EFFECTS OF EUCALYPTUS ON FARMLANDS IN WESTERN KENYA

By

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ABSTRACT

Eucalyptus (*Eucalyptus saligna* and *Eucalypts grandis* or (*saligna/grandis* hybrid) is widely grown by small-scale farmers in the highlands of western Kenya. Preference for the species is due to its fast growth, good stem form, coppicing ability, reasonably durable wood, tolerance to water logging, multiple-use (firewood, poles, posts, and timber), ready market for its products, easy workability characteristics and environmental conservation. Trees are planted as small woodlots in areas of low agricultural productivity, steep slopes or swampy places.

This study carried out in Gucha, Nyamira, Kisii. Nandi, Kakamega and Vihiga districts of Western Kenya sought to document effects of Eucalyptus on farmlands

From each districts two divisions with a large number of tree growers were selected. From each division, forty (40) farmers who have been actively involved in tree planting, management and utilization were randomly selected and interviewed using pre-prepared questionnaires. Visits and observations were also made to individual tree planting sites.

Eucalyptus though grown and preferred by many farmers, it has several negative impacts on the farmlands. Heavy water consumption, crop yield reduction and nutrient depletion are the main negative effects associated with this species.

In part II of the research, looking at the allelopathic effects of Eucalyptus on agricultural crops, it was observed that Eucalyptus leaf extracts reduced seed germination, leaf area, number of leaves, shoot length and seedling growth of maize and beans.

ACKNOWLEDGEMENT

This study could not have been completed without the support and co-operation of various people. I am greatly indebted to the Director; Kenya Forestry Research Institute (KEFRI) from whom the original idea of this study came. I most sincerely thank KEFRI for financial support. Special thanks go the District Forest Officers (Gucha, Nyamira, Kisii, Kakamega, Nandi and Vihiga) who assisted in selecting the farmers who were interviewed. I am very grateful to the field technicians in the ministry of Agriculture from the above districts who assisted me in carrying out the surveys. Laboratory and nursery staff from Maseno Regional Research Centre who assisted in laboratory analyses and green house experiments respectively. My thanks also go to Mrs Hakima Mohamed and Joska Adhiambo Ajuka for typing this report.

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PART I

EFFECTS OF EUCALYPTUS ON SOILS

BACKGROUND

Eucalyptus tree planting is a main activity of the small-scale farmers in the highlands of western Kenya. The two main species grown are *Eucalyptus saligna* and E. *grandis*. A study carried out in western Kenya and parts of Nyanza province has shown that it is the key species and most farmers interviewed indicated that this species will continue to rank highly in their tree planting programmes. Eucalyptus is preferred because of its fast growth, good stem form, coppicing ability, reasonably durable wood, tolerance to water logging, multiple-use (firewood, poles and posts, timber and essential oils), ready market for its products, easy workability characteristics and environmental conservation. Despite its popularity as already stated above there are several arguments that have been advanced as to the inappropriateness of this species on the farmlands. Some of these include: -

(1) Heavy consumer of water
(2) Most agricultural crops do not perform well in areas where Eucalyptus has been planted
(3) Suppresses other plants
(4) Exhausts the soil
(5) Sparse canopies of eucalyptus do not protect the soil from erosion

Considerably nutrient capital changes should be expected in Eucalyptus woodlots/ plantations because of the frequent thinning or felling for wood. This leads to removal of nutrients from the sites. The nutrients in the products are removed within a comparatively short period of time because Eucalyptus grows very fast and are harvested within a relatively short period of time. The three main aspects of plantation

cropping that affect the nutrients in the soil are parts of the tree that are removed, the type of management needed to obtain it and the harvesting method used. Removal of any part of the plant has a "nutrient cost". Nutrients are found in every part of the tree in different proportions, and biomass may therefore be used to measure the amounts of nutrients removed in tree crop harvests.

Despite adverse technical, ecological and socio-economic publicity on the planting of *eucalyptus* species, the species ranks highest on the farms in the densely populated highlands of Western Kenya. The negative effects associated with this species on water consumption, crop yields and soil quality are in most cases exaggerated. Studies carried out in various parts of the world suggests that eucalyptus are much more efficient users of water for the amount of biomass produced (Gelder and Poulsen, 1982; Davidson, 1980).

Although it seems that there are widespread beliefs that Eucalyptus has detrimental effects on the environment very few comparative studies have however been made on soil nutrients among plantations of different species including eucalyptus and the adjacent natural forests (Michelsen *et al*., 1996; Betre Alemu, 1998). In Kenya, literature on studies with sufficient scientific evidence to support these beliefs is lacking.

In view of the fact that we lack scientific information on the effects of Eucalyptus on soil quality, there is a need to undertake a study with the aim of finding out the main effects of Eucalyptus on farmland soils.

Broad objectives

To find out the main effects of Eucalyptus on farmlands through laboratory analyses of the (physical and chemical) soil characteristics.

Specific objectives

(i) To find out the main effects of Eucalyptus on farmlands through laboratory analysis of the (physical and chemical) soil characteristics.

(ii) Effects of Eucalyptus on the germination and early growth of common agricultural crops.

(iii) Effects of Eucalyptus on agricultural crops in the vicinity of woodlots, individual trees or boundary plantings.

(iv) Effects of Eucalyptus on water resources.

Surveys methods

Surveys were conducted at three levels; District Forest Officers (DFOs), agricultural extension staff and farmers.

District Forest Officers were interviewed on general information related to their experiences from their respective districts. The DFOs assisted in identifying the divisions where the interviews were conducted and the farmers who were interviewed

Farmers were interviewed on their reasons for site selection, effects of Eucalyptus on intercropping, adjacent crops, water resources, allelopathic effects, Effects of Eucalyptus on different crops, seed germination, seedling growth, crop yield.

Sampling methods

Selection of target divisions, individual farmers, was done at the district level. Two divisions were selected each district. From each division 40 farmers were selected for a more focused study.

Representative data on the above information by interviewing a random sample of Forty (40) farmers with a long history of tree planting, management and utilization. A total of 400 farmers were interviewed. The interviews were carried out between October, 2001 and June, 2002.

Study Area

This study was carried out in Gucha, Nyamira, Kisii, Vihiga, Nandi, and Kakamega, districts.

RESULTS AND DISCUSSION

Choice of site

Eucalyptus is mainly planted around farm boundaries (30%), along river banks and valleys (30%), on unproductive agricultural lands (14%), in the home compound (12 %) and as woodlots in some part of the farm (10%) (Fig. 1). The reasons given for the choice of site were quite varied. Eucalyptus is planted along farm hedges to act as a windbreak and to mark farm boundaries. Planting in valleys is attributed more to the fact that such sites are not appropriate for other agricultural activities such as crop production. Planting in unproductive agricultural land is attributed to the fact that Eucalyptus is able to thrive in poor sites, where other tree species and agricultural crops do not perform well. It was also noted that about 10% of the farmers have Eucalyptus in woodlots. These were not restricted to any specific site. Woodlots of

Eucalyptus specifically managed for pole production were a common site in Vihiga district where it is grown as a cash crop. It is also used as a land reclamation species where it is planted in valleys and on barren lands.

Given the small sizes of land in the study areas, most farmers prefer planting the tree in areas that it will least compete with agricultural crops such as: homesteads, riverbanks and steep valley terrains, barren lands having no other appropriate utility, or in some isolated corner of the farm. The choice of the planting site was strongly influenced land availability and utility.

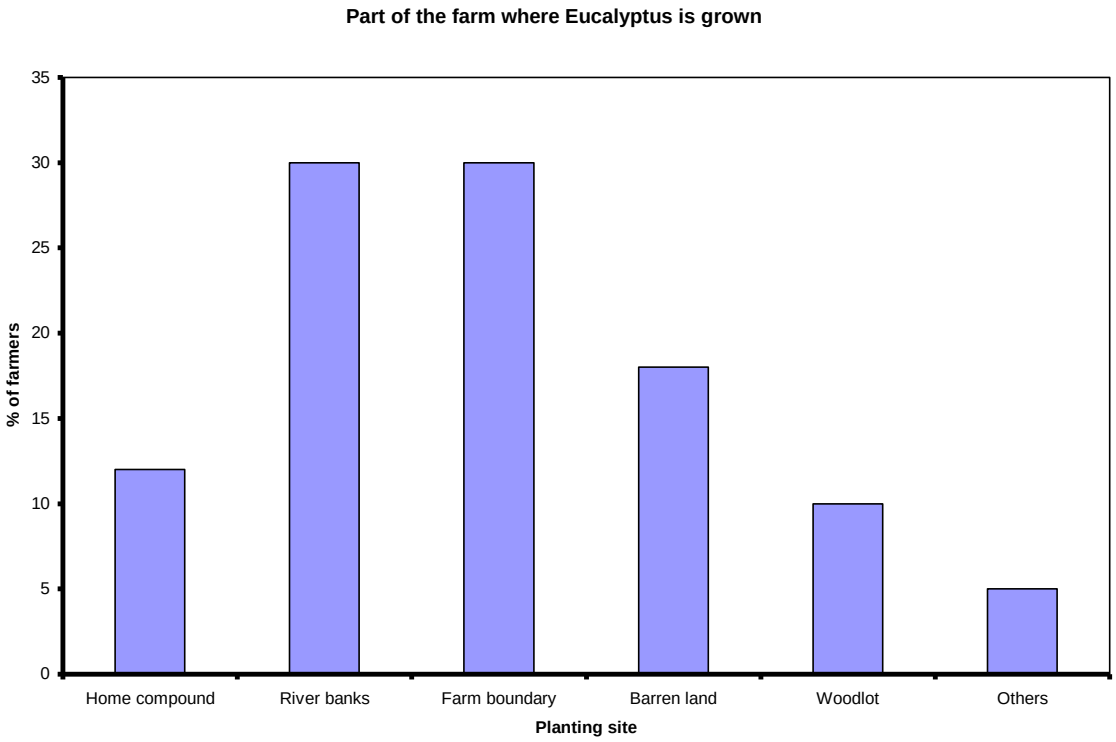


Figure 1: Part of the farm where Eucalyptus are grown.

Reasons for choice of site

Soil conservation, availability of space, avoiding competition with agricultural crops and land reclamation were the main reasons for choosing sites where Eucalyptus was planted. Research and experience elsewhere have shown that *Eucalyptus saligna* is a

good species for reclamation of water logged sites. The farmers in the study areas seemed to acknowledge this important role of Eucalyptus.

