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AGROFORESTRY SYSTEMS FOR MITIGATING THE PROBLEMS OF FUELWOOD SCARCITY IN THE MONTANE/SAVANNA ECOSYSTEMS: A CASE STUDY OF OBUDU CATTLE RANCH, SOUTH-EASTERN NIGERIA

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ABSTRACT

The study highlights the need for an agroforestry system that will reduce the problem of fuelwood scarcity in the Obudu Cattle Ranch settlement of Cross River State, South-Eastern Nigeria Using Participatory Rural Appraisal (PRA) methodology, general information on Local crop types, fuelwood species known to the people, their reasons for the preference of particular fuelwood species, the quantity extracted and who does the harvesting was collected.
Qualitative and descriptive statistics such as matrix ranking techniques, simple proportions/percentages and tables were employed in the data analysis. Results show that integration of woody species with annual crops in agroforestry systems can enhance sustainability of production systems in the montane and savanna ecosystem under low input conditions. Agroforestry has short and long-term protective and socio-economic benefit and would go a long way in checking the problems of erosion, flooding, adverse change in ecology, decline in soil productivity, loss of useful species of organisms (plants and wildlife) and the gradual deterioration of the entire forest lands (deforestation). Stable indigenous and prototype agroforestry systems suitable for the regions are available. However, they need wider testing and use.

KEYWORDS: Agroforestry systems, fuelwood scarcity, Montane/savanna ecosystems, Obudu Cattle Ranch

INTRODUCTION

Wood is the principal energy source for majority of the population of developing countries responsible for 34% of total energy consumption (Kgathi & Mlotshwa, 1997). It is used both for domestic purposes and for use in small-scale traditional industries, such as baking, pottery making, and coffee/tobacco drying.

In some areas, particularly in towns and cities, fossil fuels such as oil, kerosene and electric energy compete with wood and charcoal as sources of energy (Gregersen et al 1989). Use of fuelwood in the growing cities of the third world contrasts sharply with the more familiar patterns of rural areas. Despite the growth of energy use in other sectors, rural household consumption still dominates the energy budgets of many developing countries particularly in the poorer nations of Africa and South Asia.

Fuelwood accounts for more than 75 percent of the energy used in countries such as Nepal, Bangladesh; Ethopia, Burkina Faso, and even Oil-rich Nigeria (Soussan 1988).
The energy crisis experienced by majority of persons in developing countries today has been referred to as the fuelwood crisis now rechristened by some commentators as 'the second energy crisis' (Kgathi & Mlotshwa, 1997). This came to the foreground in the wake of the oil crisis of the 1970's leading to increase in the price of kerosene and a correspondingly greater dependence on wood energy by the rural population The above has accentuated the problem of deforestation throughout much of Africa and Asia (Quattara, et al & Kawate, 1989, Hayes, 1981) provoking massive tree loss and associated ecological problems such as global warming, biodiversity loss and loss of watershed function, as well as economic and health related problems of the household associated with going further a field in search of dwindling fuelwood supplies.

In the montane/savanna regions of south-eastern Nigeria, the ever increasing demand by the rural people for greater harvesting of fuelwood causes a drain of such forest resources. Over 90 percent of rural dwellers depend on forest resources as fuel. In Obudu cattle ranch, the quantity of wood extracted for fuel and rural energy supply is absolutely unsustainable in relation to the diminutive patches of montane forest remaining; covering perhaps 1-5 percent of the central area. Also in this settlement, firewood is collected from increasingly distant or marginal sources, women and children spend up to five hours a day collecting firewood. The labour demand becomes intolerable when allied to household chores such as cooking, fetching of water, health demand of children, and other social commitments.
Rural residents are dependent on fuelwood and other biomass for the cooking and heating of their homes, while the commercial trade in fuelwood to the urban area continue to flourish. The Obudu Cattle Ranch hotel is a great consumer of fuelwood as hundred of kilograms of fuelwood is purchased by them per week, they record a total rate of fuelwood consumption of 2,611 tones in 1996 and this is projected to hit 2961.85 tones by 2000AD (National Population Commission, 1991) indicating an excessive and continuous exploitation of woody species and forest which if effective measures are not taken, would lead to their destruction and loss in a relatively short time

In this study, an attempt is made to delineate appropriate agroforestry strategy that could mitigate the problem of fuelwood scarcity in Obudu cattle ranch. The primary objective of the study is to determine appropriate agroforestry systems which farmers can employ to manage their fuelwood resources sustainably The study also responds to the following:

- Most desirable tree species used for fuelwood production.
- Agronomic importance of the selected fuelwood species and their overall fit within local farming systems

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- Possibility of integrating these species on farmlands for sustainable fuelwood production in the study area.

AGROFORESTRY SYSTEMS AND THE FUELWOOD PROBLEM

Having the problem of deforestation in mind and appreciating the need for fuelwood within agricultural lands in montane and savanna vegetation, several works have been carried out most of which are suggestive of the benefits and need of agroforestry practice in an ecosystem.

Throughout history, fuelwood has played a fundamental role in meeting the domestic and non-domestic energy requirements of world populations (Pasztor & Kristoferson, 1990: 6; Bogach, 1985: 1-15). A substantial amount of these resource is used in the rural domestic/household sector which consumes most of the world's wood energy needs (Wood 1980:60; Leach and Mearns, 1988: 1; Rosillo-calle et al, 1992).

