

# Die-back of *Dalbergia sissoo* plantation in Saptari and Rupandehi districts, Nepal

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A survey carried out in Saptari and Rupandehi districts in April to May 2004 has indicated that sissoo die-back is still prevalent. Dead trees per hectare are found less in community and private plantations in Saptari as compared to the survey results of 2000. In Rupandehi district, the dead trees per hectare in all types of plantations is slightly increased from 44 to 47 whereas dying trees per hectare has considerably decreased from 83 to 34 during 4-year period. The trend is just the opposite in Saptari district where percentage of dead trees is less now but the percentage of dying trees is higher in 2004. The trend of dead trees in private plantation in Rupandehi district is almost the same during 4-year period but there is a slight decrease in percentage of dead trees in community and institutional plantations during that period. 5% and 4.4% trees are dead, while 5.5% and 3.9% are dying in Saptari and Rupandehi districts respectively. In private land, the trees of all age classes (6-20 years) covered in the survey had been affected by the die-back. Death of sissoo trees in private land has led the farmers to select fruit trees as an alternative to sissoo. There is no definite trend in effect of die-back disease based on increasing age of plantation. Around 5% dead and dying trees signify that the level of die-back effect in both the districts is low.

**Keywords:** *Dalbergia sissoo*, die-back, plantation

It is generally estimated that more than 90% of plantations in Terai and lower valleys constitute *Dalbergia sissoo*. It was the most preferred species for planting by government, private land owners and communities (Gautam 1996). Sissoo plantations have been suffering from a serious die back disease since early nineties (Thapa and Gautam 2004). Baral (1995) cited in Joshi and Baral (2000) first reported sissoo die-back in the plantation of Nepal in 1993. Later, in 1996/1997 an official report was published by the Department of Forest Research and Survey. This detail report gives broad analysis of disease, casual agents, and appropriate recommendation (FORESC 1997). Large scale monoculture, lack of quality seed, lack of well equipped institution to immediately control the disease and lack of proper management are the major contributing factors responsible for scaling up of disease attack in the Terai plantations (Parajuli *et al.* 1999; Gautam 1996; Joshi and Baral 2000).

Some curative measures were suggested by earlier researchers to minimize the further damage and loss in sissoo plantation in the Terai, though the extent of damage is still prevalent. As these recommendations were not sincerely put into practice.

Department of Forest Research and Survey (DFRS) conducted survey and research on sissoo die-back in 24 Terai districts in 2000. After that, the Department did not monitor the status of die-back in these districts. Therefore, the present study aims to survey the sissoo die-back in Saptari, eastern Terai and Rupandehi district, western Terai of Nepal in order to know the extent and status of sissoo die-back.

## Methodology

The survey was carried out in Saptari and Rupandehi districts from 19 April to 8 May 2004. The sites were selected to represent different types of plantations (private, community, institution, canal and sides) established in different types of land (river bank, khet, bari, canal bank, open land and degraded forest land). The sample plots were selected using the systematic sampling method. A reference point was taken at the northeast corner of the plantation, and a start point was selected randomly with a suitable bearing. The first sample was taken at a distance of 50m from the starting point. After that, other plots were selected at an interval of 100m. The size of sample plots was 30mX30m (900m<sup>2</sup>). In case of canal

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side plantation, a systematic sampling was followed at an interval of 3 km. The first plot was taken at a distance of 500m. The length of a plot was 100m and width was the same as the width of the plantation. Within the sample plot, total number of trees, number of dead and dying trees were counted. The height and dbh of median healthy tree was measured. The dbh of all dying and dead trees were measured. The species other than sissou were counted separately and recorded. The selection of number of sample sites in each category of plantation was based on the field instructions for the sissou die-back national survey in 2000.

Altogether, 11 plantation sites (7 private, 1 canal sides and 3 community plantations) in Saptari District and 12 sites (6 private, 4 institutions and 2 community plantations) in Rupandehi District were surveyed. Two public hearings were organised in each district together information regarding the disease symptoms, incidence trends, preventive and remedial measures and concerns about the disease. The information was also collected through interviewing key informants and group discussions with key forest farmers, government staff and community user groups members. Other necessary information was recorded through making direct observations. The data were analysed using statistical computer packages.

