Tree species selection for buffer zone agroforestry: the case of Budongo Forest in Uganda

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SUMMARY

This paper highlights the importance of careful selection of tree species for use in buffer zone agroforestry, as a conservation strategy for threatened forest resources. A case study from the Budongo Forest buffer zone in Uganda is used to elaborate the process, where local communities applied a pair-wise ranking system to establish priority tree species and technologies for agroforestry. Maesopsis eminii, Vernonia amygdalina and Lasiodiscus mildbraedii were the top three species selected for integration into the buffer zone farms. Their selection reflects the many good attributes experienced by farmers in the area, such as provision of timber, construction poles, and firewood. The most popular technologies were woodlots, boundary planting and shade trees (multistrata tree planting), in that order of priority. Areas for further research include an evaluation of the economic aspects of the species and technologies, on farm propagation and management protocols and markets for the tree products.

Keywords: Buffer zone, Budongo forest, local communities, Agroforestry technologies, species selection

Sélection d'arbres pour l'agroforesterie des zones-tampon: le cas de la forêt Budongo en Ouganda

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Cet article souligne l'importance d'une sélection précise d'espèces d'arbres en vue de leur utilisation dans l'agroforesterie des zones-tampons. C'est une stratégie de conservation pour les ressources forestièrs menacées. Une étude-cas de la zone-tampon de la forêt Budongo en Ouganda est utilisée pour élaborer le processus, où les communautés locales utilisèrent un système de classement par paires pour établir les espèces d'arbres prioritaires et les technologies pour l'agroforesterie. Le Maesopsis eminii, la Vernonia amygdalina et le Lasiodiscus mildbraedii étaient les trois espèces supérieures selectionnées pour l'intégration dans les fermes des zone-tampon. Leur sélection reflète nombreux attributs positifs dont les fermiers de cette région ont fait l'expérience, comme l'approvisionnement du bois, des mâts de construction et du bois de chauffage. Les technologies les plus populaires étaient les woodlots, la plantation délimitée et les shade trees (plantation d'arbres en strates multiples), dans cet ordre de priorité. Les aspects à même de produire une recherche plus poussée comprennent une évaluation des aspects économiques des espèces et des technologies, la propagation des élevages et la gestion des protocoles et des marchés pour les produits dérivés des arbres.

Selección de especies arbóreas para la agrosilvicultura en zonas de amortiguamiento: un estudio del bosque de Budongo, Uganda

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Este estudio resalta la importancia de una selección cuidadosa de especies arbóreas para la agrosilvicultura en zonas de amortiguamiento alrededor de reservas forestales, como estrategia de conservación de recursos forestales amenazados. Se describe el proceso realizado en la zona de amortiguamiento del bosque de Budongo (Uganda), donde las comunidades locales aplicaron un sistema de clasificación por parejas (pairwise, en ingles) para establecer las especies arbóreas prioritarias y las tecnologias agroforestales más adecuadas. Maesopsis eminii, Vernonia amygdalina y Lasiodiscus mildbraedii fueron seleccionadas como las tres primeras especies a ser integradas en las fincas de la zona de amortiguamiento. Esta selección refleja los muchos beneficios de estas especies para campesinos de la región, como por ejemplo el suministro de troncos, postes para la construcción y leña. Las tecnologías más populares fueron el uso de lotes asignados de área fija y el sembrado de especies arbóreas para la demarcación de los terrenos y para sombra (cultivos en multiestratos), en aquel orden de prioridad. Para una investigación posterior, será necesaria una evaluación de los aspectos económicos de las especies y tecnologías, incluyendo la propagación en las fincas y los protocolos de gestión y la localización de mercados para los productos forestales.

INTRODUCTION

Management of areas near forest margins must be carried out carefully in order to ensure conservation and sustainable use of forest resources. Farming in areas adjacent to forests can have profound effects on the forest. Due to the high diversity of forests and communities living in their neighbourhood, it is hard to have a universally accepted definition of 'buffer zones'. There is a high diversity of buffer zone management initiatives and strategies (Lynagh *et al.* 2002). The often used definition of buffer zones is that they are areas around protected resources where land use is regulated to protect the core area (Meffe and Caroll 1997, Semlitsch 1998). More generally, buffer zones are defined as areas peripheral to a protected resource designated with the intention of benefiting the local community, while simultaneously providing an extra layer of protection to a conservation area (Lynagh and Urich 2002, Oldfield 1988). In this paper, we will use the general understanding that a buffer zone is an area that is sustainably managed so as to facilitate the protection/conservation of a threatened resource, in this case Budongo Forest.

Buffer zone agroforestry is one of a number of strategies currently being promoted because it can provide alternative sources of forest products commonly harvested from protected forests. For this strategy to succeed, tree species selection for buffer zone Agroforestry must be handled carefully, in order to respond to felt needs of local people. This requires their participation in the species selection process. Leakey and Jaenicke (1995), Franzel *et al.* (1996), Simons (1996) and Leakey and Simons (1998), proposed different approaches to tree species selection for use in agroforestry. Generally, the selection involves the identification of farmers' needs and preferences in management and utilization of forest trees, and the priority ranking of such needs and preferences. Priority setting and characterisation based on users' perceptions is an essential element for tree species selection and more importantly, the rapid adoption of selected species and technologies.

