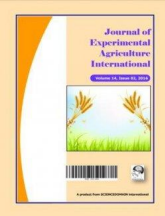

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Evaluation of Production Systems, Traditional Knowledge of Pigeon Pea (*Cajanus cajan*) and Risks of Extinction of Pigeon Pea, Jack Bean (*Canavalia ensiformis*) and Lubia Bean (*Lablab purpureus*) in Some Parts of South West Nigeria

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Authors' contributions

This work was carried out in collaboration between both authors. Author VIE designed the study, wrote the protocol and first draft of the manuscript. Author OIO performed the statistical analysis. Authors VIE and OIO managed the analyses of the study. Author VIE managed the literature searches. All authors read and approved the final manuscript.

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ABSTRACT

Indigenous agricultural knowledge is an important part of the process of making agriculture sustainable. Therefore, the aim of the present study was to i) determine the techniques of pigeon pea production at farmers' level ii) investigate the level of extinction of pigeon pea, Jack bean and lubia bean species ii) assess the distribution and potential of the three minor crops in the study areas. One hundred and fifty respondents were investigated using structured questionnaire. Direct observation, field visit and focus group discussion were carried out. The survey was conducted in Osun and Oyo State from October to December 2017. Producers mainly grow pigeon pea for its grains for home consumption. Pigeon pea's leaves were used for medicinal resolutions to treat

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primarily malaria and fever. Farmers used pigeon for soil fertility and to prevent erosion. There is fear that Jack bean and lubia bean species disappear with time. Though farmers abandoned Jack bean for good reason because it becomes poisonous after two years of cultivation which always leads to death. Conservation strategies can be put in place to avoid the losses of these species for their genetic resources. This study contributes to raise awareness on the risks of losing Jack bean and lubia bean through extinction. In addition, further study is needed to be carried out to found out the chemical compound responsible for poisonous seeds of jack bean after the first harvest.

Keywords: Neglected crops; extinction; attentiveness; production; genetic preservation; farmers.

1. INTRODUCTION

Indigenous agricultural knowledge is a vital part of the process of making agriculture sustainable. Henceforth, traditional knowledge of crop species in Africa context encompasses cultural value, their symbols for the community related to crop diversity including different usages of crop species, their symbols for community, peculiarities of the crop recipes associated to the crop and genetic material exchange networks and management, songs and folks through which knowledge is transmitted and penchants for cultivars [1,2,3,4]. Changes occurring in agricultural systems resulting from globalization, urbanization, agro-industrialization and intensification of agricultural systems have led to over reliance on production of few major crops and few elite cultivars [5,6,7]. Thus, there is a decrease in production and diversity of so-called minor crops, important for food security in marginal areas, and the traditional knowledge associated with their conservation [8]. This rapid decline in the diversity of neglected crops species and local knowledge systems related to their uses and management hinders agroecosystems resilience, reduces options for adaptation to changing biophysical conditions and limits the potential to develop improved varieties [9,6]. Understanding factors driving farmers' uses of crop genetic resources is a key component to design conservation strategies and promote their cultivation and uses [10] particularly for the minor or underutilized ones. In this perspective, traditional knowledge on uses and conservation of crop diversity has been documented for many crops [8,11,12,13].

More often, agricultural genetic resources have been the primary, if not sole feature in national biodiversity strategy discussions on agrobiodiversity. There is a compelling reason for this focus: the future food supply of the world depends on the exploitation of genetic diversity for crop improvement [14]. Farm genetic resources have been conserved over millennia through social systems that reinforced conservation because it was useful. The maintenance of diversity in local varieties or breeds depends both on natural selection and on farmer management, or "human selection". In order to develop a cohesive national conservation strategy, it is important to understand the ways in which these two interact and their relative importance. Modern cultivation has threatened the age-old bonds between local farmers and traditional crops [15].

