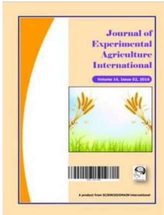

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Comparative Performance of Traditional Farming Practices and Improved Practice on the Development of Cassava in the Field in Pissa (Central African Republic)

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Authors' contributions

This work was carried out in collaboration between all authors. All authors read and approved the final manuscript.

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ABSTRACT

Cassava is generally grown by small farmers, with low technological input in terms of nutrient intake. The aim of this work was to study the impact of traditional farming practice and improved practices in the development of Cassava in the field. The study was carried on the three accessions locally called 6 mois, Gabon and Togo. Data collection for the agronomical and morphological characterization of the accessions was made over a period of twelve months from 34 descriptors of Cassava. The analysis of variance revealed that the difference between the means of the

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circumferences was highly significant as well according to the accessions (p = 7.28e-06) and to the Cassava practice system (p = 2e-16). The seedlings resulting from the improved practice have the largest diameter (2.88 ± 2.48). Whereas the TFP (traditional farming practice) or PP plants have the mean diameter between (2.03 ± 1.84). The heights of the plants considered according to cultural techniques show a significant difference (p = 0.0075). Depending on the accessions, the difference is highly significant (P = 0.00074). Improved practice has resulted in taller plants in height compared to traditional farming practice. There is a highly significant difference (p = 0.000743) in relation to the number of leaves according to different accessions and not significant (p = 0.103) according to cultural practices. The "6 mois" accession has a large number of leaves according to the practices. Each axis (composite variable) is a combination of morphological descriptors weighted by their level of explanation of the overall variability of the system. The main contributions (PC> 13%) to the first axes of correspondence come from the accession Togo. This explains why there is a great agro-morphological variation much more marked by the "Togo" accession. There was a highly significant difference (P = 3.55e-09) between the number of tubers per plant and the number of tubers marketable per plant (p = 5.8e-11) according to cultural practices. The "Togo" accession; "6 mois" and "Gabon" have respective yields 8.9 kg / plant, 7.4 kg / plant and 4.5 kg / plant according to improved practice or GIPD while they have respectively 3.8 kg / plant, 4.1 kg / plant and 3.3 kg / plant according to traditional farming practice. Root length and width are also economically important, since plants with roots too long and too thick may indicate plants with more than one vegetation cycle.

Keywords: Cassava; performance; diversity of cultivating; Central African Republic.

1. INTRODUCTION

Grown in more than 90 countries, Cassava ranks as the 6th most important source of energy in human diets on a worldwide basis and as the 4th supplier of energy after rice, sugar, and corn/maize [1]. Cassava is a nutritionally strategic famine crop and could support food security in areas of low rainfall. The crop"s starchy root is widely used worldwide, though the fresh foliage is also consumed in several regions of the world. The use of cassava as a food source is increasing, because it yields well even in poor soil without fertilizer, and is drought resistant [2]. The root can be left in the ground for up to 3 years as a reserve source of food. In a drought, the leaves drop off, and the plant is kept alive by its large roots, and when the rains come the leaves sprout again [3]. Cassava is utilization as food varies from region to region an Central African Republic (CAR) is no an exception. In CAR, Cassava is a source of food security, not only because it can be grown on less productive land, but because it is a source of income for urban and rural populations [4].

Cassava is generally grown by small farmers, with low technological input in terms of nutrient intake. The constant use of cassava by these traditional communities may be influenced both by propagation and multiplication of the plant; propagation material (stem cuttings) is available for new planting after each crop, and the cassava plant is hardy and adapts to environmental variations ([5], [6], [7]. Focusing on important of Cassava in rural area of CAR, the objective of this work was to study the impact of traditional farming practice and improved practices in the development of Cassava in the field.

2. MATERIALS AND METHODS

2.1 Site Description

The experimental for the agro-morphological characterization was located in the village Pissa (Fig. 1). Pissa was chosen to represent a range of environments and management practices in cassava-based cropping systems in the mid-altitude zone of CAR. Main soils in the region include ferric and orthic Acrisols and orthic and haplic Ferralsols; soils that are derived from strongly weathered granite or sedimentary parent material [8]. The climate in all sites is sub-humid with a bimodal rainfall distribution. This allows for the production of most annual crops during both the long (March-August) and the short rains (September-October). Altitude ranges between 1200 and 1500 masl. Cassava is planted in the first 2 months of the short or long rains and remains in the field for about a year. Agricultural systems are diverse with farmers growing 4-6 main crops on average [9].