Availability of space (18%) was an important reason given that land in the study area is very scarce. Most sites chosen are those not appropriate for any agricultural activities. Farmers had no option but to utilize any available space. Farmers were also keen on avoiding competition (16%), as most farmers are aware that Eucalyptus is a heavy water consumer and therefore affects agricultural crops negatively (reduction in crop yields).

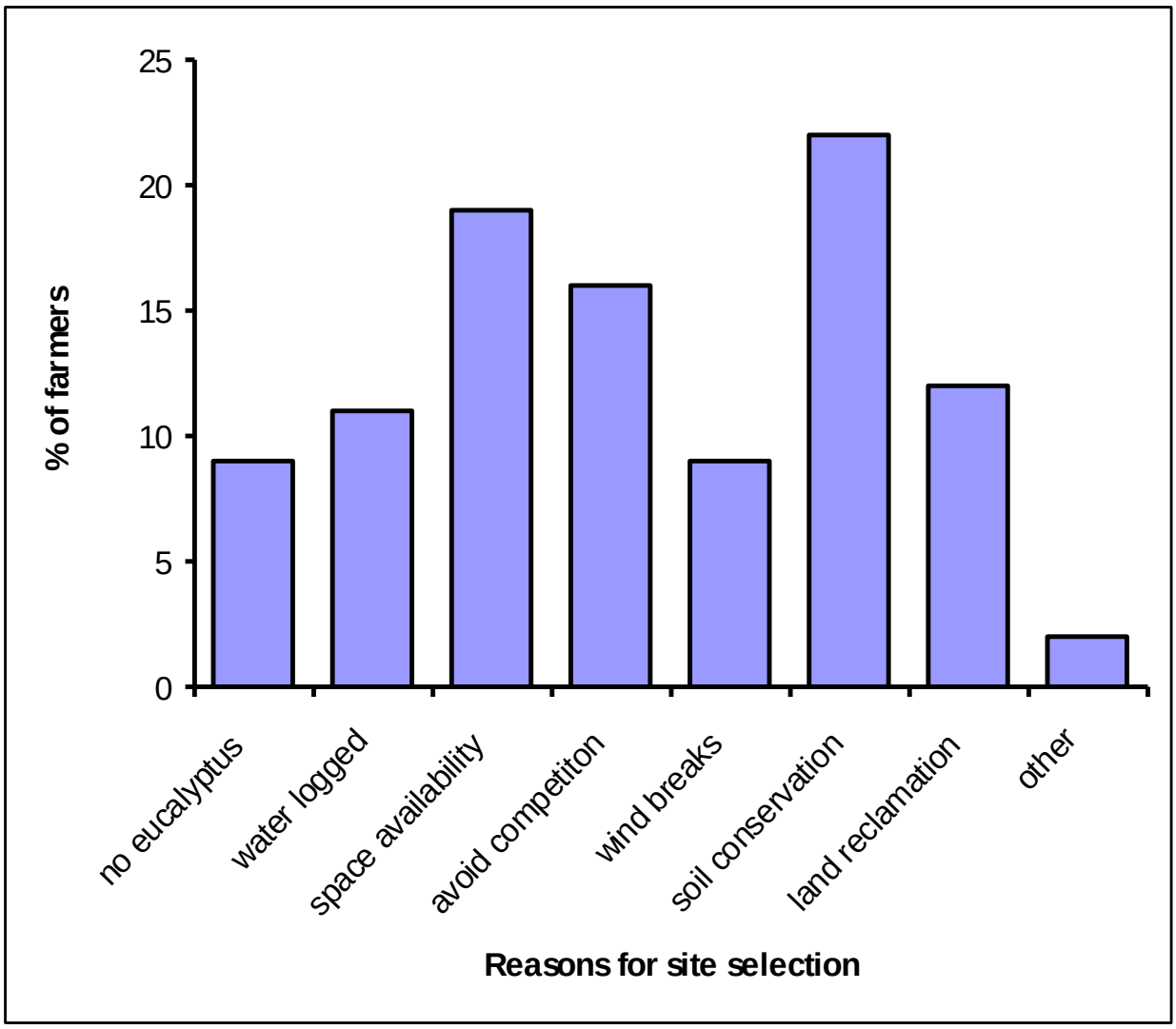


Figure 2: Reasons for site selection

Eucalyptus as an intercrop

The negative (allelopathetic and competition) effects of Eucalyptus on crops seemed to be well known to the farmers hence perhaps the reason why 76 % of the farmers interviewed do not intercrop (fig. 3).

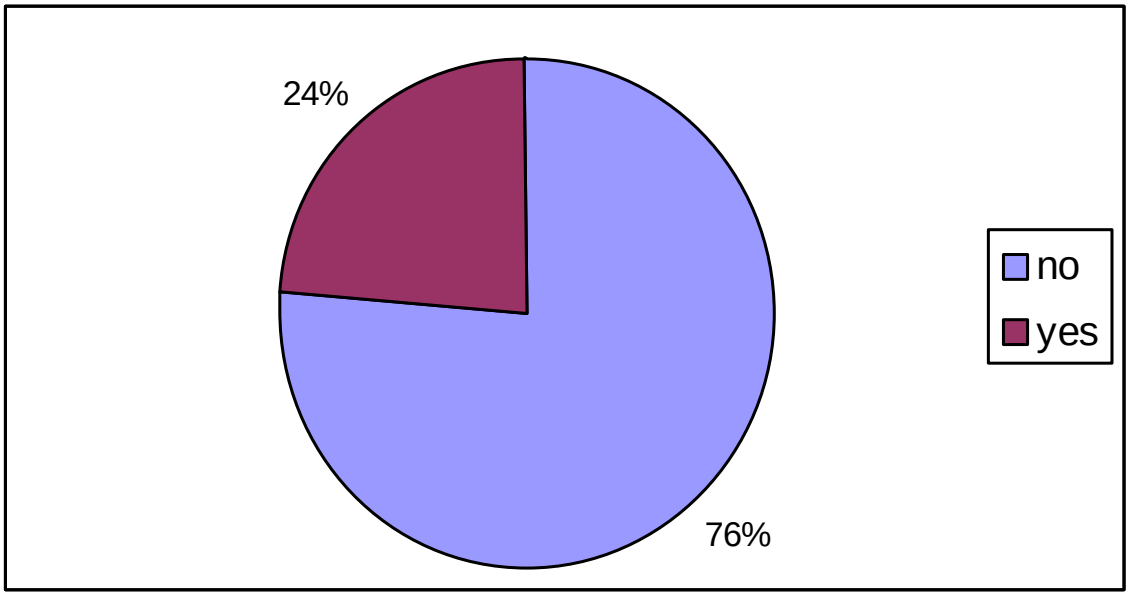


Figure 3: Intercropping with Eucalyptus.

Effects of Eucalyptus on intercrops

About 50% of the farmers are of the opinion that Eucalyptus has negative effects on intercrops while 8% of the farmers thought Eucalyptus had positive effects. The rest (42%) think that it has either no effect or were unaware of any effects (Fig.4). The main negative effects are those associated with reduction in yield and stunted growth resulting from competition for moisture, nutrients, shading and allelopatic effects (direct chemical influences of Eucalyptus on other plants) and the cumulative effects of any chemical/physical changes in the soil.

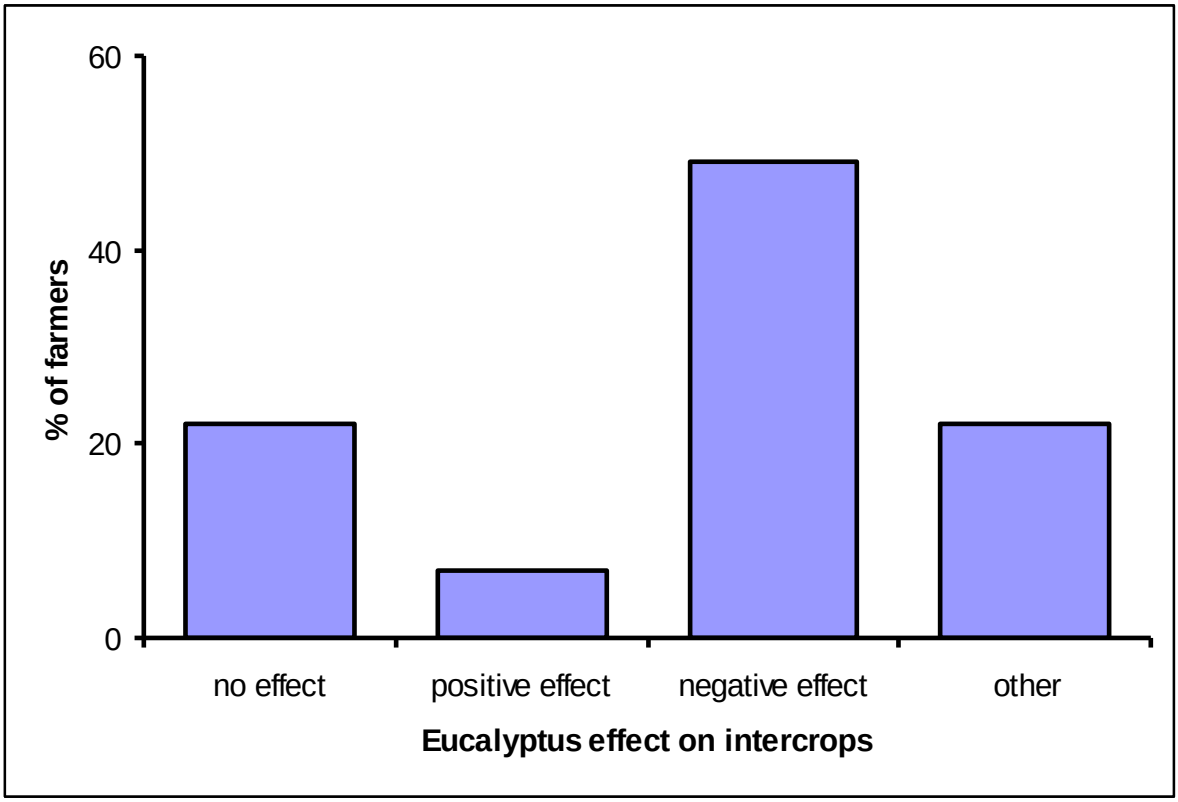


Figure 4: Effect of Eucalyptus on intercrops

Effects of Eucalyptus on adjacent agricultural crops

Approximately 80% of the farmers were of the opinion that Eucalyptus has negative effects on adjacent crops. Farmers noted some of the negative effects as high consumption of water leading to lowering of the water table. This may explain the marked drying up of soil up to 10 – 15m from the shelterbelt that was observed in most farms. There was a considerable reduction in growth rate, biomass and grain yields of most agricultural crops in the distance noted above.

