Draft 1 of May 27, 2002

Woodlot establishment in Malindi and Kilifi Districts, Coast Province The case of Casuarinas growing as a strategy for poverty reduction.

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Abstract

Casuarina equisetifolia is one of the widely grown exotic tree species along the Kenyan Coast. However the farmers were using different espacement and therefore a participatory woodlot establishment experiment, which was financed by GOK/GTZ through the promotion of sustainable Forest Management Project (PSFM), was started at the Gede Regional Research Centre in 1998, though the project was started in 1996 with other research activities.

The Centre, which is mandated to conduct forestry Research in the whole of coast province, was to co-ordinate the implementation of the project activities in both Malindi and Kilifi Districts. After discussions with farmers and the Extension officers in the two Districts, only 16 farmers were selected. They were composed of 7 schools 5 men and 4 women farmers.

All the farmers tried six different espacemnts i.e. 0.5 x 1.0m, 1.0 x1.0m, 1.0 x 2.0m, 1.5 x1.5m, 2.0 x 2.0m and 2.5 x 2.5m. Due to lack of enough space for replication of the treatment on the same piece of Land, the different farmers acted as the replicates.

During the first year, there was no major change in height growth across the treatments. This was noticed in the second and third years of growth whereby the wider espacements appeared to encourage faster growth and vice versa. In the fourth year of growth, when the diameter at Ground Level (DGL) was measured, there was a clear distinction between the narrow and wider espacements/treatments, in growth of the diameter i.e. increment in diameter.

Farmers started harvesting their trees from the wider espacements after the third year of growth. Those from the closer espacements have not yet attained the market size for the various products required by the customers.

Farmers have now experienced through practice and have recommended the best espacements to be 1.5 x1.5m and 2.0 x 2.0m. These two espacements ensures faster growth, early maturity and produce poles of high quality and therefore of high demand by the customers.

ACKNOWLEDGEMENT

We acknowledge the Director KEFRI for his guidance and technical support during the visits to the participating farmers in Msabaha, Gede and Mida Majaoni, Malindi district.

The National Programme Coordinator, Farm Forestry Programme for technical support.

The authors acknowledges the efforts of the enumerators who assisted in data collection and filling of the Questionnaires and the support of all the Centre staff.

Also acknowledged are the FD staff led by the DFO's Malindi and Kilifi including the Foresters Bahari and Malindi Divisions for their participation.

INTRODUCTION:

Plantation Forestry in the Coast Region is poorly developed with only about 700 ha under plantation. Farm Forestry is also not well developed along the coastal strip although some farmers have concentrated on planting of *Casuarina equisetifolia*. This species is heavily used for construction of houses by the flourishing tourism industry. The farmers themselves also use the species while constructing their houses and other on-farm structures, though this latter use is limited.

Apart from *Casuarina equisetifolia*, other species planted are fruit trees e.g. mangoes (*Mangifera indica*), coconuts (*Cocos nusifera*), oranges (*Citrus sinensis*), cashew nuts (*Anacardium occidentale*). Other tree species such as *Eucalyptus spp., Pinus spp., Gmelina arborea* etc are mostly planted by Government Institutions i.e. Forest Department and Kenya Forestry Research Institute.

Participatory Woodlot establishment with selected farmers was initiated in 1998 to try to address some of the problems encountered by farmers. The experiment was started at Gede Regional Research Centre through the Promotion of Sustainable Forest Management Project (PSFM), which was funded by GoK/GTZ. Similar trials were setup in Nyeri, Turbo and Londiani. Sixteen (16) farmers were identified and initial training done on issues such as acquiring of seeds, nursery establishment, sowing and tree management on the farms. This was organized by KEFRI/FD with other departments notably Agriculture and Social services participating. Training was held at Gede Regional Research Centre before the implemention of the activities on their farms.

The 16 farmers included 7 schools, 4 women and 5 men whereby Kilifi District had 3 farmers and 2 schools and the rest were from Malindi District. Those in Kilifi included Matsangoni Primary School, Mkongani Primary School, Gladys Kanju, Florence Mwango and Irene Mramba. Those in Malindi included Msabaha Primary School, Mijomboni Primary School, Kavinyalalo Primary School, George Kaingu, Beatrice Mwambire, Mary Kambi, Charo Sirya, James Mwakaya, Raphael Ziro and Gede Regional Research Centre.

Some of the experimental plots failed due to a number of factors. These include the Gede Regional Research Centre on-station one, which was meant to act as a control. The Dik Diks foraged on it while young and it was later completely destroyed by elephants in the second year. A combination of factors ranging from theft, livestock damage, and technical knowledge to environmental factors led to the failure of the other 3 experimental plots.

METHODOLOGY

The main purpose of the experiment was to establish the right espacement for the growth of *Casuarina equisetifolia* in collaboration with the farmers. This was to make developments of the technology and its adoption by the farmers, cheaper and effective. The following 6 espacements were used in the experiment:

- 0.5 x 1.0 m)
- 1.0 x 1.0 m)
- 1.0 x 2.0 m)
- 1.5 x 1.5 m) - These espacements are Treatments 1-6 respectively.
- 2.0 x 2.0 m)
- 2.5 x 2.5 m)

The six espacements were arrived at after deliberations amongst the model farmers, Researchers, Agriculture officers and Forest Officers at Gede Forest Station during a training workshop held to initiate the implementation of the experiment.

Due to limitation of space, it was not possible to replicate the treatments on the farmer's plot. The different farmers therefore acted as replicates for the experiment.

Photo 1 A woodlot after 4 years showing Casuarina inter planted with coconuts

The selection of the model farmers was based on their active participation in tree growing as per the Forest Department extension officers from the two districts i.e. Kilifi and Malindi. The schools were selected on the basis of those who had been given seedlings by KEFRI in 1997 and had managed them well.