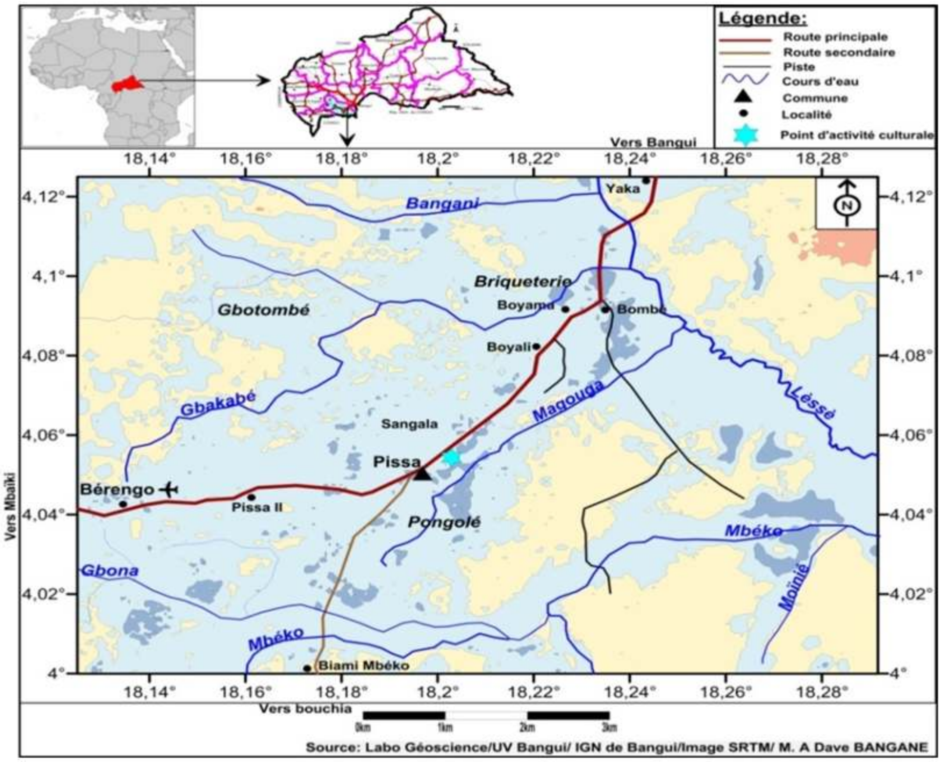

Fig. 1. Location of the Pissa in Central African Republic

2.2 Experience Description

2.2.1 Traditional farming practices for cassava cultivation

Traditional farming practice was characterized by planting each accession (locally called 6 mois, Gabon and Togo) in disorder. There is no respect of the distance between Cassava plants, more density of planting, no good aeration of the plant in the field. Manual weeding was done as required. No fertilizer was applied. Harvesting was done 12 months after planting.

2.2.2 Improved practices for cassava cultivation

Cassava cuttings of 20-30 cm in length were planted at a distance of 1 m by 1m. Each of the accessions (locally called 6 mois, Gabon and Togo) had a total of 20 stands in two lines. In each mound, we planted three cuttings of the same variety. Manual weeding was done as required. No fertilizer was applied. Harvesting was done 12 months after planting.

2.3 Data Collection

Data collection for the agronomical and morphological characterization of the accessions was made over a period of twelve months from 34 descriptors of cassava ([10], [11]). The data were collected in four steps the third month after planting. Agronomical and morphological profile of descriptors was reported in Table 1.

As recommended by the authors, characterization of leaf and petiole was performed 6 to 9 months after planting, and stem and root were performed at harvesting time, established as 12 months after planting.