## Results and discussion

### Die-back effect by plantation category

Comparative results of die-back survey carried out in 2000 and 2004 in Saptari and Rupandehi districts are presented in Table 1. In both surveys, average number of dead and dying trees per hectare varied with category of plantations. Dead trees per hectare are found less in community and private plantations in 2004 survey in Saptari as compared to the survey in 2000. Although, dying trees per hectare is considerably higher in 2004 survey in this district,

the decrease in number of dead trees may not be due to the decreasing trend of the disease but because of the gradual removal of the dead trees from the site by the farmers and communities. Moreover, increase in number of dying trees from 4 to 45 in private and 4 to 67 in community plantation clearly shows the existence of sissou die-back in Saptari district.

In Rupandehi district, dead trees per hectare in all types of plantations have slightly increased from 44 to 47 whereas dying trees per hectare decreased from 83 to 34 during 4-year period. The number of dead and dying trees per unit area may be slightly higher than those presented in Table 1 in both districts. Dead and dying trees cut down by the farmers and communities in different times (based on discussion and interview with the farmers and communities). The results indicates prevalences of sissou die-back in both the districts condition. However, level of severity has not increased and remained stable.

Average percentage of dead and dying trees varied with category of plantations. The trend is reversed in case of dead and dying trees in Saptari district. As percentage of dead trees is less in 2004 than in 2000 survey whereas the percentage of dying trees is higher in 2004. The trend of dead trees in private plantation in Rupandehi district is almost the same during 4-year period but there is a slight decrease in percentage of dead trees in community and institutional plantations during that period.

In Saptari and Rupandehi districts 5% and 4.4% trees are dead, while 5.5% and 3.9% are dying respectively. Looking at the result of dead and dying trees of sissou from both surveys, the disease effect in Saptari has been slightly increased during 4-year period. The percentage of dead and dying trees are slightly higher than that presented in Table 2. Farmers and communities have gradually removed dead and dying trees in both districts during last 4 years. Although, a considerable decrease in the percentage of dying

**Table 1: Average number of dead and dying trees per unit area in Saptari and Rupandehi Districts**

Plantation Category	Saptari				Rupandehi			
	Dead trees / ha		Dying trees per/ha	Dead trees / ha		Dying trees per/ha		
	2000	2004	2000	2004	2000	2004	2000	2004
Private	63	49	4	45	81	85	127	32
Community	81	69	4	67	16	24	52	48
Institution	-	-	-	-	12	40	45	28
Canal	36	94	6	128	-	-	-	-
<b>Overall</b>	<b>70</b>	<b>59</b>	<b>4</b>	<b>60</b>	<b>44</b>	<b>47</b>	<b>83</b>	<b>34</b>

Source: Field Survey, 2004 and 2000

Table 2: Average percentages of dead and dying trees in Saptari and Rupandehi Districts

Category of plantation	Saptari				Rupandehi			
	Dead trees (%)		Dying trees (%)		Dead trees (%)		Dying trees (%)	
	2000	2004	2000	2004	2000	2004	2000	2004
Private	19.8	3.6	0.7	3.7	8.4	8.5	13.2	3.1
Community	5.9	6.7	0.3	6.3	5.3	1.5	17.3	6.8
Institution	-	-	-	-	6.8	3.8	25.6	2.8
Canal	12.8	9.7	4.5	15.2	-	-	-	-
<b>Overall</b>	<b>11.3</b>	<b>5.0</b>	<b>0.5</b>	<b>5.5</b>	<b>6.3</b>	<b>4.4</b>	<b>15.2</b>	<b>3.9</b>

Source: Field Survey, 2004 and 2000

trees from 15.2 to 3.9 and marginal difference in percentage of dead trees in Rupandehi district during 4-years reflects the decreasing trend of the die-back disease. However, regular monitoring is essential to confirm such findings. The data also indicates no definite trend in the spread of disease with respect to types of plantations.