The farmers together with Foresters from KEFRI and Forest Department did the selection of planting sites on the farms The farmers did the clearing and cultivation of the plots whereas KEFRI supplied the seedlings and did the staking and supervised the planting. KEFRI as well did the assessment in collaboration with the farmers. The parameter assessed was height. There was to be a meeting every year up-to the fourth year to enable farmers share experiences and acquire new technologies.

RESULTS:

The seedlings were assessed for growth in height for the first four years i.e. 1998-2001 and for height and diameter (DGL) in February 2002.

The measurements in height the first year are shown in Table I below where all were between 0.3 to 0.53m in height, across the treatments.

Table 1: Summary for height measurements for all participating farmers (1998)

Farmers Name/Treatment	T1	T2	T3	T4	T5	T6
GLADYS KANJU	0.37	0.44	0.44	0.39	0.36	0.39
GEORGE KAINGU	2.42	0.40	0.47	0.43	0.47	0.40
CHARO SIRYA	0.51	0.42	0.46	0.53	0.44	0.46
IRENE MRAMBA	0.33	0.44	0.41	0.39	0.40	0.44
BEATRICE MWAMBIRE	0.48	0.42	0.46	0.49	0.46	0.48
JAMES MWAKWAYA	0.38	0.45	0.44	0.57	0.52	0.46
MATSANGONI P. SCHOOL	0.44	0.43	0.42	0.33	0.28	0.31
FLORENCE MWANGO	0.40	0.37	0.35	0.39	0.36	0.39
MIJOMBONI P. SCHOOL	0.32	0.35	0.28	0.30	0.32	0.33
MKONGANI P. SCHOOL	0.33	0.34	0.34	0.30	0.37	0.32
KAVINYALALO P. SCHOOL	0.36	0.40	0.34	0.39	0.35	0.37
MSABAHA P. SCHOOL	0.37	0.44	0.38	0.33	0.43	0.42
TOTAL	4.71	4.90	5.16	4.80	4.80	4.79
AVERAGE Ht	0.39	0.41	0.43	0.40	0.40	0.40

Height measurements in the second year are shown in Table 2 where they ranged from 0.3 to 3.21m across the treatments.

Table 2: Summary of Height measurements (1999)

Farmers Name/Treatment	T1	T2	T3	T4	T5	T6
GLADYS KANJU	0.87	1.52	1.67	1.26	1.77	1.56
GEORGE KAINGU	0.35	0.57	0.75	1.80	0.82	1.30
CHARO SIRYA	0.84	0.86	0.88	1.88	1.68	1.02
IRENE MRAMBA	1.04	0.82	1.20	1.85	1.91	1.05
BEATRICE MWAMBIRE	1.03	1.01	1.13	1.21	1.45	0.99
JAMES MWAKWAYA	2.55	3.21	2.99	2.46	3.01	2.81
MATSANGONI P. SCHOOL	1.68	1.49	1.04	0.35	0.62	0.42
FLORENCE MWANGO	1.01	0.93	0.96	0.84	0.62	0.75
MIJOMBONI P. SCHOOL	0.62	0.50	0.39	0.60	0.93	0.30
MKONGANI P. SCHOOL	1.62	1.95	1.45	0.59	1.16	0.97
KAVINYALALO P. SCHOOL	0	2.56	1.41	2.33	1.20	1.15
MSABAHA P. SCHOOL	1.00	1.41	1.53	0.84	1.20	1.05
TOTAL	12.61	16.83	15.40	16.01	16.37	13.37
AVERAGE Ht	1.05	1.40	1.28	1.33	1.36	1.11

Height measurements in the third year, shown in Table 3 below ranges from 0.33 to 6.62m across the treatments.

Table 3: Summary for height measurements (2000)

Farmers Name/Treatment	T1	T2	T3	T4	T5	T6
GLADYS KANJU	3.68	4.43	4.70	4.04	3.87	5.06
GEORGE KAINGU	2.60	2.37	2.70	2.80	2.40	4.01
CHARO SIRYA	2.39	3.20	2.40	4.87	4.59	3.32
IRENE MRAMBA	4.01	2.96	3.66	4.80	4.57	3.38
BEATRICE MWAMBIRE	3.90	4.10	4.29	4.91	5.15	3.54
JAMES MWAKWAYA	4.45	6.09	6.62	5.89	6.44	6.33
MATSANGONI P. SCHOOL						
FLORENCE MWANGO	3.28	2.82	2.86	3.42	2.41	3.92
MIJOMBONI P. SCHOOL	2.14	1.64	0.72	1.50	2.12	1.07
MKONGANI P. SCHOOL	4.52	5.12	3.23	4.70	4.40	3.60
KAVINYALALO P. SCHOOL	0.35	0.40	0.33	0.39	0.35	0.36
MSABAHA P. SCHOOL	3.74	4.37	4.59	3.28	4.44	4.35
TOTAL	35.56	37.50	37.10	40.60	40.64	38.94
AVERAGE Ht	3.23	3.41	3.37	3.69	3.69	3.54

Height measurements in the fourth year, are shown in Table 4 below and ranges from 1.19 to 8.35m across the treatments.

Table 4: Summary of height measurements (2001)

Farmers Name/Treatment	T1	T2	T3	T4	T5	T6
GLADYS KANJU	5.97	6.75	6.60	6.76	7.78	7.79
GEORGE KAINGU	3.62	3.02	5.14	5.20	3.42	5.86
CHARO SIRYA	3.67	6.22	4.91	7.62	7.75	6.96
IRENE MRAMBA	5.36	4.15	6.79	6.93	6.93	5.46
BEATRICE MWAMBIRE	5.60	5.64	6.24	7.18	7.65	6.24
JAMES MWAKWAYA	7.13	8.35	-	-	-	-
MATSANGONI P. SCHOOL						
FLORENCE MWANGO	5.14	3.57	5.53	5.75	5.07	6.08
MIJOMBONI P. SCHOOL	4.65	3.41	3.10	3.14	4.90	3.52
MKONGANI P. SCHOOL	5.39	7.30	6.78	6.03	6.34	6.31
KAVINYALALO P. SCHOOL		2.56	1.41	2.33	1.20	1.19
MSABAHA P. SCHOOL	6.43	6.62	6.62	5.93	7.53	6.11
TOTAL	52.96	58.59	53.12	56.87	58.57	55.60
AVERAGE Ht	5.30	5.86	5.31	5.69	5.86	5.56

Height measurements in the fifth year are shown in Table 5 below and ranges from 4.32 to 10.45m across the treatments.