Currently there is limited information on the selection of indigenous tree species to use in agroforestry in forest buffer zones. Data are needed on the canopy and root systems of tree species to enable understanding of the likely impact of these trees on agricultural components within the farming system (Sinclair *et al.* 1994). Farmers typically use morphological, cultural, traditional and functional criteria to select trees for planting (Tan 1999). Site factors (soils, interactions with agricultural crops), establishment, management, nutritional and water requirements, root, crown, bole, growth and phenological characteristics and product value and quality, are some of the attributes that need to be considered (Leakey and Simons 1998, Dwivedi 1992).

A recent study showed that local people in all parishes around Budongo Forest use wood fuel, poles, timber, and Luti (wood for tobacco curing) regularly (Kasolo 2005). The study identified four sources of tree products for local people: Budongo Forest, farms, plantations and public lands. Budongo Forest was indicated as the major source of firewood (75%), poles (74%), sawn timber (93%) and luti (74.4%).

Since 1987 Uganda has included buffer zones in forest management and conservation strategies (Howard 1991). The 1997-2007 management plan for
Budongo Forest, prescribes internal zoning of the forest into a core Strict Nature
Reserve: SNR, and two social buffer zones (Zones I and II) with differential management. (Karani *et al.* 1997). The plan recommends that 30% of the area of
Budongo Forest is set aside as core reserve area, 7% as Social Buffer Zone I, and the rest as Social Buffer Zone II. Social Buffer Zone I is concentric around the core, and only the collection of wood fuel, herbal medicine, fruits, mushrooms and tubers for food is allowed in this zone. The remaining area of Budongo Forest is categorized under Buffer Zone II. Logging and all the activities permissible in Zone I are also allowed in this zone. Buffer zone agroforestry is a however, a relatively recent introduction in Uganda.

Although forest management in Uganda embraced 'buffer zones management' as a conservation strategy, there have been no studies regarding its potential and application modalities in buffer zones outside protected areas. This study was therefore timely for providing information about opportunities, modalities, limitations and challenges related to buffer zones management initiatives in external forest buffer zones habited by farming communities, as a conservation strategy for threatened forest resources. It is hoped that the results and experience, can be applied in other buffer zone management initiatives for conservation of threatened forest resources, within and outside Uganda