Crop diversity contributes to augment food security, to alleviate poverty and to protect environment [1,16,17]. Cultural diversity in a given region is reflected through crop diversity, from which local population source their food and other goods and service to meet their ever-changing needs [16]. Recently, the relationship between indigenous knowledge and diversity of grown plants has drawn attention and a parallelism has been established between cultural diversity and biodiversity [18,19]. Consequently, numerous international agreements including Convention on Biological Diversity, International Treaty on Plant Genetic Resources for Food and Agriculture have emphasized on the contribution of indigenous knowledge in the maintenance of genetic diversity.

The aim of the present study was to i) determine the techniques of pigeon pea production at farmers' level ii) investigate the level of extinction of pigeon pea, Jack bean and lubia bean species ii) assess the distribution and potential of the three minor crops in the study areas.

2. METHODOLOGY

2.1 Study Area, Sampling Techniques and Data Collection

The data used in this study were from farm household surveys conducted in three local governments: Ogo-Oluwa and Ogbomoso South in Oyo State and Ola-Oluwa in Osun State. The villages surveyed were: Olukotun, Oke Ogun,

Obamoro, Bode, Lolu, Oke-Esin, Telemu, Ogbagba, Ile-Mowu, Ikire-Ile, Omosan, Ikonifin, Otamokun, and Opete. In the study area, approximately 90% of the population lives in rural areas and agriculture was their major activity.

Our sample consists of 150 farmers from village households that were interviewed in November and December 2017. A multi-stage sampling technique was used in the study. The first stage involved the purposive selection of the five Local Government Areas known to be pigeon pea producing areas in the two States. The second stage involves a random selection of 5 villages from each LGA. Finally, Selection of respondents was conducted via a purposive sampling method. A questionnaire was administered to sampled pigeon pea, Jack bean and lubia bean producers. The questionnaire was divided into three main sections namely: 1) Techniques of pigeon pea production, and abandonment level of pigeon pea, Jack bean and lubia bean 2) Uses of different parts of pigeon pea plants (seeds, stems, roots and leaves); 3) name of each cultivated variety, number of pigeon pea varieties held at the household level, traits of each variety as perceived by farmers.

In each village, a focus group was held with on average 8 pigeon pea, Jack bean and lubia bean producers including female and male to collect data related to these species. The questionnaire consisted of a series of questions about the socio-demographic characteristics of the household such as household composition, education, marital status, ethnic group and the farm characteristics such as land size, production systems were also considered.

2.2 Data Analysis

Descriptive statistics such as frequencies were computed to describe quantitative data, namely percentage of respondents for each category of pigeon pea use including home consumption, commercialization and soil conservation and number of pigeon pea varieties households, the level of extinction of the three species. Spearman's rho correlation coefficient was determined to see the association between variables. In addition, a chi-square test of independence on the reasons why the farmers abandoned the cultivation of pigeon pea between the two states studied was computed.

3. RESULTS

We had a total of 150 respondents which spans 60% from Osun state and 40% from Oyo State. One hundred and thirty one (87.3%) males and 18 (12%) females with a mean age of 51.79 years; and they are predominantly Yoruba (98%) and Togolese (2%). Ninety four (94%) were married and 4.7% were single. 54.7% of our respondents have primary education, 14.7% have secondary education while 27.3% have no education. 52% are alphabetized while 43.3% are not alphabetized. The respondents have been farming pigeon pea for an average of 24 years.

Eighty eight percent (88%) of the respondents planted on their own lands and 10% were loaned (Table 2). Fifty five point three percent (55.3%) of the respondents cultivates on 1-5 acres of land and 20% cultivates 6-10 acres of land (Table 2). Forty five point three (45.3%) of the respondents have abandoned the cultivation of pigeon pea and 19.3% of them had abandoned it because it is too stressful and demanding while 16% abandoned it because of lack of buyers and have abandoned it for an average of 6 years. Therefore, a total of 35.3% of respondent abandoned pigeon pea cultivation (Fig. 1). Other neglected crops that have been abandoned are Jack bean (98%) because it becomes

Table 1. Socio-demographic characteristics of respondents

Designation		Frequency	(%)
Sex	Male	131	87.3%
	Female	18	12%
Ethnic Group	Yoruba	147	99%
	Togolese	2	1%
Educational Level	Primary	82	55%
	Secondary	21	14%
Migration	Native	137	93%
	Foreign	10	7%
Alphabetization Level	Alphabetized	78	54%
	Non-Alphabetized	66	46%

poisonous after three years of cultivation, and lubia bean (83%) because of lack of buyers (Fig. 1).

