International Journal of Innovation and Scientific Research
ISSN 2351-8014 Vol. 20 No. 2 Feb. 2016, pp. 500-515

http://www.ijisr.issr-journals.org/

Folk taxonomy and traditional management of cassava (*Manihot esculenta* Crantz) diversity in southern and central Benin

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ABSTRACT: Cassava (*Manihot esculenta* Crantz) is an important food security crop for poor rural communities, particularly in Africa. At household level, cassava landraces used for cultivation are mainly selected based on farmers' interests, leading to very particular diversity evolution over generations. The structure, composition and factors influencing cassava diversity at that level is not well monitored and under documented. This study aimed at capturing and analyzing local knowledge on cassava genetic diversity and the key parameters affecting it in Benin, for better and sustainable local cassava genetic resources management. The methodological approach was based on field visits, interview using questionnaire and group discussion with farmers. Data were collected from one hundred and ninety eight (198) respondents and analyzed using descriptive statistics. The majority (82%) of the respondents were male, generally 20 to 80 years old. Positive correlation was found between cassava diversity maintained per household with cultivated area and household size (R^2 = 0.162). Farmers used mainly stem and leaves characteristics to identify cassava varieties. Plant materials for next season were mostly selected according to the disease (mainly plant free of viral infection) status, size of the stem and number of nodes. The study revealed existence of a high diversity of cassava at the household level. However, various factors constrained cassava production and threats on cassava diversity were observed. Establishment of community field genebank, introduction of new varieties were some of the on-farm conservation strategies proposed by cassava farmers.

KEYWORDS: Benin, cassava, diversity, *Manihot esculenta* on farm conservation.

INTRODUCTION

Cassava, *Manihot esculenta* Crantz, is one of the most produced staple crops in Southern and Central Benin where it also has a cultural and economic value. Cassava processing and commercialization of cassava-based products are important economic activities, generating incomes for local populations and participating in job creation (Soulé et al., 2013). In this regards, cassava is an important crop for poverty alleviation and appears to be one of the most important crops in Benin, mainly supported by a crucial genetic resource component (Adekambi et al., 2010).

Despite its importance, cassava production is hindered by many constraints among which high susceptibility of some local cultivars to diseases and pests, inability of some cultivars to adapt to a wide range of agro ecological conditions leading to low productivity, and a high post-harvest loss (Agre et al., 2015).

In Benin, several studies have been carried out to investigate various aspects related to cassava production systems (Maroya, 1986; Agre et al., 2015), diseases (Onzo et al., 2005), commercialization (Hongbete et al., 2011), value chains (Soule et al., 2013), genetic resources and agro-morphological evaluations (Agre et al., 2015). However, little on-farm conservation strategies of cassava diversity and the possibilities to enrich the existing diversity through introduction of new cultivars without losing existing varieties are not documented yet. This study aimed to access indigenous knowledge relative to cassava production and its management at household level and the key factors influencing the production system.

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Specifically this study aimed to: analyze socio-demographic parameters, which affect cassava production in Benin, identify the different criteria used by cassava farmers for varietal identification and analyze practices used by farmers to manage cassava pests and diseases.

MATERIAL AND METHODS

STUDY AREA

The study was carried out in the major cassava growing areas in Benin (Southern and Central). The climatic conditions consist of two rainy seasons (from March to July and from September to November) and two dry seasons (December to March and July August September) with an average yearly rainfall of 1200 mm and average temperature of 27°C (Adam et Boko, 1993). The predominant vegetation is an arborous savannah type. Villages surveyed for this study were selected based on both socio-cultural and landraces diversity as revealed by Agre et al. (2015). In total 10 villages Table 1) were explored and every fifth household encountered in randomly selected streets was surveyed.

Table 1: List of the selected villages for the survey

No	Village	Municipality	Department	Major ethnical group	Regions
1	Agbodji	Bopa	Mono	Sahoue	Southern
2	Alafia	Savè	Collines	Tchabè	Central
3	Assaba	Bantè	Collines	Ifè	Central
4	Ewè	Kétou	Plateau	Fon	Southern
5	Gbèdavo	Dassa	Collines	Fon	Central
6	Glo Glégbodji	Abomey-Calavi	Atlantique	Aïzo	Southern
7	Lokogba	Lalo	Couffo	Adja	Southern
8	Miniki	Savalou	Collines	Ifè	Central
9	Omou	Kétou	Plateau	Yorouba	Southern
10	Tori-Bossito	Tori-Bossito	Atlantique	Aïzo	Southern

DATA COLLECTION AND ANALYSIS

Data was collected using participatory rural appraisal tools and technics such as individual interviews and field visits (Ajani and Onwubuya, 2013). In each village, prior to the interview, the objectives of the research were explained to the cassava farmers. Farmers' prior consent was obtained following the guide of the International Society of Ethnobiology (International Society of Ethnobiology, 2006). With the help of the head of the village and a local guide, interview was performed and the person to be interviewed in the household was determined by the adult members of the household (Adewuyi et al., 2013; Ajani and Onwubuya, 2013). Socio-demographic data such as age, sex and education level of the farmer and data related to household including household size, number of active members and cultivated area were collected. Data related to the number of cultivated varieties per household, seed system (i.e. origin of cuttings, criteria for stem selection, stem conservation methods, usage of seeds), different diseases and pests infesting cassava and their management were also recorded. For germplasm conservation strategies, the possibilities of setting up a community or village-based on-farm conservation of cassava genetic resources and the different strategies for sustainable conservation and utilization were discussed with farmers. To gain insight into varietal taxonomy criteria, two villages were selected from the study area, one in Central Benin (Miniki) and another one in Southern Benin (Agbodji). Different cultivars from each selected village were collected with their various names and coded. In each of the two villages, 30 farmers were separately invited to identify the coded local cassava varieties and to explain the morphological trait used for the identification. These criteria were enumerated and ranked by farmers according to their importance and relevancy in the identification of the varieties.

The collected data was summarized with descriptive statistics (mean, standard error, percentage). An analysis of correlation was performed to estimate the relation between cassava varietal maintain per household and the socio demographic variables (age, sex, size of the household, education level and number of active member of the household, cultivated area) using Statistica 7.1. The different results obtained were presented as Tables and Figures.

