AN ASSESSMENT OF RESIN TAPPING FROM PINUS CARIBAEA TREES GROWN IN KWALE DISTRICT.

By

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A report to the Chief Conservator of Forests, Forest Department.

Abstract

Rosin Kenya Ltd. has tapped *P. caribaea* trees grown in Kwale District for oleoresin since 1992. There had been reports that some of these trees were dying probably due to some stress from the resin tapping operations leading to the Forest department halting these operations in this District. An assessment of the tapping operations in this district was therefore done to establish if they had any adverse effects on the trees and if there was any evidence of wood loss and incidence of insect attack associated with the operations in order for the Forest department to make informed decision on future tapping operations.

Tree samples used in the study were obtained randomly from the oldest, medium aged and youngest pine plantations in Shimba block and represented four diameter classes (<15, 15-24, 25-34 and >35 cm). For each tree selected, incidence of insect attack was observed, width and number of working faces, vertical height of face, height of clear bole, Dbh, bottom, mid and top diameters of the chipped channels were measured and circumference of tree chipped and portion of clear bole so far chipped computed. Data on pine resources in Kenya for potential resin tapping were also compiled from Inventory section.

The mean number of working faces was 3 and the mean face width was 11.6 cm. Number of faces and face width varied significantly ($p<0.001$) with diameter class and compartment (age of the tree). The overall mean circumference of the tree exposed due to the bark chipping operation for the whole period of tapping was 48.8 %. The mean height of vertical face was 2.0 m while the mean height of clear bole was 8.2 m and percentage of clear bole so far chipped being 27.8 %. Vertical height of face and clear bole height varied significantly with compartment but not with diameter class.

It is concluded that resin tapping as currently practiced does not have any observable effect on growth and health of the trees tapped and also does not expose the tapped trees to additional stress from insect attack and that the drying up or death of the tapped trees may be more as a result of climatic, environmental, site and pathological factors as opposed to resin tapping per se.

A number of recommendations are made on future resin tapping operations including the establishment of permanent sampling plots for obtaining reliable data on effect of tapping on growth. It is also recommended that FD allocates additional pine plantations to Rosin Kenya for resin tapping to help in easing the pressure on the plantations already being tapped and that FD incorporates a pine resin tapping cycle in its management plan in the short term. It is further recommended that FD puts in place a medium to long-term plan for the establishment of plantations with species suitable for pine resin tapping.

1. 0 Introduction

Tapping of oleoresin from *P. caribaea* trees in Kwale District by Rosin Kenya Ltd. has been going on since 1992. Resin tapping is carried out by a bark chipping method, which involves cutting of a 14 cm wide face and a 21- day cycle. At each visit to the tree, the tapper removes a 2.5 cm high strip of bark and applies an acid paste stimulant. The exudate is collected in open cups affixed to the tree.

Reports coming from these sites had indicated that some of the trees were dying probably due to some stress induced in the trees by the resin tapping operations. This resulted in the Forest department halting the tapping operations by Rosin Kenya in these areas. Studies elsewhere have shown that it is possible for the wood volume growth of tapped trees to decrease by up to 22 percent as resin tapping diverts materials from a tree's carbohydrate substrate pool to replace extracted oleoresins (Hodges and Green, 2001). Resin tapping also involves opening up the bark, which is responsible for transportation of sap down the tree trunk. As face width and number of working faces have been identified to significantly affect the amount of resin produced (Chikamai, 1995), there may be a danger of exposing a high portion of the tree circumference during tapping. Studies in the USA have indicated that an exposure of up to 60 % of the circumference of the trees at the same time results in reduction in growth by 25 % in the first year of working and up to 40 % in the second year (Clements, 1974).

The current tapping method may also promote the incidence of insect attack especially that of Turpentine beetles (*Dendroctomus terebrans*)(Hodges, 1995). It was therefore necessary to visit the plantations in Kwale District where resin tapping is going on and evaluate the tapping operations and the effect of resin tapping on the wood loss and incidence of insect attack in order for the Forest department to make informed decision on future tapping operations.