Table 5(a): Summary of height measurements (2002)

Farmers Name/Treatment	T1	T2	T3	T4	T5	T6
GLADYS KANJU	7.10	8.19	9.19	9.79	10.53	10.40
GEORGE KAINGU	4.32	4.38	6.70	6.69	5.46	10.45
CHARO SIRYA	5.58	6.96	6.86	7.58	8.60	9.25
IRENE MRAMBA						
BEATRICE MWAMBIRE	5.47	6.46	9.04	10.34	9.53	9.04
JAMES MWAKWAYA	Harvested					
MATSANGONI P. SCHOOL						
FLORENCE MWANGO	6.36	5.37	8.17	8.36	6.09	7.68
MIJOMBONI P. SCHOOL	9.24	4.38	3.65	3.53	5.46	6.00
MKONGANI P. SCHOOL	5.16	9.08	8.78	5.66	8.34	9.40
KAVINYALALO P. SCHOOL						
MSABAHA P. SCHOOL	8.24	7.98	7.48	7.48	9.10	8.01
TOTAL	51.44	52.80	59.84	58.68	63.12	62.24
AVERAGE Ht	6.43	6.60	7.48	7.46	7.89	7.78

Diameter at ground level measurements in the fourth year are shown in Table 5(b) below and ranges from 3.1 to 9.3cm across the treatments.

Table 5(b): Summary of diameter (DGL) measurements (2002)

Farmers Name/Treatment	T1	T2	T3	T4	T5	T6
GLADYS KANJU	4.0	5.1	5.9	6.1	9.3	7.7
GEORGE KAINGU	4.0	3.8	5.3	4.6	4.8	9.2
CHARO SIRYA	4.3	5.0	5.0	5.7	6.4	7.4
IRENE MRAMBA[1]						
BEATRICE MWAMBIRE	3.1	3.8	5.1	6.8	7.8	7.1
JAMES MWAKWAYA[2]	Harvested					
MATSANGONI P. SCHOOL[3]						
FLORENCE MWANGO	4.2	4.0	5.3	6.3	4.9	6.1
MIJOMBONI P. SCHOOL	4.1	3.4	3.3	4.1	6.2	5.5
MKONGANI P. SCHOOL	3.2	6.0	7.3	5.2	6.3	80
KAVINYALALO P. SCHOOL						
MSABAHA P. SCHOOL	4.7	4.9	5.8	5.6	7.6	7.1
TOTAL	25.6	28.8	34.4	44.8	53.6	58.4
AVERAGE DGL	3.2	3.6	4.3	5.6	6.7	7.3

[1] No assessment was done
[2] He sold his trees to pay school fee for his children
[3] Matsangoni and Kavinyalalo Primary Schools- Assessment was discontinued due to damage by livestock.

A summary on the current situation/status of the experimental plots i.e. woodlots is shown in Table 6 below. Only four of the farmers have harvested trees from five or less of the treatments. Most of the trees have not yet attained the market size and they are still standing.

Table 6: A SUMMARY OF WOODLOT STATUS

TREATMENTS:

Farmer's Name	0.5m x 1.0m	1.0m x 1.0m	1.0m x 2.0m	1.5m x 1.5m	2.0m x 2.0m	2.5m x 2.5m
James Mwakwaya	S	FH	H	H	H	H
Irene Mramba	S	S	S	S	S	S
Gladys Kanju	S	S	FH	FH	S	FH
Florence Mwango	S	FH	S	S	S	FH
Mkongani P. School	FH	FH	S	S	S	S
Mary Kambi	S	S	FH	FH	FH	H
Charo Sirya	S	FH	FH	FH	FH	S
Beatrice Mwambire	S	S	S	S	S	S
George Kaingu	S	S	S	S	S	S
Msabaha P. School	S	S	FP	FP	S	FH
Mijomboni P. School	S	S	S	S	S	S
Kavinyalalo P. School	AD	S	S	S	S	S
Matsangoni P. School	TF	TF	TF	TF	TF	TF

KEY:

H Harvested
P Poached
FH Few Harvested (about 10%)
S Standing i.e. Not yet harvested
AD All Dead
TF Trial Failed
FP Few Poached

Growing of *Casuarina equisetifolia* has great potential in reducing poverty in the two districts from the sale of the poles. Table 7 below shows comparative gross annual returns from the sale of poles by two model farmers i.e.James Mwakwaya and Madunguni Primary School.

Table 7: Estimated comparative gross returns from sale of Casuarina pole per hectare

Farmer	Espacement in meters	Stems per Ha	Assuming 75% survival	Price per pole during		Amount earned (profit)	
				low demand	high periods	low demand	high periods
James Mwakwaya	2m x 2m	2,500	1,875 stems	100 Shs	400 Shs	187,500Sh	750,000Shs
	1.5mx1.5m	4,444	3,333 stems	100 Shs	400 Shs	333,300 Shs	1,333,200Shs
Madunguni Primary School	2m x 2m	2,500	1,875 stems	200 shs	400 shs	375,000 Shs	750,000Shs
	1.5mx 1.5m	4,444	3,333 stems	200 shs	400 shs	666,600 Shs	1,333,200Shs

DISCUSSION:

Casuarina equisetifolia is one of the most widely grown exotic tree at the coastal region. It is mainly grown in the North Coast i.e. around Kilifi, Watamu and Malindi. There is a correlation between the growth of the species and the presence of good road network whereby its growth is spread along the major roads. The intensity of farmers growing *Casuarina* reduces as one moves away from the main road. Also it reduces as one moves far from the major town or tourist destination/resorts. Good road network ensures ease in getting customers as well as getting the product to the market.

