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GREVILLEA ROBUSTA IN AGROFORESTRY SYSTEMS IN KENYA

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MUCHIRI, M. N. 2004. *Grevillea robusta* in agroforestry systems in Kenya. The status of *Grevillea robusta* in Kenya is reviewed. *Grevillea robusta* is an important multipurpose tree species in the maize-*G. robusta* agroforestry farming system in Kenya. It grows well in low fertility soil, is less competitive with food crops and tolerates pollarding.

Key words: Silviculture – management – yield – socio-economics – silky oak

MUCHIRI, M. N. 2004. *Grevillea robusta* dalam sistem perhutanan tani di Kenya. Status *Grevillea robusta* di Kenya dikaji. *Grevillea robusta* merupakan spesies pokok pelbagai guna yang penting dalam sistem pertanian jagung-*G. robusta* di Kenya. Pokok ini tumbuh dengan baik di tanah yang tidak subur dan kurang bersaing dengan tanaman makanan serta tahan jika dipolard.

Introduction

Grevillea robusta (silky oak or silver oak) has become an important tree species for maize farmers in Kenya. The maize-*G. robusta* agroforestry system covers an estimated area of 750 000 ha in the central highlands of Kenya. *Grevillea robusta* firewood is the major source of energy for cooking and warming for most people in this farming system. The twigs are used as fodder during years of drought. Wood yields of this farming system are significant but rarely reported. The total wood yield as estimated in a simulation is six million m^3 $year^{-1}$ (Muchiri *et al.* 2001), which is about twice the estimated annual wood yield by the 165 000 ha of forest plantations in Kenya (FAO 1989).

The purpose of this study was to review the present status of *G. robusta* in Kenya.

Distribution

Grevillea robusta is native to subtropical eastern Australia where it exists in scattered small stands in Queensland and New South Wales. *Grevillea robusta* was introduced to Kenya in the late 19th century from India and Sri Lanka where the species was used as a shade tree in tea, coffee and cinchona plantations (Harwood 1989).

Grevillea robusta is grown in 19 out of the 42 districts in Kenya (Ongugo 1992). It is grown from 850 to 2500 m asl with an annual rainfall between 900 mm and 1500 mm (Spiers & Stewart 1992). The highest concentration of *G. robusta* in Kenya is in an estimated area of 750 000 ha maize-*Grevillea robusta* agroforestry system in the central highlands around Mt. Kenya. The species is so intensively planted in this region that it is the dominant tree species especially on the eastern and southern slopes of Mt. Kenya. Kamweti (1996) estimated that *G. robusta* comprised 37% of

14 746 trees found in 254 farms which were randomly sampled in Embu district, and Akyeampong *et al.* (1999) counted 77 *G. robusta* trees ha^{-1} on farm land in Kirinyaga district.

Uses of *Grevillea robusta*

Farmers grow *G. robusta* mainly for producing timber, poles and firewood. The species has successfully been planted on farms because it grows rapidly, is easy to propagate and establish, has good form, provides economically viable products and is not significantly affected by pests and diseases. Another reason that has contributed to the successful planting of *G. robusta* is its ability to harvest water in the deeper horizons beneath the crop-rooting zone and to develop a cluster of roots that acquire nutrients from soils deficient of phosphorus (Harwood & Booth 1992, Ong 1994, Skene *et al.* 1996, Lott *et al.* 2000a). There is also considerable evidence that *G. robusta* grows faster than other agroforestry tree species (Bashir *et al.* 1989) and is less competitive with adjacent agricultural crops when compared with other trees available to the farmer (Mwihomeke 1992, Lott *et al.* 2000b). However, established *Grevillea* trees greatly reduce the aboveground biomass and grain yield of maize (Lott *et al.* 2000a). Nevertheless, the farmers manipulate the competition for resources between maize and *Grevillea* trees by pruning the branches and roots or by pollarding (complete removal of the crown) the trees (Harwood & Booth 1992).