Objectives

1. To observe and if possible quantify the incidence of insect attack on tapped trees.
2. To observe if there are trees dying as a result of tapping and estimate the wood loss by volume caused by resin tapping.
3. To assess the current tapping method and advice the industry on how best to carry out future tapping operations with minimal adverse effects on the tapped trees.
4. To determine the current tappable pine resources in the country.

2.0. Materials and methods

Tree samples

The trees used in the study were all sampled from Shimba block, compartments 4E, 3B and 2A. No tree was sampled from Kivumoni, as the plantations in this block were very difficult to access. The three compartments were chosen on the basis of being the oldest, medium aged and youngest respectively. Four diameter classes (<15, 15-24, 25-34 and >35 cm) were used in the study and the distribution of the trees sampled from each compartment as per diameter class are as shown in Table 1.

Table 1. The distribution of trees sampled per compartment and diameter class

Compartment	Age of plantation (years)	No. of trees sampled per diameter class					Mean Dbh (cm)
		<15	15-24	25-34	>35	Total	
4E	23	7	8	6	1	22	21.3
3B	29	3	10	7	8	28	27.6
2A	39	-	10	7	7	24	26.0
Total		10	28	20	16	74	25.3

<u>Experimental methods</u>

1. All trees sampled were observed and presence of any insects noted.

2. Trees in each selected compartment were observed to identify and quantify the number of trees dying as a result of resin tapping.
3. The number of faces per tree for all the selected trees were counted and recorded.
4. The face widths (bottom, middle and top) of all the faces (for trees with three and below number of chipped channels) and 3 faces randomly selected and including the current channel (for trees with more than 3 faces) were measured using a digital calliper and recorded.
5. The total height of each selected channel (vertical face) and height of clear bole for all the selected trees were measured using a telescopic measuring rod and recorded.
6. Diameter at breast height, diameter at base of the tree where bark chipping began and the diameter at the top of the channel were obtained using a diameter tape.
7. The portion of tree circumference tapped was computed as follows:
   Mean face width x number of faces x100 / mean tree circumference (%).
8. As there was no clear data on the actual duration of resin tapping in each compartment or individual tree, the approximate duration of tapping was estimated as follows:
   Duration of tapping of each channel= h x c/ d x t
   Duration of tapping of all the channels=n x h x c/ d x t x 2
   Where: h= mean total height of vertical face in cm
   C= streaking cycle=21 days
   D=number of days in a year= 365
   T= height of bark removed at each tapping=2.5 cm
   N= number of faces
   2 = 2 tapping cycles each of about 4 years
9. Data on the availability, location and area under various pines in the country were obtained from Inventory section.
10. Data was organized using Microsoft excel programme and analysed using SPSS statistical package.

3.0. Results and discussions

Insect attack

All the three compartments had incidence of black ants. This appeared to be more of a site factor than due to tapping as the ants were mainly on the un-chipped bark of the trees. Empty cases of wasps, dead young praying mantis and empty cocoons of bagworms were noticed on the chipped channels of 5 trees (about 7 %). These were sent to KEFRI entomologists for identification. The results of the identification indicate that the wasps belong to the order: *Hymenoptera* and *vespidae* family are not harmful to plants but are predacious to other insects which may be harmful to plants. The praying mantis belonging to order: *orthoptera* and *Mantidae* family are also not harmful to plants but are also predacious to other insects that may be harmful to plants. The bagworms belong to the order; *Lepidoptera* and *Psychidae* family. The larvae form individual cases of sticks or leaves and the adult females are wingless and do not emerge from the larval case. The insects are defoliators and may be destructive to plants in larval stage.

Wood loss due to resin tapping

All the trees sampled looked healthy. There were however, a few drying and some dead trees in the three compartments. The drying and subsequent death of the few trees affected was mainly due to the breaking of the crowns by wind and pathological factors. It was observed that no tree could have dried up or died as a result of resin tapping per se.