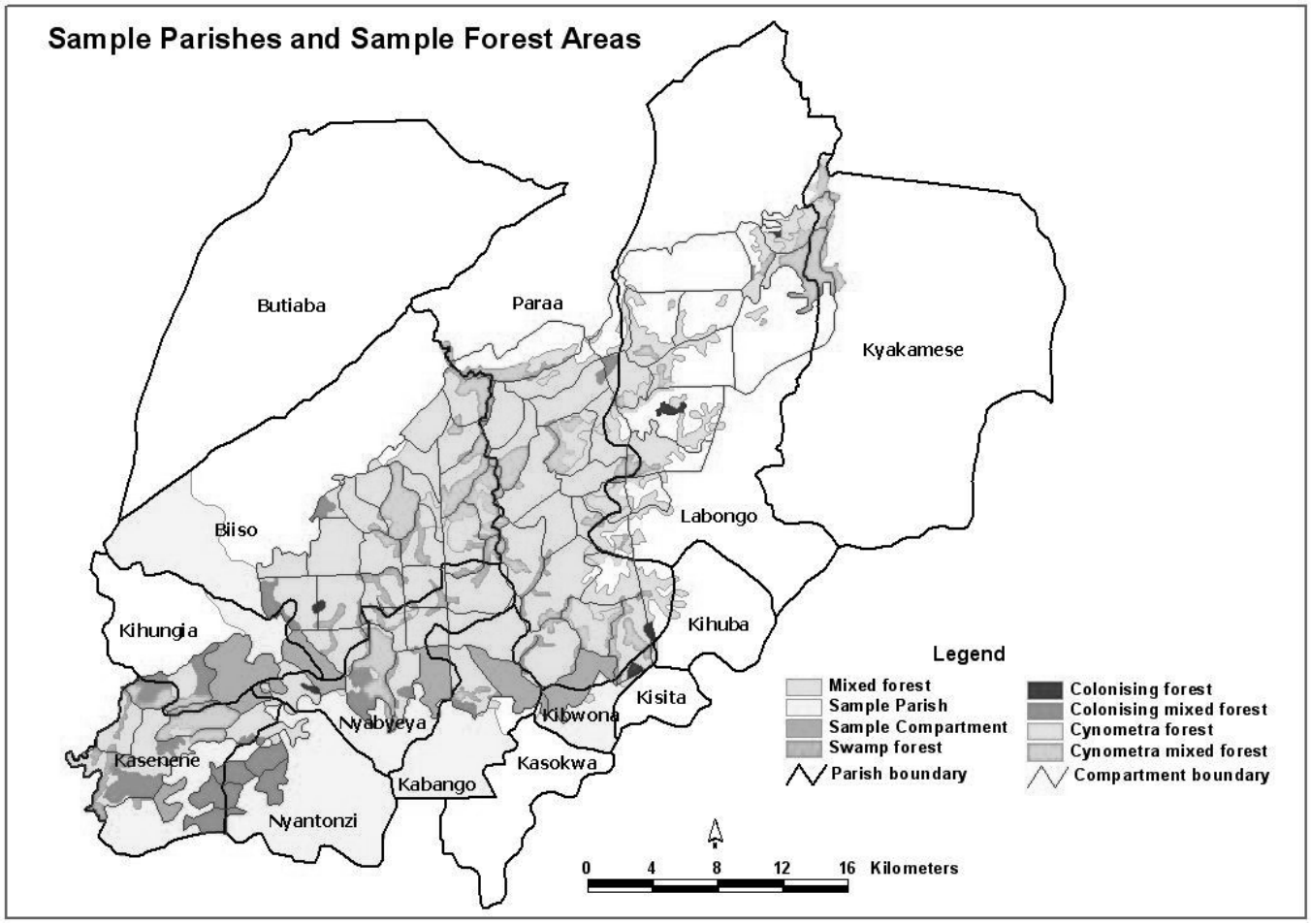
STUDY SITE

Location

The study area was Budongo Forest, and 12 surrounding parishes (administrative units) in Masindi District western Uganda (1 °37 э–2 °00 эN, 31 °22 э–31 °46 эE. 1100 m.a.s.l.). The total area of gazetted forest reserve is 825 km^2, of which 428 km^2 are forested (Howard 1991). The forest has an irregular margin, which gives it a very long boundary (Kasolo 1990). The twelve parishes that border the forest are inhabited by local communities engaged in a variety of activities within and outside the forest. The parishes are Kasenene, Nyantonzi, Kabango, Nyabyeya, Kasokwa, Kibwona, Kisita, Kihuba, Labongo, Kyakamese, Biiso and Kihungia located on the east, west and south of the forest (Figure 1). The northern side is bordered by Queen Elizabeth National Park, with no human settlements. Limited activities such as beekeeping are permitted in the park. Illegal activities such as poaching are however, common.

The parishes surrounding Budongo Forest represent considerable diversity of local communities who extract, usually without legal authority, a variety of products from the forest either for domestic or commercial purposes. The farmers also engage in a variety of agricultural practices for subsistence and income generation purposes. According to

FIGURE 1 *Budongo forest and surrounding parishes*



the 2000 census, the total human population in the study area was 60 932 distributed in 13 170 homesteads (Masindi district local government 2000). The ethnic groups include the Banyoro, Lugbra, Lendu, Alur, and Okebo from West Nile and some from the Democratic Republic of Congo and Sudan (Johnson 1993).

Buffer zone agroforestry can be practiced in a delineated external buffer zone around the Budongo Forest resource base, to supply products such as poles, firewood and timber which are ordinarily harvested from the protected forest area by local communities. This study therefore, aimed at identifying tree species commonly used for the various tree products by local communities around Budongo Forest, and selecting priority ones for integration into farming systems in the buffer zone around the forest using agroforestry technologies, as a conservation strategy for Budongo Forest.

Vegetation

Budongo Forest can be categorised into four broad forest types (Eggeling 1947,
Bahati 1995, Sheil 1998, Plumptre 2000) namely, mixed forest which is estimated to cover 49 500 ha (60% of the total area), *Cynometra* forest type 26 400 ha (32%), colonising forest 4 950 ha (6%) and swamp forest 1 650 ha (2%). The forest is characterised by high diversity of tree, shrub and herb species. Dominating the upper storey are species of *Entandrophragma, Khaya* and *Maesopsis,* in association with *Celtis mildbraedii*, *Aningeria altissima*, *Chrysophyllum, Ficus, Alstonia* and *boonei. Erythrophleum suaveolen*s is common in the upper storey of the mixed forest.

The understorey has *Funtumi,* Diospyros *abyssinica* and *Lasiodiscus mildbraedii* as common species. The common colonizing species in the forest margins are
Albizia, *Sapium ellipticum, Cordia, Acanthus arboreus, Maesopsis eminii*
and *Spathodea companulata* (Karani *et al.* 1997).

Social and economic activities in the Budongo Forest buffer zone

The majority (about 97%) of the people around Budongo are predominantly farmers.
A small section of the local community (2%) is gainfully employed, and a much smaller section (1%) of the local community is enganged in petty trade. The parishes are within the Banana/Coffee and the Banana/Millet/Cotton system zones of Ugandan agriculture (Table 1).

TABLE 1 *Farming systems in the Budongo Forest buffer zone, Uganda.*

Parishes	Farming System	Major crops	Other comments
Kasenene, Nyantonzi, Kabango, and Nyabyeya	Banana and Coffee	Cassava, millet, groundnuts, beans, potatoes, maize, coffee, bananas, sugar cane & tobacco	Sugar cane growing is becoming popular
Kasokwa, Kibwona, Kisita Kihuba, Labongo and Kyakamese	Banana, millet and cotton	Cassava, millet, maize, potatoes, tobacco, cotton, coffee, goats and cows.	Tobacco growing is becoming popular
Biiso and Kihungia	Banana, millet and cotton	Cassava, millet, maize, potatoes, tobacco, cotton, coffee, goats and cows.	Tobacco growing is predominant.

Source: Masindi district government, 2000; Johnson, 1993.

OBJECTIVES OF THE STUDY

The objectives of the study were:

1. Identification of commonly used tree species for fuelwood, timber, poles, luti (saplings used in tobacco curing), wild fruits, herbal medicines and crafts by local people around Budongo Forest.
2. Identification of suitable agroforestry technologies for use in the Budongo Forest external buffer zone
3. Identification of suitable indigenous tree species for the Budongo Forest buffer zone agroforestry initiatives.