RESULTS AND DISCUSSION

SOCIO-DEMOGRAPHIC CHARACTERISTICS OF THE RESPONDENTS

Cassava farmers randomly selected and surveyed were in majority (82%) male. The low proportion (18%) of females involved in cassava growing could be explained by the fact that cassava has a relatively long growth cycle, i.e. up to two years for some varieties. That requires a continuous access to land over a long period that female farmers do not usually have. In addition, female often prefer to specialize in cassava processing activities than in its production (Okereke, 2012; Soulé et al., 2013). Most of the female cassava producers were met in the Southern region where urbanization provided alternative activities to male, making land accessible to female. In contrary, male in the central region focus on agriculture which is the main economic activity.

The age of the surveyed cassava farmers ranged from 20 to 80 years with an average of 43years but the majority of the producers were in the economically active age range (between 30 and 50), as in most of developing countries (FAO, 2011; Adewuyi et al., 2013; Eze and Nwinbo, 2014). The experience in cassava production of interviewed farmers, in terms of years, was quite variable ranking from 1 up to 55 years, with an average of 16years. The majority of the surveyed farmers had been growing cassava for 15 to 20 years and this observation suggested that most of the respondents have enough experience in cassava farming. These findings agree with previous studies (Ajani and Agwu, 2012; Ajani and Onwubuya, 2013) stating that most of the small-scale farmers in Sub-Saharan countries have been involved in agricultural production for a relatively long period.

On average, the number of persons per household recorded was 8 persons with 3 to 4 persons actively engaged in cassava farming (Table 2). This implied that farmers' households in the cassava production areas had relatively large size, which ensures availability of labour and expansion of farm size (Mbanasor and Kalu, 2008; Ninso, 2012, Nurudeen, 2012; Onubuogu et al., 2014). This finding was consistent with the results of Ewaonicha, (2005); Onubuogu and Onyeneke (2012); Onubuogu et al., (2013); Esiobu et al., (2014) and Onubuogu et al., (2014) who reported that large household size complement labour to enhance production and reduce production cost. Sixty three per cent of the farmers were illiterate and most of those who attended school reached primary school.

Table 2: Socio-demographic parameters

N°	Variables	Range	Mean±standard error
1	Age (years)	20 - 80	43±0.78
2	Cultivated area (ha)	0.125 - 7	2±0.18
2	Size of household (persons)	1 – 25	8±0.27
4	Number of active member in farming	1 – 15	4±0.39
5	Experience in cassava production (years)	1 - 55	16±0.47

IMPORTANCE OF CASSAVA IN THE FARMING SYSTEM AND FARMERS' PERCEPTION ON CASSAVA PRODUCTION TREND

In Southern and Central Benin, cassava, maize, soya bean, yam, groundnut, cowpea, bambara groundnut, rice, cotton, tomato, pepper, pineapple and pigeon pea were cited as the most cultivated crops. For 80.98% of the surveyed farmers (32.28% as principal and 48.70% of response as major), cassava was the main cultivated crop in terms of allocated area and income generated (Table 3). Most of the farmers (78%) reported an increase in their cassava production during the last few years. This increment is likely due to the establishment, in the Central Benin (Savalou and Savè), of a Chinese alcohol industry which processes cassava into alcohol-based products. It was estimated that about half of the total cassava production in that region is supplied to that industry which represents a market outlet for cassava producers in the region. All over the country, and especially in the Southern Benin, there is a high demand of cassava-based products such as gari, tapioca and starch, which are also exported to neighboring countries such as Nigeria and Togo. Soule et al. (2013) reported the increase in cassava production nationwide and pointed out the prominent role played by many agro-industrial projects in the increase of the yield and the cultivated areas. However, for 8% of the surveyed farmers, their cassava production had been reduced due to constraints related to the commercialization of the derived products.

Table 3: Importance of cassava though the surveyed area

	Cassava	Maize	cowpea	Rice	Groundnut	Yam	Others
Principal (1st)	32.28	20	-	12.55	10	-	5
Major (2nd to 5th)	48.70	30.14	10.75	7.58	8.82	12.75	7.15
Subsistence (6th and more)	19.02	48.75	79.25	78.18	72.18	78.25	76.75

Principal (rank first); Major (Rank 2nd to 5th); Subsistence (6th and more)

DIVERSITY OF CASSAVA CULTIVARS PER HOUSEHOLD

The number of cassava cultivars per household varied from 1 to 10 with an average of 3±0.23 cultivars (Table 4, Figure 1). In total, 73% of cassava farmers surveyed grew in average one to four cultivars (Figure 1). At household level, the average number of varieties differed from one village to another (Table 4). The highest varietal diversity was recorded in the villages of Central Benin namely Assaba, Allafia, Gbedavo and Miniki, all located in the department of Collines; and in Omou and Ewe villages located in Southern Benin, department of Plateau. This observation was probably due to the fact that many projects supporting the cultivation of root and tuber had introduced new varieties in those regions. At the department level, the lowest mean of cassava diversity per household was recorded in the departments of Atlantique and Couffo (Table 5).

Considering cassava diversity held by ethnic groups, Ifé, Fon and Yorouba/Tchabè cultivated in average the highest number of cultivars per household while Aizo and Souhouè held the lowest diversity (Table 6). This is likely due to the fact that Ifé and Tchabè ethnic groups inhabit regions bordering Nigeria, a neighboring country known for its high cassava genetic diversity (IITA, 2012). As such, they could easily have access to more cassava varieties than the other ethnic groups. The highest cassava diversity observed in departments of Collines and Plateau, occupied by Ifè, Yorouba and Tchabè ethnic groups, was already reported (Agre et al., 2015).

Table 4: Diversity maintained per household at village level

Villages	Number of households surveyed	Range	Statistical comparison between villages
Agbodji	20	1 - 4	2.68 ± 0.58
Allafia	20	2 - 8	4.3 ± 0.48
Assaba	20	3 - 10	5 ± 0.78
Ewe	20	2 - 6	3.2 ± 0.21
Gbèdavo	18	2 - 4	3.9 ± 0.15
Glo Glégbodji	20	2 - 4	2.3 ± 0.49
Lokogba	20	1 - 4	2.2 ± 0.78
Miniki	20	1 -10	3.45 ± 0.14
Omou	20	1 - 4	3.15 ± 0.74
Tori Bossito	20	1 - 3	1.5 ± 0.10
Average mean	**19±0.40**	**1 - 10**	**3 ± 0.23**

