EJSIT
European Journal of Science, Innovation and Technology
ISSN: 2786-4936
www.ejsit-journal.com
Volume 3 | Number 4 | 2023

Farmers' Management of Cassava (*Manihot esculenta* Crantz) Variety Diversity in Maniema, Democratic Republic of Congo

Bopol MOKE[1], SHADARI S.A[2], Dimanche YENGA[3]
[1]Département de Phytotechnie, Faculté de Sciences Agronomiques, Université de Kindu, R.D. Congo
[2]Département de Phytotechnie, Faculté de Sciences, Université de Kisangani, R.D. Congo
[3]Département de Phytotechnie, Faculté de Sciences Agronomiques, Institut Facultaire de Sciences Agronomiques de Yangambi, R.D. Congo

ABSTRACT

Farmers on family farms have a considerable number of cassava cultivars unexploited by research. The objective of this study is to assess the level of cassava diversity and to analyze its management. A survey following a participatory approach with questionnaires was conducted among 215 farmers in 43 villages. A significant diversity of cultivars was found by the Shannon index (3.38), 35 vernacular names were inventoried. Highly significant differences were noticed for the number of cultivars which varies from 2 to 12 per village (6 on average). The variation between households is low, 1 to 4 cultivars (2 on average). The number of extinct cultivars varies from 1 to 14 (3.8 on average) per village. The loss of varietal diversity is on average 18.2% and varies between 11% and 50% depending on the villages. Farmers recognize cultivars from leaves and stems. The main criteria for cultivar selection are based on productivity, taste and the size of the tuberous roots. Exchanges of planting materials (cuttings) are made between local farmers (60.84%).

Keywords: varietal diversity, identification criteria, taxonomy, conservation

INTRODUCTION

Cassava (*Manihot esculenta* Crantz) is a tropical plant of the Euphorbiaceae family (2n=36) (N'Zué et al., 2004), cultivated mainly for its tuberous roots rich in starch. It occurs in sub-Saharan Africa, for about a third of the total production of staple foods and produces 2.2 times more calories per hectare than maize (FAO, 1986; IITA, 1990), its tuberous roots provide about 500 cal /day of food to more than 70,000,000 people in Africa (Chavez et al., 2005). This euphorbiaceae constitutes an abundant source of food energy recognized as being less expensive (Komi et al., 1994) in many tropical countries in Africa, Asia, and America (Djouble, 2005; ACF., 2009; Minengu et al., 2009). As such, it is considered a strategic food in the fight against nutritional problems that are rampant in African countries, according to the latest FAO estimates (FAOSTAT, 2014), out of 24,221,970 ha planted, world production is estimated at 270,293,801 T/year, more than 50% of which comes from Africa. Farmers own a large number of cultivars which are selected and kept for different uses and interests. Previous work on cassava (Elias, 2000; Elias et al., 2000a; Fleury, 2000; McKey et al., 2001; Pinton & Emperaire, 2001) highlighted the role of agricultural and social practices in the constitution of a high diversity. However, the methods of managing this local genetic potential have not been the subject of exhaustive prospecting and development. The in-depth knowledge of the socio-cultural, economic and agronomic factors of this peasant management contributes to the development of these local phylogenetic resources. In the case of cassava, in situ conservation depends on many criteria and parameters that are specific to each region, ethnic group, or particular economic and socio-cultural environment (Emperaire et al., 2003; Manusset, 2006; Kombo et al., 2012). The selection, recognition and naming criteria refer to both visible qualitative and quantitative characteristics (Manu-Aduening et

al., 2005; Delêtre, 2010; Kosh-Komba et al., 2014; Agre et al., 2015). Similar research has been conducted on cowpea, onion, yam, and sorghum (Baco et al., 2008; Abdou et al., 2014; Baco, 2014, Sawadogo et al., 2014). In order to improve the productivity and production of cassava and contribute to maintaining it in the Province of Maniema, a good mastery of peasant techniques and knowledge of the management of the varietal diversity of cassava is very important for the development of an improvement program and varietal creation. To date, at the level of the Province of Maniema, this local knowledge has never been documented. The objective of this study is to inventory cassava cultivars, to understand the logic of their nominations to know their extent, their distribution and to identify the selection and recognition criteria used by farmers.

MATERIALS AND METHODS

Location

This study was conducted in the Province of Maniema which covers the seven territories of Kailo, Lubutu, Punia, Pangi, Kibombo, Kasongo, Kabambare with an area of 132,520 square km with altitudes varying between 450 m to 497 m. They generally receive rainfall between 800-1400 mm per year. This region has two seasons, season A runs from September to January and small season B which runs from mid-February to June. Average temperatures vary between 25° and 27°C. As the soil is an extremely complex building, it sometimes varies quite considerably in the same area, ranging from sandy, sandy-clayey, sandy-clayey and compact clayey (Makondambuta, 1997). Territories, sectors, villages and family farms have been identified on the basis of statistical data from agricultural campaign reports (IPA, 2021) and according to security measures. In the territory of Kibombo and Kasongo, the sectors of Ankutshu and Maringa were chosen; in the territory of Kailo and Pangi, the sectors of Wasongola and Beia were chosen and in the territory of Punia the sector Baleka was chosen. The geographical coordinates of the villages were recorded using a GPS (Global Position System) and located on a map using Arc GIS 10.2 software (Figure 1).