METHODOLOGY

Commonly used forest products and tree species in the buffer zone were identified using data collected through questionnaire surveys and participatory rural appraisal (PRA). The following procedure was followed in order to undertake the participatory rural appraisal:

- A questionnaire with key questions was used to elicit the views of key informants, individually, or in interest groups such as charcoal burners, pit sawyers, farmers, youths and women in the respective parishes.
- Observations of farm components, lifestyles and the general socio-economic, and forestry related activities in each of the parishes.
- Farm reconnaissance by walking through farmlands.
- Use of charts showing potential agroforestry technologies and tree management practices, to ascertain information provided by key informers.

A target sampling intensity of 15% of households was used (Table 2) covering six sample parishes (Kasenene, Nyantonzi, Kabango, Nyabyeya, Kibwona and Biiso) within a radius of 5 km from the forest boundary, where extractivism activities are indicated to be highest (Obua 1996).

The household survey research team comprised six people (three women and three men), and operated as pairs (one male and one female). At least one of each pair had good knowledge of the local language to ease communication. One was a recorder and the other the interviewer. The combination of male and female was designed to create a more reassuring atmosphere, especially for women interviewees. Interviews, each designed to take 45 minutes, were conducted in homes or on farms, for respondents found in gardens. The roles of interviewing and recording were carried out interchangeably, depending on interviewees – the female interviewer mainly interviewed women. Before starting data collection, the team was trained in data collection using questionnaires with the help of an expert in social surveys from Nyabyeya Forestry College. The training included pilot administration of questionnaires in ten selected households in Kasokwa Parish, which was not included in the sample parishes.

Households were selected randomly from lists provided by local leaders, and charcoal burners, herbalists, pit sawyers, firewood dealers, brick makers craft makers and carpenters, were included in the survey. The surveys were carried out using questionnaires designed and adjusted after a reconnaissance survey and testing using Participatory Rural Appraisal approaches. Only one individual was interviewed from each sample household.

Local people were assisted to use a pair wise system to rank commonly used tree species preferred for agroforestry. Pair wise ranking was carried out at meetings using pairs

TABLE 2 *Sample sizes in sample parishes within 5 km from the Budongo Forest boundary*

Parish	Nyantonzi	Biiso	Kabango	Kibwona	Kasenene	Nyabyeya	Total
Number of households	1044	1268	1112	514	542	849	5329
Sample size	146	186	153	72	76	127	760

of commonly used tree species that were generated from the results of a questionnaire survey carried out earlier. Participants were presented individually with a pair of tree species and asked to indicate the more commonly preferred one. Data were entered into a matrix. The species with more tallies was ranked first, and the one with least tallies ranked last. Ranking meetings were carried out in all the communities for species used for various products. The approach was iterative in order to allow for adjustments at the different stages to accommodate changes in perspectives or objectives.

Desirable tree attributes (stem form, crown, shape, crown density, rooting pattern, growth rate etc) for the various agroforestry technologies such as shade trees, boundary planting and home gardens, which were developed with the participation of farmers were also assessed for relative importance, and rated as either very desirable, desirable, useful but not desirable, or not relevant. Lists of weighted desirable tree attributes 'D', for each of the priority agroforestry technologies were subsequently, developed.

$$D = [C_1, C_2, C_3 \text{ ---------} C_N]$$

Where C_1, C_2, C_3 ------C_N are the weights (relative importance indicators) of the desirable characteristics 1, 2, 3 up to N of agroforestry tree species. Using data from secondary sources, a list of attributes for each the priority tree species was generated. Attributes of each of the species were rated as good, fair, poor, or unknown, to produce a weighted list of tree attributes (TAs) for each of the priority tree species.

$$\begin{aligned} TA = \; & [A_{1a}, A_{1b}, A_{1c}\text{----------}A_{1m}] \\ & [A_{2a}, A_{2b}, A_{2c}\text{----------}A_{2m}] \\ & [A_{3a}, A_{3b}, A_{3c}\text{----------}A_{3m}] \\ & [\text{----------}] \\ & [\text{----------}] \\ & [A_{na}, A_{nb}, A_{nc}\text{----------}A_{nm}] \end{aligned}$$

Where $_1a$, $_1b$, 1c ----- $_1m$, $_2a$, $_2b$, $_2c$, and na, nb, nc and nm are the weights of attributes 1 and 2, up to n for species a, b, c, up to m.

The weighted list of the natural attributes of ten priority tree species (TA) was matched with the corresponding agroforestry desirable tree attributes (D) to form the matrix (T) for the weightings of the attributes of the priority tree species for agroforestry:

$$\begin{aligned} T = \; & [A_{1a}, A_{1b}, A_{1c}\text{----------}A_{1m}] \\ & [A_{2a}, A_{2b}, A_{2c}\text{----------}A_{2m}] \\ & [A_{3a}, A_{3b}, A_{3c}\text{----------}A_{3m}] \\ & [\text{----------}] \\ & [\text{----------}] \\ & [A_{na}, A_{nb}, A_{nc}\text{----------}A_{nm}] \end{aligned}$$

Where, A_{1a} is attribute (A) of species 'a' that corresponds to the needed attribute C_1, in matrix 'D' and A_{1b} is the attribute of species 'b' which corresponds with the same attribute C_1, in matrix D, across the row of T. Attribute A_2 corresponds with the needed attribute C_2, for each of the species a, b, c, to m.