Sixty eight point seven percent (68.7%) of our respondents source their seedlings from themselves while 28.7% sources from extension agents like OSADEB in Iwo, Osun State. Thirty eight percent (38%) applies both fertilizers and pesticides on their land, 45% applies only fertilizers and 12% applies only pesticides and 74% of the respondents use farm workers as manpower on their lands Table 2.

Seventy six point seven percent (76.7%) claim to intercrop pigeon pea with other crops and the crops were mainly yam (64%), cassava (20.7%) and maize (2%) (Table 2). They weed their farms twice (26%) and thrice (41.3%). Sixty five percent (65%) cultivate pigeon pea for family consumption and commercialization, 13% for commercialization alone and 8.7% for the preservation of soil. Aside from farming, 28% are into trading while 26.7% are into crafts (Table 2).

Two varieties of pigeon pea were recorded in the study site and can be differentiated based on the color of their seeds which were white and red (Table 3). Forty nine point three percent (49.3%) of respondents cultivate both varieties, while 33% cultivates only white. Seventy nine percent (79%) claimed that the seeds were small and highly productive (85.3%), but 79.3% showed that it took long time to cook between 2 hours and 3 hours and 90.7% demonstrated that it was sweet in taste (Table 3). The pigeon pea can be conserved for as long as 2-3 years (74%). Forty percent (40%) of the respondents claimed the plant was resistant to insects/pathogens and 51% claimed it was sensitive to insects/pathogens. Ninety two point seven percent (92.7%) of respondents claimed that they were resistant to drought and they do well in harmattan season. Sixty point seven percent (60.7%) of farmers sew pigeon pea seeds between March and April while the harvest was from January to February.

Farmers in the surveyed areas have local name for the three neglected crops under study (Table 3). The meaning of local name of each crop variety depended on the Yoruba language.

Other useful parts of the plants (Table 5) were leaves (77%), stem and barks as shown in Fig. 2. The leaves were processed by boiling with some other leaves or scrubbed together and taken as a drink or used to bathe in the treatment of malaria. The leaves were also good soil fertilizer (28.7%), the dry stems and roots were used for cooking (15.3%) and the barks and leaves as feed for livestock (12%).

