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Agroforestry potential of *Acacia senegal* in the rangelands of luwero and Nakasongola districts

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Abstract

Agroforestry potential of *Acacia senegal* in the rangelands of Luwero and Nakasongola districts was assessed between November 2002 and February 2003. Proportion of farmland under *A. senegal* was assessed by farm transect walks. A structured questionnaire and interviews were administered to collect information on the socio-economic profile of the farmers and constraints and opportunities to management of *A. senegal*. Questionnaire responses were entered in SPSS and logistic regression used to show the effects of socio-economic variables on people's willingness to plant and manage *A. senegal* trees on their farm. The proportion of farmland under *A. senegal* and other tree species is 16.78 %. *Acacia senegal* is a source of firewood, fodder, fencing post, soil fertility improvement, medicine and gum. Education, farm size, gender, occupation and ownership of domestic animals significantly influenced the local people's willingness to plant and manage *A. senegal* trees. Therefore, local people need to be mobilised and educated on the agroforestry potential and conservation value of *Acacia senegal*.

Key words: *Acacia senegal, rangeland, agroforestry, Uganda*

Introduction

Acacia senegal (L.) Wild is an important multi-purpose tree species (Cossalter, 1991). It produces gum arabic, stabilizes sand dunes, fixes atmospheric nitrogen and is a source of fencing posts, firewood and fodder. The species extends over a wide ecological range that differs in rainfall, soil and altitude (Cossalter, 1991). Traditionally, *Acacia senegal* has been growing wild in the wooded grassland and deciduous bushland of Uganda especially in Kotido, Moroto and Northern parts of Luwero District (Katende *et al.*, 1995, 2000). However, the local people are now integrating it in their farming system. It is retained in the gardens of cotton, millet, simsim, sorghum and groundnuts.

The population of *Acacia* species are believed to have reduced over the past years because of the increasing demands for fuelwood, fencing posts and overgrazing in these areas (Otike, 1998). There is therefore a need to conserve the species if they are to meet the increased demand for fuelwood, fodder, soil improvement through nitrogen fixation, protection of the environment and to cater for gum production, which is an important source of cash. Furthermore, there is a need to understand farmers' attitudes towards planting of the species and the constraints and opportunities to management of the species by the local people.

The study had four objectives: (i) to assess the proportion of farmland covered by *A. senegal* in the rangelands of Luwero and Nakasongola districts, (ii) to assess farmers' attitudes towards on-farm planting of *A. senegal*, (iii) to determine the socio-economic variables that influence people's willingness to plant *A. senegal*, (iv) to determine the constraints and opportunities to the management of *A. senegal* by the local people.

Decription of the study area

The study area, formerly Luwero district before Nakasongola gained a district status, borders with the districts of Masindi in the northeast, Kiboga in the west, Mukono in east and Mpigi to the south (NEMA, 1997). To the north are Apac and Lira districts. The two districts cover an area of 9,204.0 km^2 representing 3.81 % of the country's total surface area. Of these, about 240.2 km^2 is open water, which is equivalent of 2.61% of the district's surface area (NEMA, 1997). The largest part of the districts is underlain by metamorphic rocks of the pre-cambrian origin (Omoding, 1994). The soils are not uniform. The districts are predominantly covered by the Buruli catena to the north and Lwampanga catena in the low-lying areas and valleys (Omoding, 1994, Parker *et al.*, 1967). Hilly uplands dominate the southern part and ancient granitic

rocks rise up in the north. Wide interlocking valleys break up the low hills in the central region.

The climate of the area is considerably modified by relief. The mean diurnal maximum temperatures range from 18 °C to 35 °C while the minimum diurnal range is from 8 °C to 25 °C (Omoding, 1994, Parker *et al.*, 1967). Much of the area receives 1,000 - 1,250 mm of rain per annum. The southern part, especially Bamunanika and Katikamu counties, receives more than 1,250 mm and has two rain seasons: April-May and October-November. The reliability of rainfall generally declines northwards (Omoding, 1994; Parker *et al.*, 1967). The vegetation has been classified into forest/savanna mosaic (excess of 1,250 mm of rainfall per year), moist combretum woodland (1,125 - 1,250 mm rainfall per year), dry combretum (less than 1,125 mm of rainfall per year), grass savanna (1,000 mm of rainfall), seasonally flooded grass swamps (2009.3 km^2 of the two districts), permanently flooded swamps (412.2 km^2 of the districts) and post-cultivation vegetation (NBSR, 1995; NEMA, 1997). The major tribes are the Baganda, Baruli, Banyarwanda, Banyankole, Bahima and the Bakiga. Crop production, animal husbandry and charcoal production for sale in Kampala are the major economic activities in the districts with devastating effects on the savanna woodlands. Bee keeping and honey production are also common (NEMA, 1997).

