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Potential of Pigeon Pea (*Cajanus cajan*) for Planted Fallow in Edo State, Nigeria

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Abstract: In June 2003, direct field observations of fallows, near and distant farms were carried out in Edo State Nigeria, for indigenous woody species composition and pigeon pea (*Cajanus cajan* (L.) Millsp. crop combinations. To document indigenous knowledge of pigeon pea and determine its potential for planted fallow, a sample site was chosen in each of five southern and five northern local government areas of the 18 LGAs in the state, seven in lowland rainforest and three in forest savanna mosaic. At each site, 10 randomly selected farmers were interviewed. Useful indigenous woody species were common in cultivated fields in the two agroecological zones of the state. Farmers identified poor soil as second major production constraint after cash/credit in their farming systems. Combinations with maize, cassava and yams, ranged from 4% frequency of *Discorea/Cajanus* in home gardens to 37% *Zea/Cajanus* in distant farms. Farmers rated the plant as the second most important vegetable protein after cowpea. In Esan LGA, it is the preferred grain legume. Seven uses of pigeon pea were rated from food (100%) to cover crop (5%). Desirable traits of pigeon pea in order of priority were-faster cooking varieties, high yielding varieties, pest resistant varieties, day neutral varieties and varieties suitable for home gardens. The potential of pigeon pea for planted fallow is high in the northern zone due to its cultural, economic, nutritional and agricultural importance. Genetic resources management and fallow technology research will facilitate the adoption and spread of pigeon pea in planted fallows in Edo State.

Key words: Crop combinations, fallow, indigenous knowledge, leguminous, multipurpose, woody

INTRODUCTION

Edo State in southern Nigeria is between latitudes 6°45^{1}N, 7°34^{1}N and 5°4^{1}E, 6°43^{1}E (Fig. 1). The larger part of the study area was lowland rainforest vegetation which has now been largely converted through various human activities to open secondary forests. These forests are typically stratified and rich in timber producing species such as *Triplochiton scleroxylon* and *Milicia excelsa*. The northern part of the study area consists largely of derived savanna which may have originated as a result of over cultivation and over turning of the forest cover. It is characterized by fire resistance trees such as *Parkia biglobosa*, *Daniellia oliveri*, grasses including *Andropogon* sp. and woody climbers like *Combretum racemosun*.

The soil in the state, which is dominated by ferrasols, is prone to leaching and susceptible to erosion. Plants are cultivated in home gardens, near and distant farms. Cassava and yams are dominant, followed by plantain/bananas. Maize is the most widespread cereal produced in combination with root and tuber staples. Shifting cultivation with the related bush fallow, slash and burn technique is the dominant food production system. The fallow period is short (2-5 years). Under intense cultivation and shortened fallow, productivity rapidly decreases. The woodland and grassland do not have enough woody species to provide sufficient ash from burning. The production system is becoming land intensive and cash crop oriented (Dania Ogbe *et al*., 1992).

Pigeon pea (*Cajanus cajan* (L.) Millsp). ohele (Benin), otili (Yoruba), olhene (Esan), is a multipurpose woody short-lived (2-3 years) perennial, usually grown as an annual for grain but can produce both food and fuel wood within a period of three to nine months. It can grow up to four meters. There is variation in plant type due to adaptation to a wide range of latitude, altitude, soil and annual rainfall.

Agriculture is the major economic activity in the study area. Increasing population and competing demand for land has reduced the length of fallow (Dania Ogbe *et al*., 1992). The period of fallow is too short to restore soil fertility. According to Tian *et al*. (2001), vegetative fallow is a biological approach to regenerating the productivity of degraded soils in the tropics.