From the foregoing, it is important to note that all the sixteen model farmers, who participated in the experiment, were not very far from the main road. Though this was done due to cost considerations. Those far from the road network can only grow *Casuarina* for their domestic use, which would not require to be taken to the urban areas and this will only be on small scale.

During the first year of the experiment, all the seedlings were less than 60cm across the treatments. The average height ranged from 0.39 to 0.43m. There was none of the treatments, which had clear advantage over the rest. It was not even clear of any difference being offered by the site or locality of the area. This could have resulted from several factors the most critical being that the first assessment was done a few months and hence no competition for resources had set in or that they had not fully recovered from the trans-planting shock and therefore not much energy was devoted into growth yet (see Table 1).

In the second year, some clear differences in height appeared. All the treatments in James Mwakwaya's plot had over-shot in height as compared to the rest of the experimental plots, where it ranged from 2.55 to 3.21m. The site could have caused this, because it is next to the mangrove formation/forest in Mida Creek having a high water table. The soil could be rich in nutrients from the coral rocks. Other good examples are those of Irene Mramba, Beatrice Mwambire, Mkongani and Msabaha Primary Schools. The height measurement in these trials ranged from 0.82 to 1.91m (see Table 2).

Also in the second year, the widely spaced treatment i.e. T4, T5 and T6 displayed superior heights across the experimental plots. In the third year of the experiment, all the plots and treatments apart from the Kavinyalalo Primary School, had a height ranging from over 3m to 7.79m. In the third and fourth years of growth, the superiority of wider espacements in heights growth reduced although a slight distinction however remained (see Tables 3, 4 and 5(a)).

However, clear indication was shown in the diameter growth, which was only measured, in the fourth year, whereby the narrow espacements had smaller diameter (DGL) of mostly 4 and 5cm whereas the wider espacements recorded diameters of between 7 and 9cm. From the discussions during a farmers' workshop held on 9th May 2002, farmers pointed out on two espacements i.e. 1.5 x 1.5m and 2.0 x 2.0m as the best because they end up giving the farmers the right end products, which are straight and not too branchy.

Some of the farmers had negligible problems with black blister disease on their plots/ Casuarina woodlots. On this plus other fungal diseases, farmers were advised to practice crop rotation together with acquiring the planting materials from non-infected sources.

The different farmers had to cater for their own labour force to work on their woodlots. For the schools, the concerned teachers had to assign pupils to cater for the planted seedlings. Individual farmers had to work on the woodlot plots themselves. However, some could hire casual labourers at times when they could not manage all by themselves but this was on limited circumstances e.g. when the area is beyond what one can manage alone by the use of family labour. A clear example is that of Irene Mramba who had about 4ha plot under Casuarina (see appendix below)

Protection against theft forced some schools to engage some watchmen to guard their woodlots during the school holildays/vacations e.g. Mkongani Primary School. Others had to hire labour for the establishment and tending of the woodlots e.g. Watamu Primary School.

Some Questionnaires were used to note farmers needs and constraints in woodlot development. From the exercise, it was found that most farmers prefer planting Casuarina seedlings as compared to species such as *Eucalyptus,* which is only planted on a few cases in boundary marking. Another species people prefer includes *Azadirachta indica*, which is used for medicinal purposes. Also planted are the Bamboos, *Acacia mearnsii, Leucaena leucocephala and Jasminia ashok* on a small scale.

Both men and women are equally involved in tree planting and none can be said to have a superior role in the activity. However, it goes by the land ownership and the household head. There appeared to be a careful selection of the planting site for the woodlot on the farms, where individual farmers could plant between 100 to 700 seedlings annually. While schools could plant more than 1000 seedlings per each planting period.

Officers from KEFRI and Forest Department offered the extension services. However, the officers could not visit the farmers as frequently due to lack of enough financial resources. The KEFRI staffs were able to visit the farmers about 3 times per year and schools at least once per term. The major impact of this is that farmers have now become aware of the importance of planting and conservation of trees.

Proper recording and thereafter-possible estimates of the woodlot production was not possible due to lack of costing of the various activities on the farm. Also some practices such as alley cropping were not strictly practiced. No proper marketing strategies were in place either. Farmers were getting customers on a willing buyer-willing seller basis and mostly only neighbouring farmers were able to do this. The only form of advertisement for the product was through Chief's Barazas. Farmers pointed out on marketing of their products being a major problem during the workshop held early this month.

Casuarina growing is a good example of poverty reduction strategy in the two districts and most farmers are actively involved in growth of the species. If a farmer is to use any of the two espacements which they recommended during the last workshop held early this month, one can get monetary returns of between Kshs.750,000 and 1,333,300 during the

high demand period. During the low demand period the range is between Kshs.187,500 and Kshs.666,600 per year as seen from table 7 above. It is not possible to get this amount of money if the land is under food crop cultivation. From this example alone it is easy to make the conclusion that growth of *Casuarina equisetifolia* pays more than that of food crops on simple economic terms.

ACHIEVEMENTS

- There is demand from school adjacent communities to have similar woodlots
- The participating farmers have built support from the adjacent communities and the provincial administration especially on the control of grazing livestock from the neighbours. Initially support was very low

Photo 2 Livestock herding a major problem to on farm forestry in the region.

- The farmers were able to manage the trees with minimal support from KEFRI
- Neighbours are now seeking knowledge on tree growing from the model farmers.

CONCLUSIONS:

1. The effect of espacement manifests itself strongly on the growth habits after several months or after 1 year of growth.
2. The espacement plus tending care determines the rate of growth of a seedling.
3. Wider spacing encourages more diameter growth and branch ness where closer spacing encourages more growth in height and slender stems.