Munslow et al 1988 records that a vast majority of more than 60 million people who live in the Southern African Development Coordination Conference (SADCC) region rely upon wood for their basic household fuel.
They also added that biomass accounts for between 50 percent (Zimbabwe) and 90 percent (Tanzania) of national energy consumption and that woodfuel accounts for four-fifths (4/5) of the total energy consumption of the SADCC region, principally because it is the major fuel for domestic use.

According to FAO (1981) in Gregersen et al (1989) , 2,000 million people in 1981 in developing countries were dependent on fuelwood of this number, some 100million were experiencing acute fuelwood scarcity and were unable to obtain the minimum fuel required for cooking and heating, which was a significant factor in perpetuating their poverty. Moreover, an additional 1,050 million people did not have access to sufficient supplies of fuelwood and were facing fuelwood shortages.

Gregesen et al (1989) added that by the year 2000, the number of people in situations of acute shortages will increase to 2,400 million unless major action is taken to improve the management of existing wood resources, and at the same time to increase reforestation and tree planting on farms substantially. They also opined that despite this crisis, farmers will probably not grow trees solely for fuelwood except in special cases. Also, natural forests are rarely, if ever, managed solely for fuelwood production and in only a few cases have plantations been established solely for fuelwood. Therefore, there is likely the production of most of the additional fuelwood in combination with other forest products. Those working in the field of energy must bear this in mind when considering the different options for increasing fuelwood supplies.

Macdicken 1985, and Vergara, 1990, commenting on agroforestry systems in Nigeria states that the traditional bush fallow system is a predominant practice, which if practiced using the correct cultivation method and proper lengths of fallow period, fallow crops will not only provide a period of rejuvenation for cropped lands, but can also provide products such as fuelwood, small timber, fodder and fruits.

Bisong, 1998 stated that in the rainforest of Cross River State, South-Eastern Nigeria, indigenous agroforestry practices allows trees on farmlands; sometimes left scattered on farms when the land is originally cleared and at times planted as part of more complex agroforesty systems such as in cocoa and rubber plantations. A range of tree species significant to most members of the population in Bisong's study are Bush mango (*Irvingia gabonesis*), Iroko (*Milicia excelsa*), Mahogany (*Entandrophragma spp.*), Afang (*Gnetum africanum*), Palm tree (*Eleais guineensis*),Achi (*Brachystegia spp*),Bitter cola, (*Garcinia cola*),Native pear (*Dacroydas edulis*), and Balck afara. This immense diversity of tree species gradually becoming dominant factor in the agricultural landscape holds great potentials for the practice of agroforestry.

Dunn (1994) in an overview of agroforestry systems in Cross River State taking the agroecological zone of the guinea savannah comprising Yala, Obudu, Ogoja and parts of Obanliku describes the indigenous agroforestry systems as follows:
Dispersed trees on farmland including soil improvers such as *Dialium guineese* and *Parkia spp*, Trees for timber production such as *Terminalia ivorenis* and *Lophira alata*, Fruit trees such as Oilpalm (*Elaeis guineensis*), Seeding of valued trees such as Bush mango (*Irvinga gabonensis*), Bamboo (*Bambusa vulgaris*) to be used as yam stakes and firewood, Trees in home gardens acting as wind breakers during the dry season such as cashew (*Anacardium occidentale*), Neem (*Azadirachta indica*), Gmelina, *Eucalyptus spp*, Casuarinas equisetifolia, Teak (*Tectona grandis*) *Parkia spp* and Bush mango *(Irvinga gabonesis*). Live fences such as *Spondias mombin, Ficus spp, Hibiscus spp* and Trees in pasture for providing shade and fodder especially in the dry season.

The general agreement among many is that clearing land for agriculture and pasturage is the primary reason why people cut down trees (FAO in Gregersen etal 1989). Within the Cross River State agricultural economy, extending the area of land under cultivation may well be the cheapest and easiest method of increasing production. This traditional farm practice has affected the tree population and consequently resulted in the growing fuelwood crisis with the tropical rainforest receding farther. The disappearance of the forest will result in scarcity of forest products as well as affect the socio-economic well-being of the people. FAO study also suggested that acute fuelwood scarcities are already being encountered in eighteen African countries, three Asian countries and six Latin American countries affecting about 112million people.

The fuelwood crisis has a significant effect on the daily life of the women and well being of her family. FAO, 1978 in Gregersen etal 1989, also observed that degradation of forest would force the women to purchase fuelwood, a heavy burden on them since shortage of fuelwood can affect the nutritional well-being of people. They also studied that in some parts of West Africa, people have been reduced to one cooked meal a day while in the upland area of Nepal, only vegetables which can be eaten raw are grown. FAO, Indeed stated that several substantial tree planting programs initiated in the late 1970s to early 1980s, especially in the dry tropics, included fuelwood production as one of the major objective, Several of these programs involved tree planting by farmers on their own farms or in communally or publicly owned lands where they are generally known as agroforestry or social forestry projects (for fuelwood production).

According to Vergara, (1990) the general agroforestry practices that promote fuelwood production includes: alley cropping, improved fallow, home gardens, plantation crop combination, modified taungya, use of trees in soil conservation and reclamation, multipurpose trees on croplands, and Fuelwood lots. Dradley, (1985) in a survey of Kenya woodfuel development programme revealed that tree growing is extremely common. Hedges, woodlots and windbreaks are a feature of most farms, and trees are normally also found on farmlands and in the compounds. The study also revealed that farmers are much more involved in tree propagation than had been expected and are quite capable of producing their own seedlings. It was found that "Micro nurseries exist on about a third of all farms. The vast majority of trees raised in such nurseries are woody species like *Cucaltyptus* and *Cupressu, lusitanica* and *Sesbania*.

