ASSESSMENT OF SURVIVAL RATE AND GROWTH PERFORMANCE OF PLANTATIONS RAISED UNDER BILLION TREES AFFORESTATION PROJECT IN SWAT, PAKISTAN

Muhammad Naqash[1], Anwar Ali[2], Ahmad Hussain[1], Mamoona Wali Muhammad[2], Ahmad Zamir[2] and Ikram Ul Haq[1]

ABSTRACT

The Government of Pakistan Pakhtunkhwa launched the world acclaimed Billion Trees Afforestation Project (BTAP) in 2014 to raise one billion trees in the province to increase forest cover, create green jobs and combat climate change in the province. The current study was designed to evaluate the survival rate and growth performance of plantations grown under BTAP in Swat Forest Division. Twelve study areas were randomly selected and investigated for data collection in September-October 2017. A total of 88 sample plots of 0.1 ha area were laid out in the randomly selected plantations in the area. Data on type of species, natural regeneration, the density of pits, and number of seed bearers, soil, survival rate and occurrence of any disturbances was collected. The results showed that the pit density was 1261 pits per hectare, while the average number of plants regenerated per hectare is estimated to be 136, some of which were coming out of natural regeneration besides plantations. The average survival rate was 92.36% in Mingora and Matta Forest Subdivisions and Kabal and Fatehpur Ranges. In Mingora and Matta Subdivisions the survival rate was 92.08% and 94.65% while in Kabal and Fatehpur the survival rate was 89.20 and 93.50 %. Majority of plants (74%) have height of above 9 inches and 26% have height less than 9 inches. Species composition showed 83.80% *Eucalyptus camaldulensis*, *14.21% Pinus roxburghii* and 1.57% *Robinia pseduacacia.* It was found that growth rate of *Eucalyptus* and Chirpine is comparatively higher in Phase-II plantations as compared to Phase I. The study recommends to reduce the proportion of Eucalyptus in plantations to encourage regeneration and growth of native species and promote biodiversity conservation.

Key words

Billion Trees of Afforestation Project, survival rate, natural regeneration, growth rate

INTRODUCTION

Globally, the forest covers an area of 4 billion hectares, which accounts for about 31% of the earth's surface, while the Pakistan forest and planting tree cover 4.2 million hectares, which is 4.8% of the total land area (FAO, 2007). As the human population and economic activity increase, the ability of man to manipulate the natural world has increased. This manipulation is most noticeable in the cleaning of forests. During 5000 years, a total loss of 360,000 hectares per

1 Department of Forest and Wildlife Management, University of Haripur, Pakistan

2 Forest Mensuration Officer/APOF, Pakistan Forest Institute Peshawar

year was recorded (Blaikie and Moldavian, 2004). Forest is an essential source of renewable energy. It is estimated that the forest supplies 29.4 million tons of firewood per year for domestic use only. About 79% of all households in the country use wood as the primary source of wood energy. The use of firewood in the domestic sector is regulated as 82.1% cooking, 7.3% heating and 9.8% water heating. Thus, the total demand for wood consumption is estimated to be 32.5 million tons per year (Siddiqui, 2010). More than 40% of these forests are coniferous and plains in the northern hills and mountains. The provincial Forest Departments are in control of 10.06 million hectares in Pakistan. Majority of these Forests are in the northern part of the country. 40% in Khyber Pakhtunkhwa Province, 15.7% in Northern Regions and 6.5% in Azad Jammu and Kashmir (Pakistan 1999/2000 Forestry State, (Nizamani and Shah 2003). Survival and growth rates may be low, especially in low annual rainfall and long dry summer, outside of natural distribution regions. Therefore, in such arid or semi-arid regions, some additional measures should be taken to increase the afforestation success, such as deep soil cultivation, selection of suitable seed sources and better seedling material. Afforestation success depends on the seedling type to a degree. Indeed, correctly selected seedling types can significantly increase the success of afforestation by increasing survival and growth rate after planting (Pinto, 2011). Growth is one of the decisive factors for tropical forest dynamics. Many factors affecting the growth of tropical forests such as the presence of water, food and light (Toledo *et al*., 2011) despite the negative growth conditions for most crops in arid and semi-arid areas, *Acacia* and *Moringa* species are appreciated in these areas for their specific morphological and physiological features that enable them to cope with these conditions (Kasolo, 2010). However, many reforestation projects fail due to inadequate knowledge about the potential of species and the growth and survival rates in different site conditions, which are the basis for plantation success, due to improper selection of species (Wuethrich, 2007). It is well understood that structural and physiological adaptations to drought determine the growth and survival of forest tree species in dry climates. Because many different plant growth characteristics and plants in different regions are affected by environmental factors such as temperature, humidity and soil type (Dierig *et al*., 2005). Interruptions or changes in forest renewal processes caused by human activity are common in many parts of the world (Kozlowski 2002). The importance of advanced regeneration has been emphasized in forest recovery after natural and human diseases in the tropics (Zegeye *et al*., 2011). Planting areas maintain all the ecosystem and biodiversity of the forest as well as providing all the demands for people such as firewood, timber, food, fabric (Ahmed *et al*., 1992).Over the past decades, afforestation projects have been widely used in urban areas to attempt to restore degraded habitats (e.g., waste areas, old dumps or roadside) (Sullivan *et al*., 2009; Pincetl *et al*., 2013). Natural regeneration is essential for the conservation and maintenance of biological diversity. Depending on the management objectives, it is crucial to maintain the forest renewal process with appropriate natural and