### Size of trees affected by die-back

Average dbh of dead and dying trees with respect to types of plantations are presented in Table 3. Average dbh of dead and dying trees varied with plantations categories. The survey result indicates that the size of dead and dying trees are almost the same in Saptari and Rupandehi districts. Medium sized trees have been dead and dying in community plantations (Table 3). Healthy trees of such size could provide small sized timber for furniture making. Due to low value

of wood of dead and dying trees, farmers have sold the wood as firewood instead of timber. They are deprived of gaining higher amount of money from sissou plantations, which they had expected in the planting time. Therefore the farmers have now selected fruit trees as an alternative to sissou for planting in Saptari district.

The size of dead trees in all categories of plantations is almost the same in Rupandehi district. The medium-sized trees are dead in Rupandehi district. In general, dying trees are slightly larger in size than dead trees which is shown in Table 3.

Average dbh of dead and dying trees by age class and types of plantations are presented in Table 4. In both districts, average dbh of dead trees was found in a range of 11.5 cm to 30.9 cm (small to large sized trees) in different types of plantations. The trees

Table 3: Average dbh of dead and dying trees in Saptari and Rupandehi Districts

Type of plantation	Saptari		Rupandehi	
	Average dbh (cm)		Average dbh (cm)	
	Dead trees	Dying trees	Dead trees	Dying trees
Private	13.2	14.3	15.1	14.7
Community	21.1	20.1	13.0	18
Canal	33.2	30.0	-	-
Institution	-	-	15.6	17.4
<b>Overall</b>	<b>16.5</b>	<b>17.9</b>	<b>14.9</b>	<b>17</b>

Source: Field Survey, 2004.

Table 4: Average dbh of dead and dying trees by age-class and types of plantations in Saptari and Rupandehi Districts

Age class	Type of plantation	Average dbh of dead trees (cm)		Average dbh of dying trees (cm)	
		Saptari	Rupandehi	Saptari	Rupandehi
6-10	Private	11.7	10.6	11.5	13.0
	Community	12.8	-	13.1	-
	Institution	-	13.5	-	14.4
11-15	Private	15.5	21.3	14.9	17.2
	Community	-	13.0	-	12.0
	Institution	-	10	-	13.4
16-20	Private	18.7	16.4	16.0	10.0
	Community	-	-	-	-
	Canal	30	-	33.2	-
	Institution	-	21.9	-	21.6
21-25	Community	27.8	-	30.9	26.1

Source: Field Survey, 2004

of all age classes (6-20 years) covered in the survey were found affected by the die-back in private land. In Saptari district, medium sized trees are dead and dying in age classes 11-15 and 16-20 years in private plantations (Table 4). Certainly, the loss from such sized trees has created negative feeling to the farmers regarding sissoo plantation and it has led to the farmers to clear-fell even immature healthy trees.

In community plantations, the size of dead and dying trees are in the range of 11.5-30.9 cm and 12.8-27.8 cm respectively. Comparatively, larger trees have been found dead in community plantation than in private plantations (Table 4). The trees recorded in the age classes of 16-20 and 21-25 years in both districts resemble a big loss to the farmers and communities in terms of monetary values.

### Die-back effect by age-class and type of plantation

In Saptari district, the lowest percentage (2.6%) of dead trees was found in private land whereas the highest percentage (9.7%) of dead trees was in canal bank plantation. The incidence of disease in Saptari district is more in community plantations in age classes 16-20 and 21-25 years, as 8.1% and 9.7% trees have been dead in these age classes respectively. Although, the effect of disease has been found in all the ages of trees between 6 and 25 years.

In Saptari district, more sissoo trees have been found dead in canal bank plantations than in private plantations (2.6%). Higher mortality of sissoo in canal bank plantation may be due to regular root contact in prolonged water logged condition during rainy season and seepage of canal water. Sharma *et al.* (2000) reported that the correlation of prolonged

water logged conditions during raining season and seepage of canal water and mortality on canal banks in Bihar, Haryana and Himachal Pradesh. Further, they state that prolonged water logging creates anaerobic conditions for root growth, causing root infections and inhibits nutrient uptake especially of P, K and Ca and ultimately leads to death. It is clearer from the results of survey carried out in 1998 in Ginnapur, where a pure stand of sissoo along the canal bank had very high mortality i. e., 400 trees in a block were found suffering from wilt disease (Sharma *et al.* 2000).