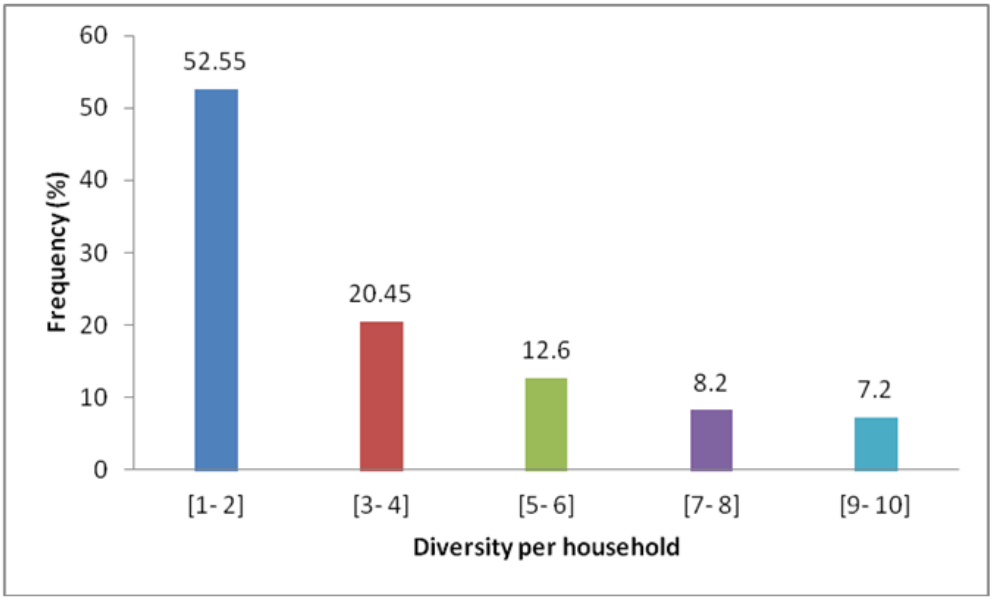

Figure 1 : Variability of the diversity per household

Table 5: Diversity maintained per household at Department level

N°	Department	Villages	Number of households surveyed	Diversity		
				Min	Max	Mean
1	Atlantique	Glo glégbodji and Tori	40	1	4	1.9[a]
2	Collines	Allafi, Assaba Gbédavo and Miniki	78	1	10	3.95[b]
3	Couffo	Lokogbo	20	1	4	2.2[a]
4	Mono	Agbodji	20	1	4	2.65[bc]
5	Plateau	Ewè and Omou	40	1	6	3.17[c]

Table 6: Diversity maintained per household considering ethnic group

N°	Ethnic group	Villages	Number of household surveyed	Diversity		
				Min	Max	Mean
1	Adja/Sahoue	Lokogbo, Agbodji	40	1	4	2.44[a]
2	IFè	Assaba, Miniki	40	1	10	4.22[b]
3	Yorouba/Tchabè	Allafi, Omou	40	1	8	3.72[b]
4	Fon	Ewè, Gbédavo	38	2	6	3.55[b]
5	Aizo	Glo glégbodji, Tori	40	1	4	1.9[a]

The analysis of the correlation between diversity maintained by household and socio-demographic variables (age, household size, number of active members in farming, gender, level of education and cultivated area) (Table 7) showed that the number of varietal diversity maintained at household level and allocated area for cassava and household size were positively correlated ($P<5\%$, $R^2 = 0.48$ and $R^2 = 0.162$). The positive correlation between the number of varieties held by household and cultivated area could be explained by the fact that having large cultivable land allowed farmers to plant more cassava varieties. However, large portion of the land is used to grow only one to three cultivars, considered as elite with high productivity and others traits of interest. The remaining cultivars were grown either for conservation purposes or for a specific trait such as friability. The larger is the household size, the higher is the diversity of cassava varieties cultivated. In fact, in many instances, each member of the household had specific traits of preference such as late or early maturing, sweet or bitter taste and then many varieties were cultivated in an attempt to satisfy all the needs of the household members. This could also be perceived as a strategy to mitigate environmental stresses and diversify the use of cassava since each variety had specific traits.

Table 7: Correlation analysis between varietal diversity and socio-demographic variables

	NV	CA	AG	OD	GD	SH	AM	ED
NV	0							
CA	0.48 0.000***	0						
AG	-0.031 0.672	-0.124 0.085	0					
OD	-0.020 0.781	-0.085 0.237	0.816 0.000***	0				
GD	0.057 0.433	0.158 0.028***	0.016 0.826	0.097 0.177	0			
SH	0.162 0.024***	0.182 0.011***	0.358 0.000***	0.351 0.000***	0.158 0.028***	0		
AM	0.116 0.106	0.212 0.003***	0.303 0.000***	0.335 0.000***	0.045 0.536	0.821 0.000***	0	
ED	0.092 0.204	0.115 0.110	-0185 0.010***	-0.170 0.018***	0.188 0.009***	-0.150 0.037***	-0.139 0.053***	0

Cell Content: *Pearson correlation and P-Value*

NB: ***NV****: Number of variety;* ***CA:*** *Cultivated area* ***; OD****: oldness in cassava production;* ***GD:*** *Gender,* ***AG****: Age,* ***SH*** *: Size of household;* ***AM*** *: Active member in farming and* ***ED*** *: Education level*

**** Significant correlation coefficient at 5%*

NOMENCLATURE AND FOLK TAXONOMY

In the areas of study, the majority of the recorded cassava names had a specific meaning. These meaning were often related to the origin (Djagbalo, Accra, Adja , Awonli, Obassandjo, Aboidassa), to the productivity (Bamigbéché, Odohoungbo, Otègbèyè and Gbamiloiya), to the earliness (Kitékponmi, Sammi, Dadjo foligbessé), good culinary characteristic (Ôlôbèkpè, Okôiyawo, Olitchountè) and the color of root skin (Loki and Okin).

In Southern and in Central Benin, cassava farmers' have good capacity to identify their plants materials (Table 8). In central Benin some varieties like Loki, Akparokoffo, Odohoungbo were identified by the entire cassava farmers' invited (Table 8). All the surveyed farmers cultivated these varieties in Central Benin . However, Agôkpa and Olikaga were identified only by some old farmers (Table 8). In reality, these two varieties are ancient and only some old farmers still continue to grow them for conservation purpose and medicinal usage. In southern region, varieties Soukounon, Hombètè and Agbeyido were the most identified by all of the different cassava farmers'. Varieties Kouyê and Acide were only identified by one person. These two varieties were known for their high toxicity level (HCN) which limits the cultivation by the youths and other cassava farmers' to avoid food poisoning.