Methodology and Data Collection

A systematic inventory of villages where cassava is grown was carried out. The villages within the different sectors of five targeted territories were chosen according to the method of Labé and Palm (1999) with particular attention to villages with large cassava production. Their number is between 7 and 10 per sector. Cassava-producing farmers in each village were randomly selected regardless of gender. Their number is between 12 and 16 per village, sector mostly with 5 ethnic groups. The statistical unit is the farm represented by the head or one of the members. In each village, a preparatory session was first held in the presence of the local authorities, where the survey objectives and protocols were presented. The first phase of the survey consisted of collecting information about the village and making an inventory of cassava cultivars. This data collection was done through participatory research methods. The second phase of the survey is a series of structured interviews in the form of a questionnaire and supplemented by unstructured interviews, conducted with 215 farmers.

Statistical Analysis

The necessary data (quantitative and qualitative) were processed and analyzed using the Sphinx software (Sphinx Plus2-Edition Lexica-V5). Analyzes of variance (ANOVA) and Newman-Keuls tests at the 5% threshold were performed on certain quantitative data using the XLSTAT-Proversion 2013.5.01 software. The area and distribution of cultivars in the research area were assessed by the method of analysis of 4 squares or "Four Square Analysis" used by Dansi et al. (2010), described and used on cassava by Kombo et al. (2012). The

cultivar loss x (CPR) at the village scale was calculated according to the method used by Kombo et al. (2012) according to the formula TPC= ((n-k)/N) x 100 with n as: number of cultivars cultivated by few households and on small areas, k being: number of newly introduced cultivars and N = the number total number of cultivars listed in the village. The results were then presented in the form of tables using Excel version 2007 software. The degree of cultivar diversity in the study environment was determined by the diversity index H according to Shannon (1948). This index was used by Agre et al. (2015) to assess the importance of cassava varietal diversity.

RESULTS

Respondent Profile

Respondents are mostly women (92%) and few men (8%). However, in the Province of Maniema, cassava cultivation is mainly practiced by women and men are involved in the preparatory work. Christianity is the most practiced religion with the majority of Reveuil Churches (60%) and a little less calotins (37%). The average age of respondents is 38, including young people (42.9%) and people over 35 (57.1%). Their level of education is average, primary and secondary (85%) and few illiterates (11%). The average number per household is 10 people with 11 years of cassava growing experience. Linguistically, 12 ethnic groups have been identified and the most spoken dialects are Kikusu, Kisongola, Kirega, Kizimba and Kikumu.

Importance of Cassava Cultivation

In the study area, among cassava-producing farmers, cassava cultivation (36.3%) is the first of the three most widely practiced crops with groundnuts (23.3%) and maize (22.5%). Cassava is cited in first position in the territory of Kasongo (20.8%), in second position in the territories of Kailo (14.4%). The average area sown is 1.75 ha per farmer. More than half of the cassava farmers surveyed (56.3%) practice cassava cultivation on areas between 1 and 3 ha. Very few (15.5%) cultivate on areas greater than 3 ha while some farmers (28.2%) only use small fields of less than one ha. Different parts of the plant are used for different purposes. The majority of respondents (92%) believe that tubers are used for self-consumption and for sale. Regarding the leaves, more than half of the respondents (52.5%) declare that they directly consume a good part of their production, even if some respondents (47.0%) claim to sell it. As for the stems, they are either reused as planting material for new crops (68.4%), directly sold (9.5%), or as firewood (20.0%). A very small proportion (10 .1%) claim to use them in cattle feed. Almost 2.1% say they abandon them in the fields where they are burned. The leaves and tuberous roots, on the technological level, are also transformed according to ethnic groups and in several forms. The so-called transformation of leaves, the main activity of women, is practiced by the majority of households (80.8%). They are grilled or soaked in hot water, pounded and cooked with other ingredients. In the case of tuberous roots, even more households process them (94.3%). The products most often prepared are cossettes (63.4%), tchikwanges (44.7%) which is a kind of cassava paste rolled up in steamed straw or banana leaves, fresh tuberous roots cooked (43.9%) and dough (42.6%). The ethnic groups most involved in cooking sweet tuberous roots are the Wasongola (60.85%), The Bakumu produce a lot of the tchikwanges (60.85%) and bazimbas (57.8%) make the dough. The transformation into cossette, for the conservation and the subsequent production of the flour, is an activity present especially in the territory of Pangi (24.44%) and Punia (21.21%).

Varietal Diversity in the Study Environment

Local taxonomy and peasant way of assigning names

Of the 5 territories surveyed, 27 vernacular names were inventoried. It shows that 7 bear their original names, 14 correspond to the names of villages, 4 others are first names and 2 refer to the structure (NGO) that introduced them. The designations are very varied with synonymies in other ethnic groups. The socio-cultural facts, the importance of cassava cultivation, the origins, the cycle, the taste and the different parts of the plant which are used by cassava producers to name the cultivars. The most cited cultivars are Kabombo (38.7%), Mwezi sita (17.5%), Kelenga (15.4%), Kavide or sombe mweusi (14.6%) and Kankwale (13.5%).