4. *Casuarina equisetifolia* is a relatively fast growing species, which can attain a height of 10m after four years, in the coastal region.
5. Farmers started selling their crop after the third year of growth. If grown for poles, *Casuarina* can have a full rotation age of 5 years.

WORKSHOP RECOMMENDATIONS:

1. Since the closer spaced trial plots have not yet reached the market size and therefore have not been sold, it is recommended that monitoring of the trials should continue up to when they will attain this size.
2. From a training workshop which was held at Gede Forest, Visitors' Centre in May 2001, it was revealed that farmers learn from their neighbours to enable them undertake any tree planting activity and care thereafter on their own. It is therefore recommended that they undergo a harmonized training covering the aspects of tree nursery, planting, diseases and their control as well as the end products. This should be based on the problems encountered by the model farmers and possible solutions. They are facilitated and mentioned as technology disseminators. Their effectiveness will be assessed through analyzing the technology and knowledge diffusion.
3. From 2 above, it is important to monitor the tree growing technology diffusion from the model farmers to their neighbours and assess the impact of the woodlot establishment experiment in the area.
4. The best spacing are 1.5m x 1.5m and 2.0m x 2.0m. They give the best products within a shorter period of time.

POST PROJECT WORKSHOPS WAY FORWARD (These are based on the workshop held on 9th May 2002)

The farmer's discussion of the way forward after the project ends are:

- The relevant government institutions/departments to continue providing the farmers with the seeds and seedlings in future at fair prices.
- Educate farmers on ways of obtaining seeds and seedlings before the nursery stage if possible.
- Provide farmers with other profitable tree species for the benefit of farming e.g. for fencing, agro-forestry, ornamentals etc.
- Frequent visits to the farmers by government technical officers, so as to encourage and guide them technically.
- Assist farmers in the marketing of the farm produce
- Keeping farmers with up-to-date research findings for better production
- Draw an agreement with the Government to lease land to farmers (community) who in turn will grow tree crops and sell themselves
- Train farmers to be able to pass over the technology and knowledge acquired to their neighbours.

Appendix 1: **Summary assessment status for individual farmer's woodlot**

MATSANGONI P. SCHOOL

Mean height for each treatment for each year

Assessment Date and Treatment	T1	T2	T3	T4	T5	T6
30-6-98	0.44	0.43	0.42	0.33	0.28	0.31
20-4-99	0.68	1.49	1.04	0.35	0.62	0.42
26-4-00	-	-	-	-	-	-
22-5-01	-	-	-	-	-	-
28-2-02	-	-	-	-	-	-
Total	2.12	1.92	1.46	0.68	0.90	0.73
MAI*	1.06	0.96	0.73	0.34	0.45	0.37
Survival %	27	-	-	-	-	-

FLORENCE MWANGO

Mean height for each treatment each that year

Assessment Date and Treatment	T1	T2	T3	T4	T5	T6
30-6-98	0.40	0.37	0.35	0.39	0.36	0.39
20-4-99	1.01	0.93	0.96	0.84	0.62	0.75
26-4-00	3.28	2.82	2.86	3.42	2.41	3.92
22-5-01	5.14	3.57	5.53	5.75	5.07	6.08
28-2-02	6.19	5.37	8.17	8.36	6.09	7.68
Total	16.19	13.06	17.87	18.76	14.55	18.82
MAI*	3.24	2.61	3.57	3.75	2.91	3.76
Survival %	75	92	89	73	75	92

MIJOMBONI PRIMARY SCHOOL

Mean height for each treatment each that year

Assessment Date and Treatment	T1	T2	T3	T4	T5	T6
30-6-98	0.32	0.35	0.28	0.30	0.32	0.33
20-4-99	0.62	0.50	0.39	0.60	0.93	0.30
26-4-00	2.14	1.64	0.72	1.50	2.12	1.07
22-5-01	4.65	3.41	3.10	3.14	4.90	3.52
28-2-02	9.24	4.38	3.65	3.53	5.46	6.00
Total	16.97	10.28	8.14	8.14	9.07	13.73
MAI*	3.39	2.06	1.63	1.81	2.75	2.24
Survival %	95	100	73	78	89	89

* Mean Annual Increment

GLADYS KANJU

Mean height for each treatment for each year

Assessment Date and Treatment	T1	T2	T3	T4	T5	T6
30-6-98	0.37	0.44	0.44	0.39	0.36	0.39
20-4-99	0.87	1.52	1.67	1.26	1.77	1.56
26-4-00	3.68	4.43	4.70	4.04	3.87	5.06
22-5-01	5.97	6.75	6.60	6.76	7.78	7.79
28-2-02	7.10	8.19	9.19	9.79	10.53	10.40
Total	17.99	21.33	22.6	22.24	24.31	25.2
MAI*	2.99	3.56	3.77	3.70	4.05	4.20
Survival %	95	92	98	95	73	97

GEORGE KAINGU

Mean height for each treatment for each year

Assessment Date and Treatment	T1	T2	T3	T4	T5	T6
30-6-98	0.42	0.40	0.47	0.43	0.47	0.40
20-4-99	0.35	0.57	0.75	1.8	0.82	1.30
26-4-00	2.6	2.37	2.70	2.8	2.4	4.01
22-5-01	3.62	3.02	5.14	5.20	3.42	5.86
28-2-02	4.32	4.38	6.90	6.96	5.46	10.45
Total	11.31	10.74	15.96	17.19	12.5	22.02
MAI*	2.26	2.14	3.19	3.43	2.5	4.40
Survival %	75	67	80	73	89	44

CHARO SIRYA

Mean height for each treatment for each year

Assessment Date and Treatment	T1	T2	T3	T4	T5	T6
30-6-98	0.51	0.42	0.46	0.53	0.44	0.46
20-4-99	0.84	0.86	0.88	1.88	1.68	1.02
26-4-00	2.39	3.2	2.4	2.87	4.59	3.32
22-5-01	3.67	6.22	4.91	7.62	7.75	6.96
28-2-02	5.58	6.96	6.86	7.58	8.60	9.25
Total	12.99	17.66	15.51	22.48	23.06	21.01
MAI*	0.38	3.53	3.10	4.49	4.61	4.20
Survival %	58	73	84	100	100	92