Materials and Method

On-farm transect walks were conducted in Butuntumula, Kagooge, Nabiswera, Ngoma and Wabinyonyi sub-counties (Figure 1). Fifty farms, ten in each sub-county, were randomly sampled and surveyed. The aim was to gauge the extent to which *A. senegal* is already part of the farming systems. A structured questionnaire and interviews were administered to collect data on the socio-economic profile of the farmers and constraints and opportunities to management of *A. senegal*. Preference matrix ranking was used to show the agroforestry tree species preferred by the local people. Each respondent was asked to indicate 15 species in order of preference. The highest priority species out of fifteen was assigned 15 points, 14 points to the second highest and the lowest ranked species assigned 1 point. The points for each species were summed across all respondents. The species priority list was derived from the total points scored.

Data analysis

SPSS was used to analyze the questionnaire responses. Logistic regression analysis (Green, 1995) was carried out to show the influence of socio-economic characteristics on local people's willingness to plant *Acacia senegal* on their farm. The dependent variables were regressed on the socio-economic variables. The description of the explanatory (independent) variables regressed are given in the Table 1. A dummy variable as a proxy for the dependent variable having a value of 1 was assigned a 'yes' response and a value 0 was assigned to a 'no' response (Koutsoyiannis, 1977). The linear logistic regression model has the form: $e^{a+B1\ X1\ +=B2+x2+\ +bnxn}/1+e^{a+B1\ x1+B2\ x^2+BNXn}$ Where e is the base of natural logarithms, á is the coefficient of the constant (intercept), B_n are slope parameters (corresponding coefficients) and $\div_n$ are the values of the variables).

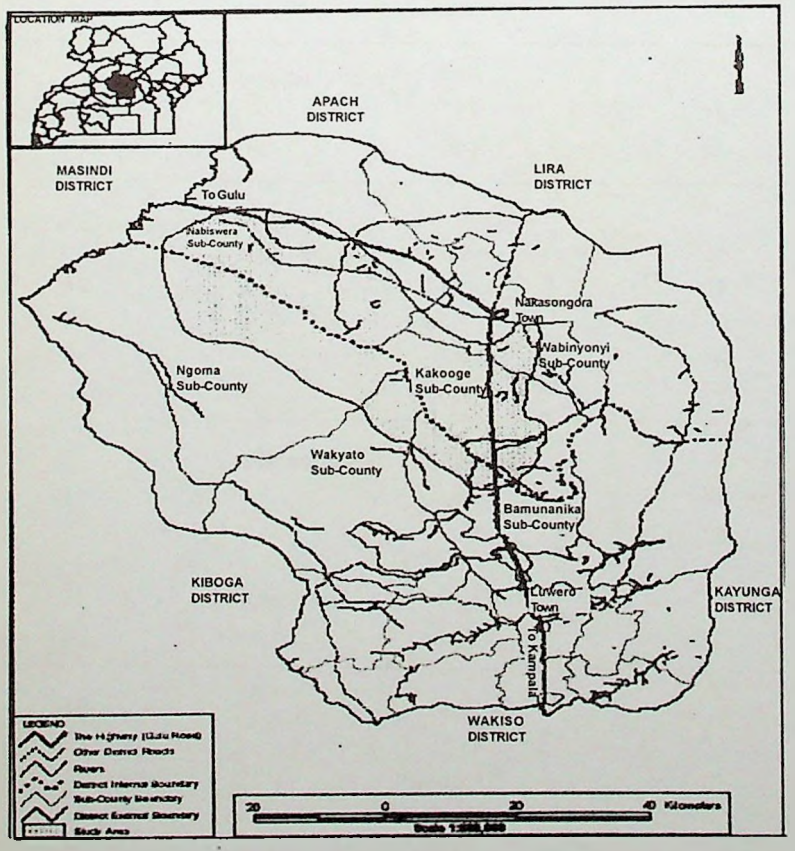

Figure 1. Map of Luwero and Nakasongola district

Table 1. Explanatory variable and their expected signs

Variable	Description	Expected sign
Age	0 = Less than 25, 1 = Greater than 25 years	+
Education	0 = Non-formal, 1 = Formal	+
Family size	0 = Small (< 5), 1 = Large (> 5 persons)	+
Farm size	0 = Small (< 3 ha), 1 = Large (> 3 ha)	+
Gender	0 = Male, 1 = Femal	
Income(Ug. Shs.)	0 = Less than 200,000, 1 = Greater than 200,000	+
Occupation	0 = Non-farmers, 1 = Farmers	+
Period of stay	0 = Less than 10 years,	+
Domestic animals	0 = Do not have, 1 = Have	+

Results and discussion

Demographic and socio-economic characteristics

Seventy eight percent of the respondents were above 26 years old (Table 2). The average family size was seven people per household. More than half of respondents were male and 55% were subsistence farmers. About 84% owned domestic animals. Goats (51%) and cattle (34%) were the major livestock animals reared. More than 72% have lived in the study area for over ten years and about 50% of the families owned less than 3 ha of land.