Diversity of cultivars at the territory, village and household levels

The number of cultivars inventoried ranges from 2 to 10 per village with an average of 6 over the entire study area (Table 1). The significant differences observed at the 5% threshold for the number of cultivars per village made it possible to classify them into two distinct groups. It is in the territory of Punia and Kasongo, with an average of 8 cultivars per village, that the highest diversity was recorded with 11 and 12 cultivars. The lowest diversity, 2 and 3 cultivars was observed in the Kibombo, Kailo and Pangi territories, with respectively on average: 3.89; 4.90; 5.57 cultivars per village. The territories with high varietal diversity are populated by Wazimba. At the household level, the number of cassava cultivars varies from 1 to 4 with an average of 2 cultivars per household. The majority of surveyed households (65.8%) use 2 to 3 cultivars. About a quarter (24.6%) use only one cultivar per household. The farmers who have the largest number, i.e. 4 cultivars per household, are of a reduced number (9.4%) and all come from the villages of the Maringa sector populated mainly by Wazimba. Moreover, the Shannon diversity index obtained is 3.38 for the entire study area.

Evaluation of the rate of loss of cultivars

At the village level and without taking synonyms into account, 18 cultivars have disappeared. This number varies from 1 to 14 with an average of 3.81 cultivars per village. Indeed, 11 villages have between 6 and 8 cultivars, and 12 others between 3 and 5 extinct cultivars. In 7 villages surveyed, only 1 and 2 cultivars are reported as missing. Even if no disappearance was noticed in 10 villages, this aspect is very pronounced in the riverside villages with respectively 50% disappearances, and 44.44%, 41.67% loss of cultivars for the Penesula and Kipakata villages (Table 2). However, the average cultivar used by many households over large areas is only one cultivar. Unlike the small areas sown by few farmers, this average is 2 cultivars. The average rate of cultivar loss for the entire study area is 18.2% and varies between 11% in Kipaka and Kisamba villages and 50% in Katako, Lokando and Kasongo-Rive villages. This rate is zero in 30.2% of the villages in the study area. At the territorial level, the number of extinct cultivars varies from 4 to 18 with an average of 11.2 cultivars. The territory of Kilo and Kasongo with respectively 18 and 14 cultivars are the most affected. Only 4 cultivars identified in the village of Nkenye disappeared from the territory of Pangi, for 8 in Punia and 9 in Kibombo.

Distribution and extent of cultivars

This distribution concerns only cultivars present in at least 3 villages (Table 3). The Mwezi sita and Kabombo cultivars have wide distribution as they are present respectively in 27 and 22 villages. The Molobwa, Mopipi and Mopela cultivars are grown only on small areas and by few households. In total, 55% of selected cultivars are planted by many households over large areas. The Siri ya baby, Miti asumani and Boss cultivars are only present in three villages and are used by few households and over large areas.

Peasant criteria for identification and preference of cultivars

These criteria are either alone or in a mixture of several others. The results show that farmers (70.1%) recognize cultivars from their leaves. Others (40.8%) do it from the stems. Petioles (2.7%) and tuberous roots (3.3%) are very little used as criteria. In addition, other so-called complementary criteria such as color, shape, size, number of lobes and number of ramifications allow cassava producers to complete their identification system. As for the selection of cultivars, this is based on 9 agronomic, technological and economic criteria. The three priority criteria for the choice of cultivars are respectively productivity, taste, and root size (Table 4). Earliness, ease of processing, income generated and resistance to disease and pests are important. Only 5% of the producers surveyed retained drought tolerance; at the territorial level, for Pangi producers (13.4%), only productivity is the most determining criterion. Farmers in the territory of Kasongo (21.9%) and Kailo (16.0%) are rather interested in cultivars resistant to diseases, pests and their productivity. Very different levels can be seen in the distribution of criteria according to ethnicity (Table 5). Among the Bakusu, Bakumu and Basongola, 7 preference criteria were found against 9 among the Bazimbas and the Baregas.

Modes of Acquisition of Cuttings

The main modes of acquisition of cuttings in the study environment are exchanges of genetic material between farmers in the same locality (60.8%) and introductions made by someone from the village (37.4%). Only a few farmers surveyed (26.1%) affirm that this introduction takes place through research and extension institutions. The results by territory (Table 6) show that local exchanges are high in the territories of Kasongo (36.4%) and Kailo (29.5%). Similarly, the peasants of Kasongo (38.7%) and those of Kailo (32.4%) report that varietal diversities are introduced by someone from the village were reported in the territory of Kasongo (31.3%) and in Kibombo (31.9%). In Kasongo, most farmers (59.8%) report that planting materials are introduced by non-governmental organizations, while in Pangi territory a higher number (82.1%) believe that this is done. through the projects.