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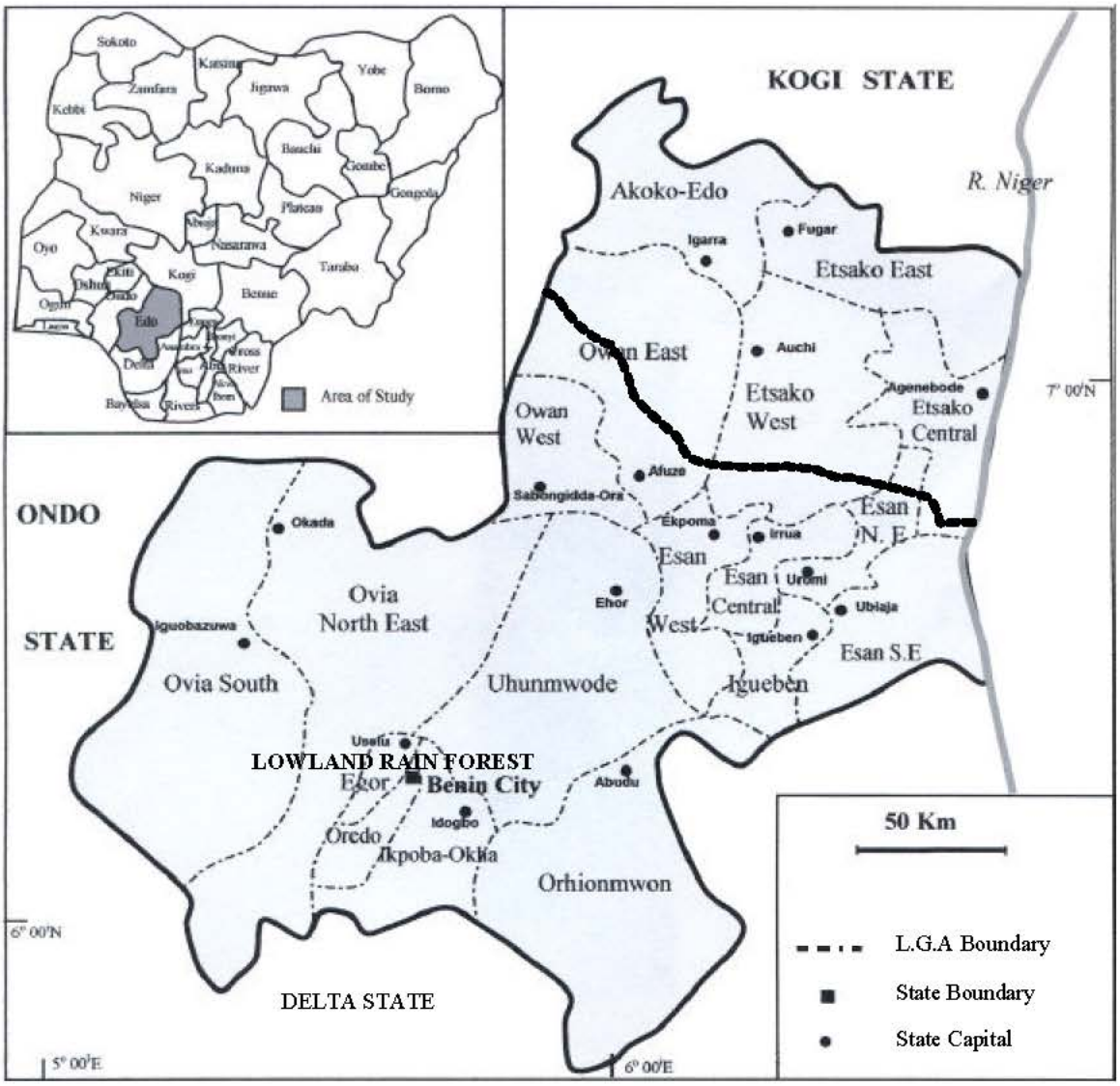

Fig. 1: Edo state local government areas

The value and feasibility of planted fallows have been demonstrated experimentally. The efficiency of the fallow system is influenced by duration, fallow species and their patterns and rates of biomass allocation and crop and fallow management (Szott *et al*., 1999). Studies have shown the use of planted woody and herbaceous vegetation to replace natural fallows in order to shorten the fallow period (Kang *et al*., 1997). Tian *et al*. (2001), reported that certain species of planted fallow appeared to be superior to natural fallow in restoring some soil microbiological parameters. In southwestern Nigeria, *Gliricidia sepium* has been reported to dominate fallows and could be regarded as an indirect planted fallow (Getahun *et al*., 1982). The development of the potential of fallow species adapted to different ecologies is one solution to sustainable agriculture in those areas. There is need to document farmers indigenous knowledge and generate several different fallow options for farmers to test. There is a dearth of research on improved fallows in Edo State. The purpose of this study was to document uses and farmer's indigenous knowledge towards exploiting the potential of pigeon pea and possibility of introducing improved fallows in the state.