Farmers in Western Bangladeh often grow *Acacia nilotica* on croplands for use as craftwood and fuel (MacDicken, 1985). Trees are generally not planted, but are allowed to grow by natural regeneration. The tree population are often thinned to less than 100 trees per hectare and are pruned and managed with rice and wheat. Farmers claim there is little reduction in wheat and rice yield due to the tree crop combination.

Notable studies carried out in steppler and Kenya by Lundgren. et al (1983) describes the *Leucaena Leucocephala* and Acacia albida as high yield fuelwood species when intercropped with maize and sorghum respectively. Accordingly, Dunn, (1994) commenting on agroforestry practices in Cross River State gave an instance of agroforestry in Ogoja Local Government area where fruit trees are being established using a system of shelter belts formed by thinning mature forest and planting fruit-trees in the clearings. Many individuals she said plant trees around the boundaries of land they have bought on which to build. The trees are being used as markers and fuelwood while the land is used to grow cassava until the project begins. The Development in Nigeria(DIN) organization is currently carrying out a fuelwood lot establishment project in the Obudu Cattle Ranch of Cross River State. The lots were planted with fast growing exotic species (*Myiana* and *Eucalyptus*) and surrounded by economic trees like guava and African .pear that grow well on the plateau. The wood lots are doing well and would soon be ready for pruning which would be used as firewood (Ifeka, et al, 1997).

Although various works have identified agroforestry systems that would encourage tree planting for fuelwood production in general, research so far has not been directed to the study of what tree species local people would prefer to plant on their farms and the agronomic potentials of these species to their crop/environment; a system that leaves room for indigenous innovations. This study has thus come to fill the gap in the literature about fuelwood used by the rural people with unbroken regularity in meeting household needs which has been totally overlooked. Thus the need to reduce the current pressure on forest resources in the fragile montane ecosystem and to develop agroforestry designs for reducing the problems of fuelwood extraction in the montane and savanna ecosystem especially in the Obudu cattle ranch prompted this study.

STUDY AREA

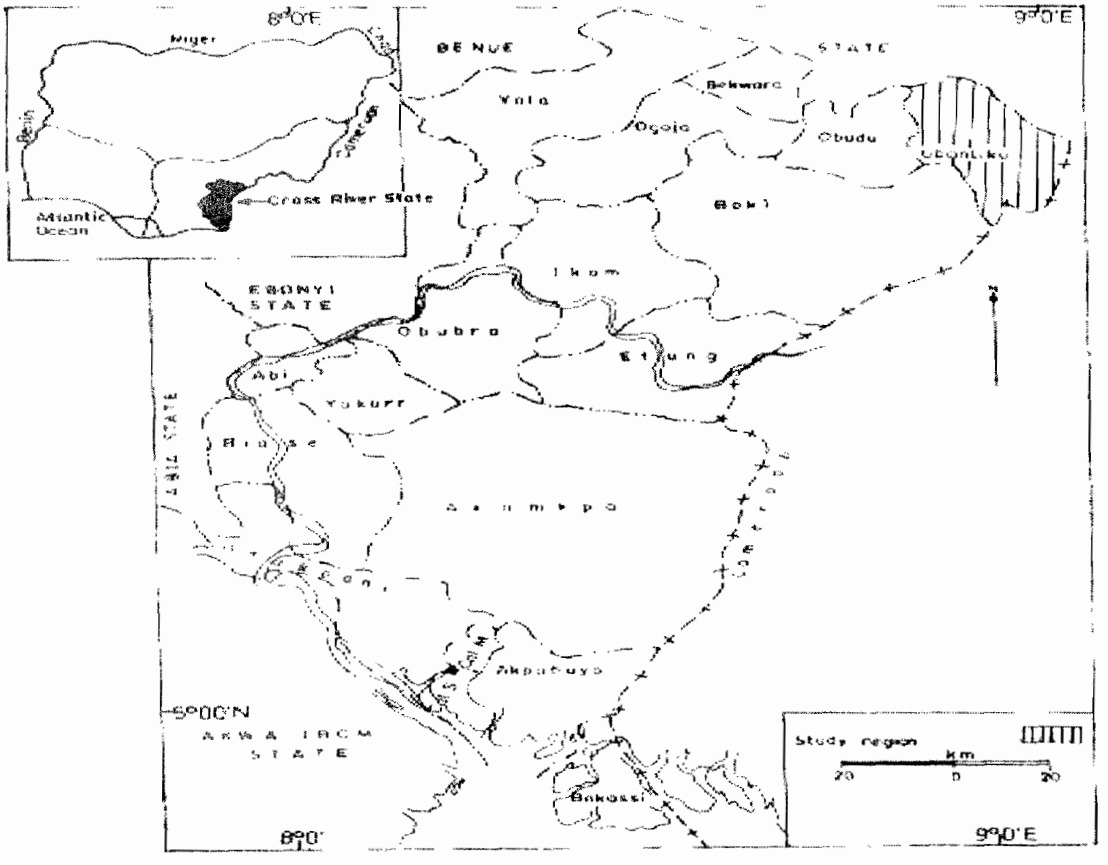
The study area is Obudu Cattle Ranch (OCR) in Obanliku Local Government area (LGA in Cross River State (Figure 1). Obudu cattle Ranch lies between latitude 8^0 49 North and Longitude 8^0 45 East of the Greenwich meridian. It is located in the northern extremity of Cross River State. It is bounded in the North by Benue State, in the West by Obudu Local Government Area, in the East by the Republic of Cameroun. The Obudu Cattle Ranch is a plateau with an altitude of about 1,800m above sea level.