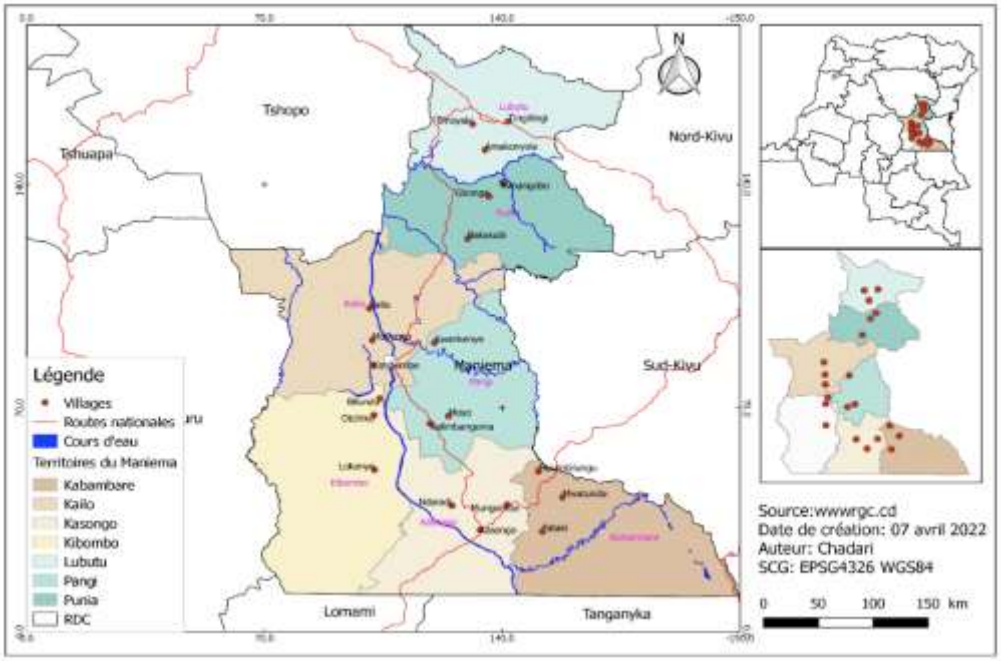

Figure 1: Geographical coordinates of the villages

Table 1: Variation in cassava diversity at the scale of territories and villages

Territory	Majority ethnicities	Village name	Minimum value of cultivars	Maximum value of cultivars	Average number of cultivars
Kibombo	Wakusu	9	2	6	3,89±0,71a
Kailo	Wasongola	10	2	9	4,90±0,68a
Pangi	Warega	7	3	8	5,57±0,81a
Kasongo	Wazimba	10	4	11	7,90±0,68b
Punia	Wakumu	7	5	12	8,57±0,81b
Study zone		43	2	12	6,16±0,74

Note: Means with the same letters are not significantly different at the 5% Newman-Keuls test

Table 2: Loss rate of cassava cultivars

Villages	M.S	T.P.(%)
Rudika, Kikuni, Sambika, Malela, Elila, Kiyungi	0	0
Mingana, Sabyazo, Kankummba,Makelele,Ongato, Mpiala	1	0
Basenge	3	0
Kipaka, Kisamba	5	11,0
Nkenye	2	12,5
Mwanga	2	14,29
Samba, Bilundu, Lubelenge	2	16,67
Kimanga	3	16,67
Mumbuza	2	18,18
Nyoka, Muyengo, Libuyu	2	20,0
Binumbi, Kasese, Tunda	3	20,0
Kafété	2	22,22
Obokote, Obolia, Molela	1	25,0
Lweki	2	25,0
Lifuma II	5	28,57
Lombela	3	33,33
Kovokovo	4	33,33
Sengamali	5	36,36
Lowe	4	37,50
Kipakata	6	41,67
Penesula	7	44,44
Lokando, Kasongo Rive	1	50,00
Katako	4	50,00
Average for the study area	**2**	**18,20**

Note: T.P.: Cultivar loss rate; M-S-: Cultivars used by few households on small areas

Table 3: Distribution and extent observed in at least three villages

Local cultivar names	NTV	M+S+	M+S-	M-S+	M-S-
Mwezi sita	27	11	2	3	3
Kendewe	09	01	0	1	4
Momama	05	01	0	2	2
Kabombo	22	10	1	2	4
Mopipi	07	00	0	0	7
Kavide, Mavi ya Tembo, Sombe Mweusi, Matembela	10	01	0	2	4
Kankwale	11	02	0	4	4
Sanci	03	01	0	2	0
Kelenga Doux	09	07	0	0	2
Kelenga Amer	10	06	0	1	3
Kepokele	05	01	0	1	3

Mopela	05	02	1	1	6
Kasusanya	03	00	0	1	2
Molobwa	05	00	0	0	5
Liyayi	03	00	0	0	1
Sawasawa	03	00	0	0	2
Glazovii	04	00	0	0	3
Sardine	03	00	0	0	3
Inambiyombiyo	06	01	3	2	0
Siri ya bebe	04	00	0	2	2
Mosengene	05	04	0	0	1
Siri ya bébé, Miti asumani, Boss	03	00	0	3	0

Note: NTV: total number of villages corresponding to a cultivar; M+S+: cultivars used by many households over large areas; M+M-: cultivars used by many households on small areas; M-M+: cultivars used by few households over large areas; M-S-: cultivars used by few households on small areas

Table 4: Main criteria for varietal selection of cassava in the Province of Maniema

Types of criteria	Producer responses (%)
Productivity	89,80
Taste (sweet)	78,80
Large tuberous roots	72,80
Earliness	63,40
Ease of processing	53,80
Strong market value	51,60
Disease resistance	51,30
Ease of cooking	35,40
Drought tolerance	4,90

Table 5: Cultivar selection criterion according to the majority ethnic groups of responses corresponding to each given criterion