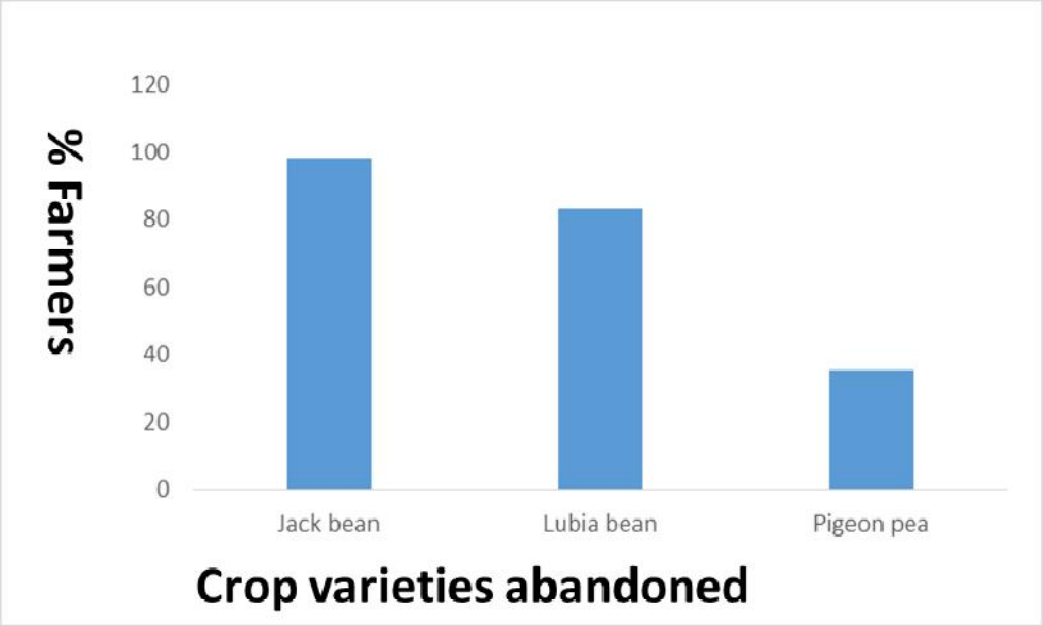

Fig. 1. Percentage of respondents who abandoned growing crop species studied

Table 2. Pigeon pea production Systems of farmers

Designation		Frequency	(%)
Area of pigeon pea production	Less than 1 acre	16	10.7%
	2-5 acres	83	55.3%
	6-10 acres	30	20%
	11-15 acres	11	7.3%
	16- 20 acres	3	2.0%
	Greater than 20 acres	4	2.7%
	No response	3	2.0%
Have you introduced new pigeon pea recently?	Yes	4	2.7%
	No	99	66%
	No response	47	31.3%
Have you abandoned the cultivation of pigeon pea?	Yes	68	50.4%
	No	67	49%
	No response	15	10%
Why did you abandon the cultivation of pigeon pea?	Less yield	6	9%
	Lack of buyers	24	16%
	Too stressful and demanding	29	19.3%
	Less yield and lack of buyers	8	5.3%
	No response	83	55.3%
Why did you abandon the other crops?	Lack of buyers	8	5.3%
	No tree to support in the farm	5	3.3%
	It's poisonous	15	10%
	No response	122	
Mode of land acquisition	Owner	132	88%
	Lodger	2	1.3%
	Loan	15	10%
	No response	1	0.7%
How did you source your seedlings?	Extension Agents	43	28.7%
	IITA	-	-
	Nigeria Institute	-	-
	Personally	103	68.7%
	No response	4	2.7%
Which inputs do you add to the land?	None	6	4%
	Fertilizers	67	44.7%
	Pesticides	18	12%
	Fertilizers and pesticides	57	38%
	No response	2	1.3%
Which manpower do you use?	Family	33	22%
	Farmworkers	111	74%
	No response	6	2%
Do you intercrop pigeon pea with other crops?	Yes	115	73.7%
	No	24	16%
	No response	11	7.3%
Which crops do you intercrop with?	Yam	96	64%
	Maize	3	2%
	Cassava	31	20.7%
	No response	20	13.3%
How often do you weed the land you are using to cultivate pigeon pea?	Once	31	20.7%
	Twice	39	26%
	Thrice	62	41.3%
	More than three times	8	5.3%
	No response	10	6.7%
Why do you cultivate pigeon pea?	Family consumption	12	8%
	Commercialization	20	13.3%
	Soil preservation	13	8.7%
	Family consumption and commercialization		
	No response	98	65.3%
		7	4.7%
What other activities do you do aside cultivating pigeon pea?	None	1	0.7%
	Trading	42	28%
	Craft industry	40	26.7%
	No response	67	44.7%