Number of working faces

The number of working faces varied from 1 to 6 (Figure 1) with means ranging from of 2 to 4 depending on the diameter of the tree (Table 2). Number of working faces varied significantly ($p<0.001$) with diameter class and compartment (age of the tree) (Figures 1 and 2). The mean circumference of the tree exposed due to the bark chipping operation for the whole period of tapping increased with number of working faces (Figure 1) and was highest in compartment 3B and least in compartment 4 E (Figure 2). It also varied from 16.4 % to 76.4 % for individual tree samples with means ranging from 35.8 % for diameter class <15 cm to 53.2 % for diameter class 15-24 cm with an overall mean of 48.8 % (Table 2). These are lower than the 60 % exposure, which is possible when two working faces each of 9 cm are used at the same time on a 30 cm diameter tree, which has been shown to cause reduction in growth by up to 40 % in the second year of tapping (Clement, 1974). Further, as only 1 to 2 faces are exposed in each half of a tapping cycle (about 4 years) by Rosin Kenya, the amount of tree circumference exposed at the same time is about 18.0 % for diameter class < 15 cm and 23 % for diameter class > 35 cm.

From Figure 1, it is evident that trees with dbh in the range of 15-24 cm with four working faces had the highest mean tree circumference chipped, followed by trees in diameter class 25-34 cm with five working faces, followed by trees in diameter class > 35 cm with six working faces and lastly those with dbh of <15 cm with 3 working faces. The results show that the optimal number of working faces with less damage to the trees could be 2, 3, 4 and 5 respectively for trees with dbh < 15 cm, 15-24 cm, 25-34 and < 35 cm respectively.

Height of vertical face

The mean height of vertical face ranged from 0.7 to 3.1 m for individual trees and ranged from 1.5 m for diameter class < 15 cm to 2.1 m for diameter class >35 cm with a mean of 2.0 m (Table 2) with compartment 2A having the highest mean vertical face and Compartment 4 E the least (Figure 5). The height of clear bole ranged from 3.0 to 17.0 m for the individual trees and varied from 6.6 m for diameter class < 15 cm to 9.6 m for diameter class > 35 cm with a mean of 5.4 m in compartment 4E to 10.6 m in compartment 3 B. This translates to percentage of clear bole so far chipped as ranging from 9 to 75.2 % for individual trees and varying from 23.4 % for diameter class >35 cm to 31.8% for diameter class 15-24 cm. Vertical height of face and clear bole height varied significantly with compartment (age of the trees) but not with diameter class (Figure 3).