Obudu Cattle Ranch has a total land area of 21.5sq km with a projected population for the year 2000 (National Population Commission, 1991). The major inhabitants of the area are the Becheve and the major language spoken is Becheve. The ranch is in the tropical climatic zone but tends to have a temperate climate caused essentially by difference in elevation. Rainfall and relative humidity here is very high throughout the year. Two wind systems prevail, the North-east trade wind (beginning from November to March and brings in dry conditions into the region), and the southwest Monsoon wind (starting from April till October which ushers-in the rainy season that last almost all the year out).

The Obudu cattle ranch has true montane vegetation enveloped in mist for a greater period of the year, Up the ranch exist short grasses and in the villages are tall trees and tall forest at the river channels called gallery forest. Also numerous plant species such as tree fern, *Cyathia maniana*, Moses and epiphytes such as orchaids and Segonians are found. The surface soils of montane ecosystem may have gravely loamy sand to sandy loam or gravely sandy clay loam (Bulktrade, 1989). Being young soils without sufficient soil development properties, they may be classified as entisols.

Specifically, the study covers three purposely selected village namely: Anape, Keji Uku and Okpanzaga. Anape village represents a community with good montane forest cover of rich tree species composition, Keji-Uku is a community with little or no forest cover while Okpanzaga community has restricted access to reduced forest cover.

The major occupation of the people is subsistence farming. Shifting Cultivation is the major agroforestry practice here. The major crops cultivated here are inter-cropped cocoyam, plantain, sweet-yam, banana, rice, maize, cassava and potato. The grazing of animals like pigs, goats, donkeys, sheep and poultry, is widely practiced here, Cattle rearing is essentially carried out by the Fulanis who are in this area. Hunting also is one of the socio-economic activities usually carried out at dry seasons.



Source: Cross River Survey Department, 2006.

Figure 1: Cross River State showing Local Government Areas and Study Region.

METHOD OF STUDY

One major source of information for this study was through the participatory Rural Appraisal (PRA) technique, using standard method by means of a semi-structured interview (SSI) checklist, group discussion and field observation. The SSI checklist was used to generate information on existing farming systems , trees and plant species in the rural landscape, preferred fuelwood species and their agronomic potentials to the people and how species grow in association with food crop.

Group discussion elicited information relating to their farming systems, what crops they grow and what combination, what tree species are used for firewood, which are most preferred with reasons within the study area In field observation, account was taken by eye witnessing of the prevailing farming system, identifying tree species and areas on landscape, which still had trees in abundance, scarce or just enough The general relief was also noted by field observation Three villages namely Anape, Okpanzaga and Keji-Uku were targeted for detailed PRA, Oral interview and questionnaire were administered to focus groups of women/men farmers and household heads to further general information on the field. A questionnaire of seventy copies were administered in these sample villages that constituted the study area. Anape village had thirty copies of the questionnaire, since it has the highest population and also largest forest cover of rich specie composition and extensive farming. Okpanzaga and Keji-Uku villages both had twenty copies each based on the reduced farming population and household number Although seventy copies of questionnaires were randomly administered, sixty four were returned and used for this study (thirty copies from Anape, seventeen from Okpanzaga and seventeen Keji-Uku). Sample units (villages) were chosen by purposive sampling base on villages location in the montane ecosystem and their similar flora composition (forest type) which is representative of other ranch villages. Having reduced the sample area into three unit, a systematic sampling technique was adopted in the administration of the questionnaires/interview among the households base on an orderly sequence of every n^{th} house (every 2^{nd} house was questioned)

Data collected was analysed by use of qualitative and descriptive statistics such as the matrix ranking technique showing the criteria that determine rural peoples preference for trees/shrubs; based on tree species, agronomic, and energy potentials. Scores were allocated to each specie for its useful value. Score 10 was described as (Excellent tree species), Score 5 was (Good tree species), Score 1 was for the (Poor species) while Score 0 was for the tree species that were not useful

RESULTS AND DISCUSSION

Prefered Fuelwood Species

The result of a group discussion conducted in the study area revealed the most common fuelwood species in the montane region and their uses in Table 1 below.

The order of preference of the most desirable tree species however, varied among villages/settlements due to village

difference in forest cover, the importance attached to the species and the effect of over exploitation leading to specie depletion. Table 2 shows the ranking of species in order or preference for Anape, Okpanzaga and keji-uku villages

In the PRA discussion, it was observed that most of the fuelwood species were of multipurpose value though some ranked higher for particular use than others. In table 2, in the three sampled settlements,, Ikaneh (*Inga spp*) came first, Aeteah sondgh (*Carapa procera*) appeared second, while Achuwechwe (*Outratea monticola*) was third followed by others. On the whole, detailed anlysis of Obudu cattle ranch settlements, revealed that Ikaneh, Aeteah –sondgh and Achuwechwe are of greater socio-economic value to the local people as compared to other fuelwood species. They meet the basic needs of firewood (energy), medicine, building and fencing materials, fodder for the animals, and income generation.

'ENERGY PROPERTIES OF IMPORTANT (PREFERED) FUELWOOD SPECIES TO RURAL PEOPLE

By participatory rural appraisal (PRA) method, the energy values of these species were also determined on the criteria provided by the local households/farmers. This sometimes constitute the primary reasons for their selective collection (extraction) practice and retainment of trees on farmland. Five energy potentials were proposed by the local farmers as a determinant for desiring specific species as fuelwood.