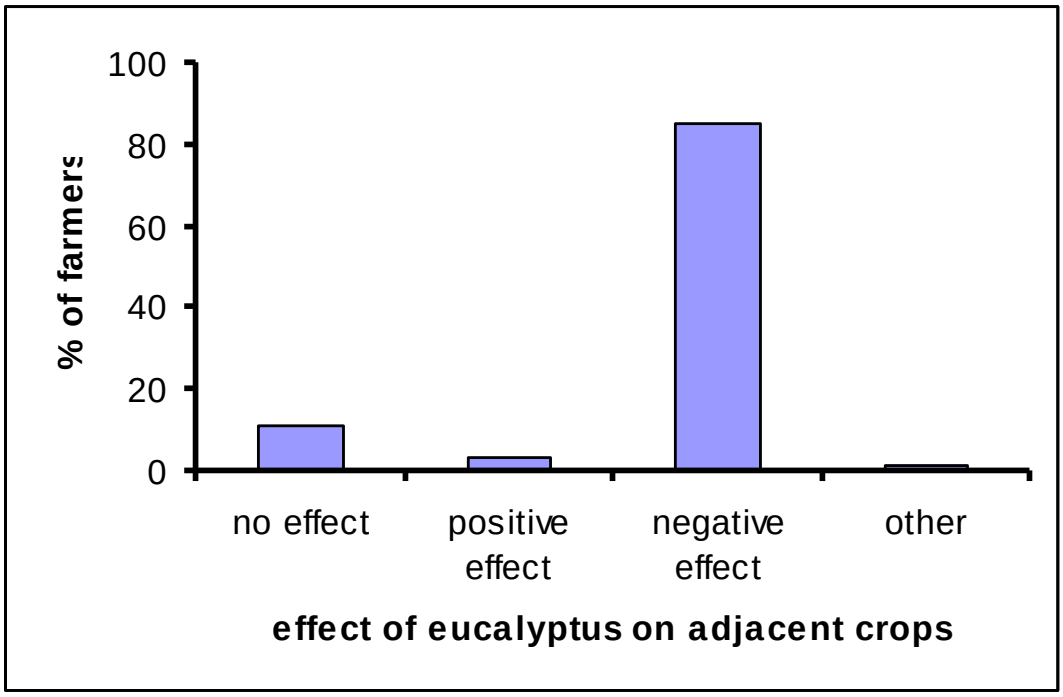


Figure 5: Effects of Eucalyptus on adjacent crops

The lowering of crop yields along common boundaries is a main cause conflicts between some neighbours in some districts particularly in Nyamira where several cases have been reported at the District Forestry and Agricultural offices. In both cases the officers in charge have not done much as there is no clear policy related to planting and management of Eucalyptus trees along common boundaries

Effect of Eucalyptus on various agricultural crops

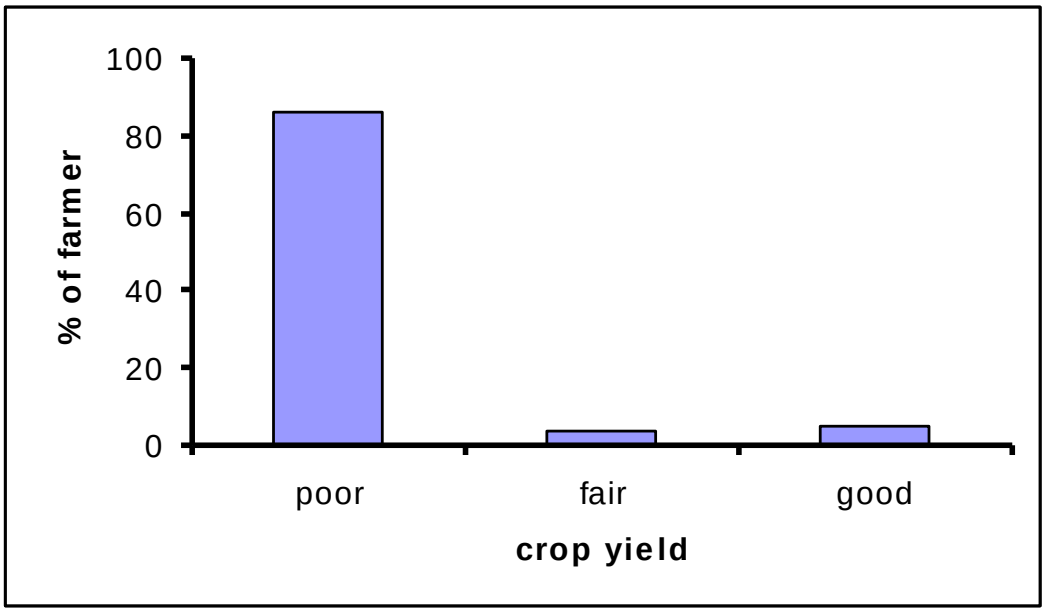
Maize, (88%), beans (47%) and tea (17%) were the most affected crops (Table 1). This observation may be explained by the fact that these are the main agricultural crops in the study areas. Given the small sizes of land, these crops were generally found commonly occurring close to the trees planted along the farm boundaries, along the road or as woodlots. The effect of Eucalyptus on other agricultural crops in the study area is not clear. This is possibly because most of the other crops were not

commonly cultivated close to Eucalyptus trees or that the farmers interviewed do not grow these crops and therefore do not have any idea as to the effects.

Table 1: Effects of eucalyptus on various crops

Crop	% of farmers		
	Affected	Not affected	others
Maize	88	12	0
Beans	47	2	51
Sorghum	6	2	92
Tea	17	2	81
Sugarcane	1	2	97
Potatoes	1	2	97
Others	17	0	83

Effects of Eucalyptus on crop yield



From figure 6 below, it is evident that, Eucalyptus has a negative effect on crop yields (88%). Reduction in crop yields was attributed to competition for moisture, nutrients, allelopathic effects and shading.

Figure 6: Effect of Eucalyptus on crop yield

Just as in yield, the growth rate of most crops is affected by Eucalyptus (Fig.) Agricultural crops were noted to be stunted in growth.

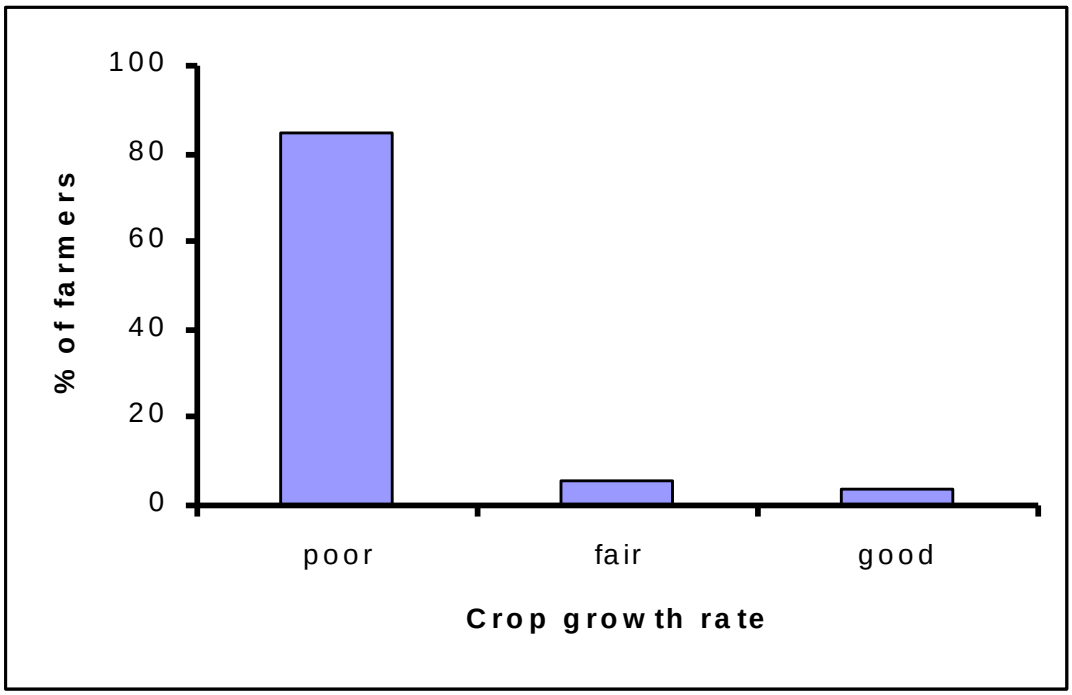


Figure 7: Effect of Eucalyptus on crop growth rate

40% of the farmers were of the opinion that Eucalyptus affects germination while 35% felt otherwise. Eucalyptus did not seem to have a serious negative effect on the germination of crops (Figure 8). This is attributed to the fact that most farmers do not intercrop.

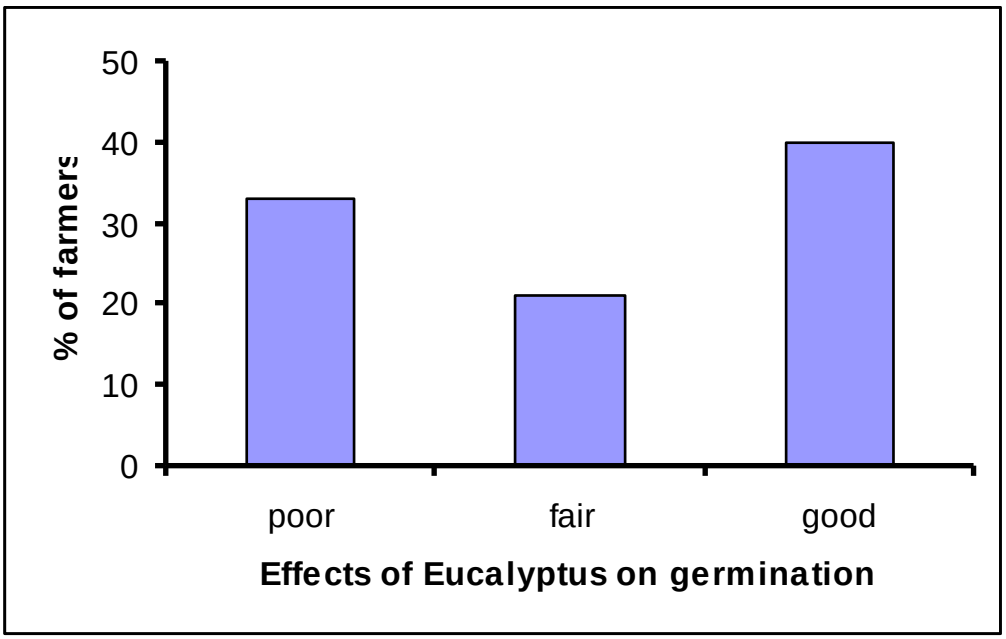


Figure 8: Effect of Eucalyptus on crop germination

Eucalyptus affects not only agricultural crops but also other trees. Figure 9 below illustrates the proportion of farmers whose other trees on the farm were affected by Eucalyptus.

