Survival status of young plantations in Parbat district, Nepal

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In Nepal, a lot of resources have been invested for establishing plantations. Due to lack of assessment of the survival status of planted seedlings, we have inadequate information about how many successful plantations that we have established in the country. This study was carried out in fourteen community forests (CFs) of Parbat district with the aim of analyzing survival status of the planted seedlings. Plantation was done in June/July 2015 and total count of the seedlings was done in June 2016. In the studied CFs, eleven species were planted comprising 20,172 seedlings in which 58.57% seedlings were survived at the end of first year. The cause of seedling mortality was identified through observation, judgment and interaction with local people. The main causes of seedling mortality (52%) were due to small size and unhealthy seedlings, lack of care during transportation and handling. Forest fire, weeds, drought, disease and grazing were found to be responsible for the mortality of 17%, 12%, 10%, 7% and 2% seedlings, respectively. Regular monitoring of plantation area with the involvement of local community members is recommended for policy makers and assessment of survival rate of different species in different ecological regions is recommended for researchers.

Key words: Plantation, mortality, seedlings, survival

Large-scale government programmes have been implemented to improve the forest resource concentrating on the creation of a new forest resource through plantation establishment (Carter and Gilmour, 1989). Forestry development is a long-term endeavour and long time is needed to get economic benefit from investment. Human patience would be exhausted to wait for until final felling of trees (Campbell and Bhattarai, 1983). Evaluation of the success of the project is required to justify the investment in the forest development. The reasonable compromise is to select short-term indicators that are as closely related to the long- term objectives as possible while still remaining measurable (Campbell and Bhattarai, 1983).

The survival rate of seedlings planted in private and government land have proved to be the most important key indicators of the success of forestry activities (Fonzen, 1986). Ghimire and Erling (1985) have similar opinion for plantations on community land in evaluating the success of the plantation project. It is necessary to track the survival rate and farmers' preference of planted seedlings to determine the effectiveness of district forest office planting and seedling distribution programmes (Bashyal and Denmanski, 1990). Not only do they measure programme achievement, but they also point out the technical and social problems that remain to be overcome (Fonzen, 1986). In addition, survival rates by species provide an indispensable guide to the species selection for plantations in the absence of scientific research (Fonzen, 1986). Various technical and social causes regarding seedling mortality have been identified by researchers (Campbell and Bhattarai, 1990; Fonzen, 1986; Ghimire and Erling, 1985). The main technical reasons identified for seedling mortality are small size and unhealthy seedlings, mismatching species to site conditions, lack of weeding and poor plantation techniques. The main social reason in mortality of seedlings is livestock grazing, although this accounted for less mortality than technical reasons (Campbell and Bhattarai, 1983). Field level detailed analysis of the causes of mortality is essential to increase the survival rate of plantations in future which ultimately is important for justifying the investment in afforestation and reforestation activities.

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Nepal has planted millions of ha. of land in the past decades. But due to lack of assessment of the survival status of planted seedlings, we have inadequate information about how many successful plantations that we have established in the country. At present, there is dearth of literatures regarding the survival status of plantations. Every year millions of seedlings have been planted in Nepal. For the fiscal year 2016/17, the Government of Nepal has allocated budget of around NRs. 170 million to the Departments of Forests to produce around 23 million seedlings (DoF, 2016). Due to lack of assessment whether our plantations are successful or not, we have been unable to improve our plantation techniques. To fulfill this gap, assessment of the survival status of plantations is necessary on a regular basis. The objective of the study was to find out the survival status of different species and analyse causes of seedling mortality in community forest plantations in Parbat district.

Materials and methods

Study area

Parbat district is a hilly district of Dhaulagiri Zone, Nepal (Fig. 1). It is situated between 27° 28' N to 28° 39' N latitude and 83° 34' E to 83° 59' E longitude (DFO, 2016). The altitude varies from 520 m to 3,300 m whereas the annual rainfall is 2400 mm to 2600 mm. The maximum temperature in summer exceeds 32.3°C and the normal winter temperature is about 7.5°C. The soils are medium to high in organic matter and are hardly suitable for agriculture in many areas. Land-slides and soil erosion are severe in Parbat district during rainy season. The total area of Parbat district is 53,668 ha, out of which agriculture land, grazing/pasture land, forest land cover 16.8%, 28.22%, 37.25%, respectively and other land types cover 17.73%. Major forest types in this district are hill *Shorea robusta* forest, *Schima-Castanopsis* forest, *Pinus roxburghii* forest and *Quercus* spp. forest. Most of the national forests in this district have been handed over as community forest (DFO, 2012; Paudel, 2015; Acharya and Paudel, 2016) and till now, 12, 963.56 ha of forest area has been handed over to 382 community forest user groups (DFO, 2016).

