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# EFFECTIVENESS OF PLANTATION PROGRAMS IN THE CHURE AND TARAI REGIONS OF NEPAL

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**Abstract:** Afforestation and reforestation program was started in 1970's to restore the denuded hills in Nepal. It was further expanded in lowland in late 80's and further expanded in 2000 through the different programs. Government of Nepal has still focused plantation program particularly in Tarai and Siwalik region. Present study has covered five districts namely Chitwan, Makwanpur, Bara, Parsa and Rautahat in Mid Nepal to identify the success of such plantation program carried out in the past. Direct observation of nurseries, interviews with officials and nursery owners regarding the seedling production pattern and discussion with local people, key informants survey and inventory of the selected plantation blocks for identification of survival status were major methods applied for the study. About 44 different species are being planted however *Eucalyptus camadulensis*, *Techtona gradish*, *Dalbergia sissoo*, *Bombax ceiba* and *Azadirachta indica* has contributed 62%. Present study reveals that less than one third (28%) seedlings are being survived among the 17.20 million seedlings planted during last one decade (from 2005 to 2015). Grazing pressure, poor quality of planting materials and improper site selection were identified major conservation threats. Permanent nursery and detail plantation plan has been recommended for the success of such plantation as pre-monsoon plantation has been found more survived and also has better growth performance.

**Keywords:** Planting materials; Plantation; Survival; Site selection

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## INTRODUCTION

Large-scale plantations in the hilly regions of Nepal were initiated from the early 1980s (Gilmour et al., 1990) to restore the forest. Tarai Community Forestry Program had done extensive plantation in Tarai regions with local Sissoo (*Dalbergia sissoo*) and other fast growing exotic species such as Teak (*Tectona grandis*), Eucalyptus (*Eucalyptus camaldulensis*), Poplar (*Populus deltoides*) etc in late eighty's (MoFSC, 2015). Plantation has been further expanded to Tarai and Chure regions particularly since 2000 with support from donor funded programs (BISEP-ST, 2011). In the context of continuous deforestation, particularly in Chure and Tarai (annual rate 0.18% and 0.40%, DFRS, 2015) government of Nepal, accelerated plantation program in region. Forest Policy (FP), 2015; Forestry Decade campaign, 2014-2024 and Master Plan for Chure Conservation, 2017 have prioritized the plantation program to improve the forest condition and develop trees outside forest (ToF). The government's budgetary Slogan; One House One Tree: One Village One Forest and One City Many Parks has increased the pace of plantation scheme in recent years. It has been targeted (Forest Decade Campaign) that about 26,000 ha degraded lands in the Tarai and Chure will be restored in that period (DoF, 2015) through plantation. However, some study suggest that the problems of the unavailability of preferred species, low quality of planting stock and difficulty of smallholders in accessing seedlings from nurseries have been identified as reasons for most smallholders not planting trees and the apparent failure of established plantations (Robinson and Thompson, 1997). The need to understand the status of such plantation, the systematic assessment in terms of

survival situations and quality of such planted trees; this study was conducted. Basically two objectives had been set for the whole study; *i.e.* to determine number of seedlings produced, species planted as well as survival rate and to identify major plantation techniques with exploration of key management issues.

## EXPERIMENTAL

**Study area:** The study was conducted in the five districts of Nepal namely Chitwan, Makawanpur, Bara, Pars and Rautahat that lie between the Latitude 27°08'18.84'' to 27°45'30.06'' and Longitude 83°55' 06.99'' to 85°30'34.88''. It represents the area between Narayani River in the west and Bagmati River in the east. Study area falls in the tropical and subtropical climatic zones so the area harbors four major vegetation types, namely grassland, tropical forest, subtropical broadleaved forest and sub-tropical conifer forest (TISC, 2002) and six forest types *i.e.,* Khair-Sissoo forest, Sal forest, mixed Tarai forest, Sal Tarai mixed forest, lower mixed broadleaved forest and pine forest (PCTMCDB, 2017). *Shorea robusta* and *Terminalia alata* are the major species found in tropical area whereas *Shorea robusta, Schima wallichii* and *Castanopsis indica* are found in the subtropical broad leaved forest. Similarly, *Pinus roxburghii* is found dominant in the sub-tropical conifer forest. Near the riverbank, mainly *Dalbergia sissoo* and Acacia catechu are found. Some exotic species like *Eucalyptus camaldulensis* and *Tectona grandis* are widely planted in the Tarai region whereas *Melia azedarach* and *Albizzia* species are being planted in the lower part of Siwalik region and *Pinus roxburghii* has been planted in the higher altitudes.