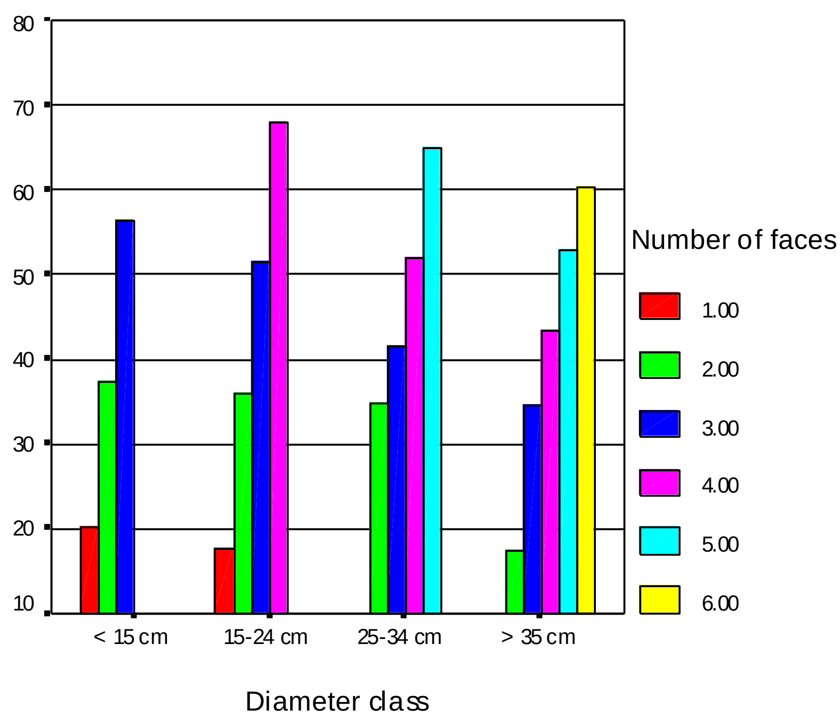

Figure 1. Variation of mean circumference of tree removed with diameter class and number of working faces.

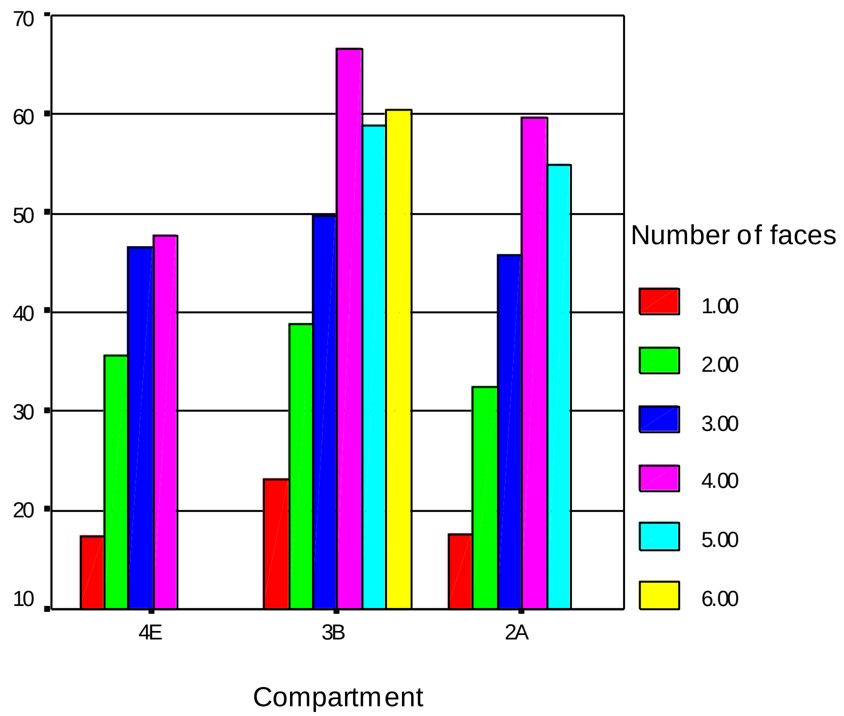

Figure 2. Variation of mean circumference of tree removed with compartments and number of working faces.