Table 8: List of the different cultivars and the identification frequency according the age

Regions	Cultivars name	Number farmers	General Frequency (%)	Frequency of youth (less than 30 year olds)	Elders (more than 30 year olds)
Central	Loki	30	100	40	60
(30 persons)	Akparokoffo	30	100	40	60
	Odohoungbo	29	96.7	36.70	60
	Adja	18	60	13.30	46.70
	Djagbalo	18	60	6.70	53.30
	Ôlôbêkpê	15	50	6.70	43.30
	Kitékponmi	12	40	13.30	26.70
	Bamigbéché	12	40	3.30	30
	Ôkôyawo	12	40	13.30	26.70
	Agôkpa	07	23,33	-	23.33
	Olikaga	03	10	-	10
Sud	Soukounon	30	100	26.70	73.30
(30 persons)	Hombètè	30	100	26.70	73.30
	Agric	24	80	26.70	53.30
	Agbeyido	20	66,66	26.66	40
	Globokoutou	20	66,66	16.70	50
	Ôkôyawo	20	66,66	26.70	40
	Kalaba	06	20	-	20
	Acide	06	20	-	20
	Oueminou	06	20	-	20
	Kouyê	1	3,33	-	3.33
	Gbakaya	1	3,33	-	3.33

As regard to the identification criteria, different parts of the cassava plant were used to discriminate the cassava varieties (Table 9). Among these, the most important was the stem (46.29% of responses), the leaves (30.19% of responses), the root (18.58% of responses) and the fruits (4.94% of response). This trend was observed throughout the surveyed regions. For the criteria related to the stem used by the farmer for cassava identification, the most important were cassava stem color (26.25% of responses), plant height (6.56% of responses), type of branching (5.25% of responses) and density of node (4.65% of responses). In Ghana (Kumba , 2012) reported that these morphological traits were the most important used to identify cassava varieties. As for the leaf, cassava petiole color (22.33% of responses), petiole length (2.03% of responses), arrangement of the leaves on the stem (1.67% of responses) and leaves color (1.08% of responses) were recorded as most used leaf parameters to identify cultivars. The roots were also useful to farmers in cassava identification. They mostly considered the color of the root cortex (8.84% of responses). Varieties Loki, Dokuin and Oko Ognibo were also identified by the color of the root skin, root pulp color (4.27% of responses) and root shape (3.93% of responses). Some cultivars were specifically identified by the presence of fruits in Central Benin (Akparokoffo) and in Southern Benin (Kalaba).

The use of farmers' criteria to identify cassava varieties is worth being capitalized on. Thus, knowledgeable farmers on classification of cassava varieties should be involved in participatory agro-morphological characterization and evaluation programs.

Table 9: Different parameters used by farmer to identify local cassava varieties

Plant part	Morphological traits	All studied areas (% of responses)	Southern	Central
Leaves	Petiole color	22.33	24.98	19.69
	Petiole length	2.08	0.30	3.86
	Disposition of the leaves on the stem	1.67	0.30	3.04
	Limb color	1.08	1.76	0.41
	Foliole size	1.06	2.13	-
	Foliole number	0.91	1.83	-
	Vein color	0.78	-	1.56
	Petiole fatness	0.28	-	0.57
	Total	**30.19**	**31.3**	**29.13**
Stem	Stem color	26.25	20.63	30.68
	Plant size	6.56	7.13	5.99
	Branching type	5.25	8.29	2.22
	Node density	4.65	2.5	6.81
	Stem shape	1.68	2.62	0.74
	Stem fatness	1.03	2.07	-
	Size of petiole scar	0.36	0.73	-
	Disposition of scar on the stem	0.24	0.48	-
	Water stem content	0.15	0.305	-
	Petiole scar shape	0.12	0.245	-
	Total	**46.29**	**45**	**46.44**
Root	Cortex root color	8.84	7.745	9.94
	Pulp color	4.27	8.54	-
	Root shape	3.93	2.195	5.66
	Root size and fatness	0.81	0.48	1.15
	Striation of root	0.61	1.22	-
	Root taste	0.12	-	0.25
	Total	**18.58**	**20.18**	**17**
Fruit	Presence of fruits	4.94	3.52	7.43

Based on the different morphological variables, the 22 cassava varieties evaluated with farmers' were grouped into 5 major clusters (Figure 2). Cluster 1 has two varieties which were identified by cassava farmers with the presence of green yellowish petioles and smooth root. Cassava varieties of the cluster 2 were identified using the color of the stem (brown light), brown dark of the root and green light color of the petiole. The cluster 3 have some cassava varieties which were recognized with their numerous scar node, high size of the plant, green reddish color of the petiole and rough root. Varieties of cluster 4 were identified by the cassava famers using traits such as presence of fructification (Akparokoffo and Hombete), brown dark of the stem, petiole long and green light, long distance of inter-node on the stem. Cassava varieties of cluster 5 were identified with the presence of red color petiole, smooth roots and green yellowish of the stem.