**Sampling Technique**: Plantation site was selected by "allocation of samples along strata" suggested by Newbold, 1984. Strata were community plantation, Collaborative Forest, plantation by government agencies and plantation by public land group. The information about such strata was taken from the government offices. Similarly, the stratum was also representing the objective of plantation i.e., production, protection of biodiversity and watershed management units using multi-stage sampling model. In each plantation block, detail inventory was conducted following the inventory guideline for community forestry approved by the government of Nepal (MoFSC, 2004). From the inventory, the information regarding the number of plant with species and growing stock was taken. The number of species during the inventory was compared with the planted seedlings for each plantation block. This has provided the survival number of plant in each block. Among the total selected sample block, three represents collaborative forest management, one each represents the government managed forest, river reclaim area and public land and remaining eleven blocks represented the community forest. Total of 296.21 ha in 17 sampled blocks were inventoried among the total of 2877 ha of 143 plantation block. The following were the selected plantation block in each district.

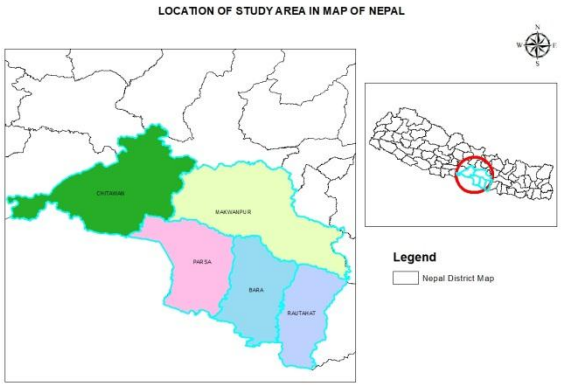



**Figure 1. Location of study Area in Map of Nepal**

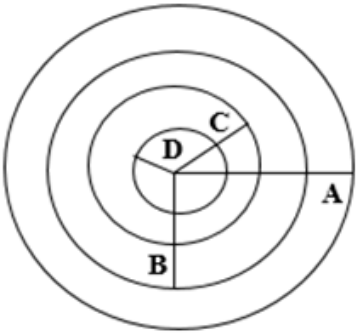
**Secondary Information:** Secondary information about the plantation site and number of seedlings produced and distributed for plantation and type of species were collected from the office records in government offices (DFO, DSCO, DPO etc.). Basically, the information about seedling production and plantation in each district between 2005 to 2011 were taken from the project completion report of the Biodiversity Sector Support Program for Siwalik and Terai (BISEP-ST), and that of the later years were collected from the official records of the respective district level offices.

**Data Analysis:** Most of the information were analyzed using computer software Statistical Package for Social Study (SPSS) and interpreted with table, charts and figure.

**Table 1. Number of Plantation blocks, Planted area and Sampled Area**

| District | No. of Plantation Block | Total Area (Ha) | Sampled block | Area (Ha) |
|---|---|---|---|---|
| Bara | 30 | 653 | 3 | 51.16 |
| Parsa | 14 | 324 | 3 | 10.00 |
| Rautahat | 35 | 962 | 5 | 128.20 |
| Makwanpur | 29 | 372 | 3 | 45.85 |
| Chitwan | 35 | 566 | 3 | 61.00 |
| **Total** | **143** | **2877** | **17** | **296.21** |

Source: Field Survey, 2017




| # | Classification of plant | Size of Plant | Size of Sample plot ($m^2$) | Radius (m) |
|---|---|---|---|---|
| 1 | Tree | Diameter at breadth height (DBH) >=30cm | 500 | 12.61 |
| 2 | Pole | DBH= 10- 29.9cm | 100 | 5.64 |
| 3 | Regeneration | Height >1m and DBH <10cm | 25 | 2.82 |
| | Sapling | | | |
| | Seedling | Height = 30cm -100cm (i.e.1m) | 10 | 1.78 |