Village analysis of fuelwood energy potentials for Anape, Okpanzaga and keji-uku indicates their preference for peculiar fuelwood species based on their high burning quality, good charcoal production, low smoking capability, species ability to dry-out quickly and ease of cutting. While table 3 shows the average total or general rating of the species from all settlements sampled on the basis of the selected criteria, tables 4, 5 and 6 show these for specific settlements.

Table 1: Most Common preferred fuelwood species in the montane region and their use.

S/NO	SPECIES LOCAL NAME	BIOLOGICAL NAME	USES
1	Ikaneh	*Inga spp*	Firewood, Timber, Fencing material and income generation
2	Aeteachsondgh	*Corapa pcocera*	Firewood, fodder, poles, income generation and building material.
3	Achuwechwe	*Ouratea monticola*	Firewood, food, medicine income generation and building material.
4	Egaga	*Harungana madagascariesis*	Firewood, and income generation
5	Asaga	*Blighia welwitschii*	Firewood, and income generation
6	Ashofenda	*Doncryedas eduli*	
7	Otuwe		Firewood and fodder
8	Okamamba	*Moracecae*	Firewood
9	Awessa	*Pentaclesthra robilis*	Firewood
10	Ocieciel	-	Medicine, firewood and religious value
		-	Firewood, and building material
11	Ikoluo	-	Firewood, and fencing/building material.
12	Okaale	-	Firewood,
13	Decolena	*Bridelia Speciosa*	Firewood, and fencing/building material
14	Odungor	-	Firewood
15	Etenyi	*Isoberlina doka/Anthonata*	Firewood and fencing material (windbreaker)
16	Alienie efondi	*Syzygium/guineese/mytragina cilliata*	Firewood, building material, and fencing material (windbreaker)
17	Agemba	*Ficus asperilofolia*	Firewood, medicine and fencing (windbreaker)
18	Odala	*Landolbhia*	Firewood, food, windbreak.

Source: Authors' Field Survey, 1999

Table 2: Ranking of most Desirable Tree Species used for Fuelwood Production in the Study area.

Anape			Okpanzaga			Keju-Uku		
Order of Preference	Local Name	Botanical Name	Order of Preference	Local Name	Botanical Name	Order of Preference	Local Name	Botanical Name
1st	Ikaneh	*Inga spp*	1st	Ikaneh	*Inga spp*	1st	Ikanneh	*Igna spp*
2nd	Aeteah-sondgh	*Carapa procera*	2nd	Aeteah-sondgh	*Carapa procera*	2nd	Aeteach-sondagh	*Carapa procera*
3rd	Achuwechwe	*Outratea Monticola*	3rd	Achuwechwe	*Outratea Monticola*	3rd	Achuwechwe	*Outratea monticola*
4th	Ashofenda	*Doncryedas edulis*	4th	Asaga	*Blighia welsitschii*	4th	Ikoluo	-
5th	Asaga	*Blighia welsitschii*	5th	Egaga	*Harungana madagascariensis*	5th	Okaale	-
6th	Egaga	*Harungana Madagascanensis*	6th	Efenyi	*Isoberlina doka/anthonata*	6th	Odungor	-
7th	Aweesa		7th	Agemba	*Ficus asperilogolia*	7th	Ecolena	*Bridelia spp*
8th	Otuwe	*Pentaclesthra robilis*	8th	Akindeh	-	8th	Alienie-efondi	*Syzygium guineenses/ Mytrognia ciliata*
9th	Okamamba	*Moracecae spp*	9th	Odala	-	-	-	-
10th	Ocieciel	-	-	-	-	-	-	-

Source: Authors' Field Survey, 1999

Table 3: Energy properties of Top ranked Fuelwood Species in the Study area (General Rating)

	MATRIX RANKING OF FUELWOOD SPECIES ACCORDING TO FIVE ENERGY PROPERTIES																		
Criteria	Ikaneh (*Inga Spp*)	Achuwechwe (*Ouratea Monticola*)	Aeteah-sondgh (*Corapa procera*)	Egaga (*Harungama*)	Asaga (*Blighiawelwitschii*)	Ashofenda (*Doncryodas aduli*)	Okamamba (*Moraneecae*)	Agemba (*Ficus asperilofiolia*)	Ikoluo	Okaale	Akinde	Ocieciel	Otuwe	Decolena (Bridelia Spp.)	Odala	Odungor	Etenyi (Isoberlinia	Alienie-efondi (*Syzguim Guineese/Mytragina*)	Awessa (*Pentraclaustra robilis*
BURNINGQUALITY	10	10	10	10	10	10	5	5	5	5	5	5	10	10	5	5	5	1	5
CHARCOAL PRODUCTION	10	10	10	5	5	10	10	1	5	5	5	10	1	1	1	1	1	5	1
SMOKING CAPABILITY	1	1	1	1	5	5	5	5	1	5	1	5	10	10	5	5	5	5	10
SPECIES ABILITY TO DRY OUT QUICKLY	10	5	5	5	5	1	5	1	1	5	10	1	10	1	1	5	1		10
EASE OF CUTTING	10	10	5	5	5	5	5	10	5	1	5	1	10	5	5	1	1	5	1
POSITION/RANK	1st	2nd	3rd	4TH				5TH					6TH	7th	8th	9th		10th	

SCORE KEY; 10-EXCELENT 5 GOOD 1-POOR 0-NOTUSEFUL
Source: Authors' Field Survey, 1999