MATERIALS AND METHODS

The study was carried out in June, 2003. Edo State is 70% lowland rainforest. The forest-savanna mosaic is confined to the northern extremities, mainly Akoko-Edo, Etsako East and Central LGAs and the northern parts of

Table 1: Sample locations

Local government area	Zone	Agro-ecological zone
Akoko-edo		
Etsako central	Northern	Forest-savanna mosaic
Owan east		
Lowland rainforest		
Esan west	Northern	Lowland rain forest
Esan southeast		
Ovia northeast		
Ovia south		
Uhunmwode	Southern	
Ikpoba-okha		
Orhionmwon		

Esan North East, Etsako West LGA and Owan East LGAs (Fig. 1). A sample site each was chosen from 10 LGAs divided into northern and southern zones of five LGAs each (Table 1), seven in lowland rainforest, three in forest-savanna mosaic. Information was collected from direct field observation of fallows, home gardens; near and distant farms for indigenous woody species composition and pigeon pea crop combinations.

The species inventories were complemented by interviews with 10 randomly selected farmers at each sample site on potential of pigeon pea in the farming system; its uses, method of propagation, importance and desirable traits; changes in farmers' attitude; problems and constrains in their farming systems. Distribution and percentage values were calculated.

RESULTS

Indigenous woody species: Indigenous woody species encountered in cultivated fields with their frequency and use category are given in Table 2. There were eight frequently or commonly occurring woody species in the southern zone. In the northern zone, out of the six species, the most frequently occurring species included a cultivated legume, *Cajanus cajan* while some other useful legumes such as *Dialium guineensis* and *Parkia biglobosa* are protected. Leguminous woody species were not common in cultivated fields of the southern zone. In fallow land, non-food but useful species dominated. Table 3 gives a list of protected and wild woody leguminous species, found in fallows in the study area which include food producing *Dialium guineensis*, *Pentaclethra macrophylla*, in Southern zone, *Parkia biglobosa* and *Prosopis africana* in the northern zone.

Inputs and potential of pigeon pea: Farmers said that there were no inputs in the production of non-staples and recognized the potential of pigeon pea in this low input agriculture. It will produce in marginal land where other crops will not do well because of soil infertility, acidity or topography.

Table 2: List of indigenous woody species in cultivated fields of Edo state

Ecological zone	Species	Use category	Frequency
Lowland rainforest			
1	*Annona muricata*	Fruit	Common
2	*Chrysophyllum albidum*	Fruit	Common
3	*Cola* sp.	Masticant	Frequent
4	*Dacryodes edulis*	Fruit	Common
5	*Dennettia tripelata*	Condiment	Common
6	*Elaeis guineensis*	Oil	Frequent
7	*Ricinus communis*	Oil	Common
8	*Treculia africana*	Fruit	Common
Forest savanna mosaic			
1	*Cajanus cajan*	Grain legume	Frequent
2	*Cola* sp.	Masticant	Frequent
3	*Dialium guineense*	Fruit	Frequent
4	*Parkia biglobosa*	Condiment	Frequent
5	*Prosopis africana*	Oil	Common
6	*Vitellaria paradoxa*	Oil	Common

Table 3: List of indigenous woody leguminous species in fallows of Edo state

Ecological zone	Species	Family
Lowland rainforest		
1	*Albizia feruginea*	Mimosaceae
2	*A. gumifera*	Mimosaceae
3	*A. zygia*	Mimosaceae
4	*Anthonota macrophylla*	Caesalpiniaceae
5	*Baphia pubescens*	Papilionaceae
6	*Dialium guineense*	Caesalpiniaceae
7	*Khaya ivorensis*	Mimosaceae
8	*Lonchocarpus sericus*	Papilionaceae
9	*Millettia thonningii*	Papilionaceae
10	*Pentaclethra macrophylla*	Mimosaceae
11	*Pterocarpus mildbreadii*	Papilionaceae
12	*P. soyauxii*	Papilionaceae
Forest-savanna mosaic		
1	*Albizia adanthiofolia*	Caesalpiniaceae
2	*A. africana*	Caesalpiniaceae
3	*Bauhinia thonningii*	Caesalpiniaceae
4	*Daniella oliveri*	Caesalpiniaceae
5	*Dichrostachys cinerea*	Mimosaceae
6	*Entada africana*	Mimosaceae
7	*Khaya senegalensis*	Mimosaceae
8	*Parkia biglobosa*	Mimosaceae
9	*Piliostigma thonningii*	Caesalpiniaceae
10	*Prosopis africana*	Mimosaceae
11	*Pterocarpus erinaceus*	Papilionaceae

Table 4: Frequency of crop combinations in different farming systems in Edo state