**Figure 2. Sampling frame and Enumeration techniques**

## RESULTS AND DISCUSSION

### Number of Seedlings Produced

Seedling production has no any trends in the districts. In the last ten years period (2005 to 2015), more than 17.2 million seedlings have been produced. About 4.7 million seedlings were produced in last fiscal year (2015/16) alone. This fiscal year (FY 2016/17) altogether 4.25 million seedlings have been produced in all five districts. However, no any formal record system was found about the seedling production. The record was just found with financial report in account section but there was not found any technical report. There were recorded 164 different forest nurseries however nurseries have neither maintained the nursery registers for the record of seedlings production nor record for the seedling distributions. Number of seedlings production for each year depends upon the target of the program/projects run in the district for any particular year. The production of seedlings from the year 2015/16 was found increased in the entire district. The cause behind the increased seedling production trends was due to the focus on plantation from Chure board and also started the implementation of forest decade social campaign in entire five districts. The figure 3 reveals that the seedlings productions trends was maximum in Chitwan in previous year however in the recent year, Bara and Rautahat district are producing maximum seedlings in compare to the other district of this cluster.

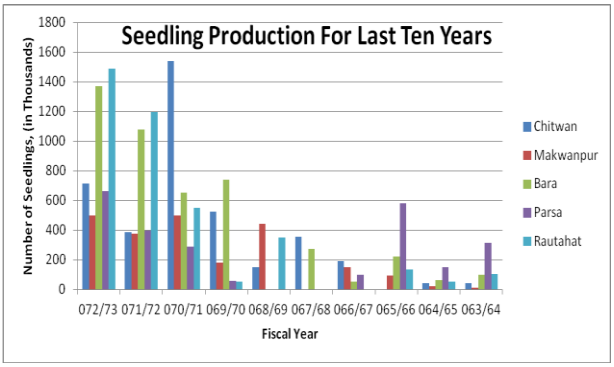



**Figure 3. Number of seedlings produced by year and District**

### Seedling Species

Altogether, forty two different species are being produced in the nurseries, however some are more preferable species and rest are being produced in nominal numbers. Among the different species; *Eucalyptus camadulensis, Techtona gradish, Dalbegia sissoo, Bombax ceiba, Azadirachta indica* are mostly produced species in Tarai district and *Melia azaderarch, Michelia champaca, Dalbergia sissoo, Artocarpus lookucha, Cinamomom tamala, Garciana magnistana* and *Leucaena leucocephela* are mostly produced species for Chure area of Chitwan and Makwanpur district. *Asparagus recimosus* was found important NTFP species followed by *Rawolfia serpentine* in the nursery operated by DPRO, Makwanpur. Table 2, shows the number of seedlings produced by species in the district. Among the total of seedlings more than 62% are from five species. More than 45% was found *Eucalyptus camaldulensis* followed by *Dalbergia sissoo* (5.43%), *Bahunia veriegata* (4.86%), *Melia azadarach* (3.28%) and *Acacia catechu* (3%). Some highly demanded species

like *Techtona grandis* has been produced only 3.97% in government nurseries.

**Table 2. Most Preferred Seedling species**

| Species | District | | | | |
|---|---|---|---|---|---|
| | Chitwan | Makwanpur | Bara | Parsa | Rautahat |
| *Techtona grandis* | 3100 | 8196 | 46551 | 62700 | 48480 |
| *Eucalyptus camaldulensis* | 16655 | 41000 | 765333 | 172800 | 933228 |
| *Cinnamomum camphora* | 28972 | - | 120 | - | - |
| *Melia azadarach* | 73514 | 12100 | 36516 | 14500 | 17500 |
| *Michelia champaka* | 72195 | 11200 | - | - | - |
| *Bauhinia purpurea* | 129181 | 32000 | 16062 | 10000 | 19740 |
| *Dalbergia sissoo* | 39000 | 23600 | 96182 | 72600 | |
| *Acacia catechu* | 20000 | 35020 | - | 3000 | 69840 |
| *Asparagus recemosus* | - | 100000 | - | - | - |
| *Rawafia serpentine* | - | 52000 | - | - | - |
| *Bambusa species* | 15595 | - | - | - | 5000 |
| Others | 311788 | 252195 | 266691 | 184400 | 155576 |

Source: Field Survey, 2017

## Plantation Block

Total of 2877 ha of land was planted in last ten years (BISEP-ST, 2011). Total of 143 plantation blocks were found in all five districts. Maximum number of block was recorded in Rautahat and Chitwan district and lowest number was found in Parsa district. The areas of plantation block were found from 0.35 ha to 100 ha. Largest block was found in Rautahat and smallest block was found in Makwanpur district. Among the total of 143 plantation blocks, altogether 17 different blocks were sampled for the detail. Among the 17 selected blocks, three were from collaborative forest management, one each represents the government managed forest, river reclaim area and public land. Rest 11 blocks was from the community forest management regime. Similarly, among the sampled block, two were taken from old plantation that were more than five years and rest were planted after 2011 (less than five years).