Another use of *G. robusta* tree is in soil conservation. *Grevillea robusta* also conserves soil moisture due to shading and the mulch it provides and its litter increases the amount of the organic matter in the soil (Raju 1992).

Most of the farmers in the maize-*G. robusta* agroforestry system are entirely dependent on *G. robusta* firewood for cooking and warming. It is estimated that 60–80% of the total yield of *G. robusta* trees is from repeated pollarding and 10 trees are enough to provide fuelwood for a family of eight people on a sustained basis (Kamweti 1992). Young trees and loppings are also used as fencing materials and rafters in construction. The mature trees are sawn to supply construction and furniture timber. *Grevillea robusta* provides fodder during drought when twigs of *G. robusta* are the only fodder available for some homesteads. They also serve as live fences for marking farm boundaries.

Flowering, seeding and propagation

Grevillea robusta trees produce viable seed at the age of six to eight years (Harwood 1992). Abundant seed production (about 2 kg of clean seed per tree) is attained when trees are 20–40 years old. The trees flower almost throughout the year. However, in Kenya, peak flowering periods are in January to February in south western highlands and September to December in central highlands (Anonymous 1992).

The seed is relatively small and in pods. The pods are yellowish brown when mature and ripen 10 to 16 weeks after flowering. The seed is dispersed by wind

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within three days after the ripening of pods. The procedures for collecting, processing and storing the seed are outlined by Anonymous (1992).

Grevillea robusta regenerates naturally from seeds but is mainly propagated from seedlings raised at nurseries. The seed does not require pre-sowing treatment although soaking in cold water for 24 hours has been noted to significantly improve germination (Anonymous 1992). The seedlings are not very susceptible to damping off and can tolerate severe root pruning. There are no serious nursery pests and diseases that infest *G. robusta* seedlings (Spiers & Stewart 1992).

Farmers raise *G. robusta* mainly through natural regeneration by taking wildings from a neighbour's farm, buying seedlings from commercial nurseries or by obtaining free issues from the Forestry Department and non-governmental organisations. However, Kenya Forestry Research Institute (KEFRI) has successfully propagated *G. robusta* by grafting, budding and tissue culture to ensure production of seedlings of high quality and known genetic base.

Silviculture and management

Grevillea robusta sprouts when pollarded but do not coppice. However, very limited coppicing may occur if the trees are felled at the age of less than 10–15 years old. The ability to coppice declines sharply when the trees are more than 25 years old (Owino 1992).

The trees are either planted in rows (alley cropping) or randomly at various densities on farms. They are intercropped with agricultural crops such as maize, beans, bananas and coffee. Fence planting is usual to mark the boundaries between family farmers (Forssblad & Spångberg 1992, Kamweti 1992, 1996). The land between alley rows can be ploughed mechanically and it is easy to manage the trees without much damage to crops.

There is a large variation in tree density on farms. In Kirinyaga district, some farms had about 200 trees ha^{-1} while other farms had barely 50 trees ha^{-1} (Ling 1993). Kamweti (1996) reported 65 trees ha^{-1} and a spacing of 2.0 m as the most common single-row spacing in Embu district. Forssblad and Spångberg (1992) gave the average single-row spacing in Trans Nzoia district as 1.9 m for trees less than five years old. Akyeampong *et al.* (1999) suggested 100–200 trees ha^{-1} for optimal wood yield when *G. robusta* is intercropped with food crops. Kenya Forestry Department recommends an initial spacing of 2.5 × 2.5 m when *G. robusta* is planted in pure stands (plantations and woodlots).

In general, trees are rarely fertilised but some farmers fertilise the trees at one stage or another during the first year after planting. However, fertilisation of crops benefits trees also. Weeding of trees and crops are done together.