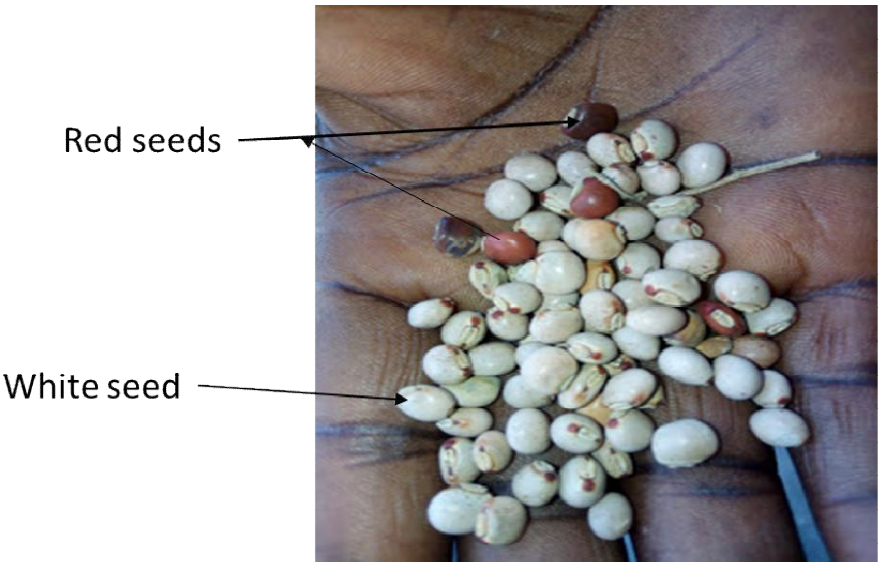

Fig. 2. The two varieties of Pigeon pea based on their seed colors

Table 3. Plant and seed characterization of pigeon pea

Designation	(%)	Frequency	(%)
Colour of seed you plant	Red	22	14.7%
	White	50	33.3%
	Red and white	74	49.3%
	No response	4	2.7%
Size of the seed	Small	119	79.3%
	Big	5	3.3%
	No response	26	17.3%
How productive is the seed?	Low	14	9.3%
	High	128	85.3%
	No response	8	5.3%
How long is the cooking time?	Short	17	11.3%
	Long	119	79.3%
	No response	14	9.3%
How sweet is it to taste?	Sweet	136	90.7%
	Not sweet	5	3.3%
	No response	9	6%
How long is the conservation period?	Long	19	12.7%
	Short	111	74%
	No response	20	13.3%
The height of the plant	Short	44	29.3%
	Long	58	38.7%
	No response	48	32%
Does it mature early or late?	Early	3	2%
	Late	38	25.3%
	No response	109	72.7%
Is it resistant/sensitive to insects/pathogens	Resistant	60	40%
	Sensitive	77	51.3%
	No response	13	8.7%
Is it resistant/sensitive to drought?	Resistant and sensitive	139	92.7%
	Not resistant and sensitive	2	1.3%
	No response	9	6%
What is the planting and harvesting season?	March/April – February	50	33.3%
	May – January/February	41	27.3%
	No response	59	39.3%

Table 4. Local names given to the three species of minor crops used

Common names	Scientific names	Local names
Pigeon pea	*Cajanus cajan*	Otili
Jack bean	*Canavalia ensiformis*	Awuye
Lubia bean	*Lablab purpureus*	Sese

Is there a significant difference between the states and the reasons why the farmers have abandoned the cultivation of pigeon pea?

A chi-square test of independence on the reasons why the farmers abandoned the cultivation of pigeon pea and the two states studied gives a chi-square value of 10.821 and a p-value of 0.013 which is less than 0.05 and we can conclude that the reasons the farmers in both states abandoned the cultivation of pigeon pea are valid for both states (Table 6).

The relationship between age, size of household, length of time they have been cultivating pigeon pea, how long they have abandoned its cultivation and the different varieties they have were investigated using Spearman's rho correlation coefficient (Table 7). Preliminary analyses were performed to ensure no violation of the assumptions of normality, linearity and heteroscedasticity. There was a strong positive correlation between age, size of household, number of years of farming and abandoning; r=0.322, 0.519, 0.419 respectively, and each having $p<0.05$, with increased age associated with increase of each variables.

There is no significant correlation between the varieties of pigeon pea and either, the number of years they have been farming pigeon pea or abandoned its cultivation.

4. DISCUSSION

Men (87.3%) were more involved in pigeon production than women (12%). This indicates women were not so interested in the production of pigeon pea and this could be due to their involvement in other activities especially household works. The majority of the respondent (54%) were primary school dropout.

Pigeon pea has multiple uses as shown in table 4. It should be noted that the majority of farmers were not willing to give the full list of pigeon pea usefulness. These results are consistent with those of past works [4,20]. Pigeon pea is used for consumption, commercialization, soil conservation, soil fertility, to treat various diseases. [21] also found in their study that pigeon pea contributes to enhanced soil fertility, higher levels of biomass production and pigeon pea grain yield. [22] demonstrated that pigeon pea seed boiling was shown to be important in reducing anti-nutritional factors notably trypsin and increasing digestibility of protein and carbohydrate.