Normal	Home garden (%)	Near farm (%)	Distant farm (%)
Cajanus/Manihot	6	23	35
Zea/Cajanus	10	3	37
Discorea/Cajanus	4	18	25

Place of pigeon pea in the farming system/crop combinations: Pigeon pea occurred in all the different agricultural land use systems. The most frequent crop combinations were *Cajanus/Manihot*, *Zea/Cajanus* and *Dioscorea/Cajanus* (Table 4). They occurred in distant farms, followed by home gardens and least in near farms. The range varied from 4% frequency of *Discorea/Cajanus* in home gardens to 37% *Zea/Cajanus* in distant farms. Farmers realized the numerous attributes of the plant. It is always propagated from seeds and intercropped with

staple crops. It is planted as an intercrop towards the end of the year when the short season maize had been harvested. It is also intercropped with yams and cassava. The farmers explained that the plant is not monocropped because it takes up both wet and dry seasons.

Uses/importance: Farmers growing pigeon pea were 38% of those interviewed and they rated the plant as the most important non-staple crop in the northern zone and second most important vegetable protein after cowpea in the state. There is demand in the northern zone of the State where the crop is valued for home consumption as food as well as sources of cash income. Other uses in the state include green manure, especially in *Cajanus/Manihot* combinations; ash from burning after harvesting before the next planting; temporary shade for young cocoa crops; anti-erosion in soil conservation and stakes for yams. Sometimes, after harvesting, the plants are left on the farm till the next year in which case it fruits before the newly planted crop. A female farmer remembered that a company, Ilupeju Farms used the plant to demarcate large areas of farm land more than 30 years ago in Benin City. She however commented that its cultivation in the southern half of the state has diminished dramatically. Cultivation is now largely restricted to the northern half of the state. Cultivators rated seven uses of pigeon pea as shown in Table 5, the highest was for food 100% and the lowest as cover crop 5%.

The largest market oriented cultivation is from the Esan West, Esan Central and Esan North East LGAs. In these LGAs, farmers estimated that about 75% of total production gets to the markets because there is preference for pigeon pea over cowpea. Esan farmers claimed that pigeon pea does not cause heart burn like cowpea.

Desirable traits: Farmers were asked to give traits desired in pigeon pea. The following was their response in order of priority-faster cooking varieties, high yielding varieties, pest resistant varieties, day neutral varieties and varieties suitable for home gardens.

Changes in attitudes/problems/constraints in farming systems: Farmers identified poor soil as second major production constraint after cash/credit in their farming systems. Fertilizers are expensive; they are not supplied, arrive too late or are limited in availability. Animal manure is not used and there is very limited use of green manure in the state. The farmers are becoming aware of globalization from the example of increased demand and earning for manihot cultivation in the country. They identified long period of cooking, susceptibility of pigeon pea to pest and difficulty in harvesting as constraints in its cultivation. None of the 100 farmers interviewed had participated in any research on improved fallows or was aware of any research and development of improved fallows in the state during the period of study.

Table 5: Cultivators' rating of the uses of pigeon pea in Edo state

Use category	Percentage
Food	100
Green manure	20
Fodder	12
Anti-erosion/soil conservation	11
Shade plant for young cocoa crops	6
Fuel wood	6
Cover crop	5

DISCUSSION

Pigeon pea plays an important role in the farming system in the state where it is intercropped with cereals, roots and tubers and in crop rotation in both lowland rainforest and forest savanna mosaic agroecological zones.

The population pressure and availability of land is very uneven in the state. The greatest population densities are in the LGAs around the state capital followed by the Esan LGAs. Nevertheless, soil fertility is still a general constraint. The Federal Ministry of Agriculture and Natural Resources plans to improve provision of inputs such as fertilizers and irrigation for farmers. The services and distribution are currently erratic. However, research into sustainable low input traditional agriculture is not yet a government priority in Nigeria. Farmers recognize the soil improvement property of woody species. In the northern zone, pigeon pea ash is used to improve soil and farmers in Akoko-Edo LGA know that the foliage can be used as green manure. It had been recognized as a suitable multipurpose shrub species for alley farming systems in lowland non-acid soils of the sub-humid tropics (Bansh and Psychas, 1992).

Yield is characteristically poor in the traditional farming systems, especially when the area subjected to the rotation of cultivation and fallow is considered together with the surface actually harvested. A planted fallow species that will improve the soil, produce green manure and pulse that is a good source of protein will increase research interest in the conservation and utilization of its germplasm. Increased utilization will reverse the genetic erosion of the species in the state.