Study selection criteria	Percentage of responses by group	Responses in the majority ethnic area				
		Bakusu	Bakumu	Basongola	Bazimbas	Barega
Productivity	89,80	9,40	13,10	5,80	28,00	4,90
Taste (sweet)	78,80	7,70	10,70	5,80	27,40	4,70
Large tubers	72,80	7,90	9,80	3,60	27,40	4,40
Earliness	63,40	9,40	9,60	6,10	26,30	3,30
Ease of processing	5,80	3,60	5,20	3,50	26,70	2,50
Disease resistance	51,30	0,30	5,40	1,40	26,10	3,90
Strong market value	51,60	6,50	6,50	1,30	15,40	0,50
Ease of cooking	35,40	2,00	7,10	2,50	14,60	0,20
Drought tolerance	4,90	-	-	-	4,40	0,20

Table 6: Modes of acquisition of cuttings

Territory	Local	Someone from the village	Research/extension (%)	ONG	Project
Kasongo	36,43	38,66	31,33	59,78	3,57
Kailo	29,46	32,35	10,24	11,96	7,14
Kibombo	4,65	17,23	31,93	28,26	-
Pangi	16,80	5,88	5,42	-	82,14
Punia	12,66	5,88	21,08	-	7,14
Total	**100**	**100**	**100**	**100**	**100**

DISCUSSION

In Maniema Province, cassava is occasionally grown in association with other crops. This technique has had significant impacts on the income of peasant farmers, as was also reported by Obasi et al. (2015), in a study conducted in Nigeria where the association of cassava with yam, maize and melon was very beneficial in terms of financial benefits. The importance of cassava in this study was also demonstrated by various uses of different parts of cassava. The tuberous roots and leaves are intended for consumption and sale. Stems are increasingly used as cuttings, firewood. The leaves are eaten after cooking. Compared to tuberous roots, the study revealed several by-products including Tchikwanges, calves (parts of grilled tuberous roots), tshapati. The most popular local name for cassava in the Province of Maniema is “Ugali or Ugari” which also means Foufou in Lingala or cassava-based leg in French. The attribution of vernacular names to cultivars as well as their meanings are common practices rooted in the traditional environment. Several studies have reported these practices. Missihoum et al. (2012) asserted that the local name is the basic unit that peasant producers use in the management and selection of plant genetic resources. The need for cultural factors in the management and maintenance of genetic diversity has also been pointed out by Manusset (2006). In the case of this study, concerning the naming of cultivars, the peasant producers use names of people and villages of origin, proverbs, and expressions relating to the advantages that cassava cultivation generates. Amerindian populations, on the other hand, attach more importance to architectural features and the cultivar is named by referring to the epigeal part of the plant (Emperaire et al., 2003). In Maniema, when a cultivar does not have a specific name, it is simply called sweet or bitter cassava in the various dialects. The most common soft nominatives: soft Kelenga, Ngolo, Kankwale; for bitter cultivars: Kabombo, Mwezi sita, Kavide, Sombe mweusi. Northwest (Emperaire et al., 2003). On the other hand, among the Wayapi of French Guiana, a given cultivar of cassava can be attributed several names which are often types of motivated combinations (Grenand, 2002). This peasant way of naming cultivars are identical to those observed in this study area, the analysis of which reveals that the Bazimbas and the Basongola assign more names to cultivars with respectively 21 and 13 denominations? These naming methods have also been reported on sweet grain sorghum varieties from Burkina by Sawadogo et al. (2014) and also on cassava in Vanuatu by Sardos et al. (2008). In the cassava production areas in Maniema, the language of the majority ethnic group originating from the territory is used to name the local cultivars or to rename the introduced ones. Unlike Baco (2014) who estimates that yam transfers in Benin are rarely linked to name transfers. The majority of cultivars listed are local and their number is low compared to other areas. 76 cultivars have been counted among the Makushi Amerindians (Elias, 2000). This varietal diversity is even higher with 296 cultivars identified throughout French Guiana (Manusset, 2006). Despite this gap, the local genetic potential highlighted in this research is considerable. Shannon's index is also greater than that obtained by Agre et al. (2015), in the case of the study of cassava cultivars in central Benin. The inventory also noted that it is the sweet cultivar which is the most cultivated. However,

there is no particular distribution of cultivar types according to the territories. Cassava farmers in the province of Maniema cultivate both sweet and bitter cultivars. However, both at the village and household level, this diversity is lower compared to the results obtained in Bouenza in the Democratic Republic of Congo (Kombo et al., 2012). However, the number of cultivars in use per household is similar to that obtained in Ghana (Manu-Aduening et al., 2005). On the other hand, it is higher than that observed in the south and center of Benin (Agre et al., 2016). Compared with Amerindian villages with high diversity (Emperaire et al., 2003), it is rather very low. The high number of varieties observed in the fields of Amerindians is explained by the fact that the latter combine the system of propagation by vegetative and sexual means (Sardos et al., 2008; McKey et al., 2012). These techniques have an advantage on the dynamics of maintaining plant genetic diversity (Elias et al., 2001; Sardos et al., 2008; McKey et al., 2012). In Maniema, cassava cultivation is practiced exclusively in the form of cuttings, just as in central Benin, the sexual propagation of cassava is little known to farmers (Agre et al, 2015). In order to preserve their cultivars, farmers jealously guard them by replanting them, which partly explains the reduced number of cultivars observed at the household level. The research has also shown that variations in the number of cultivars have been observed between villages in the same territory and even villages in different territories. Those who hold one or more cultivar types in a village are well known. These results are similar to those of Willemen et al. (2007), who claim that farmers have control over the exact and precise number of existing cultivars in their villages. Taking into account the number of cultivars at the village level to assess varietal diversity has also been reported for other crops (Missihoum et al., 2012; Gbaguidi et al., 2013). The diversity observed at the village level and in relation to ethnic groups shows that cassava cultivation is taken in different ways according to the communities. In the terroirs of Bazimbas and Basongola, there is a higher number of cultivars than in the other villages of the study area. Similarly, these two ethnic groups have distinguished themselves by giving more names to the cultivars. Unlike Barega and Bakusu, which are more in a traditional rice-growing area.