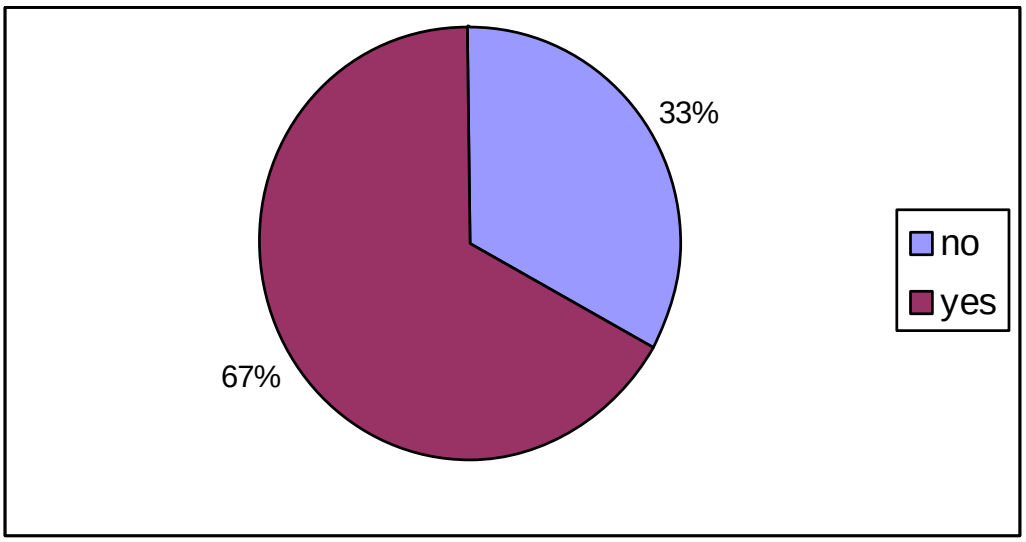


Figure 9: effects of Eucalyptus on other vegetation

Effect of Eucalyptus on other plants

67% of the farmer interviewed were of the opinion that Eucalyptus trees have a negative effect on other plants. This is evidenced by the fact that very little vegetation is able to establish in Eucalyptus woodlots. Due to fast growth rates, Eucalyptus trees are more competitive for water than most plants. Some Eucalyptus are known to produce toxins which can inhibit the germination or growth of some plants (Power and Fries, 1985).

Eucalyptus and soil nutrients

Effects of Eucalyptus on soils were noted as drying up the soil (48%), nutrient exhaustion (30%) and others unspecified effects (22%) (Fig.10).

Most farmers interviewed were of the opinion that the tree uses a lot of nutrients leading to soil exhaustion and reduction in crop yields. This could be because of its fast growth rate. Most plants perform poorly on sites previously planted with Eucalyptus. A study carried out in India (A. N. Chaturvedi) to develop yield tables for Eucalyptus hybrids established the fact that mean annual increment reaches a peak in

the 6th or 7th year of growth. Consequently the growth rate is high, leading to a high demand for nutrients. If the trees are therefore harvested before attaining the age of maximum growth, soil declines in nutrients and moisture content.

Considerable nutrient capital changes should be expected in Eucalyptus woodlots managed for pole production because of the frequent thinning or felling of the wood. The nutrients in the products are removed within a comparatively short period of time because Eucalyptus grow very fast and are harvested within short duration.

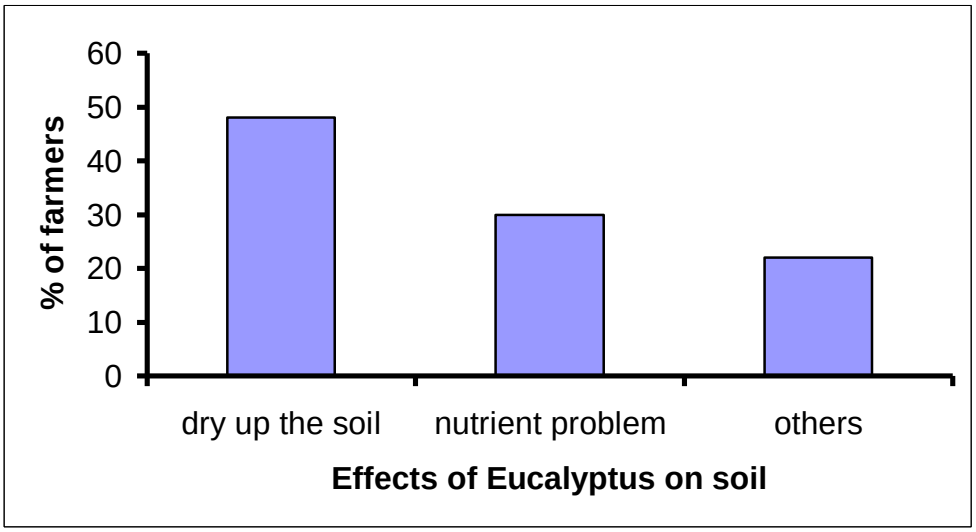


Figure 10: Effects of Eucalyptus on soils

Eucalyptus and soil erosion

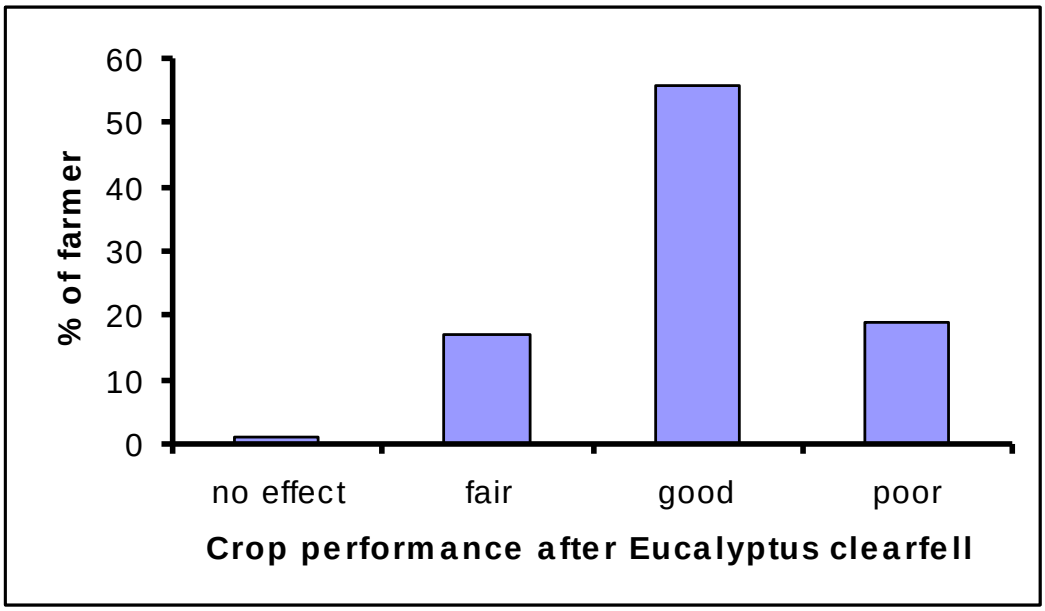
In a number of the farms visited in the study areas, Eucalyptus trees were found in some of the steepest topographies on the farm where no other crops could be grown. Though this was done with the aim of maximizing on land use, there was the indirect understanding that the trees were used to hold the soil together. This is more so along the riverbanks. It is essential for physical soil cover to be present and for incorporation of organic matter into the soil to slow runoff and improve infiltration. Farmers seem to know that when planting Eucalyptus, this should be done in dense

stands that are periodically thinned/coppiced only part at a time so that there is a multi layered canopy and they allow grass to grow underneath.

Tree monocultures of any kind may not be the best solution to soil erosion, particularly sheet or surface erosion, however *Eucalyptus globulus* has a good reputation for catchment protection. It is widely planted in many countries for this purpose.

Performance of crop after Eucalyptus clearfell

Over 55% of the farmers reported a good crop performance following clear fell of Eucalyptus stands (Fig. 11). This may be attributed to soil fertility from organic matter that has accumulated over a period of time. The good crop performance may be expected in the first 1-3 seasons. This is usually followed by a decline in crop yields resulting from nutrient depletion as a result of crop uptake, removal of topsoil



by soil erosion agents and other losses such as denitrification.