Table 4: Matrix ranking of Fuelwood Species in Anape

CRITERIA	SPECIES RANKING ACCORDING TO ENERGY PROPERTIES									
	Ikaneh (*Inga spp*)	Achuwechwe (*Ouratea monticola*)	Aeteah-sondgh (*Carapa procera*)	Ashofande (Doncryodas edulis)	Egaga (Harungama)	Asaga (*Blithiawelwitschii*)	Awasse(*Pentraclaustra rabilis*)	Otuwe	Okamamba (*Moracecae*)	Ocieciel
BURNING	10	10	10	10	5	5	5	10	5	5
QUALITY										
CHARCOAL PRODUCTION	10	10	10	10	5	10	10	1	10	10
SMOKING CAPABILITY	1	1	1	1	1	5	5	10	10	5
SPECIES ABILITY TO DRYOUT QUICKLY	10	5	1	1	1	5	1	10	10	1
EASE OF CUTTING	5	10	5	5	5	1	10	10	10	1
POSITION/RANK	1ST	2ND	3RD	4TH	5TH	6TH	7TH	8TH	9TH	10TH

SCORE KEY; 10-EXCELENT 5 GOOD 1-POOR 0-NOTUSEFUL
Source: Authors' Field Survey, 1999

Table 5: Matrix ranking of Fuelwood Species in Okpanzaga

CRITERIA	SPECIES RANKING ACCORDING TO ENERGY PROPERTIES								
	Ikaneh (*Inga spp*)	Achuwechwe (*Ouratea monticala*)	Aeteah-Ondgh (*Carapa procera*)	Egaga (*Harungama*)	Asaga (*Blithiawelwitschii*)	Akinde	Agemba (*Ficus asperilofelia*)	Etenyi (*Isoberlinia doka/Anthonata*	Odala (*Landolbhia*)
BURNING QUALITY	10	10	10	10	5	5	5	5	5
CHARCOAL PRODUCTION	10	10	10	5	5	1	1	1	1
SMOKING CAPABILITY	1	1	1	1	1	5	5	5	5
SPECIES ABILITY TO DRYOUT QUICKLY	10	5	1	1	10	1	1	1	1
EASE OF CUTTING	10	10	5	5	1	10	10	5	10
POSITION/RANK	1ST	2ND	3RD	4TH	5TH	6TH	6TH	7TH	8TH

SCORE KEY; 10-EXCELENT 5 GOOD 1-POOR 0-NOTUSEFUL

Source: Authors' Field Survey, 1999

Table 6: Matrix ranking of Fuelwood Species in Keji-Uku

CRITERIA	SPECIES RANKING ACCORDING TO ENERGY PROPERTIES							
	Ikaneh (*Inga spp*)	Achuwechwe (*Ouratea monticola*)	Aeteah-sondgh (*Carapa procera*)	Okaale	Okoluo	Odungor	Decolena (*Bridelia spp*)	Alienie-efondi(*Syzgium Guineese/mytragina ciliata*)
BURNING	10	10	10	5	5	5	10	1
QUALITY CHARCOAL PRODUCTION	10	10	10	5	5	1	1	10
SMOKING CAPABILITY	1	1	1	1	1	5	10	5
SPECIES ABILITY TO DRYOUT QUICKLY	10	5	5	5	1	1	1	1
EASE OF CUTTING	10	10	5	5	5	5	10	5
POSITION/RANK	1st	2nd	3rd	4th	5th	6th	7th	8TH

SCORE KEY: 10- EXCELLENT 5-GOOD 1-POOR 0-NOT USEFUL

Source: Authors' Field Survey, 1999

From all indications it is clear that the people placed more importance on species burning quality and its charcoal production capability. The ranking also made clear the preference for particular fuelwood species. In all three communities, Ikaneh (*Igna spp*) ranked 1st, followed by Achuwechwe (*Outratea monticola*), Egage (*Harungama*) and then Asaga (*Blighia welwitschii*). Other species came after and are said to be used as substitutes where the above mentioned species are not readily available. Villagers say that there is need for the wood to dry out quickly to promote its burning quality. In support of the results in table 4, 5 and 6, they agreed to Ikaneh being the most inflammable wood in that montane region which could burn when cut fresh and used mostly during the rainy seasons, thus termed "High quality". "Low quality" woods were those that did not produce good charcoal and had high smoking capability e.g Decolena (Bridelia spp) in keji-uku, Aweesa (*Pentaclesthra robilis*) in Anape etc.

AGRONOMIC IMPORTANCE OF PREFERED FUELWOOD SPECIES IN THE STUDY AREA.

To determine the overall fit of the desirable fuelwood species in the agroforestry systems of the settlements studied the general and specific agronomic rating of the properties of these species were examined and reported in table 7 to 10.