Pits of standard size 30 cm * 30 cm *30 cm were prepared in April/May, 2015 and plantation was carried out in June/July, 2015. Single year seedlings provided by the District Forest Office (DFO) Parbat were planted. The plantation sites were protected from grazing. The forest users had monitored and weeded planted seedlings.

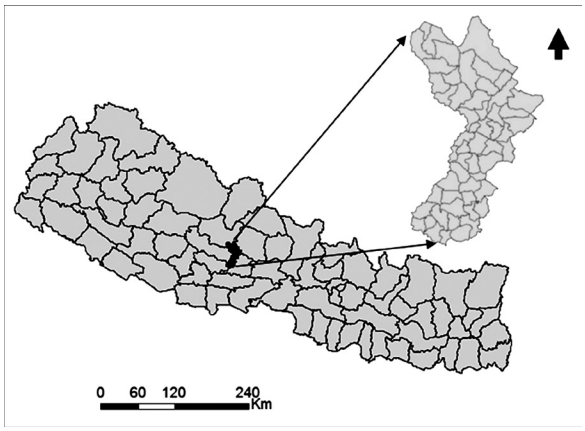

Fig. 1: Map of the study area

Data collection

The plantations done in fourteen community forests in 2015 were identified from the records of the District Forest Office (Table 1). Concerned CFs members were consulted and discussed on the assessment of the survival of planted seedlings. Total count of seedlings was done in June/July 2016 involving the users. Causes of mortality of seedlings were identified through observation, discussion with officials and interaction with local users. The data were analysed in Ms-excel.

Results

Plantation survival

Eleven tree species were planted in 14 community forests (Table 2). Altogether 20,172 seedlings were planted of which only 11,814 (58.57%) were survived at the end of first year (Table 2).

Causes of mortality

The main reasons identified for seedling mortality (52%) were due to small size and unhealthy seedlings, lack of care during transportation and handling (Fig. 2). Similarly, the natural as well as anthropogenic factors were responsible for the seedling mortality. Due to fire and drought,

Table 1: Number of different species planted in 14 CFUGs in Parbat district

SN	Name of the CF	Local name	Scientific name	Seedlings Planted
1	Kharsubas	Louth salla	*Taxus baccata*	500
2	Reshpatal	Louth salla	*T. baccata*	500
3	Samekhoriya	Badhahar	*Artocarpus lakoocha*	400
4	Dhulepalsing	Badhahar	*A. lakoocha*	800
5	Kalibanjar Ketichou	Badhahar	*A. lakoocha*	300
6	Banpala Bhumesthan	Khanyu	*Ficus semicordata*	400
7	Khaharesalyan	Khayer	*Acacia catechu*	4000
8	Tandibisauna	Lapsi	*Choerospandias axillaris*	200
9	Samekhoriya	Lapsi	*C. axillaris*	500
10	Gairakharka	Lapsi	*C. axillaris*	100
11	Banpala Bhumesthan	Lapsi	*C. axillaris*	200
12	Ek salle	Lekchamp	*Michalia champaca*	5000
13	Paitedhanda	Lekali salla	*Pinus wallichiana*	600
14	Tandibisauna	Nimaro	*Ficus auriculata*	50
15	Chihandanda	Nimaro	*F. auriculata*	200
16	Gairakharka	Nimaro	*F. auriculata*	250
17	Banpala Bhumesthan	Nimaro	*F. auroiculata*	400
18	Paitedhanda	Khanyu	*F semicordata*	350
19	Dhulepalsing	Khanyu	*F. semicordata*	365
20	Kalibanjar Ketichou	Khanyu	*F. semicordata*	50
21	Samekhoriya	Tejpat	*Cinnamomum tamala*	500
22	Thulatauka	Tejpat	*C. tamala*	200
23	Gairakharka	Tejpat	*C. tamala*	200
24	Banpala Bhumesthan	Tejpat	*C. tamala*	500
25	Musurabari	Timur	*Zanthoxylum armatum*	1457
26	Rolah	Timur	*Z. armatum*	2000
27	Banpala Bhumesthan	Tuni	*Toona ciliata*	150
	Total			**20,172**