Awareness and use of *Acacia senegal* by the households

About 83% of the respondents are aware of the agroforestry potential of *Acacia senegal* and 45% protected the species on their land. The local community depends on *Acacia senegal* as a source of fuelwood, fodder, food, fencing posts and poles for kraal construction, soil conservation, medicine and gum. Fuelwood and fodder were the major products got from the species. *Acacia senegal* was ranked as the third most preferred agroforestry trees/shrub species that local people are willing to plant and manage after *Mangifera indica* and *Ficus* spp (Table 4). It was ranked highest as a source of fuelwood and fodder. This was not surprising because NAS (1980) and Booth and Wickens (1988) reported the value of *Acacia senegal* for fuelwood and charcoal although its biomass yield per unit land area may not be sufficient to warrant planting it purely for fuelwood.

About 7% of the farmer said that seeds of *A. senegal* were eaten as vegetables during periods of food shortages while the foliage and pods are browsed by cattle, goats and sheep. The food values of *A. senegal* trees is reported by Booth and Wickens (1988), Dicko and Sikena (1992). *Acacia. senegal* leaves contain 10-13% of digestible protein and 0.12-0.15% of phosphorus, while the pods contain 15% of digestible protein and 0.12-0.14% of phosphorus. *Acacia. senegal* and its close relatives are also major sources of commercial gum arabic for food purposes. According to study by Anderson (1989), *A. senegal* is the only species in the *Acacia* family that produces acacia gum evaluated toxicologically as a safe food additive.

Table 2. Socio-economic characteristics of the households (n = 184)

Factor	(%)	Factor	(%)
Age		*Family size*	
<25	22	1-5	52
26-50	51	6-10	34
>50	27	>10	14
Sex		*Plot/land size (hectare)*	
Male	61	<3	27
Female	39	4-6	35
Current occupation		>6	38
Agriculture (farmer, herdsman)	55	*Period of stay (years)*	
Service worker (councilors, teachers)	10	<10	27
Student	8	11-20	35
Others (Housewife, Blocker, Charcoal burner, market vendors)	24	>20	38
Educational background		*Have domestic animals*	
No formal education	14	Yes	84
Primary	53	No	15
Secondary	27		
Tertiary (Institutions)	7	*Types of animals owned*	
		Cattle	34
Household yearly income (Ug.Shs.)		Goats	51
<200,000	15	Pigs	22
201,000-400,000	50	Rabbits	17
>400,000	35	Bees	32
		Others (sheep, horse)	24

Table 3. Awareness and use of *Acacia senegal* by framers (n=184)

Factor	(%)
Knowledge of Acacia senegal trees	
Yes	83
No	17
Acacia senegal grown or retained on *household land*	
Yes	45
No	37
Uses of Acacia senegal	
Fodder for domestic animals	49
Food	7
Fuelwood	61
Fence materials (Kraal)	20
Soil conservation	32
Others (medicinal, gum)	24

Gum arabic has been used for nearly 4,000 years by local people in food preparation, in human and veterinary medicine, in crafts and as a cosmetic. *Acacia. senegal* is being used for treating coughs, diarrhoea and dysentery in Luwero and Nakasongola. The uses of *A. senegal* nitrogen fixation and protection of the environment has been reported by NAS (1980). *A. senegal* trees help to control desertification through stabilisation of sand dune and serve as wind breaks.

Proportion of farmland under *A. senegal* and other tree species

Table 5 shows the proportion of farmland under *Acacia senegal* and other species in Luwero and Nakasongola districts. The average proportion of farmland under tree cover was 17% (S.E± 2.71). The proportion of farmland under tree cover was higher in Butuntumula and Kagooge sub-counties than in Nabiswera, Ngoma and Wabinyonyi sub-countries. Low proportion of farmland under tree cover implies that a lot of awareness campaign has to be done if