Analysis for best selection was carried out using Wojkowski's (1998) approach, by multiplying matrix 'D' of the weighted list of the desirable tree attributes for use in agroforestry, with matrix 'T' of the weighted attributes of the priority tree species to get the selection matrix 'S'.

$$\begin{aligned} S &= D(1xn) \times T(nxm) \\ &= (1 \times m) \end{aligned}$$

Where 1 is the row containing the sum of weights for desirable tree attributes for a particular agroforestry technology for each of the species m. To multiply the matrices, the matrix of the desirable tree attributes for the candidate agroforestry technologies (D) was transposed. The transposed matrix was multiplied with the matrix of the weighted agroforestry attributes for ten priority indigenous tree species (T), to yield a selection matrix (S), for the most promising tree species for use in each of the five candidate agroforestry technologies.

RESULTS

Priority tree species selection

Detailed results for the identified tree species which are

TABLE 3 *Summary by parish, of tree species used around Budongo Forest, Uganda*

	Biiso	Kabango	Kasenene	Kibwona	Nyabyeya	Nyantonzi	Average
Timber	14	13	12	10	14	14	13
Fuelwood	17	14	12	11	14	17	14
Poles	9	10	12	9	13	12	11
Luti	11	4	9	7	8	10	8
Medicine	10	9	12	11	14	12	11
Crafts	6	5	5	6	4	6	5
Fruits	11	3	5	4	7	9	7
Overall	55	41	40	37	43	57	46

commonly used for tree products by local people around Budongo Forest are given in Annex 1. A summary of species used for each product indicates that a diversity of species is involved (Table 3).

When counts of tree species commonly used in each parish for the various tree products where transformed into standardized Z-values, differences between parishes and within parishes (variations from the mean rank) were clearly visible.

Ranking results covering twenty commonly used tree species around Budongo Forest indicated that the first priority species are mainly for supplying fuelwood, followed by poles, luti and medicine. Species for sawn wood supply are not prominent in the first priority species category. The second priority species category is again largely for supply of wood fuel, followed by poles, sawn timber and wood for tobacco curing. The third priority species category is mainly comprised of species for supply of poles, followed by timber and tobacco curing (Table 4).

(C1-C27) for the different agroforestry technologies (Matrix D), which were produced with farmers, are presented in Annex 2. Weighted natural attributes of the ten priority indigenous forest tree species (Matrix TA) which were produced through secondary information sources and with respondents are given in Annex 3. Results of a selection matrix (S) are presented in Table 6. The results indicate *Maesopsis eminii* as the preferred tree species for woodlots, boundary planting, shade trees, home gardens and scattered planting in farmlands.

A comparison of the ratings for all the species in the selection matrix for use in the identified agroforestry technologies using a scatter diagram (Figure 2) highlights the differences in their suitability as perceived by farmers.
A summary of the results for ranking of preferences for agroforestry technologies, and priority tree species for use in the Budongo Forest buffer zone (Table 7) indicates high preference for woodlots, followed by boundary planting and shade trees. *M. eminii* is indicated as suitable for use in all

TABLE 4 *Priority categorization of commonly used species in the Budongo Forest buffer zone, Uganda*

Ranking of tree species	Uses						Category
	Fuelwood	Poles	Timber	Luti	Crafts	Medicine	
1. Lasiodiscus mildbraedii	×	×		×			1
2. Cynometra alexandri	×	×		×			
3. Maesopsis eminii	×		×			×	
4. Vernonia amygdalina	×	×		×		×	
5. Alstonia boonei			×			×	
6. Khaya anthotheca	×		×			×	2
7. Funtumia elastica	×	×		×			
8. Celtis mildbraedii	×	×		×			
9. Terminalia glaucescens	×	×					
10. Entandrophragma angolense			×				
11. Celtis durandii		×	×	×			3
12. Grewia mollis	×	×		×			
13. Albizia zygia			×				
14. Coffea canephora		×		×			
15. Phoenix reclinata		×			×		

Suitable agroforestry technologies

Household surveys and participatory ranking were used to identify and rank potential agroforestry technologies (Table 5). Differences were evident among parishes in terms of preferences for potential technologies. Woodlots, boundary planting, scattering on farms and home gardens were nevertheless, indicated as the most suitable technologies by all parishes.

Suitable forest tree species for agroforestry

Twenty-seven weighted desirable tree species attributes

technologies. It is therefore, ranked highest, and followed by *V. amygdalina*. *Maesopsis eminii* is indicated as suitable for all technologies, followed by *Vernonia amygdalina* and *Lasiodiscus mildbraedi*i, while *Cynometra alexandrii* is the least favoured.

DISCUSSION

In order to enhance the contribution of buffer zone agroforestry to the conservation of the protected resource base, it is necessary to identify carefully the species for integration into farming systems in the buffer zone as a way