artificial regeneration. Clear cuts, while accelerating the loss of seedlings and seedlings, also disrupts the natural state of the natural forests and thus the ecosystem (Haque *et al*., 1988). Forest degradation implies a reduction in the capacity of a forest to generate ecosystem services such as carbon storage and wood products as a result of anthropogenic and environmental changes (ITTO 2002). It is indispensable to meet the growing demand for its products, including wood and wood, wood and saw logs. (Brown *et al*., 1997).Besides, the creation of timber plantations can reduce deforestation by reducing pressures in natural forests, recover degraded soils and increase biodiversity .The research was undertaken to evaluate the relative growth model of some lumber and medically important tree species in the Swat forest habitat in Division Swat. It was assumed that all study sites bear the same productive potential and show a similar growth pattern in district Swat. This objective of the research was to evaluate survival rate, regeneration status and growth performance of departmental plantations grown in the Swat Forest division within the scope of billions of afforestation projects. Billion Tree Tsunami Afforestation Projects aims to plant, design, launch and implement the Green Growth Initiative in the forestry sector of Khyber Pakhtunkhwa Province.

MATERIALS AND METHODS

This study was carried out in the Lower Swat Forestry Division of the district Swat region (Fig. 1), which has a total area of 5337 square kilometers to the north of Khyber Pakhtunkhwa. Topographically, Swat is a mountainous area and is divided into two zones according to Swat Kohistan and Swat proper. Red-purple and gray sandstone are intertwined with clay and the most common geological material of the region. In climatic conditions, the city of Mingora falls into subtropical high and humid regions. Summer is warm, and the temperature rises to 33 risk levels. The coldest month is January, the average minimum temperature drops to -3 falls. The highest rainfall recorded in March is approximately 242 mm. Agriculture is the largest sector of the economy and the main livelihood of the rural population. Among fruits, pear, apple, apricot, plum and citrus are found in the region. The apple orchard is common in Mingora. The dominant species are *Pinus roxburghii*, *Cedrus deodara, Poplar euphratica, Euclyptus* spp, *Melia azedarach* and *Ailanthus altissima*. Data collection in this area was carried out between 25 September and 14 October 2017.