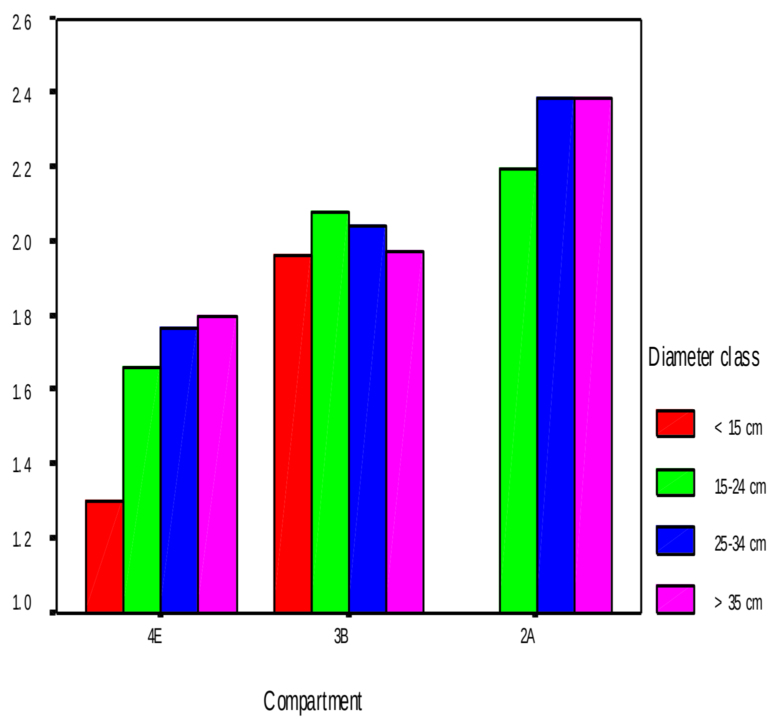

Figure 3. Variation of mean vertical face height with compartments and diameter classes.

Table 2. Various tree and resin tapping variables

Diameter class (cm)	No. of trees	Statistic	Variable							
			Approximate Duration of tapping (yrs)	DBH (cm)	No. of faces	Face width (cm)	Portion of tree circumference chipped (%)	Vertical height of chipped channels (m)	Height of clear bole (m)	Portion of clear bole already tapped (%)
<15	10	Mean	3.3	13.1	2	8.4	35.8	1.5	6.6	26.0
		S.D.	1.5	1.2	0.6	1.8	10.8	0.5	3.5	11.6
		C.V. %	45.5	9.2	31.4	21.4	30.2	33.8	52.0	44.6
15-24	28	Mean	7.1	19.9	3	11.3	53.2	2.0	7.5	31.8
		S.D.	2.6	2.9	0.8	1.5	14.6	0.4	3.4	13.7
		C.V. %	36.6	14.6	27.0	12.9	27.4	17.8	45.3	43.1
25-34	20	Mean	9.2	28.0	4	12.1	51.5	2.1	8.8	26.3
		S.D.	2.8	4.0	0.84	1.8	13.5	0.5	3.2	8.3
		C.V. %	30.4	14.3	21.2	15.0	26.2	21.5	36.4	31.6
>35	16	Mean	10.5	38.9	4	13.2	45.7	2.1	9.6	23.4
		S.D.	3.3	3.3	1.2	2.1	14.3	0.4	2.5	8.6
		C.V. %	31.4	8.5	27.1	16.1	31.3	19.0	25.2	36.8
Total	74	Mean	8.0	25.3	3	11.6	48.8	2.0	8.2	27.8
		S.D.	3.4	9.2	1.2	2.3	14.9	0.4	3.3	11.4
		C.V. %	43.2	36.4	34.3	19.5	30.5	21.9	39.7	41.1

Note: S.D= Standard deviation; C.V. = Coefficient of variation

Face width
The mean face width varied from 9.9 cm in compartment 4E to 12.5 cm in compartment 2A with an overall mean of 11.6 cm. Face width ranged from 7.0 to 15.7 cm for individual trees and the mean varied from 8.4 cm for diameter class < 15 cm to 13.2 cm for diameter class > 35 cm (Table 2). Face width varied significantly ($p<0.001$) with diameter class and compartment (Figure 4). With a mean duration of tapping of 8 years and a mean number of faces of 3 and a mean face width of 11.6 cm it implies that at the end of every year approximately 34.8 cm (total width surface) x 43.5 cm (vertical height) of a tree surface is exposed. This is slightly higher than that recommended by Chikamai of 28 cm x 43.5 cm (a maximum of four faces each of 7 cm for 8 years) recommended for economical production while taking into consideration the environment. The slightly higher face width could be probably due to the workers wanting higher resin yield as they are paid as per the amount of resin produced and most likely due to poor supervision of the workers by Rosin Kenya and Forest Department.