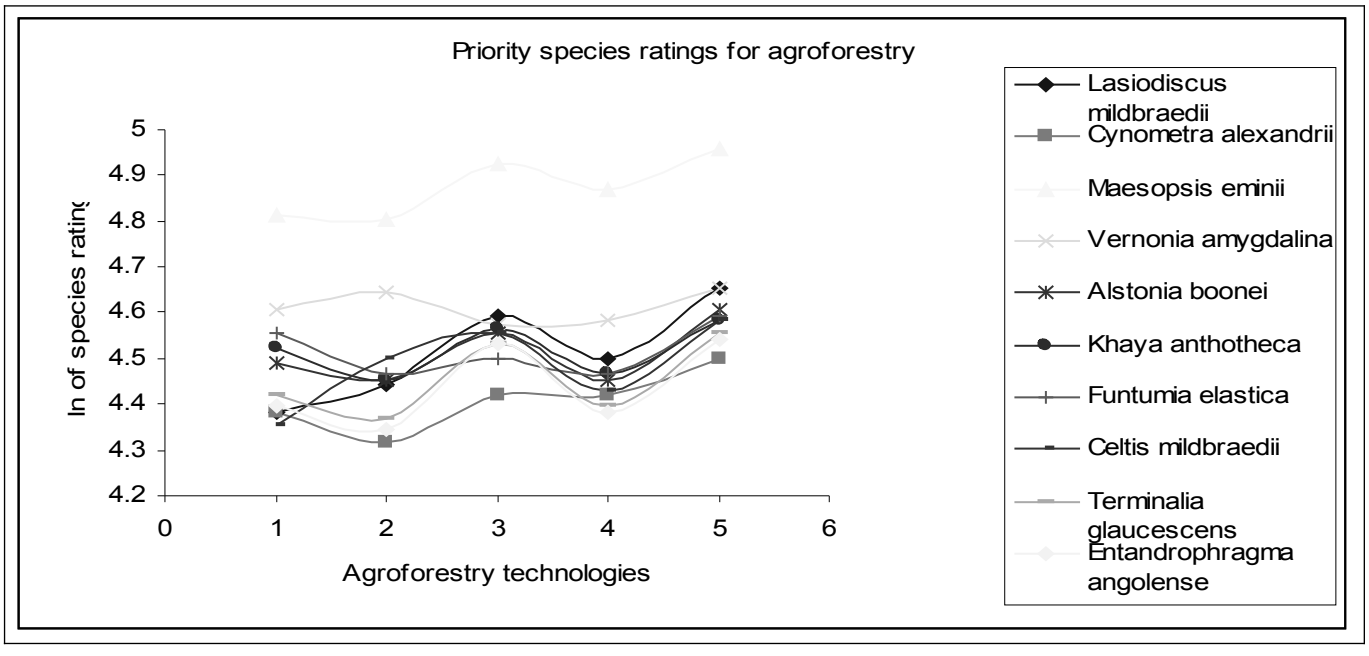
TABLE 5 *Pair-wise ranking of agroforestry technology preferences for the Budongo Forest buffer zone, Uganda*

Rank	Technology	Ranking tally scores
1	Woodlot	8
2	Boundary planting	7
3	Shade trees	6
4	Homegardens	5
5	Scattered trees on farm	4
6	Alley cropping	3
7	Live fences	3
8	Fodder banks	2
9	Fallowing	1
10	Taungya	0

TABLE 6 *Selection matrix for priority tree species for agroforestry potential for the Budongo Forest buffer zone, Uganda*

Agroforestry technology	Species relative ranking									
	Lasiodiscus mildbraedii	*Cynometra alexandrii*	*Maesopsis eminii*	*Vernonia amygdalina*	*Alstonia boonei*	*Khaya anthotheca*	*Funtumia elastica*	*Celtis mildbraedii*	*Terminalia glaucescens*	*Entandrophragma . angolense*
Woodlots	80	80	123	100	89	92	95	78	83	81
Boundary planting	85	75	122	104	86	86	87	90	79	77
Shade trees	99	83	138	97	95	96	90	95	93	93
Home gardens	90	83	130	98	86	87	87	84	81	80
Scattered trees in gardens	105	90	142	105	100	98	99	98	95	94

FIGURE 2 *Priority tree species ratings for agroforestry use*



Key: 1 - Woodlots; 2 - Boundary planting; 3 - Shade trees; 4 - Home gardens; 5 - Scattered trees on farm

TABLE 7 *Summary of five priority technologies and related species rankings*

Ranked technologies		Species rankings				
		1	**2**	**3**	**4**	**5**
1	Woodlots	*Maesopsis eminii*	*Vernonia amygdalina*	*Funtumia elastica*	*Khaya anthotheca*	*Alstonia boonei*
2	Boundary planting	*Maesopsis eminii*	*Vernonia amygdalina*	*Celtis mildbraedii*	*Funtumia elastica*	*Khaya anthotheca*
3	Shade trees (Multi-strata)	*Maesopsis eminii*	*Lasiodiscus mildbraedii*	*Vernonia amygdalina*	*Khaya anthotheca*	*Celtis mildbraedii*
4	Home gardens	*Maesopsis eminii*	*Vernonia amygdalina*	*Lasiodiscus mildbraedii*	*Funtumia elastica*	*Khaya anthotheca*
5	Scattered trees in gardens	*Maesopsis eminii*	*Vernonia amygdalina*	*Lasiodiscus mildbraedii*	*Funtumia elastica*	*Celtis mildbraedii*

of providing alternative sources of goods and services for the livelihoods of the dependant local communities. This can be most successfully done with the participation of the beneficiary communities.

Overall, people around Budongo Forest commonly use 46 different indigenous tree species for sawn timber, poles, wood fuel, luti, medicines, crafts materials and wild fruits, suggesting a big impact on the Budongo Forest biodiversity, and highlighting a potential conservation threat to the forest resource base. The spectrum of species involved varied widely from parish to parish but in every case, underlined the contrast between species valued by professional forestry and those valued by local people, although there was shared interest in some high value species *(E. angolense, K. anthotheca, and M*. eminii). Contrary to common expectation, ranking of timber species is very low among the commonly used tree species. Instead, fuelwood and pole species rank high among the commonly used indigenous tree species around Budongo Forest.