## Species Planted

The species planted in the plantation block has no any trends. Among the total of 42 species produced in the nursery, only 19 species were found in the surveyed plantation block. It was really difficult to find out the planted species as there was not any recording system for plantation block. *Techtona grandis, Eucalyptus camaldulensis, Dalbergia sissoo* and *Acacia catechu* were found in Tarai district where as in Chure area *Michelia champaca, Melia azadarach, Terminalia alata* and *Cinnamomum tamala* has been planted. In some plantation area, planted species were found totally replaced by natural regeneration by other species. For example, Sabaiya plantation block in Parsa district, initially there was planted *Dalbergia sissoo, Techtona grandis and Eucalyptus camaldulensis* but now the plantation has been completely replaced by natural regeneration of *Dalbergia sissoo* and in Rangapur plantation block in Rautahat district, natural regeneration of *Acacia catechu* has replaced the *Techtona grandis* and *Eucalyptus camaldulensis*. Similarly, in Satanchuli community forest of Chitwan district, initially there was planted *Acacia catechu, Dalbergia sissoo, Bombax ceiba*, and *Michelia champaca but* now most of the plantation area is covered by unwanted weeds named *Adatoda vasica.* In recent day, the plantation of *Bombusa species* has been started for the conservation of riverside and other landslide area. The following are the major prioritized planted species in selected district.

**Table 3. Preferred Planted Species in each District**

| # | District | Nursery Species | Key Planted Species |
|---|---|---|---|
| 1. | Chitwan | *Bauhinia purpurea, Michelia champaca, Cinnamomum camphora* | *Cinnamomum tamala, Bauhinia purpurea, Michelia champaca* |
| 2. | Makwan-pur | *Dalbergia sissoo, Melia azaderach, Michelia champaka* | *Dalbergia sissoo, Melia azadarach, Cinnamomum tamala,* |
| 3. | Bara | *Eucalyptus camaldulensis, Techtona grandis, Dalbergia sissoo* | *Techtona grandis, Eucalyptus camaldulensis, Dalbergia sissoo* |
| 4. | Parsa | *Eucalyptus camaldulensis, Techtona grandis, Dalbergia sissoo* | *Eucalyptus camaldulensis, Ceiba pentendra, Dalbergia sissoo* |
| 5. | Rautahat | *Eucalyptus camaldulensis, Techtona grandis, Acacia catechu* | *Eucalyptus camaldulensis, Acacia catechu, Dalbergia sissoo* |

Source: Field Survey, 2017

## Plantation Techniques

Most of the plantation was done with polybag seedlings followed by root shot cutting. Mostly root shot cutting plantation techniques was applied for the teak plantation and other species were planted from the seedlings produced in polybag. Such poly bags were itself becomes problem during the plantation after removal of poly bag for plantation. Instead of poly bag

container, introduction of biodegradable containers could solve the problem in two ways. First, biodegradable container will increase the survival of the planted seedlings due to fewer disturbances in the root system of the seedlings during plantation. Secondly, it will reduce polythene pollution in the plantation site. The entire seedlings ready for plantation were single year seedlings as the government has no any provision of rearing the nursery seedlings more than one fiscal year. Budget was found major limiting factor for caring of seedlings beyond the completion of fiscal year.

**Figure 4. Plastic Pollution due to disposal of polybag of seedlings after plantation in Saktikhor, Chitwan**


**Figure 5. Plantation Techniques**

Mostly, the plantation was conducted in monsoon season. General trend of the plantation was mid-July to Early August as most of the seedlings were shown in the nursery during November-February. The seedlings were reached in plantation size (about 30cm. Height) by July. The seedlings that were planted in late monsoon were found poor establishment status as such seedlings got less time for growth. As after September, most of the planted area becomes dried and seedlings go in the high stress of moisture loss in the plantation block particularly in Chure area. In such moisture stress area, pre-monsoon plantation was found more success in compare to the monsoon plantation. For pre-monsoon plantation, seedlings should be produced before starting the new fiscal year. Spacing of the plantation was found same for all type of species in every plantation block. It was 2.5m× 2.5m.spacing for all the species and plantation block. It was not followed the scientific techniques. The spacing for *Techtona grandis* and *Dalbergia sissoo* in flat land is justified however the spacing near the Chure area needs denser for the protection of soil as well as reduction of weed competition for planted species.