Figure 11: Performance of crop after Eucalyptus clearfell

For most agricultural crops no effects were noted on utilization of lands previously under Eucalyptus as shown in table 4 below. Most agricultural crops were noted to perform well after clearfell of Eucalyptus woodlots

Table 2: Response of various crops after Eucalyptus clearfell

Crop	**Affected**	**No effect**	**others**
Maize	38	59	3
Beans	28	69	3
Vegetables	12	85	3
Nappier	23	74	3
Millet	13	83	4
Others	35	62	3

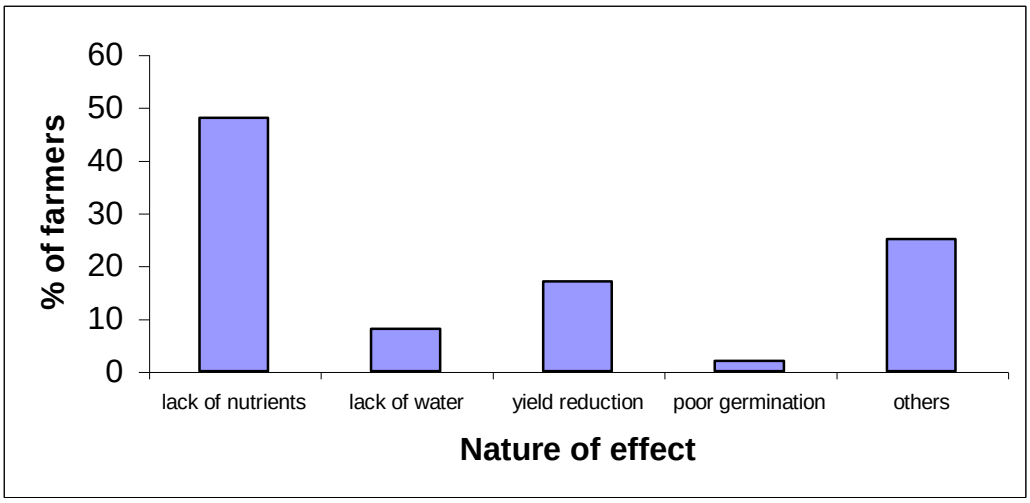


Figure 12: Ways in which Eucalyptus affect crops

Effects of Eucalyptus on water resources

Most of the farmers interviewed (71%) noted that Eucalyptus does affect water resources (Fig.13). The main effects were noted as reducing the volume of rivers (42%), drying of streams (26%) or both (32%). It was particularly noted that many waterlogged places had dried on introduction of Eucalyptus. In a number of places, springs were noted to have dried up in areas close to Eucalyptus trees. Drying of previously swampy places where Eucalyptus has been introduced and lowering of water levels in river and drying of some streams that were previously permanent were reported in many places.

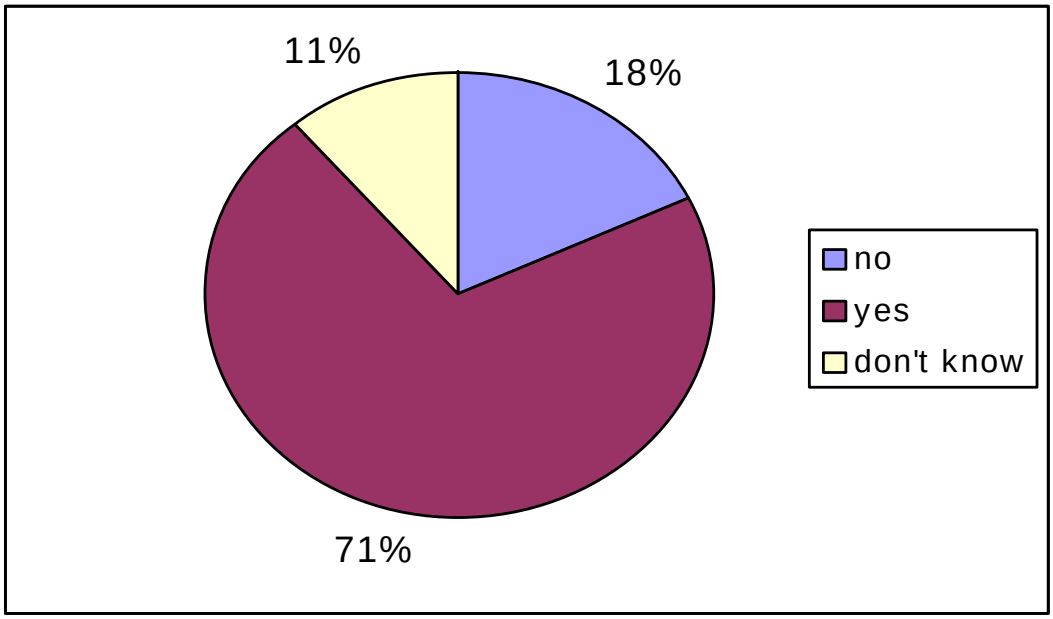


Figure 13: Farmers response as to whether Eucalyptus affects water resources

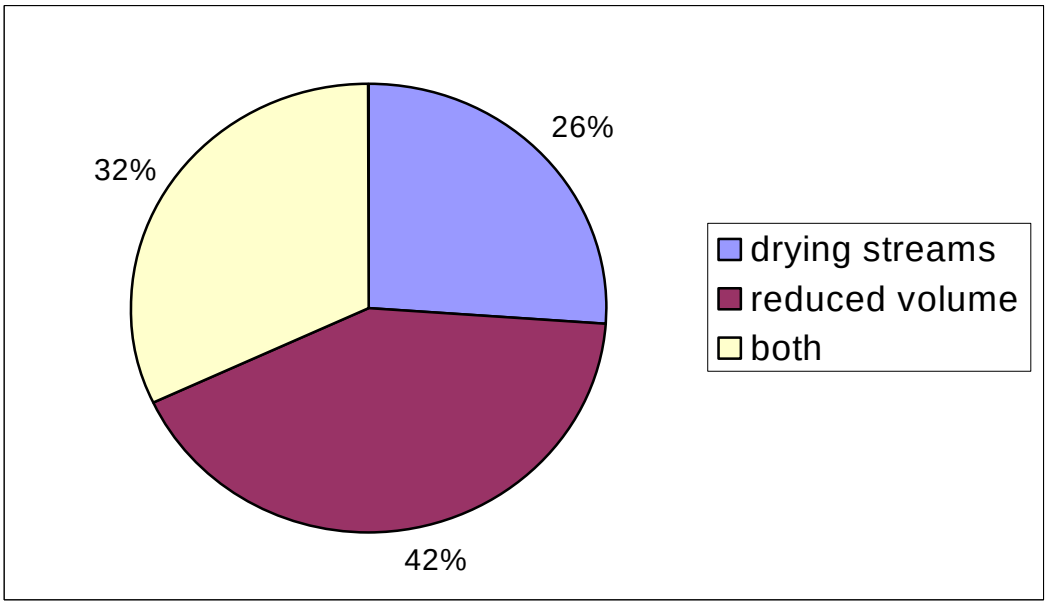


Figure 14: Effect of Eucalyptus on water resources

Disadvantages of Eucalyptus

Eucalyptus have been and will continue being grown due to its fast growth, good stem form, coppicing ability, reasonably durable wood, tolerance to water logging, multiple-use (firewood, poles and posts, timber and essential oils), ready market for its products, easy workability characteristics and environmental conservation. Heavy consumption of water (55%), no intercropping (12%), damage to houses (10%) and attraction of lightning (4%) were noted as the main disadvantages of Eucalyptus.

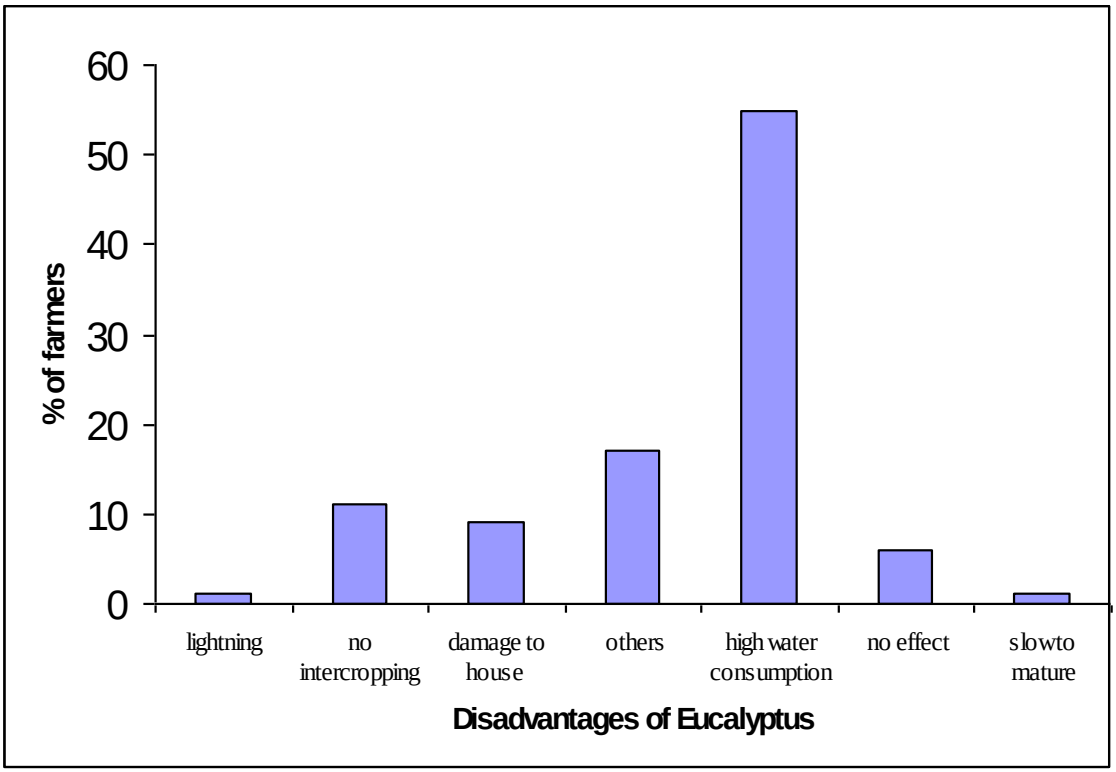


Figure 15: Disadvantages of Eucalyptus

PART II

ALLELOPATHIC EFFECT OF EUCALYPTUS ON AGRICULTURAL CROPS

Introduction

Allelopathic effect on agricultural crops by several tree species has been well established. General allelopathy to agricultural crop is well established, for example, a number of tree species (*Eucalyptus tereticornis*, *Casuarina equisetifolia* (Rai, 1987); *Eucalyptus citriodora*, *Eucalyptus camaldulensis* and *Eucalyptus grandis* (Igboanuga, 1988) have been reported to be allelopathic to cow peas resulting in reduced seed germination, seedling growth and yield. Sanker and Rai (1993) found that leaf extracts of *Eucalyptus camaldulensis* produced strong volatile toxins identified as phenols and terpenes. The allelopathic effects of aqueous leaf extracts of *Eucalyptus spp* was reported to reduce considerably seed germination and seedling growth of a wide variety of crops (Anwar, 1991; Bansal *et al*, 1992; Sanginga and Swift, 1992). Due to their fast growth, wide adaptability and multiple uses, Eucalyptus *spp* have overshadowed the indigenous tree species in plantation forestry in many countries.