The average rate of loss, following both agronomic and technological constraints, is relatively high or even very high in some villages compared to some previous studies (Kombo et al., 2012; Agre et al., 2015), this rate is average. Despite these impediments, cultivars continue to be kept for well-determined needs. The distribution and range of cultivars vary from village to village and from one territory to another. This unequal distribution and geographical location is due to the low distribution of cuttings between distant localities, the adaptability of certain cultivars to a territory, the choices of farmers and the proximity of introduction areas. Referring to the risk of their total disappearance which is confirmed by the fact that less than a quarter are cultivated on large areas and by the majority of households, it would be imperative that they be integrated into the selection program both provincial and national. Indeed, Elias et al. (2000b) showed that local cassava cultivars remain a significant source of genetic diversity. In the study environment, growers use one or more traits to recognize cultivars. Stems and leaves are often used and they are the first level of identification due to the ease of observation in the field as found by Agre et al. (2016). The agronomic characters linked to the tuberous roots are used in the second place to complete the information obtained at the level of the aerial organs. This is not the case observed by N'Da et al. (2013), in the Center-North of the Ivory Coast where agricultural producers identify maize cultivars exclusively using a single character which is the color of the grains. To select the cultivars, the farmers use three priority criteria, the size of the tuberous roots, the taste, and the productivity. It reproduces a similarity to those reported by Kombo et al. (2012). However, their importance is very variable because the constraints of cassava cultivation arise distinctly according to the localities.

Speaking of the methods of obtaining propagation materials (cuttings), the same cuttings pass from one farm to another. This same mode was also reported by Abdou et al. (2014) who assert that the management of onion genetic resource diversity is affected by the modes of seed exchange, transmission and selection. Various trading modalities have also been reported in the case of cowpea and yam (Baco, 2014). For this study, cuttings are often exchanged, given away for free and sometimes sold. At the territorial level, inter-farmer exchanges are more important in the territories of Kasongo and Kailo. The low level of introduction of cuttings from specialized institutions is the reason for the low number of improved cultivars identified.

CONCLUSION

The study revealed that cassava cultivation, due to the importance of its production, contributes significantly to food security. These different organs have multiple uses, see the derivative products resulting from technological and culinary transformations show the interest of this culture for the population of the Province of Maniema. The named cultivars are significant in the study setting. Farmers' methods of maintaining this diversity are based on in situ conservation. The cultivars are characterized by vernacular names which provide information on the origin, the cycle, the yields, the technological and organoleptic characteristics, the color, the shape and the appearance of the different parts of the plant. They are selected according to the special needs of peasants and ethnic groups. Criteria are used for their identification and the farmers make the inter-exchanges of the cuttings. These practices are of capital importance for this diversity. The high rate of loss of cultivars and the lack of knowledge of the sexual reproduction of cassava constitute permanent risks despite the fact that some farmers become aware of the level of diversity in their village and the surrounding area. This is why the supervision of cassava producers in the practice of sexual propagation techniques and molecular analyzes of the cultivars listed in this study should be taken into account in the national and provincial research program.

CONFLICTS OF INTEREST

The authors declare that there are no conflicts of interest between them at this level.

AUTHORS' CONTRIBUTIONS

The Principal Author conducted the field study, collecting data from the peasant population, interpreting the results obtained and preparing the manuscripts. The IPA contributed to the identification of cassava production areas, identification of cassava producers in the survey territories. Msc Ir SHADARI contributed to the statistical analyzes and the development of the location map. Dr Ir YENGA Dimanche continuously supervised all planned activities, reviewed results, analyzed and provided guidance, prepared and corrected manuscripts.

ACKNOWLEDGMENTS

Our sincere and deep thanks to both provincial and territorial authorities for technical support.

REFERENCES

Abdou, R., Malice, M., Bakasso, Y., Saadou, M., & Bauduin, J.P. (2014). Taxonomie locale et analyse des critères des paysans pour caractériser les différents écotypes d'oignons (Allium sepa L) du Niger. *Cah. Agric., 23*(3), 166-176. DOI: 10.1684/agr.2014.0700

A.C.F. (Action Contre la Fain). (2009). Rapport sur l'agriculture périurbaine de Kinshasa, Province de Kinshasa République Démocratique du Congo.

Agre, A.P, Kouchade, S, Odjo, T, Dansi, M, Nzogbadila, B, Assogba, P, Dansi, A, Akoegninou, A, & Sanni, A. (2015). Diversité et évaluation participative des cultivars du manioc (Manihot esculenta Crantz) au centre de Benin. *Int. J. Biol Chem. Sci., 9*(1), 388-408. DOI: http://dx.doi.org/10.4314/ijbccs.v9i1.33

Agre, A.P, Badara, G, Adjatin, A, Dansi, A, Bathacharjee, R, Rabbi, I.Y, Dansi, M, & Gedil, M. (2016). Folk taxonomy and traditional management of cassava (Manihot esculenta Crantz) diversity in southern and central Benin. *International journal of Innovation and Scientific Research, 20*(2), 500-515.