The production of pigeon pea tends to decline because of the following reasons: Less yield, too stressful and demanding and lack of buyers. And the study areas, farmers preferred the white variety than the red. Amongst the variety of pigeon pea red color seed variety is almost abandoned by farmers, when asked why? They said the white variety has been grown since their forefathers and because of the slight difference in its taste when compared to the red one. [7,23] showed in their studies that farmers abandoned pigeon pea varieties because they found them less desirable. Similarly, [24,4] revealed that this could also be due to the fact the abandoned varieties failed to meet consumers' preferences. The results of the present study revealed that pigeon pea is sensitive to insects and pathogens. This is similar to the work of [20] who demonstrated that post-harvest storage of pigeon pea seeds was susceptible to insect infestation, therefore seed viability deteriorates rapidly during storage and cause considerable economic loss.

These three species are not threatened especially Jack bean and Lubia bean. Farmers mentioned that Jack bean becomes poisonous after the first harvest and has killed many people and this was the reason of its abandonment. But this remains to be found out scientifically and also identify the chemical compound that develops in Jack bean after the first harvest. Because of this particular trait farmers has abandoned its cultivation. This could also due to cropping systems, biophysical environment and many other factors. Despite some undesirable traits mentioned by farmers as reason for their abandonment, these crop species may have some traits that can be exploited in breeding programs for further adaptation. In order to avoid the loss of those varieties, strategies for on-farm

conservation should be designed. In addition, seed exchange between farmers in the various growing areas should be encouraged with the support of extension agents. In fact, this action lies in the fact that varieties with less preference in some regions may be preferred in others. Furthermore, for ex situ conservation and exploitation of useful traits in Nigeria pigeon pea, jack bean and Lubia bean germplasm, collection and characterization of the cultivated these crop species are advocated. [25] supported the customary practices to save, use, exchange or sell farmers' varieties of seeds that contribute significantly to food security. In the same vein, [26] also reported that agricultural scientists has come to realize that plant genetic diversity can be collected and stored in the form of plant genetic resources (PGR) such as seeds, vegetative parts, gene bank, DNA library. .They further stated that, conserved PGR must be utilized for crop improvement in order to meet future global challenges in relation to food and nutritional security in the world and in Nigeria in particular. And diversity in plant genetic resources by definition provide opportunity for plant breeders to develop new and improved cultivars with desirable characteristics, which include both farmer-preferred traits (yield potential and large seed, etc.) and breeders preferred traits (pest and disease resistance and photosensitivity, etc.) [26]. [27], also referred crop diversity to as plant genetic resources for