Traditionally famous species for timber such as *E. angolense* (Budongo mahogany) were ranked very low on the lists of commonly used species, indicating a possible shift in use from the traditionally much sought after species, to the less well-known ones. An emerging potential is indicated for *C. alexandrii* for fuelwood, *L. mildbraedii* for poles, *M. eminii* for timber, *C. canephora* for tobacco curing, *A. boonei* for medicine and *P. reclinata* for craft material.

Pair wise ranking results for agroforestry technology preferences indicated woodlots as the most popular, followed by boundary planting, then shade trees (multi-strata agroforestry), home gardens and scattered trees on farms as priority technologies. It emerged strongly that farmers were aware of many attractive attributes of trees, and that for individual roles, trees varied in potential from species to species. There is evident scope to develop this positive attitude of the farmer further, not only for livelihood improvement but for conservation benefits.

By combining scores for attributes of priority tree species with farmer specification of tree attributes desired for different agroforestry situations it is possible to relate tree species to appropriate agroforestry technologies. Basing these combinations on the opinions of farmers rather than land resource professionals increases the chances of farmer take up. The ranking by farmers simplifies technology and tree species selection, and it also makes it easy to relate choices to the needs of the farmer, the farm environment, and the preferred technology for integrating trees into the farming system.

Four of the priority species have been studied to a reasonable extent in terms of management to produce timber and other products - *M. eminii, K. anthotheca, E. angolense* and *C. Mildbraedi*i. A larger number of the high ranking species have generally been disregarded in the past - V. *amygdalina*, *L. mildbraedii, T. schimperiana, A. boonei, C. alexandrii, F. elastica.* Knowledge on good site characteristics, reproductive biology, increment and artificial regeneration aspects is seriously deficient for these species. Available information on some of the species is restricted to conventional forest management needs and strategies (for timber production objectives), and not relating to agroforestry with these species. There is therefore, a great need to improve our knowledge about the priority species both through new research, or/and collation of information that is already recorded but dispersed in different communities and institutions.

The participation of local communities in the selection of species and technologies for use in buffer zone agroforestry is an important requirement as a protected resource conservation strategy. In the Budongo Forest buffer zone agroforestry case study, results show that selection and ranking of tree species by farmers was largely based on availability of such species, quality and multiplicity of services from the species, utilisation history and management knowledge. It is however important that even where farmers have very clear ideas on what species and technologies they want, other considerations such as productivity, competition with other crops or resources (e.g. water discharge), ecological and economic performance be taken into consideration in decision-making. Knowledge in these areas is currently very poor.

CONCLUSION

The agroforestry technologies that underpin peoples' needs and expectations in the Budongo Forest buffer zone

are woodlots, boundary planting and shade trees (multi-strata tree planting), in that order of priority. *M. eminii,* followed by *V. amygdalina* and *L. mildbraedii* are the most promising priority tree species for integration into farming in the Budongo Forest buffer zone farming systems. Their selection reflects the many good attributes experienced by farmers in the area.

Buffer zone agroforestry has a potential for enhancing the protection status of natural forests which are threatened by high extractive activities by dependant communities. Species which are commonly harvested from the forest can be integrated into farming systems around the forest, to provide alternative sources for the associated products and services. Buffer zone agroforestry should be developed in the area, after further analysis of production technologies and optimization of socioeconomic and conservation benefits. The following processes are pertinent:

1. Undertaking studies to improve the knowledge gap regarding reproductive biology, regeneration, growth characteristics and management regimes for the priority tree species to inform the development of effective agroforestry technologies
2. Careful development of methods to integrate selected trees into the farming systems in buffer zones.
3. Good understanding of ecological and socioeconomic settings within which, buffer zone agroforestry initiatives can be undertaken
4. Sound knowledge of the impact of intensified agroforestry systems and their trends over long periods of time.

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ANNEX 1 *Ranking of tree species used for forest products around Budongo Forest, Uganda*

Tree species	Forest Products					
	Firewood	Poles	Timber	Luti	Medicine	Crafts
Acacia kirki	3	4	4	4	4	4
Acacia seyal	3	4	4	4	4	4
Acacia sieberiana	4	4	4	4	3	4
Albizia coriaria	4	4	2	4	3	4
Albizia glaberrima	4	4	3	4	4	4
Albizia zygia	4	4	2	3	4	4
Alstonia boonei	4	4	1	3	1	4
Antiaris toxicaria	4	4	3	4	4	4
Caffea canephora	4	2	4	1	4	4
Calamus deeratus	4	4	4	4	4	1
Canarium schweinfurthii	4	4	4	4	2	4
Celtis mildbraedii	2	1	4	1	4	4
Chrysophyllum perpulchrum	4	4	2	2	4	4
Combretum collinum	1	3	4	3	4	4
Combretum molle	4	3	4	4	3	4
Cordia milleni	4	4	1	4	4	4
Cynometra alexandrii	1	1	4	2	4	4
Entandrophragma angolense	4	4	1	4	4	4
Entandrophragma utile	4	4	2	4	4	4
Erythrina abyssinica	4	4	4	4	2	4
Erythrophloem suaveolens	2	2	4	3	2	4
Ficus natalensis	3	2	4	4	4	4
Funtumia elastica	1	4	3	1	4	4
Grewia mollis	2	3	4	3	4	1
Hallea stipulosa	4	4	1	4	4	4
Khaya anthotheca	3	4	1	4	1	4
Lasiodiscus mildbraedii	1	4	4	1	4	4
Lovoa trichilioides	4	4	3	4	4	4
Maesopsis eminii	2	4	1	4	3	4
Mangifera indica	4	4	4	4	1	4
Markhamia lutea	4	2	4	2	2	4
Milicia excelsa	4	4	2	4	4	4
Phoenix reclinata	4	1	4	4	4	1
Piliostigma thonningii	4	4	4	4	2	4
Rinorea ardisiaeflora	4	1	4	2	4	4
Senna didmobotrya	4	4	4	4	3	4
Senna siamia	3	3	4	4	4	4
Teclea noblis	4	2	4	1	4	4
Terminalia glaucescens	2	3	4	4	4	4
Vernonia amygadalina	1	4	4	2	1	4
Warburgia ugandensis	4	4	4	4	2	4