Table 4. Agroforestry tree/shrub species ranked by local people

	Uses									
Tree/shrub species	Fuel wood	Fruit/ food	Fodder	Building/ soil		shade	Charcoal	Medicine	Total score	Rank
Mangifera indica	670	1,864	-	-	593	1621	889	-	5637	1
Ficus spp.	1252	637	-	643	621	1012	808	489	5462	2
Acacia senegal	1,306	68	1,498	477	650	-	241	873	5113	3
Acacia mellifera	1126	-	1290	-	1187	-	-	608	4211	4
Tamarindus indica	805	901	662	604	83	210	204	708	4177	5
Citrus spp.	840	2012	-	-	-	-	-	803	3655	6
Artocarpus - heterophyllus	241	1810	68	202	-	890	203	64	3478	7
Psidium guajava	703	1622	-	88	-	-	24	-	2437	8
Albizia spp.	608	0	12	808	73	107	723	85	2416	9
Borassus aethiopum	65	766	22	1025	-	-	104	423	2405	10
Combretum spp.	907	-	-	32	-	-	853	420	2212	11
Markhamia spp	.420	-	-	1021	98	104	60	52	1795	12
Moringa oleifera	-	204	471	-	8	66	-	898	1647	13
Carica papaya	-	404	-	-	-	-	-	760	1164	14
Eucalyptus spp.	146	-	-	277	-	-	48	18	489	15

Figures under each use category are the summation of all scores given to it by the respondents.

Table 5. Proportion of farmland under Acacia senegal and other tree species

Location (Sub-county)	Farmland area under tree cover (%)	SD
Butuntumula	26.2	7.19
Kagooge	23.6	9.02
Nabiswera	8.5	8.80
Ngoma	7.7	3.93
Wabinyonyi	17.9	6.11

Average farmland under tree cover = 16.78. %
SD = Standard deviation.

Table 6. Farmers' willingness to plant and manage A. senegal

Factor	%
Future of Acacia senegal on private land	
Promising	27.5
Uncertain of its future	17.8
Willingness to conserve Acacia senegal	
Yes	52.9
No	1.1
Don't know	4.3

local communities are to meaningfully integrate *A. senegal* in the farming systems. Many people are aware of the agroforestry potential of the species which are growing naturally in the wild.

Farmers' willingness to plant and manage A. senegal

Nearly 53% of the farmers said that they are willing to plant and manage *A. senegal* in their land while 18% were uncertain (Table 6). The logistic regression analysis of the relationship between the demographic and socio-economic variables versus farmers willingness to plant and manage *A. Senegal* on-farm showed significant relationship between education, farm size, gender, occupation, ownership of domestic animals and willingness to plant *Acacia senegal* trees (Table 7). The influence of gender on willingness to plant *Acacia senegal* as an agroforestry species was low (R = 0.19) but significant (P = 0.02). Women were more willing than men to plant *Acacia senegal*. The marginal change on the willingness to plant *Acacia senegal* as a result of gender is 0.15. This indicates that if female, the probability of planting *Acacia senegal* increases by 15%. In extension activities, planners often focus on women. As such, there is a need to encourage women to invest labour in tree planting. Moreover, women are the primary gatherers of firewood and suppliers of traditional medicines obtained from *Acacia senegal*.The level of education positively influenced local people's willingness to plant *A. senegal*. People with formal education were expected to be more willing to plant the trees than the uneducated people. The marginal effect of 0.17 implies that there is a 17% greater chance of planting plant *A. senegal* if the respondent had formal education. Education increases people's environmental awareness, appreciation of the value of trees and people's ability to communicate (Obua *et al.*, 1998). Occupation is significant and positively related to willingness to plant *A. senegal* trees. The marginal change on the willingness to plant *Acacia senegal* as a result of occupational status is 0.1699. This implies that if the respondent is a farmer, the probability of planting *A. senegal* increases by 16.9%. Farmers often attach values to trees and withstand high risks associated with planting and managing trees in their gardens. Trees on-farm provide farm-family with cheap sources of firewood and other environmental services.

The size of the farm positively influenced the respondents' willingness to plant *A. senegal* as an agroforestry species (P = 0.05). Individuals with larger farms were more willing to plant the trees than those with smaller farms. In general, larger farms tend to have greater incomes and more cash reserves to sustain risks of crop failure and allocate resources to new inputs. Small farms tend to have scarce cash reserves. Food shortages can reduce the farmer's ability to consider risk increasing activities like planting and managing trees. Respondents who own domestic animals were willing to plant *A. senegal* trees. The marginal change on the willingness to plant *Acacia senegal* as a result of owning domestic animals is 0.1353. This implies that the probability of planting *A. senegal* by farmers who own domestic animals increases by 13.5%. This is not surprising because Booth and Wickens (1988) and Greenberg *et al.* (1997) reported that *A. senegal* is a good source of fodder for livestock.