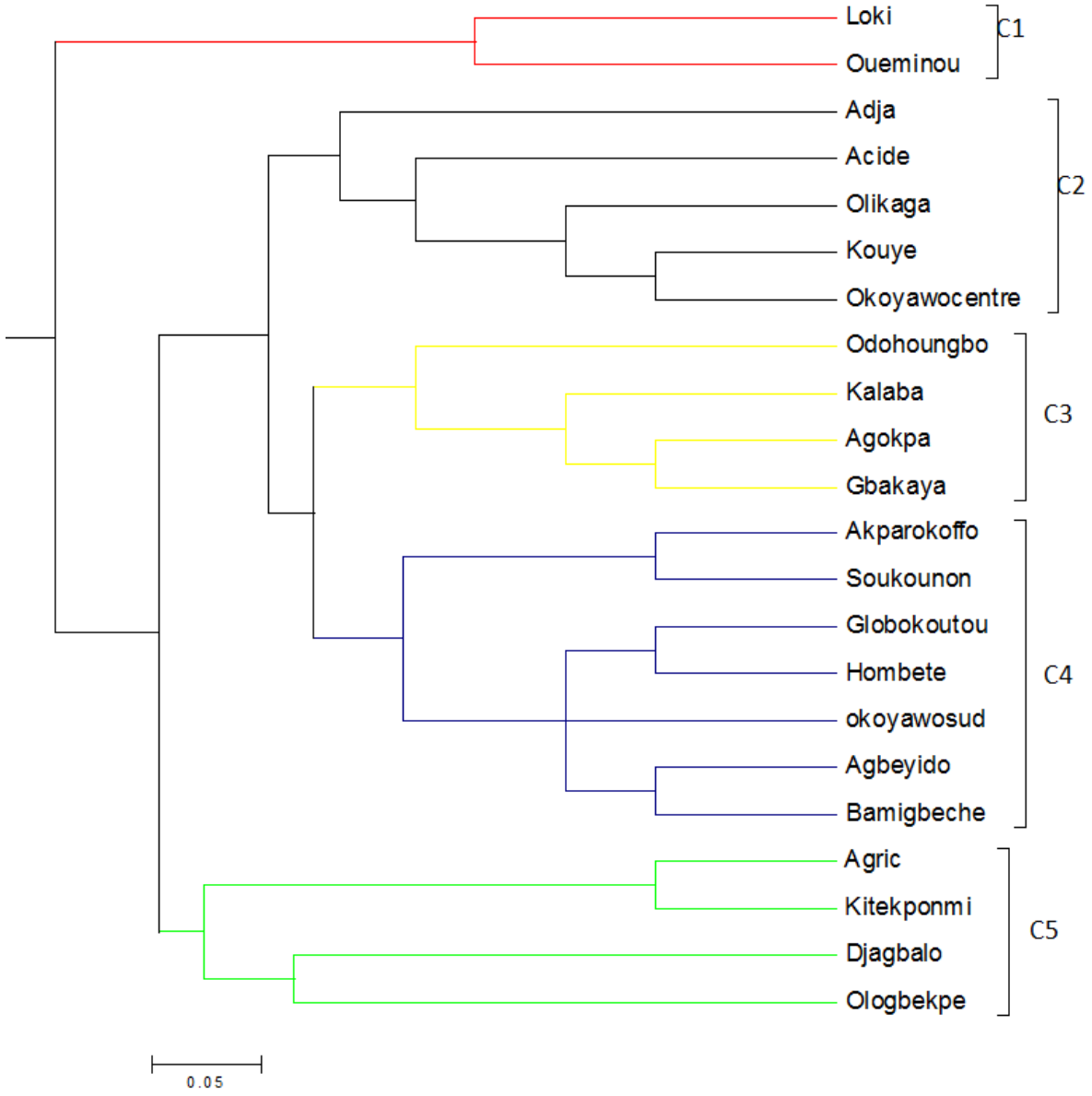

Figure 2: Dendrogram showing the morphological similarity

CROPPING SYSTEMS

Cassava cropping systems were influenced by land availability and the type of soil. Crop rotation (38.88% of respondents) and monoculture (30% of respondents) were reported as the most frequent practices adopted by cassava farmers', especially in the central region of Benin (Departments of Collines and plateau in Southern Benin) where demographic pressure is not high. In contrast, intercropping systems were mostly encountered in Southern regions (Departments of Atlantique, Mono and Couffo) characterized by high population density and lack of cultivable lands. This mixed cropping practice enabled a rational use of land and allowed farmers to ensure food security/availability all year round, increased income and reduced incidence of pests and diseases. More so, it predominates among subsistence growers as means of maximizing productivity, efficiency and diversification for small landholders and ensuring thus income (Onubuogu and Onyeneke, 2012; Onubuogu et al., 2014). However, farmers mentioned that the productivity in monoculture was higher than in intercropping. Cassava farmers grew several cassava varieties (1 to 4 varieties), in majority (82% of responses), all the varieties were cultivated in the same farm (mixture of cassava varieties), except for high cyanogen (toxic) varieties, which are planted and harvested separately to avoid food poisoning. Only 18% of the respondents planted their different cassava cultivars on separated fields, taking into account the growth cycle and the toxicity of the cultivars.

SEED SYSTEM AND STEMS CONSERVATION METHODS

Cassava stem or cuttings used by farmers in surveyed villages as planting materials were often inherited from their parents. To establish new cassava fields, farmers generally harvest mature stems from already established farms. The harvested stems were left in the fields or stored in specific locations (under shade) that can ensure better conservation. This system was practiced by almost all of the farmers. It occurred that farmers exchanged stems of one cassava variety with another one when they lacked stems or if there was possibility to get a new interesting variety. Cassava stems were also bartered for seeds of other crops. Cassava cuttings trading was also well developed in Southern Benin particularly in the Departments of Atlantique, Mono and Couffo where respectively 35%, 25% and 27.90% of farmers bought planting stems (Table 10) from other farmers. Only few farmers (19.24 % responses) have reported to obtain planting material from national agricultural research institutes in Benin, which are usually improved varieties, e.g. RB, TMS and Carder. The improved cultivars are mainly developed by IITA and distributed to National institutes in the sub-region. The reasons given by farmers for low adoption rate of improved varieties is that traditional local varieties have good underground storability, compared to improved varieties.

Table 10: Source of supply

Source of supply	Study area (% of responses)	Variability per Department				
		Atl	Col	Cou	Mon	Pla
Exchange between farmers	47.2	40	49.01	38.2	41.65	42.2
Purchase of stems/cuttings	20.18	35	5.00	25.00	27.90	8.00
Extension services	19.24	40.28	5.18	15.29	19.12	15.29
Introduction from Neighboring countries	13.38	14.24	8	12	9.25	19.24

Atl: *Atlantique****; Col:*** *Collines****; Cou:*** *Coufo****: Mon:*** *Mono****; Pla:*** *Plateau*

In Southern and Centre Benin, various strategies were developed by cassava farmers to conserve their cuttings safe for planting in the next season (Figure 3). The most important ones included leaving the cassava stems on the fields and cut the stems at the moment of planting (49% of respondents). Some farmers (22.45% of the respondents) tied up and stored the stems in a hole under shade, after harvest (Figure 4). The third strategy consisted of laying up the stems horizontally under oil palm trees and covering them with palm leaves (17.30% of responses). These two later techniques were more common in Southern Benin, where land availability is a limitation. In addition, in this region, farmers needed to harvest all the planted cassava to provide space for other crops or for the establishment of a new cassava field. However, conserving cassava stems under trees has limitations as severe drought or heat can make the cassava stems to dry out and lose their viability. Farmers whose fields were not far from their houses (11.25% responses), conserved the stems in their courtyards to ensure a permanent monitoring (Figure 5a and 5b).

