, 1966). Age classes are usually in small groups resulting from the growth of regeneration in the gaps created by felling. Single tree selection system is only suitable for shade bearing tree species. The system becomes more promising in highly erodible steep slopes where complete removal of the overstorey can cause serious erosion.

Selection fellings consist of removing all trees which have attained a certain diameter or girth. However, sometimes some trees are retained to serve as seed bearers. Selection fellings also involve the removal of dead, dying, diseased, misshapen or otherwise defective trees or trees of undesirable species particularly if they interfere with the growth of valuable stems (Khan, 2011).

Single tree selection system provides relatively better protection to soil against erosion, landslips and snow-slides. It also provides cover to young seedlings against direct sun, frost and cold winds. The retention of elite trees as seed bearers also provide for genetic improvement of the forest crop. Single tree selection system is considered as the best from aesthetic point of view and conservation of bio-diversity as it results in the development of forest nearly resemble to virgin forest (Troup, 1966).

On the other hand, single tree selection system has several

disadvantages. Due to the scattered nature of the fellings, their supervision and monitoring is difficult. The cost of logging operation and extraction is higher than any other management system. Fellings and extraction cause heavy losses to younger trees and saplings. The timber produced in selection system is of lower quality than the even-aged forest and the correct determination of the yield is quite difficult (Troup, 1966). The system is also not suitable for areas where grazing is practiced as the regeneration is spread over the whole of the forest and no area can be allocated for grazing.

Fig.2. Forest worked under selection system

Source: Troup, 1966

Application of single tree selection system in Moist temperate forests of Pakistan

Single tree selection system is particularly suitable for the moist temperate forests of Pakistan due to several reasons. First, these forests mainly consist of shade bearing tree species. Secondly, these forests are located in critical watershed areas which is highly erodible and fragile to landslides and snow-slips (Sheikh, 1993). The primary objective of forests management in these areas is to protect the upland watersheds. However, due to scarcity of high quality timber in the country and dependence of local people livelihoods on these resources, the forests are subjected to selective loggings (Hasan, 2007).

The forest area is divided into blocks which are taken up for selective felling and regeneration each year. Thus the number of blocks is equal to the number of years required for completion of felling. This period is known as felling cycle. Though there is no fixed rotation or limit on the size of felling cycle, usually it is 20-30 years in the moist temperate forests in Pakistan (Khan, 2011). The duration of felling cycle is fixed in such a way to allow for the economic removal of the produce and ensure sufficient time for trees to reach exploitable size and to stimulate sufficient regeneration. Usually the size of compartment in these forests is 200-250 ha (Khan, 2011).

The felling of exploitable trees is sometimes coupled with thinning among immature trees. Full enumerations are conducted at short intervals-usually 10 years to determine the volume of the growing stock, the increment over the period and size class distribution. These figures are then compared with yield tables of normal forest to estimate the yield. The exploitable trees are marked by the forest officials. Usually for coniferous species like *Pinus wallichiana* and *Cedrus deodara*, the exploitable diameter size is 60 cm, which is attained at about 120-150 years depending on the site quality (Khan, 2011). Sometimes, the trees above the exploitable size are retained if they are growing vigorously either among groups of middle aged trees or in groups on gentle slope where most of the trees are mature and regeneration felling will be made later under uniform system. Dead, diseased and undesirable trees are also removed. In thinning, more valuable species are retained such as deodar is preferred over kail and fir. Kail is proffered over fir and spruce. Similarly walnut is preferred over coniferous species due to its scarcity and high market value (Khan, 2011).

The moist temperate forests are managed under sustained yield principles that allow only for the removal of annual yield from the forests, without harming the growing stock. The officials of the Forest Department mark the trees to be felled, the harvesting, transportation and sale is the responsibility of an autonomous Government organisation, Forest Development Corporation (FDC). Before 1973, Forest Department used to sell standing volume of trees to private contractors, who were then responsible for logging, transportation and sale of timber. These contractors were able to fell much more trees than that permitted on a sustainable yield basis (Hasan, 2007). The practice was stopped in 1973 when the government created FDC to conduct logging operations in the forests.

Timber extraction

Extraction of timber is a serious problem in single tree selection system. Due to rough topography, forest roads are absent in most of the mountain forests in Pakistan (Iqbal, 1991). The felled trees are converted into logs which are rolled down to primitive roads and then transported to sale points. Sometimes, when extraction of logs is not possible, logs are converted into scants at felling sites before extraction by mules (Iqbal, 1991). In first case quality of timber is deteriorated due to rolling on steep slopes and collisions with rocks. This also destroys the young seedlings and pole crop. In case of log conversion to scant, 30-40% of timber volume is wasted in the form of chips (Matiullah, 2004). The chips remaining on the logging sites are a major source of fuel that enhances the chances of forest fire.