Baco, M.N, Ahancchedé, A, Bello, S, Dansi, A, Vodouhé, R, Biaou, G, & Lescure, J.P. (2008). Evaluation des pratiques de gestion de la diversité du niébé (Vigna unguiculata): uune tentative méthodologique expérimentée au Benin. *Cach Agric., 17*(2), 183-188. DOI: 10.1684/agro.2008.0169

Baco, M.N. (2014). Les pratiques de gestion de la diversité variétale de l'igname au Bénin. *Agridape, 30*(1), 3.

Chavez, A.L., Sanchez, T., Jaramillo, G., Bedoya, J.M., Echeververry, J., Bolarnos, A., Ceballos, H., & Iglesias, C.A. (2005). Variation of quality traits is in cassava roots evaluated in landraces and improved clones. *Euphytica, 143*, 125-133.

Dansi, A, Andoukonou-Sagbadja, H, & Voduhe, R. (2010). Divversity, conservation and related wild species of Fonio millet (Digitaria spp.) in the in the northwest of Benin. *Genet. Resour. Crop. Evol., 57*, 827-839.

Delêtre, M. (2010). The ins and outs of manioc diversity in Gabon, Central Africa. A pluridisciplinary approach to the dynamics of genetic diversity of Manihot esculenta Crantz (Euphorbiaceae). PhD thesis, University of Dublin, Trinity College, p.364.

Djouble, D.R. (2005). Mise au point d'un ferment mixte destiné à la bio conservation des racines de manioc cyanogène. Thèse de doctorat, Ngaoundere. Consulté le 27/12/2018. hhp://tel.archivesouvertes.fr/docs/00/04/82/82/PDF/tel-00009811.pdf.

Elias, M. (2000). Le manioc chez les Makushi: Une richesse à valoriser. In P. Grenand (Ed.), *Les Peuples des Forets Tropicales Aujourd'hui* (Vol. 4). Région Caraïbes Guyanes Bélize Programme APFT: Bruxelles; 201-221.

Elias, M, Panaud, O, & Robert, T. (2000a). Assessment of genetic variability in a traditional cassava (Manihot esculenta Crantz) farming system, using AFLP markers. *Heredity, 85*, 219-230.

Elias, M, Rival, L, McKey, D, Panaud, O, & Robert, T. (2000b). Perception and management of cassava (Manihot esculenta Crantz) diversity among Makushi Amerindians of Guyana (South America). *Journal of Ethobiology, 20*(2), 239-265.

Emperaire, L, Santos Muhlen, G, Fleury, M, Robert, T, McKey, D, Pujol, B, & Elias, M. (2003). Approche comparative de la diversité génétique et de la diversité morphologique des maniocs en Amazonie (Brésil et Guyane). Les Actes du BRG, 4, 247-267.

FAO. (1986). La cinquième enquête mondiale sur l'alimentation, Rome: FAOMLW/87/009. On strengthening. Cassava research and development in Malawi: FAO. Retrieved from Consulté le 14/04/2019. http://faostat.fao.org

FAOSTAT. (2014). Base e données statistiques agricoles Romme, Italie. http://faostat3.fao.org; consulté le 24/12/2022.

Fleury, M. (2000). L'agricccculture Wayana : une transition viable. In P. Grenand P (Ed.), *Les Peuples des Forets Tropicales Aujourd'hui.* Région Caraïbes Guyanes Bélize Programme APFT: Bruxelles ; 151-161.

Gbaguidi, A.A, Dansi, A, Loko, L.Y, Dansi, M, & Sanni, A. (2013). Diversity and agronomic performances of the cowpea (Vigna unguiculata Walp.) landraces in Southern Benin. *International Research Journal of Agricultural Science and Soil Science, 3*(4), 121-133.

Grenand, F. (2002). Stratégies de nomination des plantes cultivées dans une société tupi-guarani, les Wayapi. Revue Amerindia, 26/27, 209-247.

IPA. (2021). Inspection Provinciale de l'Agriculture du Maniema.

IITA. (1990). Le manioc en Afrique Tropicale, un manuel de reference. IITA, Iband, Nigeria, 190 p.

Kinkela C., Tingu M., Ntoto R., Mpanzu P. & Belani J. (2009). Rapport final de l'étude de filière maniocdans les provinces de Kinshasa et du Bas-Congo. Proseca, Kinshasa, 144 p.

Kombo, G.R, Dansi, A, Loko, L.Y, Orkwor, G.C, Vodouhe, R, Assogba, P, & Magema, J.M. (2012). Diversity of Cassava. (Manihot esculenta Crantz) cultivars and its management in the department of Bouenza in the Republic of Congo. *Genet. Ressour. Crop. Evol., 59*(8), 1789-1803. DOI: 10. 1007/s10722-012-9803-0.

Komi, E, Guyot, M, Tetevi, K, Raffaillac, J.P., & Bahum, E.A. (1994). Tude de la variabilité des composantes du rendement du manioc en fonction de la fertilité du sol, 122.