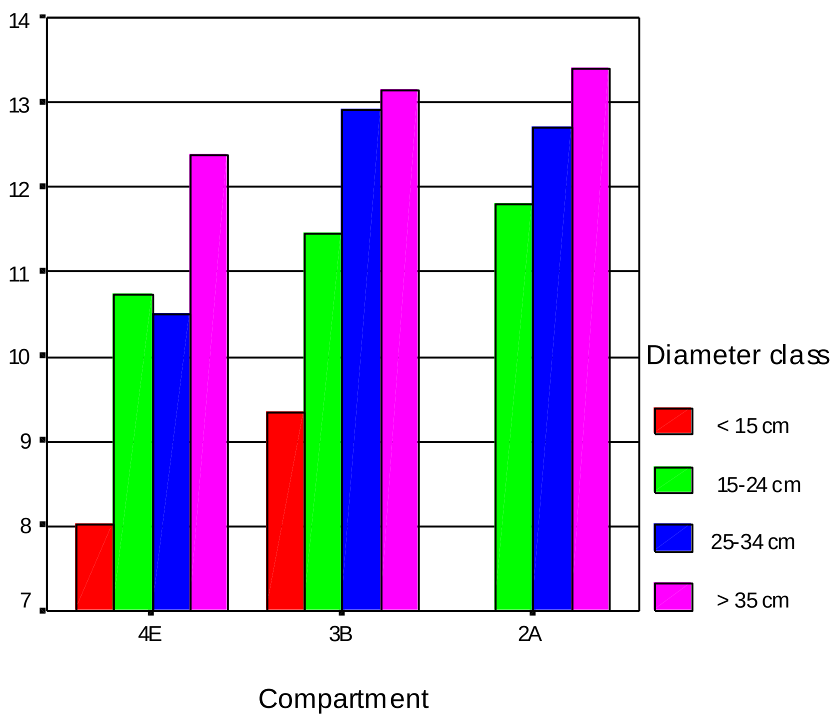

Figure 4. Variation of face width with compartments and diameter classes.

Pine resources in Kenya for potential resin tapping

The area under pines in Kenya excluding *P. patula* as obtained from the Inventory section of the Forest department is as summarised in Table 3. There are a total of 7652.7 ha under pines in 19 districts in the country. Out of this 6999.1 ha (91.5 %) have the three pine species being tapped currently i.e. *P. radiata* (6660.8 ha), *P. elliotti* (223 ha) and *P. caribaea* (115.3 ha) and only about 1390.3 ha (19.9 %) of this is currently being tapped.

Table 3. Pine resources in Kenya for potential resin tapping.

District	Species	Total area (ha)
Koibatek	*P. radiata*	1312.3
	P. caribaea	4.2
	P. halepensis	58.1
	P. elliotti	47.0
	P. canariensis	10.6
	Total	**1432.2**
Nakuru	*P. radiata*	1306.4
	P. caribaea	7.8
	P. elliotti	25
	P. canariensis	44.4
	P. pinaster	6.0
	Pine spp.	18
	P. paniculata	3.0
	P. montezumae	3.0
	P. pseudostecbus	3.0
	Total	**1416.6**
Uasin Gishu	*P. radiata*	767.7
	P. elliotti	1.6
	P. khasya	0.8
Kericho	**Total**	**770.1**
	P. radiata	1462.7
	P. halepensis	36.7
	P. elliotti	21.0
	P. canariensis	50.4
	P. pinaster	8.3
	Pine spp.	0.4
	P. paniculata	0.8
	Total	**1580.3**
Nyeri	*P. radiata*	361.6