In order to improve logging practices and reduce losses, new techniques were introduced in some forests with technical and financial support from

German Government in 1980. Chain saws and cable cranes were introduced that helped in reducing logging losses (Iqbal, 1991). A comparison of the two methods applied in moist temperate forests of Pakistan is shown in Figure 3. However, in most of the mountain forests the conventional methods of logging are still in use that not only result in wood losses but also endanger the safety of workers and survival of seedlings and young trees. The cost incurred on felling, involved, conversion, extraction and transportation is very high and only economical for those trees which have high economic value (Matiuallah, 2004).

Figure 3: Timber extraction through cable cranes in Moist Temperate Forests in Pakistan
Source: FDC, 2011

Figure 4:Skidding of timber in Mountain forest in Pakistan
Source: Matiuallh, 2004

Regeneration in Moist Temperate Forests

Single tree selection system mainly depends on natural regeneration in moist temperate forests. Small gaps are created by removing selected trees in which new seedlings emerge. Seed bearers are retained to ensure supply of seed for natural regeneration which are removed later on after the establishment of natural regeneration (Khan, 2011). Though there is no special efforts to prepare seed bed, the logging operations help in loosening the soil surface, making it suitable for seed germination.

Seeds fall on the ground in the months of October-November and remain dormant during the following few months when heavy snow fall occurs until March-April when snow melts and the temperature becomes favorable for germination. By remaining in snow for several months the seed dormancy is

broken down and the seed start germinating on the onset of favourable seasons. The undergrowth protects the young seedlings from grazing. Most of the species are well adopted to this form of regeneration. However, few tree species particularly *Abies pindrow*'s germination has been declining for last few decades that can be attributed to several factors. Accumulation of thick humas layer, low viability of seed and low tolerance to exposure and grazing adversely affect the germination and survival of fir (Haq, 1992).

Matiullah (2004) reported that regeneration in a forest worked under selection system in northern Pakistan was not sufficient. These forests are depleted and open with density ranging from 25% to 40%. There are large blanks and forests are found in patches. The crop is separated by creeks, open spaces and cultivated fields. These forests need complete protection to encourage natural regeneration. Artificial regeneration and soil conservation works are also required (Matiullah, 2004). There is also a lot of endangered wildlife species in these forests such as western trapogon pheasants, Snow Leopard, Asiatic Leopard and Black Bear that need protection and their survival is seriously endangered by the extensive logging.

Selection System in Forests managed for REDD+

Reducing emissions from deforestation, forest degradation, sustainable forest management, conservation and enhancement of forest carbon stocks known as REDD+ has emerged as a promising option for forest-based climate change mitigation in developing countries (Scheyvens, 2010). Selection system is best option for forests which are managed for generating carbon credits under REDD+ Programme. As sustainable forest management is allowed under REDD+, single tree selection system can be applied in moist temperate forests which avoid significant reduction of carbon stock in these forests. As pointed out by Ali (2017) moist temperate forests of Khyber Pakhtunkhwa have above carbon stocks of 85 t/ha, there is a need to conserve this carbon stock from being lost through deforestation and forest degradation.

CONCLUSIONS AND RECOMMENDATIONS

Single tree selection system is the most appropriate sivicultural system for managing the Himalayan moist temperate forests. If properly practiced, single tree selection system can protect the steep slopes from erosion and produce timber and other forest products on sustainable basis. However, the moist temperate forests of Pakistan are subjected to severe external disturbances like illegal logging, grazing and clearance of forestland for pastures and food crops leading to extensive deforestation and forest degradation. Forest Department has been unable to contain this process of deforestation and degradation mainly due to the exclusion of local communities from forest management. Consequently

single-tree selection felling is leading to removal of elite trees both by the Forest Department and illegal loggers. This practice deprives the forest of good quality trees and lack of sufficient regeneration. Felling and extraction of timber incur high economic cost. Due to absence of forest roads, the felled logs are converted into scants at the felling sites which causes 30-40% loss of valuable timber. Alternatively, the logs are rolled on the ground that not only deteriorates the timber quality but also causes severe damages to regeneration and soil. There is always a possibility that while felling a tree, the surrounding smaller trees may come in the direction of the fall and are damaged in the process.

There is a need to stop the illegal logging of the forests. This can be made possible by involving local communities in forest management and providing them with some incentives to protect the forests. Selective fellings should be restricted to well stock forests and rest of the forests should be protected from logging and grazing to allow them sufficient time to regenerate. Improved techniques of logging such as directional felling and cable cranes should be introduced in all forests worked under selection system to minimize wood losses and protect soil and young crop. Old and dead trees should be retained as habitat trees and an appropriate number of mature trees should be marked as recruit trees to ensure the protection of wildlife in the moist temperate forests.

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