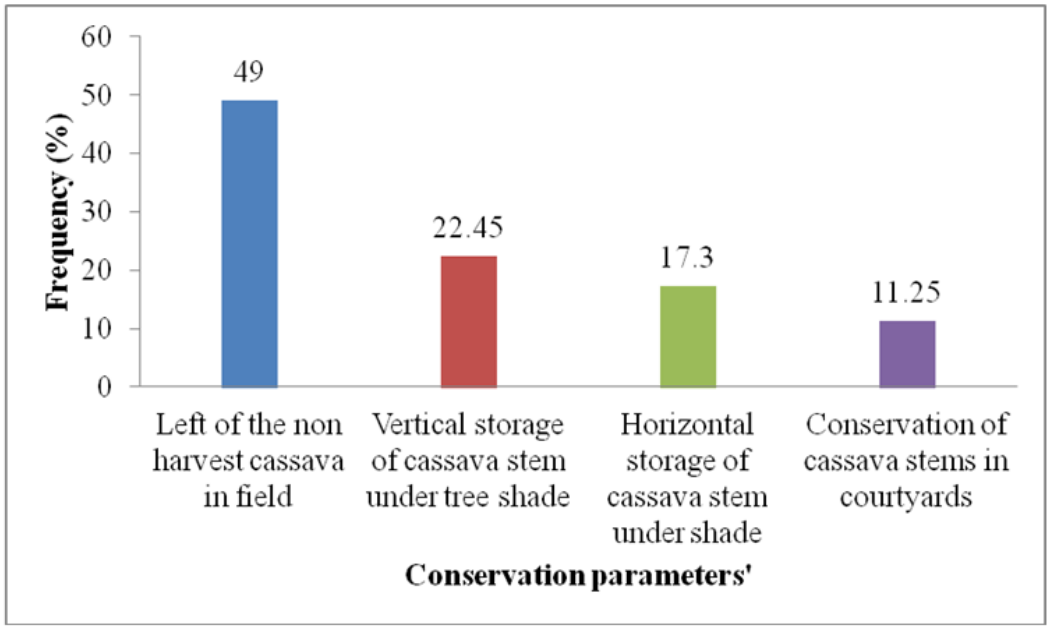

Figure 3 : Conservation parameters' in the study area

Figure 4: Conservation of cassava stems under a tree shade

Figure 5a: Conservation heap under the roof of a town house .bédavo

Figure 5b: Conservation of cassava stems behind a shower in a village of Dassa

The choice of planting material for next season is a crucial step for plant health and better productivity. However, 45% of respondents did have no criteria for the selection of cuttings, i.e. all kind of stems could be used as planting materials. In contrary, 55% of farmers used several morphological criteria for choosing cuttings to plant for a new season (Table 11). Among the criteria, the most important were disease-free stems cuttings (38.90% responses), big stems (22.11% responses) and moderately big stems with many nodes (18.80% of responses). Other criteria such as stems keeping leaves for a long period, with high branching ability and erected stems were also mentioned by farmers (Table 11). These criteria were virtually identical from one zone to another except for high branching ability and erected stems which were mostly used by cassava farmers in Centre Benin (Table 11).

Table 11: Morphological traits used by farmers to select cuttings

Selection criteria	Study area (%)	Variability per region	
		Southern (%)	Central (%)
Whole stems and free from disease	38.90	40	37.40
Big stems	22.11	20	24.40
Moderately big stem with many nodes	18.80	20	19.60
High ability to retain leaves	9	7.40	10.60
High branching ability	7.10	4	10.20
Erect stem	5.10	-	10.20

BOTANICAL SEEDS RECOGNITION AND PLANTLETS MANAGEMENT

The majority (59%) of surveyed farmers recognized that cassava plants produce flowers. Only 42%, of the respondent, especially producers from Centre Benin reported have seen fruits on cassava plants. Less than one third of producers (30%) acknowledged that cassava seedlings could emerge from seeds. They added that the characteristics of those seedlings presented specific traits that differentiated them from plant obtained from cuttings. Those traits were i) lack of stub (28.75% of responses), ii) too thin and flexible stems (25.50% responses), iii) production of single root (22.75% of responses), iv) germination away from planting line (12.25% of responses) and v) plants with different leaves and stems color (11.75% of responses). Because of those characters, almost 98.78% of the farmers interviewed did not use stems derived from cassava seed and they systematically removed them while weeding since they are considered as off-types. Only one farmer in the Department of Atlantique mentioned the usage of stems from seedling as cuttings but he had stopped because of the undesirable characteristics of the obtained plants. In addition, the low or none germination from cassava seeds and the low productivity (since only one root is produced) increased farmers reluctance to use seed for planting. Cassava seeds are produced by genetic recombination (free or controlled hybridization) and can thus be source of new cultivars, in a single generation (Kawano et al., 2003; Okogbenin et al., 2008; Kombo et al., 2012 da Silva et al., 2015). To increase cassava diversity and its production in Benin, Research institutes, organizations for agricultural promotion and NGOs should design and implement participatory breeding programs using cassava seedling.

FARMERS KNOWLEDGE OF DISEASES AND PESTS AND MANAGEMENT OF INFESTED PLANTS

Interviewed cassava farmers had a good knowledge of various diseases and pests related to the production of cassava. The most reported diseases were viral infections (68%). Infected plants were reported to have wilting leaves; a slow growth and plants necrosis in severe cases, resulting in reduction of the crop productivity (Figure 6). For plants infected by anthracnose, stems were characterized by injury on leaf scars. Nematode infection on cassava root was identified by 5% of the respondents in the Department of Couffo by the presence of red to brown mark in the root flesh.

Figure 6: Symptoms of cassava mosaic disease on Leibo, a highly susceptible cultivar

Among the insects that attack cassava fields and hinder plant growth, the most important were grasshoppers. They attacked leaves and stems of cassava and caused severe damage to foliage, mainly during dry season. Whiteflies attack was reported by 15% of cassava farmers. The presence of white spots on stems leaves and especially at the apical meristems of infected plants were the main symptoms of whiteflies attack reported by farmers. Centipedes forming galleries in the roots causing huge loss were also reported.