Kosh-Komba, E, Akpavi, S, Woegan, Y.A, Atato, A, Duval, M.F, Dourma, M, Zinga, I, Yandia, P, Longue, D, & Semballa, S. (2014). Diversité agrmorphologiques de Manihot esculenta Crantz (Euphorbiaceae) cultivée dans trois zones agroclimatiques en République Centrafricaine (RCA). *European Scientific Journal, 10*(3), 365-380.

Labé, V. & Palm, R. (1999). Méthodes et techniques. Statistique empirique, formelle : quelle enquête sur la collection d'informations sur les exploitations agricoles ? *Cahiers Agricultures, 8*(5), 397-404.

Manu-Aduening, J.A, Lamboll, R.I, Dankyi, A.A, & Gibson, R.W. (2005). Cassava farming systems. *Euphytica, 144,* 331-340. DOI: 10.1007/s10681-005-8004-8.

Manusset, S. (2006). Proposition pour une clé d'identification des variétés de manioc chez différents groupes culturels en Guyane française. *Antropo, 11,* 61-73.

McKey, D, Emperaire, L, Elias, M, Pinton, F, Robert, T, Desmoulière, S, & Rival, L. (2001). Gestions locales et dynamiques régionales de la diversité vari étale du manioc en Amazonie. *Genet. Sel. Evol., 33*, 465-490.

McKey, D, Elias, M, Pujol, B, Duputié, A, Delêtre, M, & Renard, D. (2012). Maintien du potentiel adaptatif chez les plantes domestiquées à propagation clonale. *Revue d'Ethnoécologie, 1*. URL: http://ethnoecologie.revues.org/741; DOI: 10.4000/ethnoecologie.741.

Minengu, J. D. D., Ikonso, M., & Mawikiya, M. (2018). Agriculture familiale dans les zones péri-urbaines de Kinshasa: analyse, enjeux et perspectives (synthèse bibliographique). *Revue africaine d'environnement et d'agriculture*, *1*(1), 60-69.

Missihoun, A.A, Agbangla, C, Adoukounou-Segbadja, H, Ahanhanzo, C, & Vodouhe, R. (2012). Gestion traditionnelle et statut des ressources génétiques du sorgho (Sorghum bicolor L.Moench) au Nord-Ouest du Benin. *Int. J. Biol. Chem. Sci., 6*(3), 1003-1018. DOI: http://dx.doi.org/10.4314/ijbcs.v6i3.8

Makondambuta, E. (1997). Les types de climat. Congonline. Afriqu'Info asbl, Bruxelles, Belgique/ Consulté le 31/6/2020. Consulté le 25/05/2021. https://www.sifee.org/home 2015: climat et secrétariat international francophone pour l'évaluation de l'environnement/ Kindu Maniema 12p.

N'Zué, B, Zohouri, P G., & Sangaré, A. (2004). Performances agronomiques de quelques variétés de manioc (Manihot esculenta Crantz) dans trois zones agroclimatiques de la Cote d'Ivoire. *Agronomie Africaine, XVI,* 1-7. Consulté le 17/08/ 2021. http://dx.doi.org/10.4314.aga.v16i2: 1646.

Obasi, P.C, Henri-Ukoha, A, Anosike, O.N, & Ibekwe, U.C. (2015). Net returns to Cassava-based crop mixtures in Imo State, Nigeria. *European Journal of Agriculture and Forestry Research, 3*(1), 15-21.

Pinton, F. & Emperaire, L. (2001). Le manioc en Amazonie brésilienne : diversité variétale et marché. *Genet. Sel. Evol., 33*(1), 491-512.

Sardos, J. McKey, D, Duval, M.F, Malapa, R, Noyer, J.L, & Levor, V. (2008). Evolution of Cassava (Manihot esculenta Crantz) after recent introduction into a South Pacific Island system: the contribution of sex to the diversification of a clonally propagated crop. *Genome, 51,* 912-921. DOI: 10.1139/G08-080

Sawadogo, N, Nebie, B, Kiebre, M, Kando, P.B, Nanema, R.K, Traore, R.E, Naoura, G, Sawadogo, M, & Zongo, J.D. (2014). Caractérisation agromorphologique des sorghos à grains sucrés (Sorghum bicolor L.) du Burkina Faso. *Int. J. Biol. Chem. Sci., 8*(5), 2183-2197. DOI: http://dx.doi.org/10.4314/ijbcs.v8i5.22

Shannon, C.E. (1948). A Mathematical theory of communication. *Bell system Technical Journal, 27,* 379-423. DOI: 10.1002/j.1538-7305. 1948. Tb01338.x

Willemen, L, Scheldeman, X, Cabellos, V.S, Salazar, S.R, & Guarino, L. (2007). Spatial patterns of diversity and genetic erosion of traditional Cassava (Manihot esculenta Crantz.) in the Peruvian Amazon: An evaluation of socio-economic and environmental indicators. *Genet. Resour. Crop. Evol., 54*(7), 1599-1612. DOI: 10.1007/s10722-006-9172-7

Wydra, K. & Verdrier, V. (2002). Occurrence of Cassava diseases in relation to environmental, agronomic and plant characteristics. *Agriculture, Ecosyystems & Environment, 93,* 211-226. http://doi.org/10.1016/S0167-8809(01)00349-8.