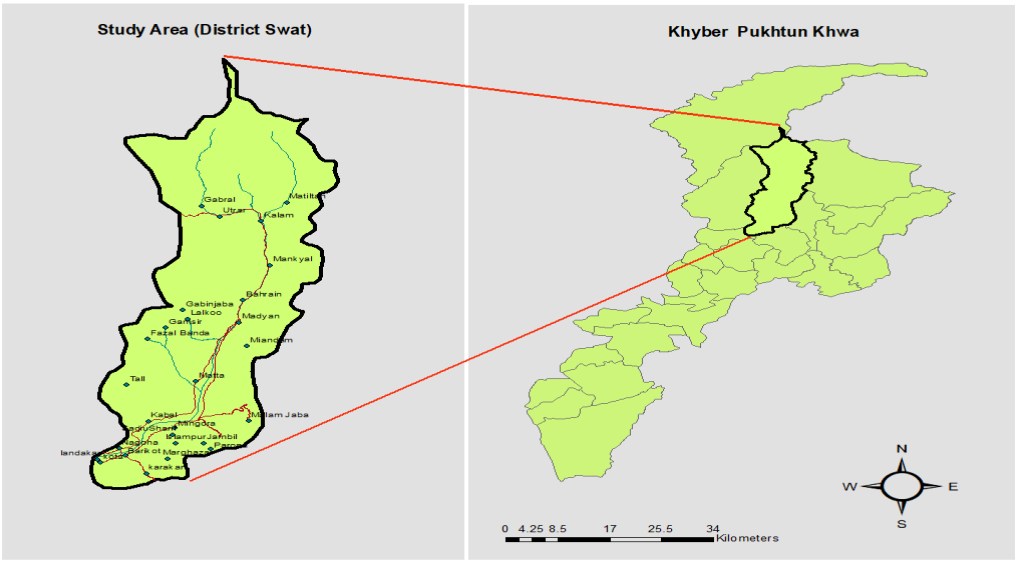

Fig.1. Map of District Swat, Khyber Pakhtunkhwa

Circular plots containing a radius of 17.84 m (0.1 ha area) were obtained through the measuring tape. The distance to the plot was 100x100 m in the field. In each sample, the plot data were collected with the following parameters; the number of pits, number of hollow pits, names of species planted in pits, number of natural regeneration, plant perimeter in centimeters, plant height in meters. All collected data were transferred to Microsoft Excel pages for compilation and tabulation. The data were interpreted with descriptive statistics of the averages and percentages. Since the study area has 6451.91 hectares of plantation within the scope of BTAP, random sampling techniques have been used to collect data from the field since it is not possible to make the full inventory in the field.