Farmers (95% of the respondents) were left with no option to manage the various diseases and pests in their cassava fields. Some of the cassava farmers' (5%) reported the use of chemicals, against the above mentioned cassava pests and diseases but this method were perceived by farmers as ineffective. Most of the farmers' reported that stems with CMD symptoms were left in the stem. As cassava is predominantly vegetatively propagated crop, the presence of some infested stems in the field spread off the cassava mosaic disease. As suggested by Fregene et al., (2000); Parkes et al., (2013) Rabbi et al., (2014) and cassava mosaic disease (CMD) is a viral disease of the important tropical staple crop cassava (*Manihot esculenta*), the best option to fight against CMD is usage of resistance genotype. Tolerant cassava cultivars have been developed from the breeding programme of the International Institute of Tropical Agriculture (IITA), based in Nigeria. These cassava varieties should be evaluated through many multi-location trials for evaluation in order to find out the best varieties with characteristics that meet the preferences criteria of farmers and consumers. As a preventive measure, extension agents should sensitize farmers on the importance to remove infested cassava varieties from the field to avoid the virus inoculums to spread in the farming system particularly in varieties that suppress virus accumulation.

PROPOSED STRATEGIES FOR *IN SITU* CONSERVATION AND ENHANCEMENT OF CASSAVA VARIETAL DIVERSITY

In the coming years, many cassava cultivars will be lost in the study area, if nothing is done. For economic reasons, cassava farmers tended to increasingly grow a small number of highly productive cassava cultivars with good culinary traits. Therefore, it is important to develop a dynamic on-farm conservation strategy of the existing diversity that would allow cultivars to adapt continuously to the changing environment. Towards this end, most of cassava farmers suggested many strategies among which the most important were: maintain the existing diversity (27.97% of responses), encourage farmers' exchanges plants materials (25.20% of responses), increase introduction of novel varieties with good characteristics (20.50% of responses) and development of participatory plant breeding (10.09% of responses). These trends were observed through the different regions surveyed with slight modification (Table 12). According to cassava, maintain the existing diversity consist to establish local cassava farm in representative villages. This field should contain cassava varieties cultivated in and around the selected villages. Introduction of new varieties with good traits and Participatory Plant Breeding (PPB) were also suggested by farmers as important strategies for cassava management in Benin. For this cassava farmers mentioned that high yields of cassava storage roots and resistant to pest and disease were not at all time the most important traits for farmers (Kawano et al., 2003; Robooni et al., 2012). Many improved cassava cultivars have been developed for these traits but unfortunately these varieties were not fully adopted by farmers'. It's important to note that the need for involvement of

farmers in breeding program through PPB is an imperative (Okogbeni et al., 2014). The effective application of PPB approaches can result in development of cassava varieties that are widely adapted to the local agro-climatic conditions, efficient in the use of the available resources. Association of farmers into PPB will help famer to easily adopt the new varieties develop. As mentioned by Robooni et al. (2012); Kombo et al., (2012) it is worth nothing that to design a successful breeding programme under smallholder production systems, the farmers' perceptions and traits preference should be understood and taken into consideration

Table 12: Proposed strategies for conservation along the study area

Strategies	Study area (%)	Variability per regions (%)	
		Southern	Central
Maintain the existing diversity	27.97	15.47	34.50
Encourage farmers exchange plant material	25.2	27	23.40
Increasing introduction of new varieties	20.15	29	11.30
Develop and support PPB	10.09	4	16.18
Organization of national fair diversity	8.89	13.98	4.00
Develop and establishment community farm	5.26	5.10	5.30
Link extension agents with cassava farmers'	2.44	4.88	-

CONCLUSION

This study carried out on cassava management system at household level in Benin showed high cassava diversity at the household level and vary from one zone to another and according to farmer preferences and interests. This study also revealed that cassava farmers have good knowledge about folk nomenclature and suggest their involvement in plant identification program. Valuable information was gathered on household composition, which also influences cassava production system, as well as the diversity maintenance methods. Strategies were proposed by farmers for on-farm conservation and enhancement of cassava genetic diversity as support of crop improvement programs and better production.

ACKNOWLEDGEMENTS

This study was sponsored by UEMOA through PAES program. We thank anonymous reviewers for their suggestions and constructive criticisms. We are grateful to ODJO Tiburce, DOSSOU Diane and Mbazola Boris all technicians in Laboratory of Biotechnology, Genetic Resources, Plant and Animal Breeding (BIORAVE) for their help during data collection. We express our gratitude to the cassava farmers of Benin for providing useful information during knowledge documentation.

REFERENCES

[1] Adam S., Boko M. 1993. Le Bénin. Les éditions du Flamboyant/EDICEF, Cotonou, République du Bénin, 96 p.

[2] Adewuyi S.A, M.U Agbonlahor and Oke, A.T. 2013. Technical efficiency analysis of cassava farmers in ogun State, Nigeria. IJAFS 4, 2013, 14: 515- 522.

[3] Agre AP, Dansi A, Rabbi IY, Battachargee R, Dansi M, Melaku G, Augusto B, Sanni A, Akouegninou A, Akpagana K. 2015. Agromorphological Characterization of Elite Cassava (*Manihot esculenta* Crantz) Cultivars Collected in Benin. *Int. J. Curr. Res. Biosci. Plant Biol.,* **2**(2): 1-14.

[4] Ajani, E.N. and Onwubuya, E.A. 2013. Analysis of use of improved cassava production technologies among farmers in Anambra state, Nigeria. Wudpecker Journal of Agricultural Research. 2(12), pp. 035 – 341.

[5] Ajani EN, Agwu AE. 2012. Information communication technology needs of small-scale farmers in Anambra State, Nigeria. J. Agric. & Food Inform., 13(2): 144-156.

[6] Ewaonicha, O.A. (2005). Resource use efficiency in pineapple production in Ika South and Ika North-East Local Government Areas of Delta State. Unpublished B.Sc. Project. University of Benin, Benin City, Nigeria.

[7] Esiobu, N. S., C. S Nwosu and G. C Onubuogu (2014). Economics of Pineapple Marketing in Owerri Municipal Council Area, Imo State, Nigeria. Int. J. Appl. Res. Technol. 3(5): 3 – 12.

[8] Eze, C.C; Amanze, B and O.O Nwankwo (2012). Resource Use Efficiency in Arable Crop Production Among Smallholder Farmers in Owerri Agricultural Zone of Imo State, Nigeria; Agric. Food System. 2007; 1(4): 303 -309.