Key: Rank 1 - Most commonly used species; Rank 2 - Occasionally used species; Rank 3 - Rarely used; Rank 4 - Not known

ANNEX 2 *Desirable tree attributes weighting for agroforestry technologies*

Desirable tree attribute	***Weighting for potential agroforestry technologies (D)***				
	Shade trees	Scattered trees	Home gardens	Woodlots	Boundary planting
Fast growing	3	3	3	3	3
Previous agroforestry use	3	3	3	3	3
Multipurposenness	3	3	3	3	3
Easy to establish	3	3	3	3	3
Easy to manage	3	3	3	3	3
Germplasm availability	3	3	3	3	3
Easy propagate	3	3	3	3	3
Pests/insects resistant	3	3	3	3	3
Diseases resistant	3	3	3	3	3
Deep rooting	3	3	3	2	2
Compatibility with crops	3	3	3	1	2
Nitrogen fixing	3	3	3	1	1
Non competitive with crops	3	3	3	0	2
Deciduous	3	3	1	1	0
Single stemmed	3	2	2	2	1
High branching	3	2	2	2	1
Low branching	3	1	1	1	2
Light crown	3	3	2	1	1
Straight stem	2	2	2	3	2
Good response to pollarding/ pruning	2	3	1	2	2
Non thorny	2	1	2	2	1
Wide crown	3	1	1	0	1
Coppiceable	1	2	2	3	3
Self pruning	1	1	1	3	0
Narrow crown	0	2	2	2	2
Multiple stemmed	0	1	1	1	2
Dense crown	0	0	1	1	2

Adapted from: Burley, 1985; ICRAF, 1992; Huxley, 1984 and National Academy of Sciences, 1980.

Weighting interpretation:
3 - Strongly desirable attribute,
2 - Desirable attribute,
1 - Useful but not desirable
0 - Not relevant

ANNEX 3 *Weighting of agroforestry attributes of the ten priority tree species*

Desirable tree attribute	Weighting of tree species agroforestry attributes (T)									
	Lasiodiscus mildbraedii	*Cynometra alexandrii*	*Maesopsis eminii*	*Vernonia amygdalina*	*Alstonia boonei*	*Khaya anthotheca*	*Funtumia elastica*	*Celtis mildbraedii*	*Terminalia glaucescens*	*Entandroph. angolense*
Fast growing	3	0	3	3	3	2	2	3	2	1
Previous use history	0	0	3	1	0	0	2	0	0	0
Multipurpose ness	1	2	3	3	3	2	2	1	1	1
Easy to establish	1	1	3	2	0	2	0	2	2	2
Easy to manage	2	1	3	2	1	2	2	2	2	2
Germplasm available	2	1	3	2	2	3	2	1	2	2
Easy to propagate	1	2	3	3	2	2	2	2	2	2
Pests/insects resistant	2	3	1	2	0	3	2	2	2	2
Diseases resistant	2	2	1	2	2	2	2	2	2	2
Deep rooting	2	1	3	1	3	3	2	3	3	3
Compatibility with crops	2	0	3	1	2	0	1	1	1	1
Nitrogen fixing	0	3	0	0	0	0	0	0	0	0
Non competitive	1	2	2	0	1	1	1	1	1	1
Deciduous	2	0	2	0	3	2	1	3	3	3
Single stemmed	3	3	3	2	3	3	3	2	3	3
High branching	0	2	2	0	2	2	3	0	1	2
Low branching	3	1	1	3	1	1	0	3	2	0
Light crown	3	2	2	1	0	0	0	2	0	1
Straight stem	2	2	3	2	3	3	3	1	1	3
Good response to pollarding/pruning	3	2	3	2	2	2	3	2	2	2
Non thorny	3	3	3	3	3	3	3	3	3	3
Wide crown	0	1	3	1	3	3	0	3	2	3
Coppiceable	0	3	3	3	3	0	0	3	0	0
Self pruning	0	2	3	1	3	3	3	1	3	3
Narrow crown	3	2	0	2	0	0	3	0	1	0
Multiple stemmed	0	0	0	1	0	0	0	1	0	0
Dense crown	0	1	1	2	3	3	1	1	2	2

Note: Adapted from Eggeling, 1951; Katende, 1995; ICRAF, 1992;
Score interpretation: *3 - Good; 2 - Fair; 1 - Poor; 0 - Unknown*