* Mean Annual Increment

IRENE MRAMBA

Mean height for each treatment for each year

Assessment Date and Treatment	T1	T2	T3	T4	T5	T6
30-6-98	0.33	0.44	0.41	0.39	0.40	0.44
20-4-99	1.04	0.82	1.20	1.85	1.91	1.05
26-4-00	4.01	2.96	3.66	4.80	4.57	3.38
22-5-01	5.36	4.15	6.79	6.93	6.93	5.46
28-2-02	-	-	-	-	-	-
Total	10.74	8.37	12.06	13.97	13.81	10.38
MAI*	2.69	2.09	3.02	3.49	3.45	2.58
Survival %	92	92	89	92	100	84

BEATRICE MWAMBIRE

Mean height for each treatment for each year

Assessment Date and Treatment	T1	T2	T3	T4	T5	T6
30-6-98	0.48	0.42	0.46	0.49	0.46	0.48
20-4-99	1.03	1.01	1.13	1.21	1.45	0.99
26-4-00	3.90	4.10	4.29	4.91	5.15	3.54
22-5-01	5.60	5.64	6.24	7.18	7.65	6.20
28-2-02	5.45	6.46	9.04	10.34	9.53	9.04
Total	16.45	17.63	21.16	24.13	24.24	20.29
MAI*	3.29	3.53	4.23	4.83	4.5	4.06
Survival %	100	89	97	97	92	64

JAMES MWAKWAYA

Mean height for each treatment for each year

Assessment Date and Treatment	T1	T2	T3	T4	T5	T6
30-6-98	0.38	0.45	0.44	0.57	0.52	0.46
20-4-99	2.55	3.21	2.99	2.99	2.46	3.01
26-4-00	4.45	6.09	6.09	6.62	5.89	6.44
22-5-01	7.13	8.35	-	-	-	-
28-2-02	-	-	-	-	-	-
Total	14.51	18.1	9.52	10.52	10.18	9.91
MAI*	3.62	4.52	3.17	3.39	2.95	3.30
Survival %	92	92	75	75	75	95

* Mean Annual Increment

MKONGANI PRIMARY SCHOOL

Mean height for each treatment for each year

Assessment Date and Treatment	T1	T2	T3	T4	T5	T6
30-6-98	0.33	0.34	0.30	0.37	0.32	0.32
20-4-99	1.62	1.95	1.45	0.59	1.16	0.97
26-4-00	4.52	5.12	3.23	4.70	4.30	3.60
22-5-01	5.39	7.30	6.78	6.03	6.34	6.31
28-2-02	5.16	9.08	8.78	5.66	8.34	9.40
Total	17.02	23.79	20.58	17.28	20.51	20.60
MAI*	3.41	4.76	4.12	3.46	4.10	4.12
Survival %	86	83	75	53	92	81

KAVINYALALO PRIMARY SCHOOL

Mean height for each treatment for each year

Assessment Date and Treatment	T1	T2	T3	T4	T5	T6
30-6-98	0.35	0.40	0.33	0.39	0.35	0.36
20-4-99	-	2.56	1.41	2.33	1.20	1.19
26-4-00	-	-	-	-	-	-
22-5-01	-	-	-	-	-	-
28-2-02	-	-	-	-	-	-
Total	0.35	2.96	1.74	2.72	1.55	1.55
MAI*	0.175	1.48	0.87	1.36	0.77	0.77
Survival %	25	25	47	36	50	41

MSABAHA PRIMARY SCHOOL

Mean height for each treatment for each year

Assessment Date and Treatment	T1	T2	T3	T4	T5	T6
30-6-98	0.37	0.44	0.38	0.33	0.43	0.42
20-4-99	1.00	1.41	5.53	0.84	1.2	1.05
26-4-00	3.74	4.37	4.59	3.28	4.44	4.35
22-5-01	6.43	6.62	6.62	5.93	7.53	6.11
28-2-02	8.24	7.98	7.48	7.48	9.10	8.01
Total	19.78	20.82	25.1	17.86	22.7	19.94
MAI*	3.95	4.16	5.02	3.57	4.54	3.98
Survival %	87	100	97	74	67	96

* Mean Annual Increment

APPENDIX II: SUMMARY FOR EACH FARMER AS AT FEBRUARY 2002

Farmer	Major Observations	Comments and Advice
Mijomboni P. School	▪ Trial well kept free of weeds ▪ Breakages by children and browsing by livestock ▪ Sited on poor soil	▪ The woodlot has been maintained through total weeding ▪ Parents and visitors have shown a lot of interest ▪ The woodlot is located by the roadside ▪ Locate the trial further from the reach of children and proper fencing ▪ Select a fertile site in conditions and area that allow growth ▪ The teacher requested training to be able to past over the technology to the parents and visitors
Madunguni P. School	▪ Assessment discontinued after the teacher in charge was transferred ▪ Seedlings were used for general planting not for espacement trial ▪ Many were stolen	▪ More education to the ignorant and if possible, follow KEFRI instructions
Msabaha P. School	▪ Initially weeded then later only slashing ▪ Doing fine though soils are poor ▪ Several cut without the teacher's in-charge's knowledge ▪ Benefit from the sharing of ideas in case of a problem	▪ The teacher in charge should be allowed to know about all the activities done to the plot including sales and other disposals of cut material by the Head Teacher and the School Committee
Kavinyalalo P. School	▪ Initially too off nicely ▪ Being properly weeded and later slashing ▪ Livestock damage was the main problem which later prompted assessment discontinuation due to severe damage	▪ The plot was initially under total weeding ▪ They experienced livestock grazing and had to seek help from the provincial administration ▪ Assessment was discontinued in 1999 owing to livestock damage to the woodlot ▪ Fencing around the trial and beefing up security can curb the problem. ▪ The boundary planted trees are doing well and they have used some of the trees for roofing ▪ The school also has bamboo planted in the compound ▪ Parents have shown interest but the biggest problem has been availability of planting materials ▪ Also educating the public on tree care and involving provincial administration and the school surrounding community