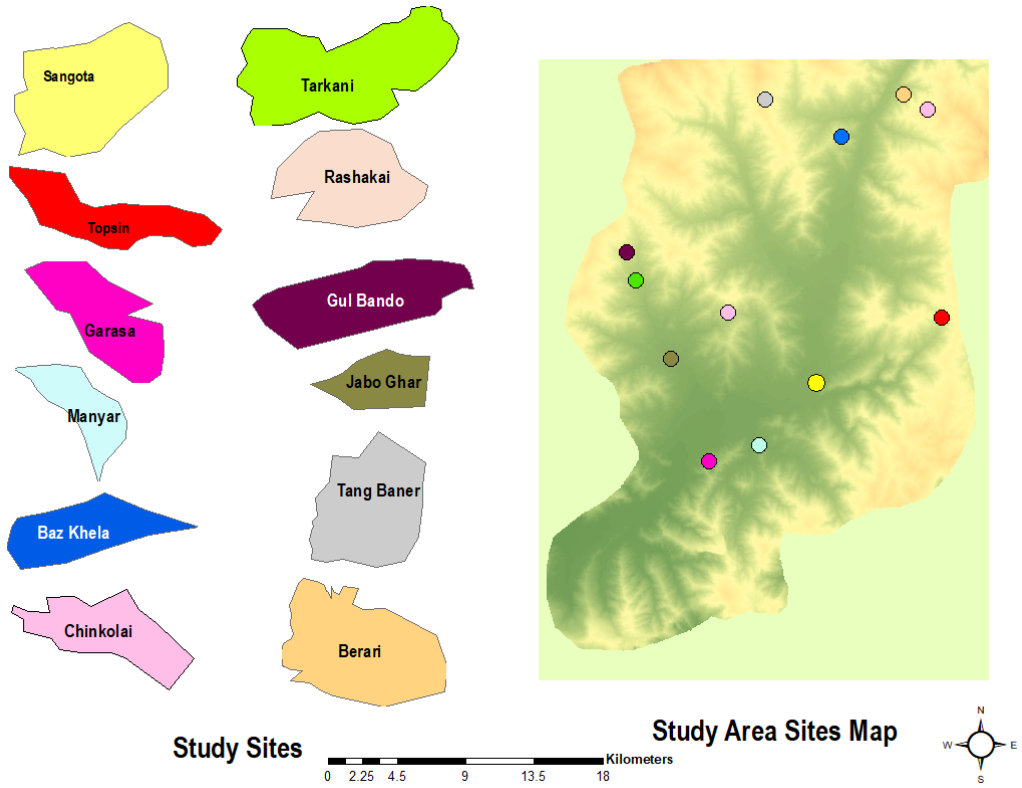

Fig. 2. Map of the study area Sites in district Swat

Two-stage random sampling was taken for the selection of sample plots. At the first stage, 10% of the total was chosen randomly for the sites from the list provided by the BTAP office. In the second stage, the area of 1% of each selected area was sampled for data collection. Thus, a total of 88 sample plots were randomly selected. The names of the selected places (Fig: 2) were recorded and the regions were approached with the help of the local Forest Guards. Details of selected areas and sample areas are given in (Table 1).

Table 1. Detail of Selected Sample Sites

S.No	Sub Division	Site	Plantation Area (Ha)	No. of Sample Plots
1	Mingora	Sangota	50	6
		Topsin	40	8
		Garasa	22	3
		Manyar	21	6
2	Kabal	Tarkani	50	10
		Rashakai	17	3
		Gul bando	458	10
		Jabo Ghar	40	5
3	Matta	Tang Baner	201	19
		Baz Khela	135	6
4	Fatehpur	Chinkolai	60	6
		Berari	167	6
	Total		1261	88

RESULTS AND DISCUSSION

A total of 88 sample plots were analyzed for survival rate, regeneration status and growth performance of plantations in Mingora, Matta, Kabal, Fatehpur counties. The pit density is the number of pits in the unit area. It is an important indicator to assess the success of the plantation program. In Khyber Pakhtunkhwa, the plantation is usually done at 10x10 ft, giving a density of 1075 pits per ha. The collected data was worked out and the average pit density in the study area was found to be 1041.91 / ha (Fig. 3).

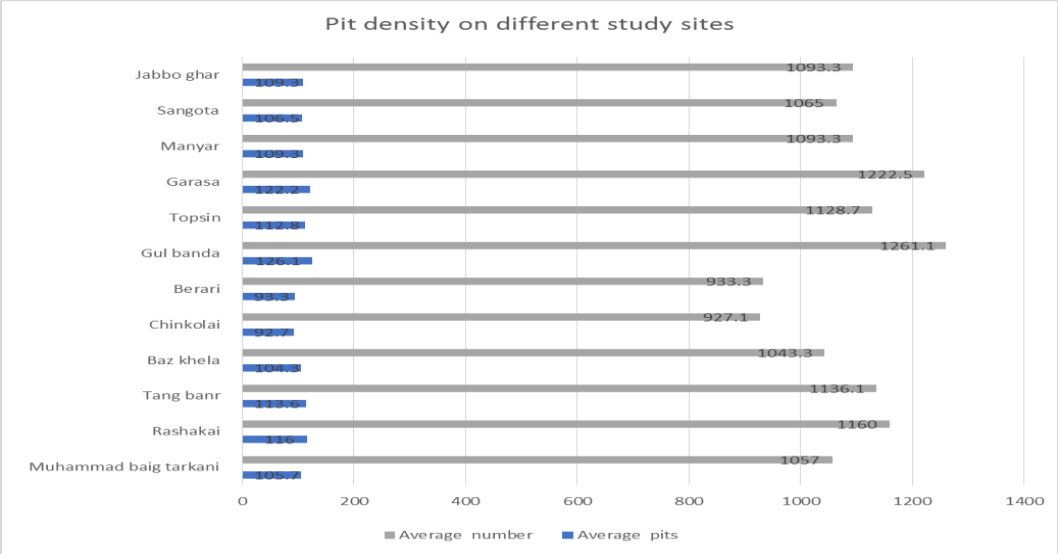

Fig. 3. Pit density on different study sites

The average number of pits per plot ranged from 92.7 in Chinkolai to 126.1 in Gul Banda; where the average number of pits per hectare ranged from 927.1 in Chinkolai to 1222.5 in Garasa. South directions, close to 5 ft intervals, owes to close-spaced plantation and proper maintenance and management.