With the controversial views about Eucalyptus *spp* especially their ill effects on the environment in terms of soil toxicity, this present study was undertaken with the objective of investigating the allelopathic effects of Eucalyptus on two important agricultural crops (maize and beans) in western Kenya

Material and methods

Water extracts from fresh and dry leaves were obtained by water distillation.

Plant Materials

Common agricultural crops – Maize, beans

Extraction of crude oil

Crude volatile oil was extracted from fresh and dried leaves of *Eucalyptus grandis* by water distillation method according to British Phaemacopoeia (1980). Prior to distillation the leaves were cut into small pieces. Some leaves were dried by direct exposure to dry air in dark room for 3 days and the remainder was be used as fresh. 300g of leaf material were placed into 5 litre round bottomed flask, 3 litres of distilled water were added. Water was boiled and distillation was carried out for two hours after boiling until no further increase in crude oil yield. The volume of oil was then measured (V/W). After cooling at room temperature, the oil was collected and dried over anhydrous Sodium Sulphate and kept in brown bottles in a refrigerator for further use.

Effects on seed germination

Germination on blotters

Standard dishes were used (9cm diameter). 3 layers of filter paper (Whatman No. 1) were placed in each petri dish. The filter paper was kept continuously wet by adding distilled water when needed. Different oil concentrations from fresh as well as from dried leaves (0.00, (control) 0.01, 0.03, 0.05, 0.1 % (V/V) were applied to the wet filter paper using a micropipette. A total of 5 healthy seeds were placed in each petri dish and kept at room temperature and germinating seeds were counted daily until the

end of germination. The experiment was replicated four times for each oil concentration from fresh and dry leaves including the control.

Germination in sterile moist sand

The same set of experiments was prepared as above, but moist sterile sand in trays divided into small components was used. Coarse sand was sterilized in an oven at 100^0C for 3 hours. The various oil concentrations were added (V/V) using a micropippette and carefully mixed with sand using a glass rod. Germinating seeds were counted daily until no further germination occurred.

Allelopatic effect on seedling growth

Agricultural crops seedlings were obtained from control treatment from the above mentioned experiments. Oil concentrations were applied to moist sand in trays as mentioned above and no oil was added as a control. Each treatment was replicated four times for oil from fresh and dried leaves each. Distilled water was added to keep the sand wet throughout the experiment when needed. The following parameters were measured for each seedling in all treatments every 48 hours for 4 weeks.

1. Number of leaves produced
2. Leaf area (cm^2)
3. Shoot length (cm)
4. Dry biomass

Statistical analysis were carried out using ANOVA.

Results

Germination in blotters

Crude oil significantly ($P<0.05$) reduced the germination % of maize/bean seeds. The mean germination was 100 %, 83 %, and 72 % in control, crude oil from dry and fresh leaves respectively (fig 1). It is evident that oil from fresh leaves was more effective as compared to that from dry leaves. Also the effect was dependent on the concentration in dry leaf oil.

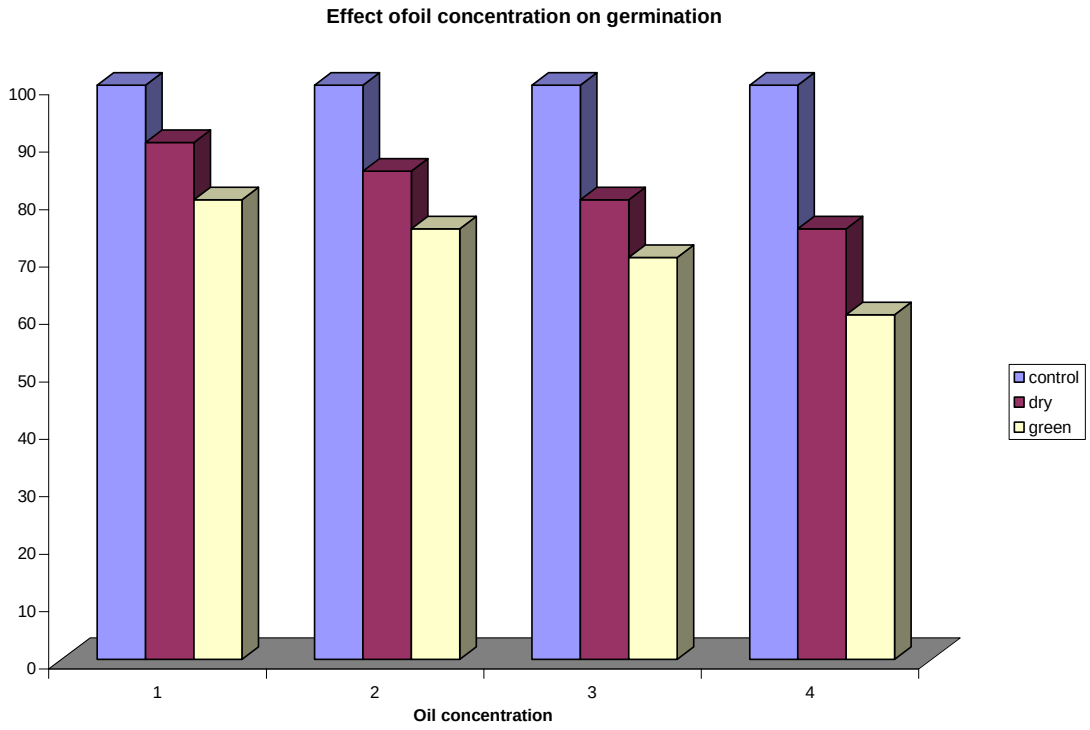


Fig 14: The effect of oil concentration on germinating seeds

Germination in sand

Similarly, crude oil from fresh and dried leaves significantly ($P<0.01$) reduced the germination % in sand. Mean germination % was 100 %, 80 %, and 65% in control, dry and fresh leaf oil respectively. It is evident that oil from fresh leaves was comparatively more effective (Fig 15). The impact was correlated with oil concentration i.e as oil concentration increased a lesser number of seeds germinated.

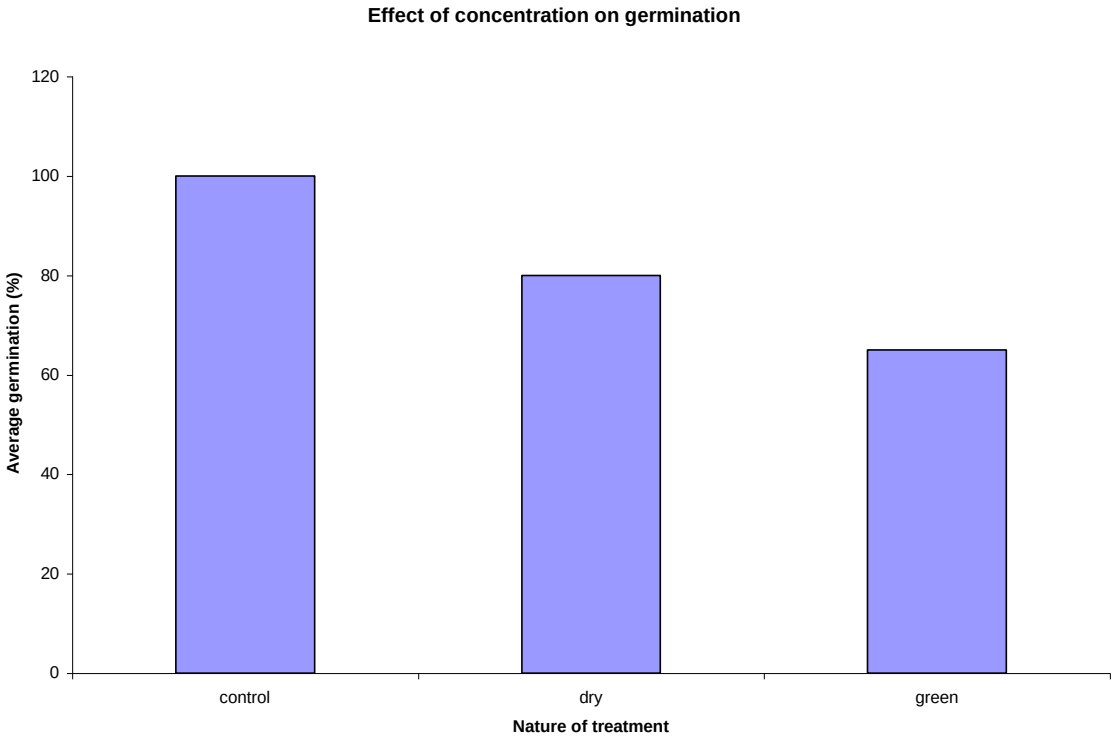


Fig. 15 Effect of different treatments on germinating seed

Effect of crude oil on seedling growth effect on number of leaves

Crude oil from green leaf extracts reduced the number of leaves produced by bean seedlings. Although there was a general decrease in number of leaves these reduction was not significant. A negative correlation was recorded between oil concentration and the number of leaves produced by the beans (Fig 16).