More than 10% trees are found dead in age classes of 11-15 and 16-20 years in private plantation in Rupandehi district. It is clear that the effect of die-back is still prominent in private plantation in Rupandehi district (Table 5). Except the age class, 21-25 years of community plantation, severity of dying trees is less in this district. One of the cause of high mortality in private land may be due to unsuitable sites for planting, as number of sites in private land are in *kebet*, which is not good for sissoo survival and growth. In clayey soil in *kebet*, the aeration is poor and the roots die of asphyxiation. Soil inhabiting fungi are able to infect the tree through dying or weakened roots (Bakshi 1957 cited in Baksha and Basak 2000).

### Die-back effect by age-class

Age wise percentage of dead and dying trees is presented in Table 6. Almost similar sized trees have been dead and dying in both districts (Table 6). The similar growth of sissoo in these districts resembles the similar site types used for planting. As already mentioned, the slight difference in the percentage of dead and dying trees in these two districts indicate

**Table 5: Average percentages of dead and dying trees by age-class and types of plantations in Saptari and Rupandehi Districts**

Age class	Type of plantation	Dead trees (%)		Dying trees (%)	
		Saptari	Rupandehi	Saptari	Rupandehi
6-10	Private	5.8	3.4	5.7	2.5
	Community	4.5	-	4.8	-
	Institution	-	4.1	-	1.5
11-15	Private	2.6	11.3	2.2	3.3
	Community	-	3.0	-	3.5
	Institution	-	7.9	-	5.1
16-20	Private	3.2	10.8	4.2	3.6
	Community	-	-	-	-
	Canal	9.7	-	15.2	2.9
	Institution	-	2.3	-	-
21-25	Community	8.1	0	-	10.1

Source: Field Survey, 2004

Table 6: Average dbh and percentages of dead and dying trees by age-class in Saptari and Rupandehi Districts

Age class (year)	Mean dbh of dead trees (cm)		Mean dbh of dying trees (cm)		Dead trees (%)		Dying trees (%)	
	Saptari	Rupandehi	Saptari	Rupandehi	Saptari	Rupandehi	Saptari	Rupandehi
6-10	12.2	12.1	12.3	13.8	5.3	3.8	5.4	1.8
11-15	15.5	13.4	14.9	13.8	2.6	7.3	2.2	3.8
16-20	24	19	27.7	19.4	5.8	3.5	8.6	3.0
21-25	27.8	-	30.9	26.1	8.1	0	7.3	10.1
All ages	17.9	14.9	19.5	17.0	5.0	4.4	5.5	3.9

Source: Field Survey, 2004

almost the same level of effect of die-back. There is no definite trend in effect of die-back disease, as it is clear from the irregular variation in percentage of dead and dying trees in different age classes. Further, it indicates that there is no strong correlation between age of the trees and disease incidence in both districts.

Around 5% dead and dying trees signify that the level of effect of die-back is not in a large-scale. With the increase of age of plantations, certainly some sissou trees die naturally. Again, most plantations are completely out of silvicultural operations.

### Results from discussion and interview

The findings obtained from discussion with key informant and interview with farmers and related people are as follows:

- Farmers have planted fruit trees (mango, banana, litchi, etc.) as an alternative to sissou, especially in Saptari district. It shows that the farmers are still interested in promotion of private forestry.
- Farmers have cut down dead, dying and even healthy trees and sold as firewood in cheap rate, instead of treating the affected trees.
- Insecticides/fungicides and technical know-how of their use are not easily available and recommended medicines are not used as a commercial purpose.
- Dissemination of preventive and curative measures for new sissou planting and sissou die-back is not at an optimum level by the concerned organizations.