**Survival of Seedlings in Plantation Site**

Analysis of survival of the seedlings was the core of this research. In each sampled area, remaining trees were calculated using the inventory guidelines. The following is the detail of the remaining trees (table 4) in each of the sampled plot, where plantation on Sabaiya CFM was completely replaced by natural regeneration.

**Table 4. Survival situation of planted seedlings**

| # | District | Survival Rate in different block | Average Survival |
|---|---|---|---|
| 1. | Chitwan | 15% to 66.25% | 48% |
| 2. | Makwanpur | 6.25 % to75% | 29% |
| 3. | Bara | 2.5% to 43% | 18% |
| 4. | Parsa | 0% to 31% | 13% |
| 5. | Rautahat | 16% to 45% | 29% |
| **Total** | | | **28%** |

Source: Field Survey, 2017

Survival of the planted seedlings was found between 2.50% to 75% however in most of the areas it is below the 30%. The average survival rate was found 26.53%. High survival rate was observed in Chitwan district (48%) and lowest survival was observed in Parsa district (13%). In some of the plantation areas, the planted species totally replaced by the natural regeneration of another species than the planted one. For example, the plantation block of Belwa area in Parsa district, there was planted Acacia catechu, *Ceiba pentendra, Eucalyptus camaldulensis* however all the species were found replaced by natural regeneration of Sissoo. Similarly, in Rangapur CFM, *Techtona grandis*, *Eucalyptus camaldulensis* and *Dalbergia sissoo* were

completely replaced by Acacia catechu and now there is only the Khair and Sissoo present in the plantation sites. Likewise, in Satanchuli CFUG of Chitwan district, unwanted species like *Adatoda vasica* has invaded the plantation area and planted species were found replaced by such unwanted species.

**Management Issues**

Site protection was most important issue for the plantation site followed by other technical matter like site selection and plantation techniques. Most of the plantation site were found disturbed by different anthropogenic activities. Encroachment and grazing were the most disturbing anthropogenic activities. So, barbed wire fencing for such plantation sites was found necessary before planning of the plantation in such areas. Similarly, the local people were found unaware about the correct plantation techniques. Improper handling of the poly bag seedlings was also observed another technical default. Improper removing of poly bag during the plantation was mostly observed technical default during the plantation. Biodegradable poly bag has been recommended to reduce such technical problems so that the people need not to remove container during the plantation. Such biodegradable poly bag could be introduced from China in similar price of ordinary poly bag used in Nepal.

**Figure 6. Free Grazing in Plantation Site in Rautaha**

Site selection was also found another problem faced in the plantation site. No any technical observation had been done before the plantation regarding choice of species and soil quality test for the suitability test of selected seedling species in particular site. The size of the seedlings was also observed another problem faced in the plantation site mostly in the Chure region and somehow in the roadside avenues. Plantation of 4-5 month seedlings in the area that has the limitation of soil moisture (Churia region) was found failure in the summer season of second consecutive year. So, it has been recommended that plantation in low quality soil should be prioritized the seedlings more than one year with hardening off of the seedlings adapted for adverse climatic conditions.