Table 2: Species wise number of planted, survived seedlings and survival per cent

Scientific name	Number of planted seedlings	Number of survived seedlings	Survival (%)
Taxus baccata	1000	450	45.00
Artocarpus lakoocha	1500	510	34.00
Ficus semicordata	1165	411	35.28
Acacia catechu	4000	2000	50.00
Choerospondias axillaris	1000	429	42.90
Michelia champaca	5000	3750	75.00
Pinus wallichina	600	0	0.00
Ficus auriculata	900	655	72.78
Cinnamomum tamala	1400	850	60.71
Zanthoxylum armatum	3457	2670	77.23
Toona ciliata	150	89	59.33
Total	**20,172**	**11,814**	**58.57**

17% and 10% seedlings died, respectively. The percentage of mortality of seedlings due to grazing and diseases was less than others, which were 2% and 7% , respectively (Fig. 2).

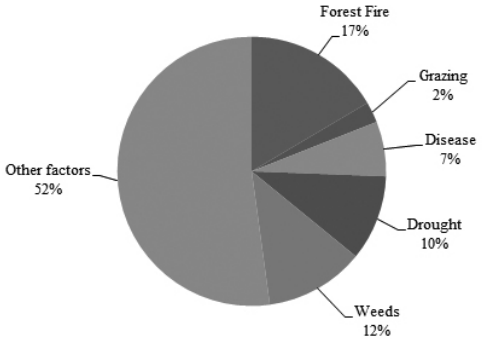

Fig. 2: Causes of seedlings mortality

Discussion

Plantation survival

The overall survival percentage of the planted seedlings was found only 58.57% which was quite lower than the findings of Fonzen (1986). The average survival rate of two-years plantation was 73.7% with a range of 42% to 94% in Palpa district (Fonzen, 1986). Bashyal and Demanski, (1990) found that the survival rate of seedlings planted in private lands of Dang and Salyan districts was 60.5% after three years. According to Ghimire and Erling (1990), overall survival percentage of seedlings was 63.8% in 14 districts. The average survival percentage of seedlings recorded by Sherpa (1996) was 66.9%.

The survival rate of four-years and one-year *A. lakoocha* in farmer's land varied from 15% to 60% in Community Forestry Development Project (Campbell and Bhattarai, 1983). Jackson (1994) stated that *A. lakoocha* is more suitable for planting by individual farmers than in community plantations. In our study, the survival rate of *A. lakoocha* was just 34% at the end of first year which is similar to Jackson (1994), as it requires fertile soil for good growth and a lot of care and attention after planting.

Neil (1990) found that survival percentage of *F. semicordata* plantation in Palpa district was 77%. The survival rate of *F. semicordata* planted during monsoon was about 90 % but it was only 58% for this species planted in winter (Sherpa *et al.*, 1992). In contrast to these findings, very low survival rate (35.28%) of *F. semicordata* was found in our study. As *F. semicordata* is a palatable species and in our case the plantation was damaged by browsing. From the discussion with the local people, it was also found that seedlings of this species were not in good condition at the time of planting due to transportation from long distance.

At Kadambas (1500 m), Sindhupalchok district, the survival of 28-months old *C. axillaris* plants was higher (80%) (Jackson, 1994) but our study recorded only 42.9% survival which could be due to poor quality of seedlings.

The survival of the *M. champaca* seedlings was found good (75%) in our study which is similar to the findings of Shrestha and Gautam (1991). They found that the survival rate of five and seven year old *M. champaca* plants was 79% and 75%, respectively in Parbat district.

The survival of *P. wallichiana* has been good at altitude over 2000 m but moderate to poor below 1600 m (Jackson, 1994). According to Joshi (1985), the survival of *P. wallichiana* was 89 % at Thulo Chaur (2250 m), Mustang district. Further, the survival rate of *P. wallichiana* was found 64%, 89% and 91% at Lower Nagarkot (1700 m), Tistung (1900 m) and Upper Nagarkot (2000 m), respectively (Jackson, 1994). This trend shows that survival rate greatly decreases with decrease in altitude from 2000 m. In our study site, the seedlings of *P. wallichiana* were completely damaged due to fire but discussion with local people revealed that there was considerable good survival before fire occurrence, as the plantation site is around 2000 m.