Matsangoni P. School	▪ Weeding was sparingly done and some plots were not even attended to ▪ Fence broke down by livestock. This was after the teacher-in-charge was transferred	▪ Educating the public and winning the heart of the head teacher if possible so as to continue with caring for the plots
Mkongani P. School	▪ This plot is far from the school but on school's land – about 1km away ▪ Initially well weeded and later slashed ▪ Doing fine to-date ▪ No cuttings yet	▪ Did total weeding initially ▪ They had a Eucalyptus plot ▪ The parents have shown interest ▪ Continue thus and try to plant another with the best espacement of their choice i.e. 2m x 2m
Jimba P. School	▪ From the onset the trial was destroyed by livestock and children ▪ This is evidently a case of poor management for immediately after planting, the teacher-in-charge got transferred	▪ Once the teacher-in-charge left, no one else seems to have anything to do with the project ▪ **Advice:** Educating the public, teachers included
Mary Kambi	▪ Initially some seedlings were uprooted by a thief ▪ Generally plots taken care of with initial weeding and intercropping with maize then later only slashing ▪ She has kept her records up-to-date	▪ Replant with the best espacement of her choice (2m x 2m) and continue acquiring more knowledge from KEFRI and other related fields.
Gladys Kanju	▪ Her plots are well taken of with initial weeding for 2 years followed by slashing to-date ▪ Some trees were stolen but the culprits not yet caught ▪ She requests for further training ▪ Has a small tree and flower nursery	▪ The land had been fallow ▪ Did total weeding and inter-cropped with maize initially ▪ Most neighbours have shown interest and want to start growing similar trees ▪ Her trees have been stolen and the culprits have not been punished ▪ Requested for a detailed training to enable her train her neighbours ▪ The husband died within the period we were working together but she has remained active ▪ Continue with her work and plant another site with the workshops unanimously agreed espacement of 2m x 2m
Irene Mramba	▪ Initially the plots were well taken care of ▪ After her demise which was only after one year, her labourer continued to care more for the husband's 4ha of Casuarina of same age ▪ However, slashing at times is done and the trees are surviving	▪ The husband's espacement was 5ft x 5ft which is nearly the agreed 2m x 2m (by participants) ▪ He should adopt 2m x 2m or if he so wishes, continue with his espacement. ▪ He is one of the middle class Casuarina farmers

Florence Mwango	▪ Being one of the more experienced Casuarina farmers, her plot was well kept with frequent weeding till canopy closure.	▪ She was the most experienced casuarinas farmer ▪ She sells casuarinas poles and seedlings to other farmers ▪ She planted eucalyptus seedlings which she had used to roof her kitchen ▪ She used eucalyptus instead of casuarinas because the former will not be bought while the latter will bring her cash ▪ She requested for detailed training to be able to train her neighbours and also advice her customers ▪ To continue thus as she gains more experience from attending more seminars which she requests
James Mwakwaya	▪ Being economically average and at home most of the time, he was able to do all the necessary coordination in weeding, pruning etc. ▪ His site was the most fertile and had a house next to the see thus a high water table and hence growth rate was the fastest	▪ Adopt the newfound best suited espacement and continue growing more Casuarinas and other species. ▪ Convey his knowledge to his sons and grandchildren and encourage then and his neighbours
Beatrice Mwambire	▪ The whole plot was total weeded and intercropped till canopy closure ▪ Trial doing fine but she noted some 2-3 trees poached. There is always a hired hand to care for her shamba	▪ Initially inter cropped with cassava and did total weeding ▪ Neighbours showed interest through enquiries ▪ Plant more Casuarinas with the newfound best espacement ▪ Continue advising farmers on Casuarina growing ▪ Require training to be able to explain the process to the interested neighbours
Charo Sirya	▪ Did total weeding initially and after 1st year continued slashing till canopy closure	▪ The plot was bushy and was cleared and the vegetation burned ▪ Initially did total weeding ▪ Many neighbours have shown interest because the plot is next to the road. This also called for fencing ▪ Experienced termite attack ▪ Plant another plot and continue giving advise and instructing his neighbours with the knowledge gained ▪ Suggested refresher training to be able to pass over the message/technology to the neighbours

George Kaingu	▪ Initially whole plot weeded till canopy closure ▪ The site is very infertile with a lot of termite attacks especially the first two years	▪ The trees were planted in an existing maize plantation ▪ Continue with more tree planting ▪ Has experienced termite attack which he controlled using ash ▪ Trees also damaged by wildlife ▪ Requested training on aspects of disease control ▪ Encourage neighbours and educate them on tree growing
Raphael Ziro	▪ Initially did weeding to whole plot ▪ Later slashing or manually uprooting big weeds ▪ Canopy closure quick since he had planted *E. camaldulensis* ▪ Started harvesting after two years ▪ Neighbours threatened him that he will be arrested so it was very hard to get him till 2 years later after much persuasion and convincing	▪ Advised not to listen too much to neighbours but to remember our agreement during the workshop that the trees are theirs. ▪ Also record his harvests and uses. ▪ He later revealed that most of the cut trees were used for construction or at times those cut were the ones leaning towards a house and used for firewood since they are of big diameters ▪ Confidence with KEFRI staff ▪ Do more planting
Elizabeth Kuto	▪ The trial was set out properly except it was very late in mid June which was towards the end of the rainy season ▪ The farmer, who is a teacher in Jimba P. School was transferred to Nairobi. We lost contact. ▪ Also due to late planting, as a result of the farmer's late shamba preparation, we felt it not in order to continue with this shamba	▪ Proper time for shamba preparation is essential ▪ Have someone else who can continue with the trial in ones absence
Watamu P. School	▪ The site was rocky and at the same time planting was later compounded by the fact that the school hired labour to plant and care for the seedlings, made us abandon the trial. The message was not properly conveyed to the recipients i.e school children or even teachers ▪ Over 90% dried up ▪ The teacher has been very active all through	▪ Site selection is important and also the passing knowledge to pupils and teachers but not hirelings who are always difference people ▪ Teacher-in-charge was only in charge to see trees being planted and occasionally cared for by hired labour and no more ▪ The school is within Watamu township and children there do not like manual labour
Mkongagani P. Sch.	▪ This was just a general planting around the school	
KEFRI-Gede		▪ Did total weeding followed by slashing at ground level supplemented by spot weeding ▪ The experiment was destroyed by wild animals especially elephants