Table 2. Natural Regeneration Status

Site	Number Regeneration					
	<9'' No/ ha	>9'' No/ha	Total	No of plots	Average no of regeneration per / plot	Average no of regeneration per/ ha
Muhammad Baig Tarkani	22	167	189	10	18.9	189
Rashakai	14	8	22	3	7.3	21.9
Tang Banr	198	183	381	19	20.05	380.05
Baz Khela	28	46	74	6	12.3	73.8
Chinkolai	0	0	0	7	0	0
Berari	0	18	18	6	3	18
Gul Banda	11	11	22	10	2.2	22
Topsin	0	3	3	8	0.37	2.96
Garasa	0	43	43	4	10.75	43
Manyar	0	378	378	6	63	378
Sangota	0	23	23	6	3.83	22.98
Jabbo Ghar	82	130	212	5	42.4	212
Total	355	1010	1365	90	184.1	1363.69

In order to measure natural regeneration, the number of regeneration is counted in each sample (Table 2). The mean number of regeneration was 1363.69 / ha. Regeneration 1010 and unregulated regeneration were 355. In the study area of Tang Banr showed a maximum average regeneration per/ha, followed by Manyar (with mean regeneration 378 / ha) and Chinkolai lacking natural regeneration. It might be due to the open sandstone.

Table 3. The Survival rate of the plantation at study sites during 2017-2018

S. No	Sub Division/Range	Survival Rate (%age)
1.	Mingora	92.08%
2.	Matta	94.65%
3	Kabal	89.20%
4	Fatehpur	93.50%
	Average	92.36%

The total survival rate was determined in various study sites of the district Swat. The survival rate in the Forest Sub-divisions Mingora and Matta was estimated to be 92.08% and 94.65%, whereas it was 89.20%. and 93.50% in Kabal and Fatehpur Forest Sub-division respectively. The relatively high survival rate is probably due to the selection of species, that is, most of the plantations consist of the Eucalyptus, which shows a very high survival rate in difficult conditions. Second, the intensive care provided by the Forestry department. Another reason for the high survival rate is to support the cultivation of seed by sowing the pits. So if sowing fails, sowing regeneration will result and the overall survival rate is not affected. Different survival rates were recorded in different regions. While the overall survival rate was greater than 92.86% in the study area, the highest survival rate was obtained in Matthew compared to other areas. The data also revealed that there was no significant change in the survival percentage of all selected regions, which were concluded to be performed in all cultivation areas of the cultivation (Table 3). The species wise growth rate was determined in Mingora, Matta, Kabal and Fatehpur. The area, length and age of the plants were calculated from different plantation areas. According to its surroundings, heights and planting dates, Deodar's age were estimated after 24 months nursery age, Chir pine after 12 months, Robinia and Ailanthus after 6 months and Euclyptus after 5 months in nursery respectively. The data are compiled in (Table 4).

Table 4. Specie Phase Wise Height and Girth

Species	Sites	Phase	Height(m)	Girth at base(cm)
Accacia modesta	Manyar, Gul banda	II	0.733333	4.574074
Oak	Tang baner	II	0.44	3.3
Ailanthus	Muhammad Bag Tarkani, Sangota	I	1.22	4.2
Ailanthus	Tang baner, Baz khela, Berari	II	1.214548	5.307143
Deodar	Muhammad Bag Tarkani, Rashaki	I	0.8425	3.658333
Deodar	Tang baner, Chinkolai, Berari	II	0.319019	2.703056
Kail	Muhammad Bag Tarkani, Rashaki	I	0.891476	4.895641
Kail	Tang baner, Berari	II	0.60	3.418044
Chir	Sangota, Muhammad Bag Tarkani	I	0.683333	6.125
Chir	Garasa, Topsin, Gul banda, Berari, Baz khela, Chinkolai, Tang baner	II	0.443785	4.607907
Robenia	Muhammad Bag Tarkani , Rashaki , Sangota	I	2.002292	6.339583
Robeniia	Manyar , Garasa , Gul banda , Baz khela , Tang baner	II	1.210134	6.043609
Euclyptus	Muhammad Bag Tarkani , Manyar, Sangota	I	1.300647	4.495865
Euclyptus	Jabbo Ghar , Manyar , Garasa , Topsin , Gul banda , Berari , Baz khela , Tang baner	II	1.210053	6.239041
Poplar	Sangota	I	1.025	4.125