### Conclusion

Die-back of sissou is still prevalent in Saptari and Rupandehi districts. Planting of fruit trees, an alternative to sissou trees has been a common phenomenon in Saptari district. About 5 to 10% of sissou trees have been dead in different types of plantations in these districts. Trees of all the age

classes, 6 to 25 years covered in the survey have been affected by the disease. Farmers have negative attitude towards promotion of sissou plantation due to die-back effect. They are reluctant to continue sissou planting on their private land. If the present attitude of farmers remains, promoting sissou as a private forestry in the Terai/Inner Terai region of Nepal would be highly difficult.

### Suggestions

Some suggestions are presented to encourage sissou planting and to minimize the effect of disease and cure sissou die-back.

- Research plots should be established to study the control methods of die-back in different parts of the country.
- Prior to planting, it is essential to take advice on site species matching from the concerned District Forest Offices. Moreover, planting of sissou should be done in a suitable site (well- drained, sandy soil avoiding clayey water- logged soil). Soil should be tested to know the site suitability for sissou.
- Growth plot of sissou should be established in different parts of the country using high quality seedlings raised from high quality disease resistant seed to remove the negative attitudes of farmers for planting of this species.
- Private growers should inform to the concerned District Forest Office (DFO) about the die-back disease and the problems related to it and then to the Department of Forest Research and Survey from DFO.
- There should be encouragement and technical input to the growers from the concerned organizations in mixed plantations i. e. sissou with other species to minimize the risk of disease in future. For instance, the block plantations and mixed cropping have not exhibited any serious mortality except for a few individuals in the fringes in Delhi. This can be due to the fact that mixed cropping/block plantations may create the

appropriate microclimatic conditions for survival of sissoo (Negi *et al.* 1999 cited in Sharma *et al.* 2000).

- Technical suggestions in management aspects of sissoo plantation to the concerned people, regular monitoring and evaluation through concerned organizations are essential.
- Uprooting dead and dying trees should be done so that breeding place of fungus/ insect is destroyed to further spread of the mortality.
- The stumps should be removed from the ground, or otherwise they will act as a source of infection from where disease will spread to healthy trees.

## References

- Bakshak, M. W. and Basak, A. C. 2000. Mortality of Sissoo in Bangladesh. *In Proceeding of International Seminar on Die-back of Sissoo*, Kathmandu 25-28 April 2000. FORSPA, FAO, Bangkok. 1-4p.
- DFRS 2000. **Study on die-back of sissoo.** Department of Forest research and Survey. Ministry of Forest and soil conservation Kathmandu Nepal. November 2000.
- FORESC. 1997. **A report on field investigations of top dying of Dalbergia sissoo growing at some districts of the central and eastern Terai.** Forest Research and Survey Centre and Department of Forests, Kathmandu.
- Gautam, K.H. 1996. Growth of multi-stems in two-year old *Dalbergia sissoo* plantation in Nepal Terai. *Banko Janakari* 6 (2): 82-84p
- Joshi, R. B. and Baral, S. R. 2000. A report on die-back of *Dalbergia sissoo* in Nepal. *In Proceeding of International Seminar on Die-back of Sissoo*, Kathmandu 25-28 April 2000. FORSPA, FAO, Bangkok. 17-22p.
- Khan, M. H. 2000. Sisham die-back in Pakistan and remedial measures *In Proceeding of International Seminar on Die-back of Sissoo*, Kathmandu 25-28 April 2000. FORSPA, FAO, Bangkok. 45-49p
- Parajuli, A.V; Bhatta, B, Adhikari, M.K, Tuladhar, J, Thapa, H.B. and Juwa, G. B. 1999. Causal agents responsible for the die-back of *Dalbergia sissoo* in Nepal's eastern Terai. *Banko Janakari* 9 (1): 7-14p
- Sharma, M. K., Singal, R. M. and Pokhriyal, T. C. 2000. *Dalbergia sissoo* in India. *In Proceeding of International Seminar on Die-back of Sissoo*, Kathmandu 25-28 April 2000. FORSPA, FAO, Bangkok. 5-16p
- Thapa, H. B. and Gautam, S. K. 2004. Sissoo disease monitoring in Saptari and Rupandehi district (in Nepali). A report submitted to the Department of Forest Research and Survey, 2004.