Appendix III : *Post Wood Establishment Workshop Summary of Key Issues*

After deliberations the farmers gave a list of proposals of what KEFRI should do to them to maintain sustainable forest (woodlots) management in their farms.

1. Educate farmers on how best to plant trees and care for them through public meetings

2. Free distribution of tree seedlings to farmers should be done evenly to all interested farmers especially when projects are involved

3. Farmers should be notified before visiting them

4. To curb thieves and other destroyers, the forest staff were requested to assist

5. As for schools, the teacher in charge should also be a farmer therefore he should be able to establish a similar trial in his farm

6. The farmérs brought up the controversial question of Eucalyptus that it dries up the water

7. Forest Station officers to market the over produced wood crops by directing buyers to farmers.

8. Conduct a Casuarina growing promotion meeting out where the people are not only farmers but mixed group

9. One farmer felt it is the work of KEFRI to do research and pass over the finding to rather than farmers doing their own research. This he said is:

   (i) Time wasting
   (ii) Energy consuming, and
   (iii) Land wastage

10. Farmers can estimate the amount of money they can get from the plot by counting their standing crop

11. They have seen for themselves the best espacements. These being 2m x 2m followed by 1.5m x 1.5m

12. They have learnt how to control and solve certain problems e.g.

    - Termites - by spraying
    - Domestic animals – by fencing
    - Drought - by irrigation notably drip irrigation with an inverted bottle especially in schools

13. Marketing their produce –they do it by passing the word verbally to their neighbours or at chief's baraza.

14. The workshop also came up with how best to collaborate with research viz-

- Visiting the research centre for consultation
- Inviting the research officer to visit their farms
- Following the officers' instructions and advice, and
- Educate the community on spacing, frequency and timing of pruning and importance of growing Casuarina.

15. The workshop also came up with some lasting benefits, viz –

(i) Spacing: They have now known the best espacement
(ii) Ignorance: Those who had no interest or were ignorant are now enlightened
(iii) Theft: There is a remarkable reduction of thefts in the forest for construction materials are with them or their neighbours
(iv) Cost: Construction materials are expensive in hardware stores than from the farmers themselves
(v) Soil erosion and wind breaks: This is given by the woodlots planted and also other trees planted by the farmers after above 15(ii)

16. Sharing knowledge and skills with neighbours but they require more training

Appendix IV: *Showing the source of labour*

	Farmer's name	Labour source
1	Mijomboni Primary	School pupils especially Wildlife club society. Security by watchmen when school go on holiday
2	Mkongani Primary	,,
3	Msabaha Primary	,,
4	Kavinyalalo Primary	,,
5	Matsangoni Primary	,,
6	Gladys Kanju	Does all the labour herself/himself
7	George Kaingu	,,
8	Charo Sirya	,,,
9	Irene Mramba	A permanent farm helper who also manages her other plot of *casuarinas* of about 4ha
10	Beatrice Mwambire	A farm helper who also does the weeding and tending of the food crops within the farm.
11	James Mwakwaya	His son and grandchildren does the work though at times he hires extra labour. He mainly supervises.
12	Florence Mwango	Does the labour with a hired labour at times but mostly with her son.
13	Mary Kambi	Does most of the labour. Hires labour when work load is much especially during the rainy weather, planting and harvesting.
14	Raphael Ziro	Does all the work himself
15	Madunguni Primary School	Pupils especially Wildlife Club Society. Security by watchmen when school closes.
16	Watamu Primary School	Hire labour to plant and tend the seedlings.
17	Mkangagani Primary School	Pupils especially Wildlife Club Society. Security by watchmen during holidays.
18	Jimba Primary School	,,
19	Mrs. Elizabeth M. Kuto	All labour and security is done by a hired hand in her farm.

NB
Hired labour is mostly done during the shamba preparation, planting and weeding periods.

APPENDIX V: LIST OF POST WOODLOT ESTABLISHMENT WORKSHOP PARTICIPANTS

	Name of Farmer	**Location**
1	Gladys Kanju	Majaoini/Mtondia – Kilifi
2	Beatrice Mwambire	Mkenge.Msabaha – Malindi
3	Florence Mwango	Roka
4	Philemon Mwango	Mkongani Primary School
5	Simeon C. Muramba	Tezo/Roka
6	James Mwakwaya	Mida/Majaoni
7	Chimega Dedan	Matsangoni Primary School
8	Cosmas Wanje	Mijomboni Primary School
9	Raphael Ziro	Madunguni
10	Mary Kambi	Gede/Jimba
11	David Muramba	Mkangagani
12	Mohamed Issa	Watamu Primary School
13	Alice Kapeku	Jimba Primary School
14	George Kaingu	Msabaha Primary School
15	Charo Sirya	Jimba
16	George M. Gungu	Madunguni Primary School
17	Roman Iha	Msabaha Primary School
18	Frankline Mole	Kavinyalalo Primary School
19	Charles Mkare.	KEFRI/Facilitator
20	G.K. Kimani	KEFRI/Facilitator
21	Wairungu Simon N.	KEFRI/Facilitator
22	M.T.E. Mbuvi	KEFRI/Facilitator