Table 7: General Matrix ranking of Top ranked Fuel Wood Species and their Agronomic Properties

CRITERIA	MATRIX RANKING OF SPECIES ACCORDING TO SIX AGRONOMIC PROPERTIES											
	Asaga (*Blihiawelwitschii*)	Aeteah-sondgh (*Carapa procera*)	Achuwechwe (*Ouratea monticola*)	Odungor	Egaga (*Harungama*)	Awasse (*Pentaclesthra robilis*)	Etenyi (*Isobaliana doka*)	Agemba (*Ficus asperilofolia*)	Ikolwe	Okaale	Ikaneh (*Inga spp*)	Decolena (*Bridelia specioca*
LITTER QUALITY & NUTRIENT SUPPLY QUALITY	10	10	10	10	5	10	5	5	5	5	5	1
EFFECT OF ROOT SYSTEM ON CROP YIELD	1	1	1	5	5	1	1	1	1	5	10	10
SOIL EROSION CONTROL CAPABILITY	10	10	10	10	10	5	10	5	5	5	1	1
TEMPERATURE REGULAION CAPABILITY	10	5	10	5	5	10	5	5	5	5	5	1
SHADE CAPACITY	5	5	5	5	10	1	5	10	1	1	1	1
GROWTH RATE	10	10	5	10	10	5	10	10	5	1	10	1
TOTAL SCORE/RANKING	1st	2nd	3rd		5TH	6TH			9TH	10TH	11th	12th

SCORE KEY: 10- EXCELLENT 5-GOOD 1-POOR 0-NOT USEFUL
Source: Authors' Field Survey, 1999

Table 8: Matrix ranking of Top ranked Species and their Agronomic Properties in Anape Village

CRITERIA	MATRIX RANKING OF SPECIES ACCORDING TO SIX AGRONOMIC PROPERTIES					
	Asaga (*Blihiawelwitschii*	Awasse (*Pentaclesthra robilis*)	Aeteah-*sondgh* (*Carapa procera*)	Achuwechwe (*Ouratea monticola*)	Egaga (*Harungama*)	Ikaneh (*Inga spp*)
LITTER QUALITY & NUTRIENT SUPPLY QUALITY	10	10	10	10	10	1
EFFECT OF ROOT SYSTEM ON CROP YIELD	1	1	1	1	5	10
SOIL EROSION CONTROL CAPABILITY	10	10	10	10	5	1
TEMPERATURE REGULAION CAPABILITY	10	10	5	10	5	5
SHADE CAPACITY	5	5	10	5	5	10
GROWTH RATE	10	10	10	5	10	10
TOTAL SCORE/RANKING	1st	2nd	3rd	4th	5th	6th

SCORE KEY: 10- EXCELLENT 5-GOOD 1-POOR 0-NOT USEFUL
Source: Authors' Field Survey, 1999

Table 9: Matrix ranking of Top ranked Species and their Agronomic Properties in Okpanzaga Village.

CRITERIA	MATRIX RANKING OF SPECIES ACCORDING TO SIX AGRONOMIC PROPERTIES					
	Asaga (*Blihiawelwitschii*)	Awasse (*Pentaclesthra robilis*)	Aeteah-sondgh (*Carapa procera*)	Achuwechwe (*Ouratea monticola*)	Egaga (*Harungama*)	Ikaneh (*Inga spp*)
LITTER QUALITY & NUTRIENT SUPPLY QUALITY	10	10	10	5	5	5
EFFECT OF ROOT SYSTEM ON CROP YIELD	1	1	1	5	10	10
SOIL EROSION CONTROL CAPABILITY	10	10	5	10	10	1
TEMPERATURE REGULAION CAPABILITY	10	5	10	5	5	5
SHADE CAPACITY	5	5	5	5	10	101
GROWTH RATE	10	10	5	5	10	10
TOTAL SCORE/RANKING	1st	2nd	3rd	4th	5th	6th

SCORE KEY: 10- EXCELLENT 5-GOOD 1-POOR 0-NOT USEFUL

Source: Authors' Field Survey, 1999

Table 10: Matrix ranking of Top ranked Species and their Agronomic Properties in Keji-Uku Village

CRITERIA	MATRIX RANKING OF SPECIES ACCORDING TO SIX AGRONOMIC PROPERTIES					
	Asaga (*Blihiawelwitschii*)	Awasse (*Pentaclesthra robilis*)	Aeteah-sondgh (*Carapa procera*)	Achuwechwe (*Ouratea monticola*)	Egaga (*Harungama*)	Ikaneh (*Inga spp*)
LITTER QUALITY & NUTRIENT SUPPLY QUALITY	10	10	10	5	5	1
EFFECT OF ROOT SYSTEM ON CROP YIELD	1	1	1	1	5	10
SOIL EROSION CONTROL CAPABILITY	10	5	5	5	5	1
TEMPERATURE REGULAION CAPABILITY	10	10	5	5	1	1
SHADE CAPACITY	5	5	5	1	5	1
GROWTH RATE	10	10	5	5	1	1
TOTAL SCORE/RANKING	1st	2nd	3rd	4th	5th	6th

SCORE KEY: 10- EXCELLENT 5-GOOD 1-POOR 0-NOT USEFUL
Source: Authors' Field Survey, 1999

The agronomic properties were determined by the farmers on the basis of the contribution of these species to farm production such as litter production and manuring properties, shade provision for crops and man, erosion control capability, temperature regulation, growth rate and effects of root system on crop yield. Six agronomic criteria were thus established. The ranking of the fuelwood species on the basis of these criteria are as shown. The general profile of the agronomic properties of desirable fuelwood species (Table 7) show species with utility for agroforestry development. Asaga (*Blighiawelwitschii*), Aeteah-sondgh (*Carapa procera*), and Achuwechwe (*Outrate monticola*) are evidently the top three. They are highly valued for their litter and manuring qualities, soil erosion control capabilities and rate of growth where they are judged excellent on the score scale with the exception of Achuwechwe (*Outratea monticola*) that has a moderate score with respect to growth rate

FUELWOOD AND AGROFORESTRY DESIGN

An important lynch pin of this study is the development of Agroforestry systems that integrates desirable fuelwood species in farmlands for sustainable fuelwood production. A reference to table 11 that compares the energy and agronomic performance of fuelwood species may assist in determining this design quickly and ease of cutting.