It was concluded that the average pit density was 1041.91 /ha in 12 study sites in district Swat. Similar findings have been reported by (WWF, 2017) average density is 1054 pits/ha Pit density at different sites of the study area is given in (Fig.3)The present investigation illustrated that Matta proved more productive (94% survival rate) as compared to the rest of the studies sites and Kabal being the least productive (89%). Natural regeneration was maximum at Tangbaner showing the record of 381 whereas Chinkolia was the least adequate. The capacity of the Gul banda site was maximum (126) pit density whereas the minimum (92) was recorded in the case of Chinkolia. Among the plant species the performance was vigorous in gaining height by *Robinia pseudoacacia*

whereas *Quercus dilatata* exhibited the least performance during the study period. It is worth mentioning to record that girth measurement was assessed maximum in case of *Robinia pseudocacia* to whereas *Cedrus deodara* exhibited the minimum girth among all plants. The results of the regeneration as given in table 3, are in accordance with WWF (2017) findings. Similar findings have been reported by WWF (March 2017) who estimated the survival rate in Mingora and Matta forest sub divisions as 91% and 91% while in Kabal and Fatephur forest Range are 93.5% and 85%.

CONCLUSIONS

The main objective of the study is to assess the status of regeneration, composition of species, survival and growth rate of plantation in District Swat. Knowing the ground condition of plantation is an additional objective.

Following are the main conclusions drawn after careful observation and data analysis.

- Pit density is found closer than the required 10′ x 10′ spacing. According to 10′ x 10′ spacing the required number of pits per hectare is 1075 but here it was found 1261 per/ ha.

- The study indicates that the majority of the regeneration i.e. 74% were established (mean above 9 inches) while only 26% were found under-established (below 9 inches).

- The data revealed that the average survival rate was 92.36% in Swat Forest Division which is comprised of Mingora Forest Sub-division, Matta Sub-division, Kabal Forest range and Fatehpur Forest range. In Mingora Forest Sub-division the survival percentage was 92.08%, in Matta Sub-division 94.65%, in Kabal Forest Range 89.20% while in Fatehpur Forest range 93.50%.

- Species composition in the plantation estimated from the recorded data is 9% of *Robinia*, 23% of *Pinus roxburghii* 1% of Oak, 6% Deodar, 3% of Ailanthus, Eucalyptus 44%, *Acacia modesta* 1% and Kail 7%.

- The survival percentage of planted species was estimated from collected data in which the survival percentage of *Eucalyptus* was 93.01%,of *Pinus roxburghii* 92.45% of *Robinia*, 92.43% Deodar and 92.78% and Ailanthus 93.29, Oak 95%, *Accacia modesta* 89.09.

- The average growth rate of Poplar was recorded in Phase-1 (2013) having height 1.0 m and girth 4.1 cm.

- The average growth rate of Oak was recorded in Phase-1l (2015) having height 0.4m and girth 4.5 cm.

- The average growth rate of *Accacia modesta* was recorded in Phase-1l having height 0.7 m and girth 4.5 cm.

- About nine species have been planted in Mingora and Matta sub-division and Kabal and Fatehpur Forest Range. *Eucalyptus* and *Pinus roxburghii* are the major species in these plantations. This is partly due to the reason that Eucalyptus is highly preferred by farmers to fulfill their needs of fuel wood and partly due to its high chances of survival.

RECOMMENDATIONS

One of the main objectives of BTAP project is the improvement of biodiversity and the promotion of ecological functions of the forests, which could be disturbed by adopting environment unfriendly measures. We recommend resorting to ecologically friendly and safe measures like biological control of pests. Local and indigenous species are more adapted to pests and disease and should be promoted. Forest department sows seed in pits which are germinating in significant number in pits but at last, the pit will give space to only one plant. The remaining will be washed out automatically so instead of pits, trenches should be preferred. The indigenous plant should be preferred over the exotic species to ensure biodiversity conservation. Social mobilization process needs further strengthening and should be given priority for protection of plantations on sustainable basis. It is also recommended to ensure plantations of seedlings which have attained desirable size in the nursery, otherwise these will not compete the weeds growing in the pits.