	P. halepensis	29.9
	P. elliotti	15.7
	Total	**407.2**
Elgeyo	*P. radiata*	239
	P. elliotti	26.0
	P. canariensis	13.8
	P. pinaster	6.6
	P. massonia	23.2
	Total	**308.6**
Kiambu	*P. radiata*	213.1
	P. halepensis	5.7
	P. canariensis	9.3
	Total	**228.1**
Nyandarua	*P. radiata*	354.7
	P. halepensis	12.6
	P. canariensis	3.2
	P. pinaster	10.0
	Pine spp.	12.1
	Total	**396.6**
Nandi	*P. caribaea*	17.4
Laikipia	*P. radiata*	156.8
	P. canariensis	6.2
	P. massonia	10.3
	Total	173.3
Thika	*P. elliotti*	21.0
	P. pinaster	70.5
	Pine spp.	108.6
	Total	**200.1**
Meru	*P. radiata*	204.7
	P. elliotti	3.0
	P. canariensis	42.2
	Total	**249.9**
Vihiga	*P. elliotti*	24.2
Malava	*P. radiata*	238.2
	P. caribaea	78.6
	P. canariensis	10.0
Kirinyaga	*P. elliotti*	2.8
Nandi	*P. radiata*	25.9
Kakamega	*P. caribaea*	7.3
	P. elliotti	10.5
	P. khasya	22.3
	Total	**40.1**
Machakos	*P. radiata*	17.7
	P. massonia	8.0
	Total	25.7
Makueni	*P. elliotti*	26.8
Grand total	**19**	**7652.7**

4.0. Conclusions and recommendations

Conclusions

1. The incidence of insect attack on tapped trees in Kwale District is very minimal implying that resin tapping as currently practiced does not expose the tapped trees to additional stress from insect attack.
2. Resin tapping does not seem to cause drying up or death of the tapped trees and such effects may be more as a result of climatic, environmental, site and pathological factors.
3. Tapping resin from *P. caribaea* using the bark chipping method does not seem to have any significant and observable effect on growth and health of the trees tapped, however care should be taken to avoid over tapping of the trees.
4. About 80 % of the tappable pine resources in the country are yet to be exploited for resin tapping.

Recommendations

1. In setting up future resin tapping operations, some trees should be left un-tapped to act as controls. The selection of the control trees to be done in consultation with KEFRI and FD to ensure that this is scientifically done.
2. Possibilities of establishing permanent sampling plots in tapping plantations be explored to facilitate collection of reliable data on the effect of tapping on radial growth, defoliation and insect resistance etc.
3. A sub-committee within the Technical Liaison Committee (TLC) on resin tapping should be established to formulate guidelines relating to resin tapping in the country.
4. A new method of resin tapping (bore hole method) developed in the USA should be evaluated for adoption in Kenya, as it is a more environmentally cleaner and friendly method of resin tapping.
5. When the bark chipping method is used the number of working faces for the various diameter classes should not exceed 2, 3 and 4 for < 15 cm, 15-24 cm and 25-34 and > 35 cm respectively and the face width should not exceed 14 cm.
6. There should be improvement in the supervision and monitoring of resin tapping operations by both Forest department and Rosin Kenya Ltd.
7. Resin tapping should be treated as any other forest operations and clear records of amount of resin obtained from each compartment be maintained.
8. The actual areas under the plantations of *P. elliotti*, *P. caribaea* and *P. radiata* that are 20 years and above identified in the study be verified, through visits to the various sites, and these be allocated to Rosin Kenya for resin tapping for at least 4 years, to help in easing the pressure on the plantations already being tapped and to generate additional revenue to the Forest department, before these trees are felled for the intended end uses in the short term. The FD should also incorporate a pine resin tapping cycle in its management plan. Meanwhile, a medium to long-term plan should be put in place by the FD in establishing plantations with species suitable for pine resin tapping.