From the table, although Ikaneh (*Inga spp*) is foremost fuelwood species, it ranks low (the 11th position) with respect to its agronomic performance and may therefore not be suitable for incorporation into agroforestry systems. On the other hand, the highly rated fuelwood species for the energy properties, namely, Achuwechuwe (*Outratea monticola*), Aeteah-sondgh (*Carapa procera)*, and Asaga (*Blighiawelwitschii)* equally score very high with respect to Agronomic performance and may thus qualify to be incorporated into farming systems for mitigating fuelwood problems but fuelwood specie like Ikaneh, scoring low on agronomic count may be part of a fuelwood lot development programme.

SUMMARY

A fuelwood crisis is building up in the study area as a result of the natives' unsustainable fuelwood extraction rate. To meet their daily energy requirements, firewood is gradually becoming scarce in most villages with little forest cover, limited specie composition, and the human impact of bush burning/gazing.

Preference for wood in the study area is primarily based on species energy potential; burning quality, charcoal production quality and species low smoking capability. Some of their top ranked fuelwood species were examined for future regeneration to alleviate the impending scarcity. Asaga (*Blighia welwitschii*) came 1st for general agronomic importance followed by Aetah-sondgh (*Carapa procera*),

Table 11: Overall Picture of Top ranked Species on the Basis of their Energy and Agronomic properties

SPECIES	ENERGY PROPERTIES	AGRONOMIC PROPERTIES
Ikaneh (*Inga Spp*)	1ST	11th
Achuwechwe (*Ouratea Monticola*)	2ND	3rd
Aeteah-sondgh (*Corapa procera*)	3rd	2nd
Egaga (*Harungama)*	4th	5th
Asaga (*Blighiawelwitschii)*	4th	1st
Ashofenda *(Doncryodas eduli)*	4th	-
Okamamba *(Morancecae)*	4th	-
Agemba (*Ficus asperilofiolia)*	5th	6th
Ikoluo	5th	9th
Okaale	5th	10th
Akinde	5th	-
Ocieciel	5th	-
Otuwe	6th	-
Decolena(Bridelia Spp.)	7th	12th
Odala	8th	-
Odungor	9th	3rd
Etenyi (Isoberlinia)	9th	6th
Alienie-efondi (*Syzguim Guineese/Mytragina)*	10th	-
Awessa (*Pentraclaustra robilis*	10th	6th

Source: Authors' Field Survey, 1999

Achuwechwe (*Ouratea monitcola*), Ikoluo, Egaga (*Harungana*) and Awessa *(Pintaclesthra robilis*). Villagers also affirmed that if asked to grow trees they would grow the above mentioned. Species like Ikaneh, and Okaale they said would be best grown separate on woodlots away from food crops because of their surface rooting system and thick canopy. It was also noted that the people did not grow trees except for fruit trees (mango, Guava, etc.). They depend solely on the forest natural regeneration ability.

CONCLUSION

The problem of fuelwod extraction and its impending scarcity can be effectively addressed by Agroforestry systems that conform with the ecozone, needs and aspirations of the local people. However, as the last patch of our much needed natural forest winds up, the need to arm the people with the right approach and knowledge becomes crucial.
Building on this premise, the incorporation of fuelwood species on farm will significantly relieve pressure on the forest, as the forest finds its way into the farms, leaving the forest as forest until the right balance is maintained.

RECOMMENDATIONS

The problems of fuelwood scarcity can be tackled through effective agroforestry system, which aim at permanent soil protection, diversification of species and continuos restoration

of forest resources. First efforts should be made to assist the resource-poor farmers gain access to and have long term control over land they till. Their absolute ownership backed up by land titles will encourage farmers to invest what they have sown, particularly trees that take many years to mature and fruit. Efforts should be made to encourage crop diversification and improve the traditional Agroforestry systems. In planning this Agroforestry programme, a comprehensive survey of existing or traditional farming systems should form the starting point so as to identify the critical issues and come up with appropriate agroforestry interventions and the much cherished/highly rated indigenous tree species (Asaga, Egaga, Aeteah-sondgh Awessa Okaale etc) be incorporated into the farming systems. Laws preventing the cutting of fresh trees/shrubs on farm site should be initiated and defaulters penalized (particularly near extinct species like Ikaneh and Ashofenda)

Species like Asaga, Egaga and Aeteah- sondgh which are known to do well with annual crops (cassava, maize, cocoyam) when grown at close intervals should be nursed and propagated on farmsites during the fallow periods This should be initiated and monitored by Development agencies and government agricultural extension officers. In addition to this, the rural community should also encourage tree planting. The species which do not do well with crops like Ikaneh, Achuwechwe and Okaale, should be grown on woodlots and backyards or planted to double as living fencing or shade trees in pasture. Thereby providing a continuos flow of firewood to the dependent communities of Anape, Okpanzaga, Keji-uku, etc.

The fragile and vulnerable mid-shape regions of the plateau should be replanted with grasses, shrubs and longer gestation trees such as Agemba and Achuwechwe and thinned round to reduce fire hazards and improve biomass productivity. Planting of trees should be included in the grazing agreement with the Fulani berdsmen and those who are able to keep their ranges free of annual wild fires compensated through reduction or discount in their annual grazing fees to the ranch landlords. In addition, enlightenment campaigns aimed at wise use of available forest resources and danger of bush burning should be intensified.

The forestry development department should be requested to send some of its technical staffs to the ranch to aid farmers tackle most of the technical lapses observed in their community forest regeneration and agroforestry trials.

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