At Tistung (1900 m), field trials of *F. auriculata* established up to 1985 failed completely while the later plantations had 50% and 87% survival rate in open land and under shade of pines, respectively (Jackson, 1994). He also mentioned that the survival rate of this species found higher if planted under the shade of pine than in the open area. Joshi and Sherpa (1992) found that the survival rate of this species also varied with the time of plantation. They recorded 100% survival for seedlings planted in May, June, August and September; 75% in October and 41% in April at Pakhribas (1700 m), Dhankuta district. In our study site, plantation of *F. auriculata* was carried out in June/July and hence fairly higher rate of survival (72.78%) was found. Our finding is similar to Jackson (1994) where he stated 70% survival of 28 months old *F. auriculata* planted

under pine at Sangachowk, Sindhupalchok district. As *F. auriculata* seedlings were planted in an open area of four CFs without applying fertilizer. The survival rate of this species can be increased further by planting under pine and applying fertilizer.

The survival rate of *T. ciliata* (59%) in our study is similar to the findings of Grob (1982) and Ghimire and Nielson (1985). According to Grob (1982), the survival percentage of *T. ciliata* was 75% in March for seedlings planted in the previous monsoon, while the survival rate was only 43% in 1983/84 at the same plantation (Ghimire and Neilson, 1985). This species grows well in moist fertile soil (Jackson, 1994), hence the lower survival rate (59.33%) in our study could be due to drought and infertile soil.

The survival percentage of 50% and above is considered as satisfactory by Pakistan Forest Institute (PFI, 2013). Our study showed 58.57% survival percentage, which could be considered as satisfactory. Discussion with officials of the District Forest Office revealed that in this case seedlings were distributed to plant in selected CFUG sites only after field verification whether sites and pits were prepared or not. But in most of the other cases plantation was carried out without preparing sites and pits. They mentioned that survival rate in other communities could be lower than the studied CFUGs.

Causes of mortality

Among the various factors identified for seedling mortality, small size and unhealthy seedlings and careless in transportation and handling of seedlings caused 52% mortality. This result was found similar to findings of the survey carried out by the Community Forestry Development Project in 1982/83, where the causes of about 40% seedling mortality were due to small size or poor health of the seedlings at the time of planting (Campbell and Bhattarai, 1983; Jackson, 1994).

Moisture stress was the leading cause of seedling mortality, as this accounted for 76 % in Dang and 68 % in Salyan districts (Bashyal and Demanski, 1990). Our finding was contrasted with their findings as drought only accounted for 10 % mortality of seedlings. The sites had sufficient moisture for seedlings so moisture stress was not the leading cause of mortality in our study. Sherpa (1996) identified livestock damage as the main cause and other causes were drought, unsuitable site, fire, landslide and frost. Ghimire and Erling (1990) identified the three main causes for seedling mortality which were species selection, size of seedling and livestock damage. The factors such as poor quality seedlings, improper site selection, improper planting methods and transportation damage contribute directly to moisture stress (Sherpa, 1996), however, these factors are difficult to determine and were not recorded. Bashyal and Demanski (1990) found that the grazing accounted for 20% and 18% seedling mortality in Dang and Salyan districts, respectively. In our study, grazing was not found a serious problem for seedling mortality as compared to the other factors. Protection of plantation carried out under pine forest from fire can improve the survival. Planting of healthy and vigorous seedlings can improve the survival rate of seedlings, so care must be given to produce such seedlings. Similarly care should be taken during handling and transportation to increase the survival of seedlings.

Conclusions and recommendations

The overall survival rate of different species in fourteen CFs in Parbat district was found to be 58.57%, which is satisfactory but there is variation in survival rate among eleven species. Care must be given to improve the survival rate of those species with low survival rate. Poor health of seedlings, and carelessness in transportation and handling were found the most influencing factors in mortality of the seedlings. Other factors *viz*. forest fire, weeds, drought, disease and grazing were also affected the survival of different species in plantations. To improve the survival status of the plantations, regular monitoring, use of large sized seedlings, site preparation and protection from fire, grazing and regular weeding are recommended. Assessment of the survival status of different species in different ecological range is also recommended for further studies.

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