There are no silvicultural and management prescriptions applied to *G. robusta* on farms until the trees are about five years old when they start to compete with the maize and other crops (Ling 1993). At this time the trees are pruned or pollarded to reduce shading of crops, provide firewood, poles, rafters, fodder, cattle bedding and mulch, and to improve tree form and diameter growth. In Meru and Embu districts, about 90% farmers prune and pollard their trees every one or two

years depending on site and convenience (Kamweti 1992). Ling (1993) reported the interval of pruning in Kirinyaga district as two years. There are no set guidelines for when or at what top height the farmers pollard the trees.

Farmers believe that heavy pruning and cutting the top of the tree increase the rate of diameter growth. However, this is not supported by research by Kiriinya (1999) and Muchiri *et al.* (2001). Removing the entire crown markedly depressed tree diameter growth (Ling 1993). Removing two thirds of the crown or half the crown had a similar but less pronounced effect and there was no statistically significant difference in dbh loss when one third of the crown was removed (Kiriinya 1999). The tree form is markedly improved by pruning one third or half of the tree crown. These findings support the farmers' view that pruning *G. robusta* is beneficial to stem form and hence to the overall value of the tree.

On farms, *G. robusta* stands are thinned either for production of timber, poles and firewood or to reduce the competition with crops and between trees. There are no prescribed regimes or methods of thinning *G. robusta* stands on farms. Nevertheless, the most common practice is to remove both suppressed and large trees depending on the objectives of the farmer.

There is no fixed rotation age for *G. robusta* on farms. Trees are harvested as early as six years when stems are of pole size. In Kirinyaga district, trees are cut for timber when the dbh is 40–50 cm (Ling 1993). In Meru and Embu districts, sawmills prefer trees more than 30 years old (Spiers & Stewart 1992). Ling (1993) predicted the optimal rotation for maximum production of *G. robusta* timber as 55 years; and the optimal rotation age that maximises the present value for timber production for different rates of interest as 53 at 0% interest rate, 37 years at 15%, 25 years at 10% and 15 years at 15%. Forssblad and Spångberg (1992) reported the optimal biological rotation in Trans Nzoia district as 15 to 30 years depending on the site. According to the model by Muchiri *et al.* (2001), a rotation period of about 55 years maximises wood production when the planting density is about 200 trees ha^{-1}.

Conclusions and future prospect

According to Ling (1993), growing *G. robusta* is very good investment because a minor investment of USD 7–11.5 ha^{-1} would yield a timber value of USD 910 in 20 years and the farmer is also supplied with firewood from the fifth year onwards. The value of the firewood over the rotation period minus labour cost is estimated at USD 1205 ha^{-1}. Crop yield loss margin is estimated at USD 1.9 ha^{-1}.

Growing *G. robusta* increases economic security of farmers because they spread the risks between more products by selling timber and firewood. The risk is also spread over time because it is possible to harvest tree products all the year round unlike crops, which are harvested seasonally. Thus, selling of *G. robusta* products softens the decline in cash income between agricultural crop yields. In addition, the beauty and the shade that the trees lend to landscape have an enormous aesthetical value to people and shelter to livestock respectively.

There has been increasing conflict among farmers because dense and unmanaged stands of *G. robusta* on farm boundaries reduce the crop yield and tree

growth of the neighbour farmer. The planting of *G. robusta* would benefit from studies of planting arrangement and cutting regime that optimise wood production and minimise the conflict between neighbouring farmers.

Although *G. robusta* has not experienced severe pest and pathogen problems in Kenya, there is always the risk that such problems may develop as it happened with *Leucaena leucocephala* (Harwood & Booth 1992). The risk is even higher because the genetic diversity of *G. robusta* is lower in Africa land races than in natural population (Harwood *et al.* 1992). It is therefore desirable to identify other tree species that can play a similar role as *G. robusta* in agroforestry fields and widen the genetic base of *G. robusta* by introducing natural provenances from Australia. A genetic improvement program for *G. robusta* has been proposed by Harwood and Owino (1992).

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