[9] Eze, A. V. Nwibo, S. U. (2014). Economic and technical efficiency of cassava production in North East Local Government Area of Delta State, Nigeria. Journal of Development and Agricultural Economics. 6(10) 429-436.
[10] Fregene, M., Bernal, A., Duque, M., Dixon, A., Tohme, J., 2000. AFLP analysis of Africancassava (Manihot esculenta Crantz) germplasm resistant to the cassava mosaicdisease (CMD). Theor. Appl. Genet. 100, 678–685.
[11] Fukuda W.M.G., C.L. Guevara, R. Kawuki., M.E. Ferguson. 2010. Selected morphological and agronomic descriptors for the characterization of cassava. International Institute of Tropical Agriculture (IITA), Ibadan, Nigeria. 19 pp.
[12] Hongbete F., Mestres C., Akissoé N., Pons B., Hounhouigan D. J., Cornet D., Nago C. M. 2011. Effects of cultivar and harvesting conditions (age, season) on the texture and taste of boiled cassava roots. Food Chemistry 127–133.
[13] International Society of Ethnobiology: ISE Code of Ethics with 2008 additions. 2006:12.
[14] IITA, 2012. Annual report. International Institute of Tropical Agriculture, Ibadan, Nigeria.
[15] Kawano, K. 2003. Thirty years of cassava breeding for productivity. Biological and social factors for success. *Crop Sci*. 43:1325–1335.
[16] Kumba Y.K. 2012. Genetic characterization of exotic and landraces of cassava in Ghana. A thesis submitted to the graduate studies, Kwame Nkrumah University of Science and Technology, in partial fulfilment of the requirements for the degree of master of science in agronomy (Plant Breeding).
[17] Mbanasor, J.A. and Kalu K.C. 2008. Economic efficiency of smallholder vegetable production farmers system in Akwa Ibom State, Nigeria: A translog stochastic frontier cost function approach. p. 317.
[18] Maroya, N., 1986. Variabilité naturelle chez quelques clones de manioc. Etudes préliminaires pour un programme de sélection génétique. Thèse pour l'obtention du diplôme d'ingénieur Agronome, FSA, UNB, 1 19 p.
[19] Ninson, D.(2012). Analysis Of Pineapple Production in the Akwapim South Area of Ghana, West African, Department of Agricultural Economics and Agribusiness, College of Agriculture and Consumer Sciences, University of Ghana, Legon, June, 2012.
[20] Nurudeen, A. J. 2012. Economics and Social Characteristics of Registered Poultry Egg Producers in Ilorin, Kwara State, Nigeria; Russian J. Agric. and Socio-Econ. Sci. 11(11)
[21] Nzeh E.C., Ugwu J.N. 2014. Economic analysis of production and marketing of cassava in Akoko North-West Local Government Area of Ondo State, Nigeria International Journal of Agricultural Policy and Research Vol.2 (6), pp. 234-237.
[22] Omonona, B. T. (2009). Efficiency of resource - use in cassava production in Kogi State, Nigeria: implications for food security and environmental degradation.
Retrieved on 27th April, 2009 from http://www.cababstractsplus.org/abstracts/SearchResults.
[23] Onubuogu, G.C; N.S Esiobu; C.S Nwosu and C.N Okereke. 2014. Resource use efficiency of smallholder cassava farmers in Owerri Agricultural zone, Imo State, Nigeria. Scholarly Journal of Agricultural Science Vol. 4(6), pp. 306-318.
[24] Onubuogu. G. C., Chidebelu, S, A. N. D. and Eboh, E. C. 2013. Enterprise Type, Size and Allocative Efficiency of Broiler Production in Imo State, Nigeria. Int. J. Appl. Res. Technol. 2(6): 10 – 19.
[25] Onubuogu, G.C, Onyeneke, R.U. 2012. Market Orientation of Root and Tuber Crops Production in Imo State, Nigeria**,** Agric. Sci. Res. J. 2(5);206-216, May 2012, http://www.resjournals.com/arj ISSNL: 2026-6073 cInternational Research Journals
[26] Okereke CO (2012). Socio-economic evaluation of cassava production by women farmers in Igbo-Eze North Local Government Area of Enugu State, Nigeria. Int. J. Agric. Sci, Res. and Technol., 2(3): 129-136.
[27] Osun Taiwo, Ogundijo Stephen Dayo and Bolariwa K.O. 2014. Technical Efficiency Analysis of Cassava Production in Nigeria; Implication for Increased Productivity and Competitiveness. Research Journal of Agriculture and Environmental Management. 3(11), pp. 569-576.
[28] Onzo A., Hanna R., Sabeli M.W., Yaninek J.S. 2005. Temporal and Spatial Dynamics of an Exotic Predatory Mite and Its Herbivorous Mite Prey on Cassava in Benin, West Africa. Environmental Entomology 34(4): 866-874.
[29] Parkes, E.Y., Fregene, M., Dixon, A., Boakye-Peprah, B., Labuschagne, M.T., 2013.Combining ability of cassava genotypes for cassava mosaic disease and cassavabacterial blight, yield and its related components in two ecological zones inGhana. Euphytica 194, 13–24.
[30] Rabbi IY, Hamblin MT, Lava Kumara P, Gedil M, Andrew G, Ikpan S, Jannink JL, Kulakow, PA, (2014) High-resolution mapping of resistance to cassava mosaic Gemini viruses in cassava using genotyping-by-sequencing and its implications for breeding. Virus research pp 10.
[31] Robooni T, Melis R, Shanahan P, Kawuki R. 2012. Farmers' Perceptions on Early Storage Root Bulking in Cassava (Manihot esculenta Crantz) in East and Central Uganda and their Implication for Cassava Breeding. World Journal of Agricultural Sciences 8 (4): 403-408.
[32] Robooni T., Shanahan P., Melis R., Kawuki R. (2014) Combining Ability Analysis of Storage [1] Root Yield and Related Traits in Cassava at the Seedling Evaluation Stage of Breeding, Journal of Crop Improvement, 28:4, 530-546.

[33] Salvador E.M., Steenkamp V., McCrindle C.M.E. 2014. Production, Consumption and nutritional value of cassava (*Manihot esculenta* Crantz) in Mozambique: An overview. Journal of Agricultural biotechnology. 6(3): 29 – 39.

[34] Soule B.G., Aboudou F., Gansari S., Tassou M., Yallou J. D., 2013. Analyse de la structure et la dynamique de la chaîne de valeur du manioc au Bénin. Rapport d'étude réalisé par le Laboratoire d'Analyse Régionale et d'Expertise Sociale. LARES, Cotonou, Bénin, 69 pages.