REFERENCES

Ahmed, G. U., Shah, M. N. and A. B. Temu, 1992. Status of natural regeneration in the denuded hills of Chittagong, Bangladesh. Commonwealth Forestry Review 71 (3): 174–182.

Blaikie, P. M. and J. S. S. Muldavin, 2004. Upstream, downstream: the politics of environment in the Himalayan region 94 (3), 520–548.

Brown, A. G., Nambier, E. K. S. and C. Cossalter, 1997. Plantations for the tropics: their role extent and nature. In: Nambiar, EKS and Brown AG (eds.) Management of soil, water and nutrients.

Dierig, D. A., Adama, N. R., Mackey, B. E., Dahlquist, G. H., and T. A. Coffelt 2005. Temperature and elevation effects on plant growth, development, and seed production of two Lesquerella species. Industrial Crops and Products. pp: 17-25.

FAO, 2007. Statistics for APFSOS II - IGF Office, Ministry of Environment, APFSOS II Conference Chiang Mai, Thailand.

Haque, S. M. S. and M. S. Alam, 1988. Some aspects of practicing the clear-felling followed by artificial regeneration system in the Cox's Bazar Forest Division. Chittagong University Studies (Part II): Science, 12 (2): 87–95.

ITTO, 2002 "ITTO guidelines for the restoration, management and rehabilitation of degraded and secondary tropical forests" ITTO Policy Development Series No. 13.

Kasolo, J., 2010. Phytochemicals and uses of Moringa oleifera leaves in Ugandan rural communities. Journal of medicinal plant research 4 (9): 753. Keenan.

Kozlowski, T. T., 2002. Physiological ecology of natural regeneration of harvested and disturbed forest stands: implications for forest management. Canadian Journal of Forest Research 158:195–221.

Nizamani, A. A. and A. A. Shah, 2003. "Review of Forest Policy Trends for Community Participation in Pakistan." http://iges/or.jp/en/fe/pdf/ report11/03/Pakistan.pdf (accessed on January 2, 2008).

Pincetl S., Gillespie, T., Pataki, D.E., Saatchi, S. and J. D. Saphores, 2013. Urban tree planting programs, function or fashion? Los Angeles and urban tree planting campaigns. GeoJournal 78: 475–493.

Pinto, J. R., Marshall, J. D., Dumroese, R. K., Davis A. S. and D. R. Cobos. 2011. Establishment and growth of container seedlings for reforestation: A function of stock type and edaphic conditions. For Ecol. Man.,2611876-1884.

Siddiqui, M. F., Ahmed, M., Khan, N., Hussain, S. S. and I. A. Khan, 2010. A quantitative description of moist temperate conifer forests of Himalayan region of Pakistan and Azad Kashmir. Int. J. Biol. Biotech. 7(3): 175-185.

Schroeder, J. M., Oke, D. O., Onyekwelu, J. C. and E. Yirdaw, 2010. Secondary forests in West Africa: a challenge and opportunity for management. In: Mery G *et al*. (eds) Forests and Society – Responding to Global Drivers of Change. IUFRO World Series 25, Tamperepp pp. 335–353.

Sullivan, J. J., Meurk, C., Whaley, K. J. and R. Simcock, 2009. Restoring native ecosystems in urban Auckland: urban soils, isolation, and weeds as impediments to forest establishment. New Zealand Journal of Ecology 33: 60–71.

Toledo, M. L., Poorter, M. Pena-Calaros, Alarcon, A. and J. Baclcazar *et al*., 2011. Climate is a stronger driver of tree and forest growth rate than soil and disturbance. J. Ecol., 99: 254-264.

Wuethrich, B., 2007. Biodiversity: reconstructing Brazil's Atlantic rainforest. Science 315:1070-1072.

Zegeye, H. D., Teketay and E. Kelbessa, 2011. Diversity and regeneration status of woody species in Tara Gedam and Abebaye forests, northwestern Ethiopia. Journal of Forestry Research 22 (3): 315–328.