Age, income, period of stay and family size did not significantly influence farmers' willingness to plant *Acacia senegal* trees. It therefore appears that local people would plant *Acacia senegal* trees irrespective of their age, income, period of stay in an area and family size.

Table 7. Logistic regression of socio-economic characteristics that influences the local people's willingness to plant *Acacia senegal* as an agroforestry species.

Variable	Coefficient	S.E ±	Probability (5%)	R	Odd ratio
Age	-0.61	0.21	0.77	-0.07	-0.12
Education	1.15	0.54	0.08	0.13	0.17
Family size	-1.41	0.14	0.30	-0.09	-0.02
Farm size	1.05	0.52	0.05	0.18	0.17
Gender	0.92	0.38	0.02	0.19	0.15
Income	0.38	0.12	0.09	0.09	0.04
Occupation	1.06	0.42	0.01	0.19	0.16
Period of stay	-0.93	0.52	0.82	-0.003	0.03
Domestic-animals	0.72	0.29	0.05	0.08	0.13

Table 8. Problems of planting and managing *Acacia senegal* on private lands

Challenges	(%)
Grazing animals	35.1
Pest and diseases	32.9
Land and tree tenure	30.9
Bush fires	26.5
Others (harsh climate, lack of planting materials)	9.7

Problems of planting and managing *A. senegal* on private lands

A number of problems faced in planting and managing *Acacia senegal* were reported (Table 8). About 35% of the respondents said that grazing is one of the major challenges in the management of the tree species both in the rangelands and their gardens. Other challenges were insecurity of land and tree tenure (30.9%), pests and diseases (32.9%), wildfires 26.5%, and drought and lack of planting materials (9.7%).

By far the most important challenge of planting and managing *A. senegal* in Luwero and Nakasongola districts is overgrazing. Luwero and Nakasongola districts are among the most overgrazed areas in Uganda. Overgrazing causes defoliation of trees, destruction of seedlings and roots of plants as well as compacting the soil through the trampling action by livestock. Bourliere (1992) reported that soil compaction livestock can significantly interfere with the regeneration of tree species. Many tree species tolerate

the removal of a limited proportion (20-75%) of their foliage. Heavy grazing may completely remove several tree species from their communities or may reduce them to low density. Overgrazing also creates a discontinuous relationship between the stocking rate and vegetation growth.

Insecurity of land and tree tenure among local residents living in rangelands was among the most serious problems of conserving *Acacia senegal*. There is a general belief that rangelands are public lands and no one has control over it. There are also fears that government may in future gazette the rangeland as a protected area. This would limit farmers' access to tree resources from such areas. Some farmers preferred to cut *Acacia senegal* and replaced them with fruit trees such as *Mangifera indica* for fear of the governments' interest in gum arabic production. Clearly, the perceived land and tree tenure systems in the rangelands of Luwero and Nakasongola may be a disincentive to the conservation of *Acacia senegal*. Insecurity of land and tree tenure will further discourage the local people from planting *Acacia senegal* as an agroforestry tree species despite the huge potential. This observation is consistent with a report by Juma and Ojwang (1996) that the absence of security of land ownership discourages farmers from long-term investment in land. Secure tenure and tree usage are usually incentives to households to plant and care for trees.

The problems associated with planting and management of *A. senegal* does not mean that the communities are unwilling to plant and manage the trees. In fact, most of the farmers were willing to participate in any long-term program aimed at conserving the species. There is therefore a need to build capacity of the local communities to play a role in the effective management and conservation of the species in the rangelands and on private lands. Although local people are willing to participate in the management of the species, the problems given above may hinder their participation. Such problems should be addressed if the agroforestry potential of *Acacia senegal* is to be fully realized.

Conclusions

Acacia senegal has a high agroforestry potential in Luwero and Nakasongola districts. It was ranked third after *Mangifera indica* and *Ficus* species. Grazing livestock, insecure land and tree tenure, bush fires, pest and diseases are the major challenges of managing *Acacia senegal* in the rangelands Luwero and Nakasongola. Education, farm size, gender, occupation and ownership of domestic animals influenced local people's willingness to plant *Acacia senegal* trees. The proportion of farmland under tree cover (*Acacia senegal* and other tree species) is small. Over 50% of the local communities living on the rangelands are willing to participate in any long-term programme of managing *Acacia senegal* trees on farm and in the rangelands.

There is a need to asses the impacts of livestock grazing, settlement and changes in the farming system on the population of *Acacia senegal* as a first step to developing strategies for its management. The local people need to be mobilised and educated on the agroforestry potential and conservation value of *Acacia senegal*.

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