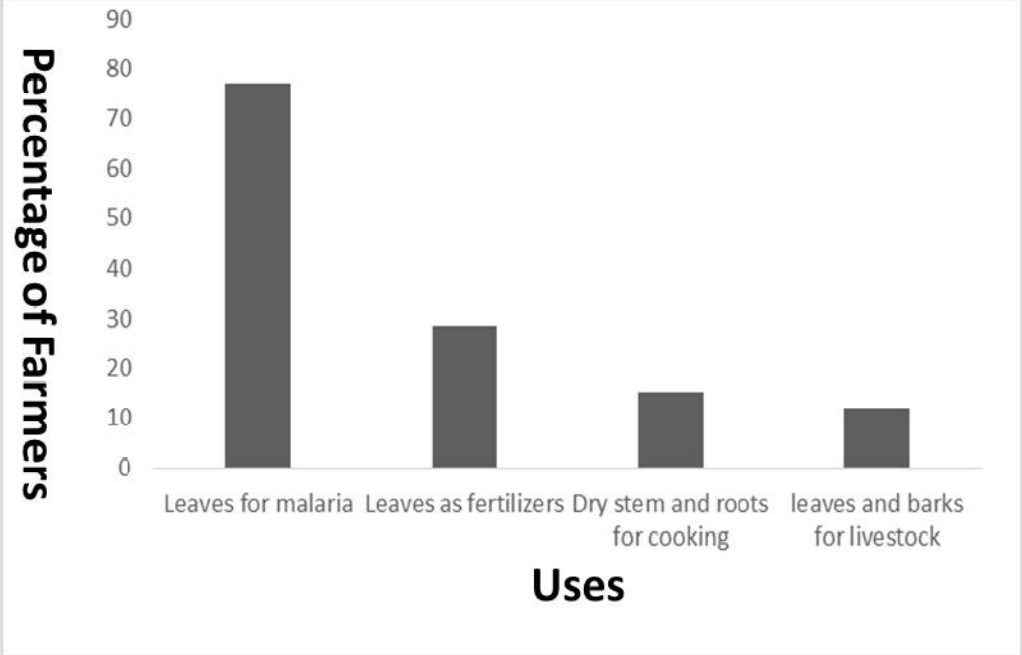

Fig. 3. Percentage of farmers for different uses of pigeon pea plant parts

Table 5. Medicinal uses and utility of pigeon pea

Parts used	Forms used	Mode of administration	Name of diseases
Leaves	The leaves boiling with some other plant leaves or scrubbed together and then filtrate	Drinking of the filtrate or used to bathe	Malaria
Leaves	Scrubbed together and then filtrate	Drinking of the filtrate or used to bathe	Fever
Other uses			
Parts used	Utilities		
Leaves	It serves as compost for soil fertility		
Stems and roots	For cooking in the farm and at home		
Leaves and barks	as feed for livestock		

Table 6. A chi-square test of independence on the reasons why the farmers abandoned the cultivation of pigeon pea

	Value	df	Asymp.sig. (2-sided)
Pearson Chi-Square	10.821	3	0.013
Likelihood Ratio	10.837	3	0.013
Linear-by-Linear Association	4.780	1	0.029
N of valid cases	67		

Table 7. Correlation between socio-demographic variables and production systems

			Age	Size of household	How long have you been farming pigeon pea	How long have you abandoned its cultivation	How many pigeon pea varieties do you have
Spearman's rho	Age	Correlation coefficient	1.000	0.322**	0.519**	0.419**	-0.141
		Sig. (2-tailed)	.	0.000	0.000	0.001	0.091
		N	146	134	145	65	145
	Size of household	Correlation coefficient	0.322**	1.000	0.243**	-0.115	0.032
		Sig. (2-tailed)	0.000	.	0.004	0.371	0.712
		N	134	137	136	62	136
	How long have you been farming pigeon pea	Correlation coefficient	0.519**	0.243**	1.000	0.224	-0.029
		Sig. (2-tailed)	0.000	0.004	.	0.070	0.723
		N	145	136	148	66	147
	How long have you abandoned its cultivation	Correlation coefficient	0.419**	-0.115	0.224	1.000	-0.143
		Sig. (2-tailed)	0.001	0.371	0.070	.	0.250
		N	65	62	66	67	67
	How many pigeon pea varieties do you have	Correlation coefficient	-0.141	0.032	-0.029	-0.143	1.000
		Sig. (2-tailed)	0.091	0.712	0.723	0.250	.
		N	145	136	147	67	148

*** Correlation is significant at the 0.01 level (2-tailed)*

food and agriculture which holds the diversity within and among crops, their wild relatives and wild edible plant species. Crop diversity also provides the biological foundation for food production and food security and contributes to economic development [27]. The conservation and management of agricultural crop diversity is a key issue in the struggle to achieve food security both locally and globally.

5. CONCLUSION

Farmers used pigeon pea to treat sickness such as malaria and fever and it was also used for cooking, soil preservation, soil fertility and cover crop. Despite its importance its production is in decline. Jack bean and Lubia bean are being abandoned for their undesirable traits and they need to be considered under specific conservation strategy to avoid loss that may hinder future improvement of the crop. We suggested an extensive collection of Nigeria lubia and Jack bean and pigeon pea genetic resource for further characterization and identification of useful traits to be exploited in the crop improvement programs. Similarly, further study is needed to be carried out to find out the chemical compound responsible for poisonous seeds of jack bean after the first harvest.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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