The farms surveyed were about 0.5 ha each and had a significant woody component. The range of woody species in cultivated fields is due to the fact that farmers do not clear potentially useful species. As such, woody species of economic, nutritional and ecological importance are encouraged. The diversity of leguminous

species in the fallows indicate that the species are part of the local plant species and include large trees like *Albizia gummifera*, *Khaya ivorensis* in low population density areas of Ovia in the lowland rainforest. However, in the forest savanna mosaic, *Parkia biglobosa* and *Prosopis africana* occur both in cultivated fields and in fallows. Although, farmers did not deliberately plant particular species in the fallow, they however were aware of the effectiveness of legumes in restoring soil productivity. The importance of leguminous tree species in fallows is demonstrated by a high diversity of indigenous species, 12 in lowland rainforest and 11 in forest savanna mosaic.

Corrective measures that have been developed by local and international research groups to address soil fertility related problems include intercropping of cereals and legumes (Sanginga *et al*., 1996). However, several studies have demonstrated the dramatic potential of 2-3 years planted fallows in Africa (Kwesiga *et al*., 1999; Mafongoya and Dzowela, 1999; Tarawali *et al*., 1999). Wezel (2000) investigated the effect of various shrubs common in fields and fallows on millet production in Niger. The different low input options which exist to overcome decrease in soil fertility and low crop production must be researched and available for small scale farmers as their accessibility to resources, timely application of fertilizer and appropriate technology vary widely. In Nigeria, increase in crop productivity is still attributed to increase in the land area under cultivation. This cannot continue indefinitely. The potential of the options to improving soil fertility have not been fully exploited. According to Sanchez (1999), improved fallows are rapidly spreading in several regions of the tropics. Kwesiga *et al*. (1999) identified generating several different fallow options for farmers to test as a key element in the development of fallow technology.

The nutritional importance of the plant in the northern zone in addition to the fact that the crop is adapted to dry ecological zones are responsible for the distribution of pigeon pea in the state. The wetter southern zone is typically dominated by vegetatively reproduced root and tuber crops, while the northern zone is characterized by root, tuber and grain crops. The market oriented cultivation of *Cajanus cajan* in Esan is demand driven due to cultural preference for the pulse over cowpea. Apart from food, demand for the plant can increase if its potential for other uses are exploited. The major constraint is the fact that the grains take a long time to cook. Although an asset is that it will produce where other crops fail, farmers said that grains from such locations take very long to cook. Therefore research is needed to select varieties for planted fallow that have high perenniality, produce fast cooking grains that can be harvested during the fallow period for dry pulse, green pods, green manure and fodder in home gardens, near and distant farms.

The potential of pigeon pea for planted fallow in the state is high in the northern zone due to its cultural, economic, nutritional and agricultural importance. Pilot studies can be initiated there in collaboration with farmers. Studies on planted fallow technologies including pigeon pea on nutrient deficient sandy loam soil have been done in some African countries (Mafongoya and Dzowela, 1999). In a study of the potential adoption of improved fallows by small holder farmers in Zimbabwe, Mudhara and Hildebrand (2002), showed that farms without draft power could rely on a one-year fallow planted in the first year, followed by maize in the second and third years, followed by another one year of planted fallow. They also showed that with market value for pigeon pea seeds, the area planted to pigeon pea would increase with the price of the seeds.

Increased utilization of the diverse genetic resources of the plant will also enhance the adoption of the plant for planted fallow. Soil erosion is a major problem in the central parts of the state due to topography. Experimentation with the plant for anti-erosion/soil conservation will yield high dividends. Cocoa is one of the crops benefiting from the Federal Government Agriculture reforms. There is great potential in the development of the plant as a shade plant for young cocoa seedlings and as a cover crop. This is the time to initiate and develop farmer enthusiasm in adopting improved fallows in the state.

CONCLUSIONS

The sustainability of shortened fallow in the traditional farming system in Edo State will benefit from research on short-term planted fallow species. Sanchez (1999) identified the supply of germplasm of improved fallow species as a main limiting factor in fallow technology research in Africa. Collection, documentation, selection for different uses, on farm fallow technology research, extension services on pigeon pea varieties best suited to maximizing the traditional multipurpose uses and planted fallow, will greatly improve the traditional farming system and the conservation of the genetic resources of the species in Edo state.

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