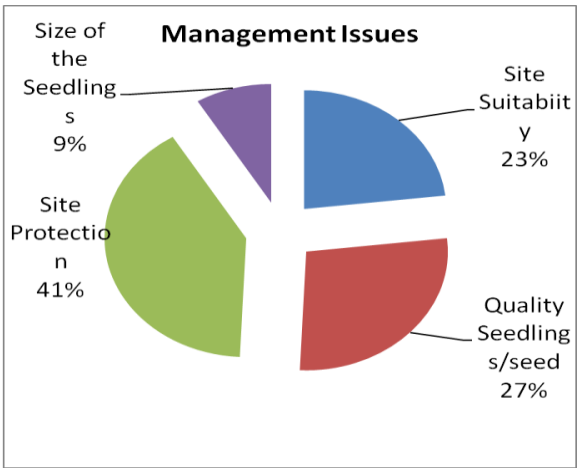



**Figure 7. Management Issues**

Mostly in the plantation site, there was found the provision of forest watcher for the first two years however after two years there is no any provisions of such watchers. The planted seedlings could not be reached in established condition within two years so the efforts made in two years becomes useless after third year due to lack of forest watchers. It has been suggested that user group forestry is the solution to be handed over to local people for the protection and management of these plantation sites. This type of problems mostly found in Tarai where the area was under the collaborative forest management (CFM) and DFO could not hand over the plantation area as community forest and also CFM are failure to organize the people in the conservation group. The reforestation and afforestation activities in Nepal have been going on for centuries. However, the extensive plantations were started from the early 80's. With the large scale plantation commenced in the early 1980s, nearly 370,000 hectares of plantations have been successfully established in Nepal (Dangal and Das, 2015). Tarai Community Forestry Program had done extensive cultivation in Tarai regions with local Sissoo (Dalbergia sissoo) and other fast growing exotic species such as Teak (Tectona grandis), Eucalyptus (Eucalyptus camaldulensis), Poplar (Populus

deltoides) *etc*. in late eighty's (MFSC, 2015). The plantation activity in Tarai had accelerated in the period of Biodiversity Sector Support Program for Chure and Tarai (BISEP-ST). The program had supported 2877 hectares of plantation in eight Mid-Tarai district in the year between 2001 to 2011 (BISEP-ST, 2011). Government of Nepal is celebrating Forestry Decade, 2014-2024 campaign in the country which has the slogan of One House- One Tree, One Village - One Forest and One City - Many Parks concept that also seek massive forest plantation in running decades. However, most of the plantations in Nepal have been done without any scientific study on provenance. The seed sources are mostly unknown which ultimately lowers the productivity of the forests and loosens the economic benefits (MFSC, 2015). The findings of the study have also supporting the fact. Average production of the seedlings per district is about 815 thousands seedlings annually but there was not observed any plantation plan for such seedlings. Government of Nepal has provision of casualty replacement of the plantation area by 20% in the next consecutive year; this provision has the assumption that about 80% seedlings has possibility of survival. The field situation has been found reverse form this assumption. Seedling mortality was observed more than 70%. The couple of cause behind this mortality has been identified in this study. Quality seed source, site protection of the plantation site and size of the seedlings were observed in this study. Poorest survival was observed in Parsa district where there is less forest based CBO's in the district. Similarly, the plantation block lies in the Chure area were found more failure. Most of the seedlings have been produced as per the easiness of the propagation rather the demand of the species as per the site suitability of the species. Similarly, some of the plantation blocks were found clear felled due to lack of management mechanism to protect the site. The situation was found severe where there is no any formal forestry organization like community forestry. The preference for Dalbergia sissoo has been decrease after the outbreak of its dieback disease in the Terai (Parajuli *et al.,* 1999). Still the seed source of most of the species has not found any reliability.

## CONCLUSION

Based on the findings of the study the More than 17.2 million seedlings were found produced in the period of last ten years (2005-2015). Seedling production has increased in the recent year however there was neither observed any plantation plan for such produced seedlings nor found any recording system for the distribution of seedlings so it is difficult to conclude where the seedlings were planted. Despite the large number of seedlings production, the quality of seedlings was major issues. The seed source has no any reliability as there was neither recorded reliable seed suppliers nor government managed seed orchard was found in entire region. Mostly, seedling production has been carried out in temporary nurseries that are being used in seasonal level. The operation of the nursery was totally dependent on the budget allocation in the district for seedling production. Limited connection was observed between the seedling production and choice of species as per the site quality requirement of the plantation block and people's preference. Most of the planting materials were single year seedlings and due to lack of hardening off of the seedlings to tolerate the adverse climatic condition, higher percentage of mortality was observed during the dry season of next consecutive year. Average survival was observed 28% that is technically unjustifiable. Pre-monsoon and/or early monsoon plantation was observed comparatively successful as the seedlings of such plantation got longer growing period in the first year of the plantation. Grazing was found major disturbing factor for the survival of plantation site so barbed wire fencing was found only the suitable options for the protection of such plantation site. High level of dependency was observed to people for development of afforestation activities in the areas where there was no community user group. Providing seedlings with free of cost and also the provision of subsidies for plantation and protection measure has increased the expectation of the local people from government line agencies for plantation and management. No any tending operation was observed in the plantation block. Growth performance was found poor in the most of the plantation blocks carried out by the initiations of the government line

agencies so limited direct tangible benefits was received by the people even in the plantation blocks that were more than five years of plantations. Multi-year Plantation Plan and establishment of permanent nursery for the production quality seedlings and provision of post payment mechanism rather the subsidy and free distribution of seedlings has been recommended for increase the survival percentage of the plantation activities in the region.

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