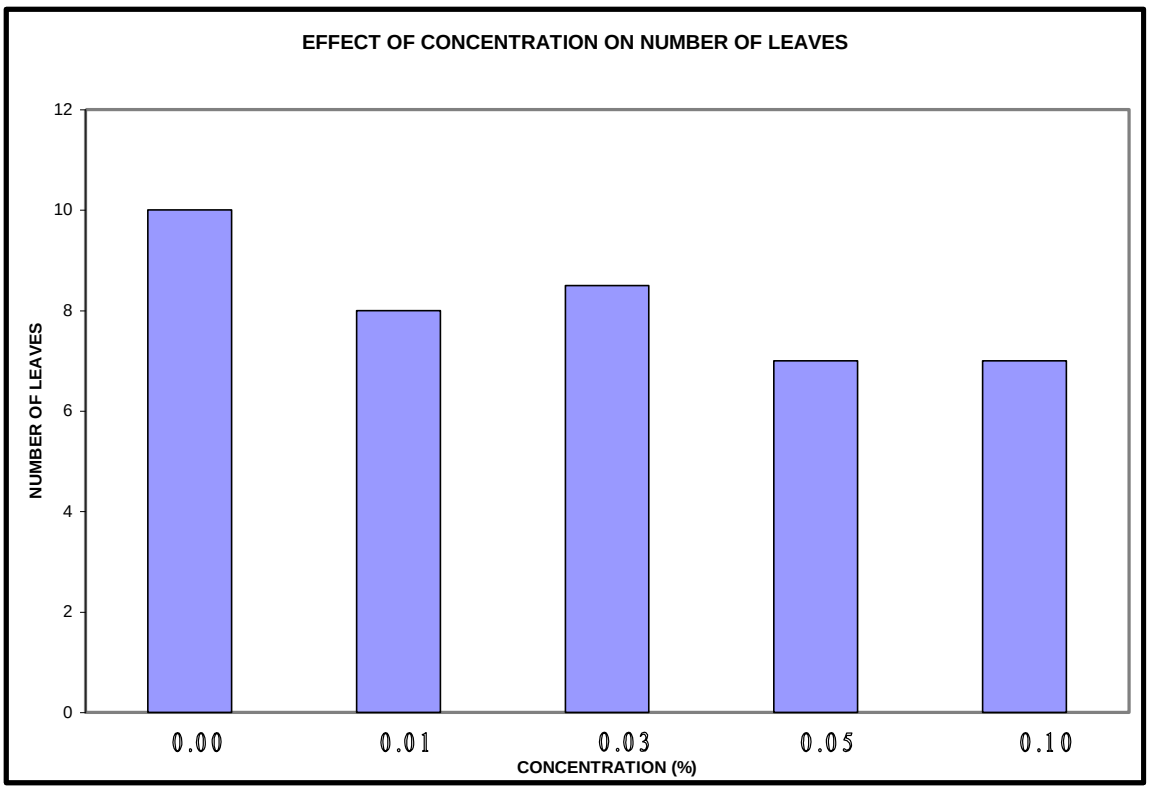


Fig. 16 Effect of different oil concentration on number of bean leaves

Effect on leaf area

A highly significant ($P<0.05$) difference in leaf area was recorded comparing control and oil treatments from leaves. Mean leaf area ranged from 58-48% for the control and the 0.1m respectively (Fig 17). It is evident that oil from higher concentration was more effective in reducing the leaf area. The impact was concentration dependent i.e. as oil concentration increased, leaf area decreased (fig. 17).

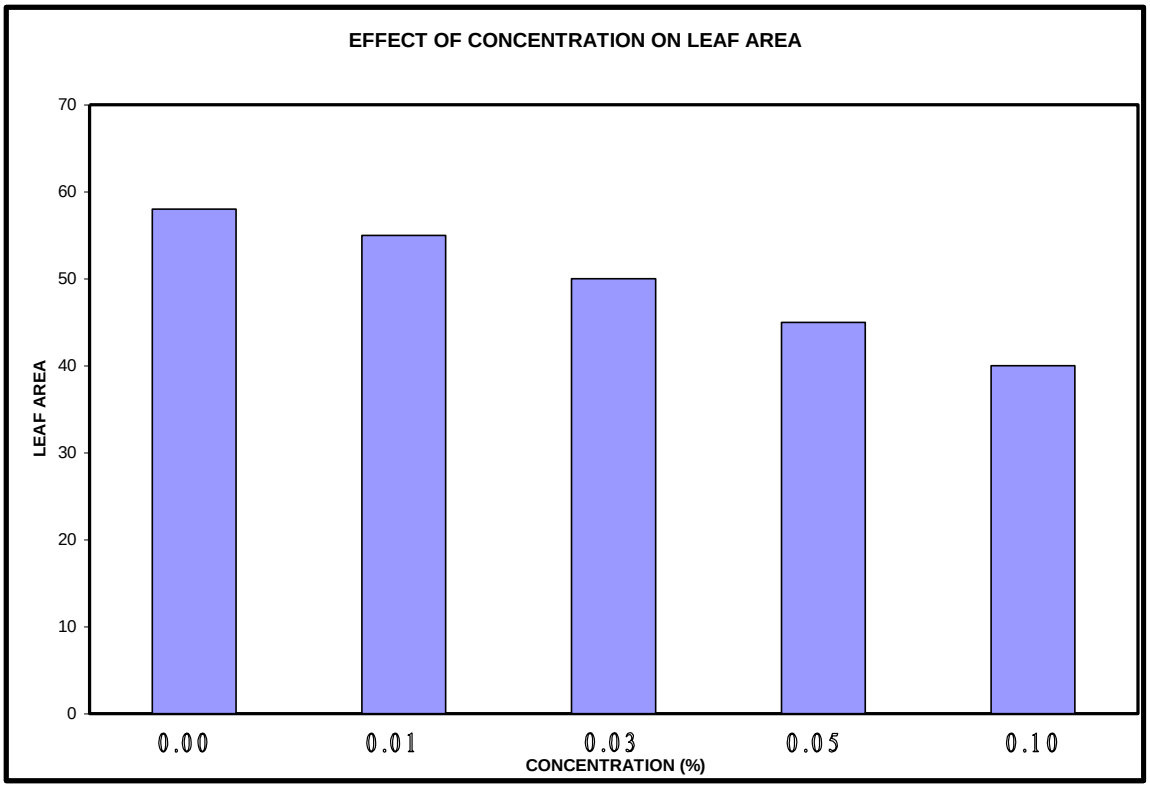


Fig. 17 Effect of oil concentration on leaf area

The effect on shoot length

Similarly, shoot length of bean seedlings was significantly ($P<0.01$) affected by oil concentration from fresh leaves, (fig 18). There was a linear significant correlation between oil concentration and reduction in shoot length from fresh.

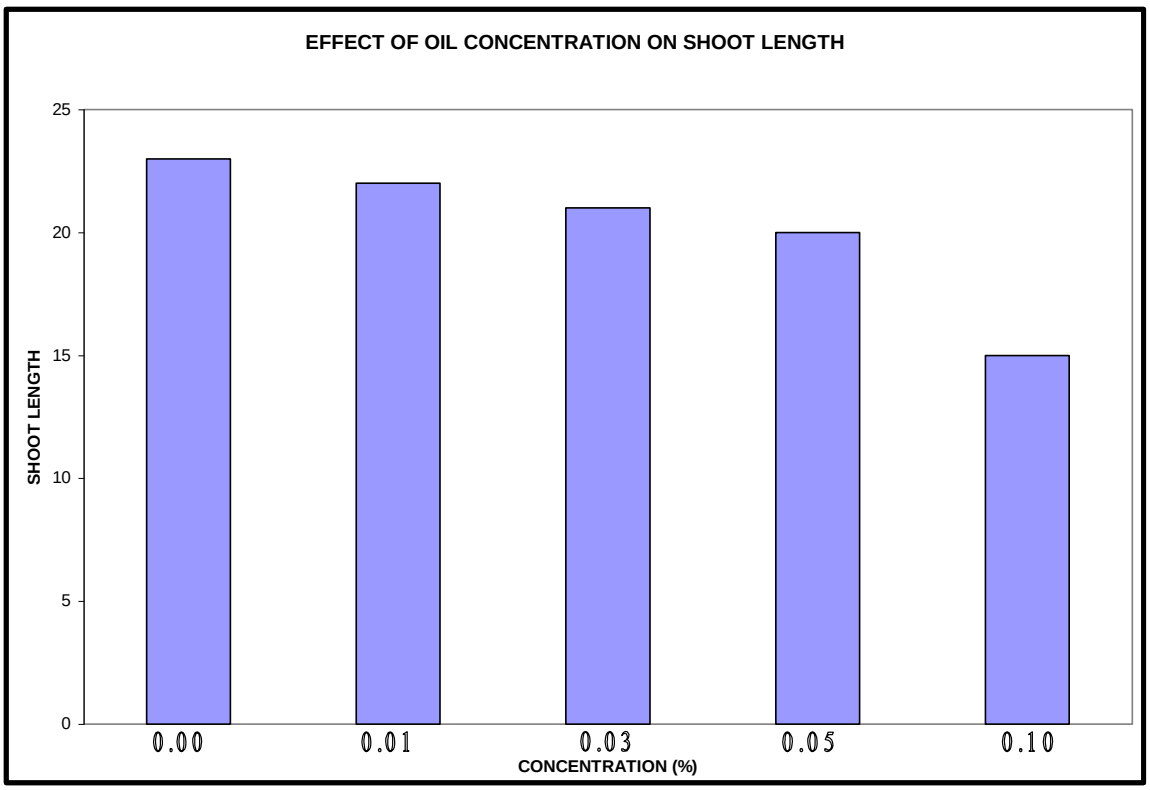


Fig. 18 Effect of oil concentration on shoot length

Effect of concentration on biomass

There was a general decrease in biomass for maize seedling. The decrease had a linear relationship with oil concentration (Figures 19)