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References

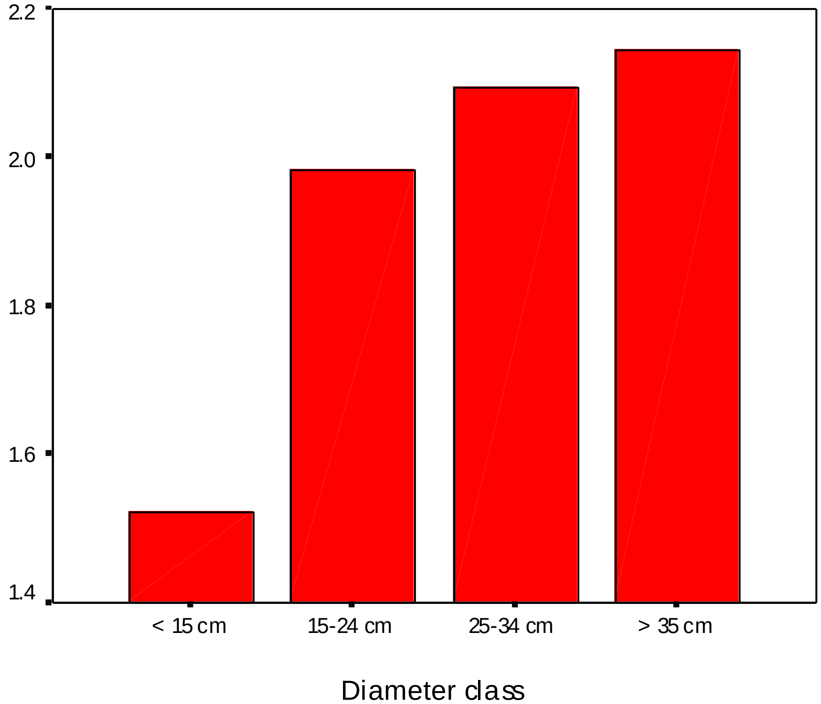
Chikamai, B.N.1995. A two-year study on oleoresin tapping in Kenya. *E. Afr. agric. For. Journal*, pp. 207-216.

Clements, R.W. 1974. Modern gum Naval stores Methods. USDA, For. Ser.Gen.Tech. Report, SE-7. 29 pp.

Coppen, J. J.W. 1995. Prospects for new gum naval stores production in sub-Saharan Africa. An assessment of the pine resources in Malawi, Zambia, Tanzania and Uganda and their potential for the production of turpentine and rosin. Natural resources Institute, Kent, UK.

Hodges, A. W. 1995. Commercialisation of Borehole Gum resin Production from Slash Pine-part 1. Naval stores review.

Hodges, A. W. and Green, T.C. 2001. Chemicals and bio fuels from pine oleoresin.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2.0
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15-24 cm
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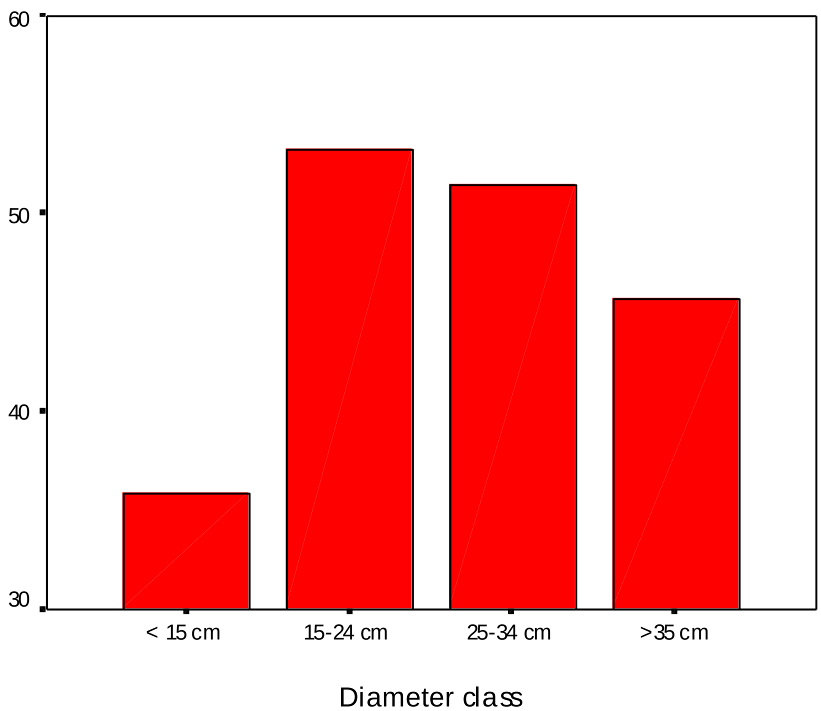
Diameter class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