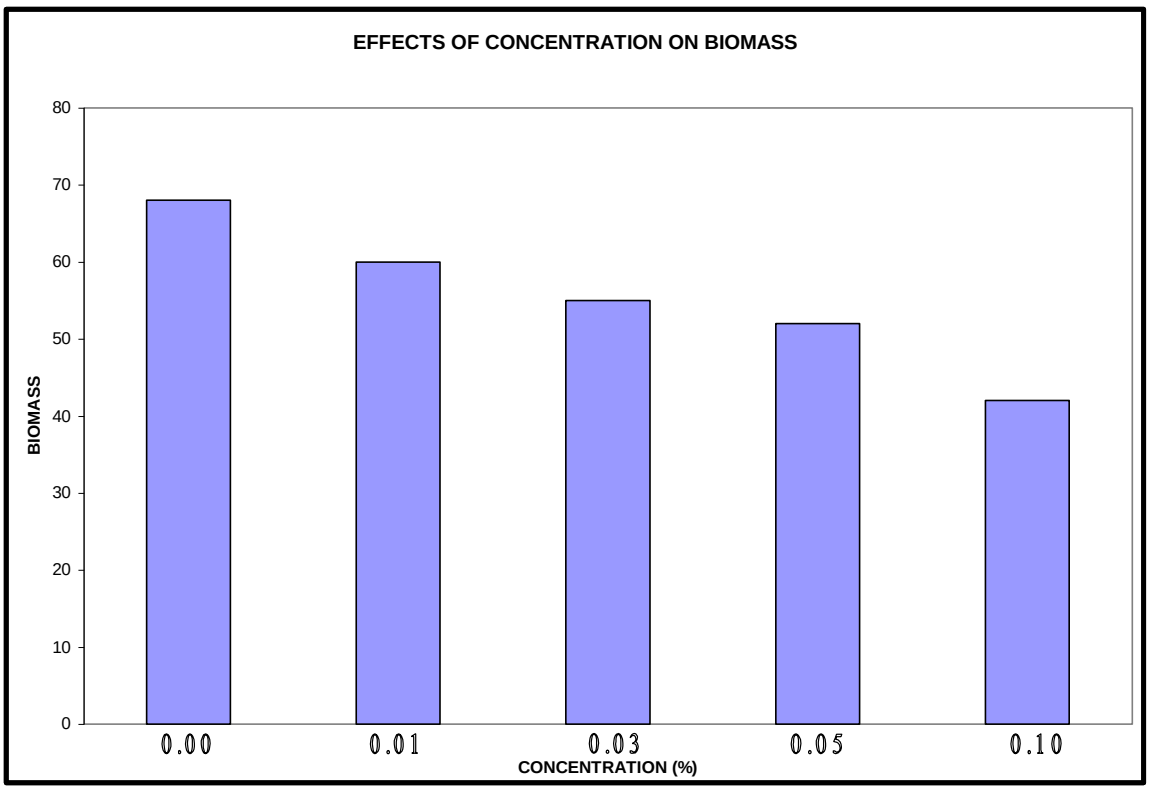


Fig. 19 Effect of oil concentration biomass

Discussion

The present study demonstrated a strong allelopathic effect of crude oil extracted by water distillation from fresh as well as dry leaves of *Eucalyptus grandis*. The allelopathic effect was expressed as a significant reduction in seed germination and seedling growth of maize and beans. These results are in agreement with several investigators. Qureish and Rai, (1987), reported that aqueous leaf extracts of *Eucalyptus tereticornis, Casuarina equisetifolia* and *Leucaena leucocephala* were allelopathic and caused significant reduction in germination, root length and dry matter production of cow pea (*V. unguiculata*). Reduced nodulation, acetylene reduction and growth of Rhizobium associated with cowpea roots occurred as a result of soil and plant extracts of *Acacia nilotica* (Singh and Lakshminarayana, 1992). Sanginga and Swift (1992), reported that leaf extracts of *Eucalyptus camaldulensis*

inhibited germination of maize seeds by 83 –100% as compared to 97% germination in control. Water-soluble extracts of *Eucalyptus globulus* leaves caused a greater inhibition of germination of lettuce seeds (Dominguez *et al*., 1988). Leaf leachates of *Eucalyptus citriodora* inhibited seed germination of cow pea, mustard and gram. They also inhibited shoot and root growth of the three crops (Singh *et al*., 1992). *Eucalyptus tereticornis* leaves, revealed a significant reduction in seed germination and seedling growth of finger millet (Padhy *et al*; 1992). The results of the present study showed that crude oil from fresh leaves was more inhibitory (allelopathic) to all growth parameters tested as compared to oil from dried leaves. This result is in line with Anwar (1991), who reported that leaf extracts from fresh leaves of *Eucalyptus alba*, *Eucalyptus robusta*, *Eucalyptus deglupta* were more inhibitory to seedling growth of maize as compared to extracts from dry leaves. This was attributed to the greater content of phenolic compounds in fresh as compared to dry leaves (Joshi, *et al*; 1992).

The allelopathic effect of oil from *Eucalyptus grandis* leaves might be explained in several ways. The genus eucalyptus has long been known to produce several volatile chemicals, which were allelopathic to several plants. *Eucalyptus camaldulensis* was found to produce phenols and terpenes which were found to be phytotoxic to plant growth (Sanker and Rai, 1993). Varro *et al*; (1981) divided the major compounds of Eucalyptus volatile oils into (1) oils intended for medical use, which contains 70-85% cineol plus lesser amounts of volatile aldehydes, terpenes, sesquiterpenes, aromatic aldehydes and alcohols and phenol (2) oils for industrial purposes such as pipertone and/or phellendrene as the principal components and (3) oils used in perfumery which are rich in geraniol, its esters and citronellal.

PART III

SEEEDLING PRODUCTION AND DISTRIBUTION

INTRODUCTION

Farmers in Western Kenya have grown Eucalyptus from early 1950s for railway fuelwood, poles and lately timber.

Studies in Western Kenya have shown that there are a number of high value tree species including *Eucalyptus*, *Grevillea*, *Markhamia*, *Pinus*, and *Casuarina*. Of all these plus many others, *Eucalyptus* is still the most popular. This is because it is multipurpose, fast growing, produces firewood, poles, timber products that have ready market in the densely populated highlands. The tree has also high coppicing ability producing many sprouts from the second ratoon onwards.

Most of the *Eucalyptus* on the farmlands are established in small woodlots with further planting being restricted due to lack or limited land mainly because of high population pressure in the highlands of Western Kenya. It is believed that the promotion of tree planting on the farms has been accelerated by lack of access to sources of wood off the farms, for marking boundaries, for enhancing land tenure rights and associated economic returns (Cooper and Attah Krah, 1996).

Studies from the main consumer areas i.e. the lake Victoria region indicate that the future demand for *Eucalyptus* wood products from farmlands will outstrip the supply. This is mainly because the areas that were previously set aside for this species have continued to decline because of the fast growing population. The other reason being that other sources of wood products mainly government forests are declining in area due to non-implementation of replanting programmes, degazetment and excision.

This leaves us with only the farmlands whose per capital land ownership is declining fast due to increasing population requiring land for settlement and cultivation.

The main implication of this scenario is that poles in particular are being cut at earlier ages (immature poles) leading to poor quality construction materials or moving further from market areas in search of mature poles leading to extra transport costs and time wastage.

Unless there are other options in addressing the eminent shortage of these tree products in these densely populated highlands, we are likely to see escalating prices for some of these tree products.

In view of the above, there will be need to introduce fast growing and high yielding Eucalyptus grandis that will quickly provide for the firewood, timber, poles, to the already increasing demand in the nearby Kisumu markets.

Objectives:

To meet the farmer's forestry wood products requirements by introducing fast growing and high yielding *Eucalyptus grandis.*

Study areas

This study will mainly be carried out in the highland districts of Western Kenya (Kakamega, Vihiga, Kisii, Nyamira, Siaya, Gucha and Nandi districts).

Methodology

Eucalyptus grandis seedlings from Zimbabwe were raised at the Maseno Regional Research Centre. These were distributed out to farmers in the districts above. Each farmer was assisted to plant approximately 200 seedlings in the long rains of April,

2002. The farms on which this planting was done will act as demonstration farms in those respective regions. Other seedlings were issued out to institutions and other interested parties.

Seedling production and distribution

Following a big demand for Eucalyptus seedling, a total of 14,340 seedlings were raised at the Maseno Research Centre and distributed to the farmers as follows:

Table 3 : Seedlings distributed to various places

District	**Number issued**	**Remarks**
Vihiga	2000	Distributed through DFO
Kakamega	1500	"
Nandi	1400	"
Nyamira	1200	"
Kisii	1200	"
Gucha	1600	"
Others	4640	Individual collections
"	800	Deaths at the nursery
Total	**14340**	

Follow up of the distributed seedlings is ongoing. We also intend to prepare technical notes on propagation and management of the improved Eucalyptus.

Problems encountered

Most small-scale farmers in Nyamira, Kisii and Gucha could not afford the land for the specified spacing of 2m x 2m. In a few cases were asked to plant at a spacing of 1m x 1m. In number of cases, some farmers were not sure of the project intentions on their land. Complaints were also registered related to the fact that the farmers were not able to incorporate other crops in the woodlots.

CONCLUSIONS AND RECOMMENDATIONS

CONCLUSIONS

1. Eucalyptus is the most important tree species for farmers in the western Kenya region. It is preferred because of fast growth rate, coppicing ability and a multiplicity of uses, easy to manage. Self-reliance in construction materials and firewood was the main reason for planting Eucalyptus.
2. Oil from Leaf extracts was found to have an effect on germination, leaf area, shoot length, and biomass of common agricultural crops.
3. The spacing of 2m x 2m is wide for most small scale farmers
4. Eucalyptus trees do affect crop planted within and adjacent to the woodlots.
5. The negative effects associated with this species are water consumption, reduction on crop yields, soil fertility reduction, lowering of the water table.
6. Farmers are very selective in the areas where they plant Eucalyptus. Most farmers prefer sites where the tree will have minimal effect on other plant or areas unsuitable to other plants.
7. Farmers are a ware that Eucalyptus has adverse effects on other crops through either shading, competition for soil water or allelopathic effects.
8. Eucalyptus is a very popular tree species and ranks highly in most farmers planting programmes.
9. Eucalyptus affects other crops by, draining excess water from soil, casting alot of shade, competing for nutrients with crops, It makes crops have stunted growth, growing too long to receive light and weak, Lacking nitrogen thus leaves becoming yellow in colour, Photosynthesis process does not take place efficiently thus production becomes very low, Crops becomes dwarfs and

withers, Most farmers experience poor yielding on their farm, Most crops do germinate but later don't grow well.

RECOMMEDATIONS

1. Given that Eucalyptus was found to have a direct effect to a distance of 10-15m. It is proposed that adjacent crops be planted atleast 15m a way from woodlots/Eucalyptus trees.
2. To minimize soil water competition, trenches should be dug to minimize spread of roots.
3. Eucalyptus should be planted in sites where they will have minimal effects on other plants.
4. Eucalyptus should not be planted a long common boundary in areas close to agricultural crops.
5. A clear Forestry/Agricultural policy should be set up to guide on the propagation and management of Eucalyptus on farmlands to avoid misunderstanding between neighbours.
6. Due to fast decreasing land area, farmers should be assisted to plant fast growing varieties of Eucalyptus.
7. Eucalyptus trees should be planted where they will have little effect on crops e.g. alongside a road, pastureland and very unproductive agricultural land e.g. rock/steep slopes. Eucalyptus planting could be recommended on rocky and steep slopes since they provide soil cover and protection.
8. Proper site selection and management gives the best options on reducing the negative effects on the environment. Establishing and managing an uneven

aged stand is high recommended to ensure ground cover as well as recirculation of nutrients. Prolonging rotations is recommended.

9. Eucalyptus forest for catchment protection really needs to be grown and not harvested at all on slopes over 100% on slopes from 40% to 100% the stands are best developed into uneven aged ones by selective cutting over a period of years. Whatever the tactic adopted, better quality planting material, better species–site matching, better establishment and better aftercare, in short better silviculture and management together are required.

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