2.4 Data Analysis

R software was used for data analysis. The Multiple analysis of correspondence of morphological descriptors was conducted using the software using R. This analysis project accessions on a plane whose axes are defined as new independent variables composites. Each axis (composite variable) is a combination of morphological descriptors weighted by their level of explanation of the overall variability of the system.

Table 1. Agro-morphological descriptors

At 3 months			At 6 months			At 9 months			At 12 months		
N^0	**Descriptor**	**Codifi-cation**	**N^0**	**Descriptor**	**Codifi-cation**	**N^0**	**Descriptor**	**Codifi-cation**	**N^0**	**Descriptor**	**Codifi-cation**
1	Color of Apical leaves	CFA	6	Retention of leaves	RF	19	Leaf scar	CF	28	fruit	F
2	Presence or Absence of Pubescences	PAP	7	Form of central leaves	FFR	20	Color of stem cortex	CCT	29	seed	G
3	Circumference of Plant at collet	CP	8	Color of Petiole	CP	21	Color of epidermis of stem	CET	30	Height of the plant	HP
4	Height of Plant	HP	9	Color of leaves	CF	22	Color of external stem	CTE	31	Height of the first ramification	HR
5	Number of leaves at 10 cm of Apical	NF	10	Number de Lobe	NL	23	Length of internodes	LEN	32	Level of ramification	NR
			11	Length of lobe	LL	24	Form of the stem	FT	33	Wort plant	PP
			12	larger of Lobe	lL	25	Color of adult branch plant	CBPA	34	Angle of branching	AR
			13	Marge of Lobe	ML	26	Length of the Stipule	LS			
			14	Length of Petiole	LP	27	Marge of the Stipule	MS			
			15	Color of principal nervure	CNP						
			16	Orientation of Petiol	OP						
			17	Floor	P						
			18	Pollen	P						

3. RESULTS

3.1 Result at 3 Months after Planting

3.1.1 Circumference of plants

The analysis of variance revealed that the difference between the means of the circumferences was highly significant as well according to the accessions (p = 7.28e-06) and to the Cassava practice system (p = 2e-16). The seedlings resulting from the improved practice have the largest diameter (2.88 ± 2.48) whereas the PP (traditional farming practice) plants have the mean diameter between (2.03 ± 1.84).

3.1.2 Height of plant

The heights of the plants considered according to cultural techniques show a significant difference (p = 0.0075). Depending on the accessions, the difference is highly significant (P = 0.00074), (Fig. 3). Improved practice has resulted in taller plants in height compared to traditional farming practice.

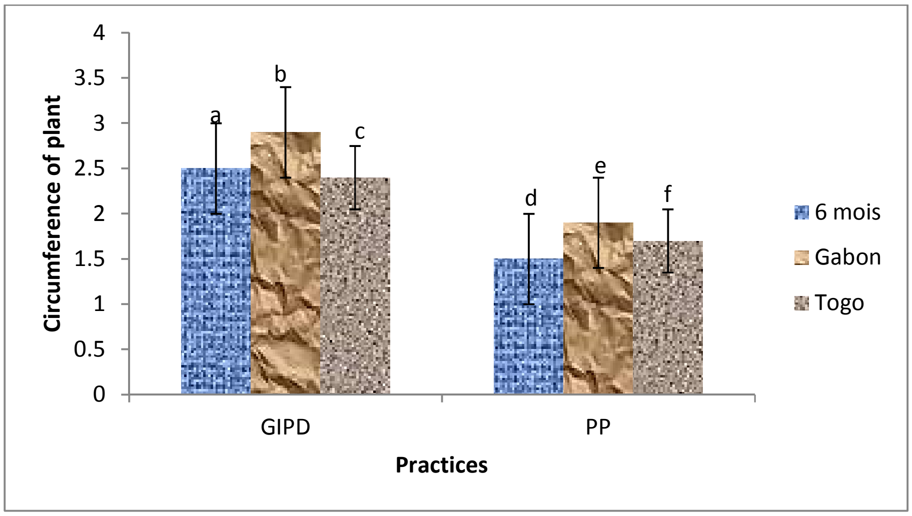

Fig. 2. Circumference of plants at three month

a,b, c, d, e and f mean values on the same row with different superscripts differ significantly (P<0.01)

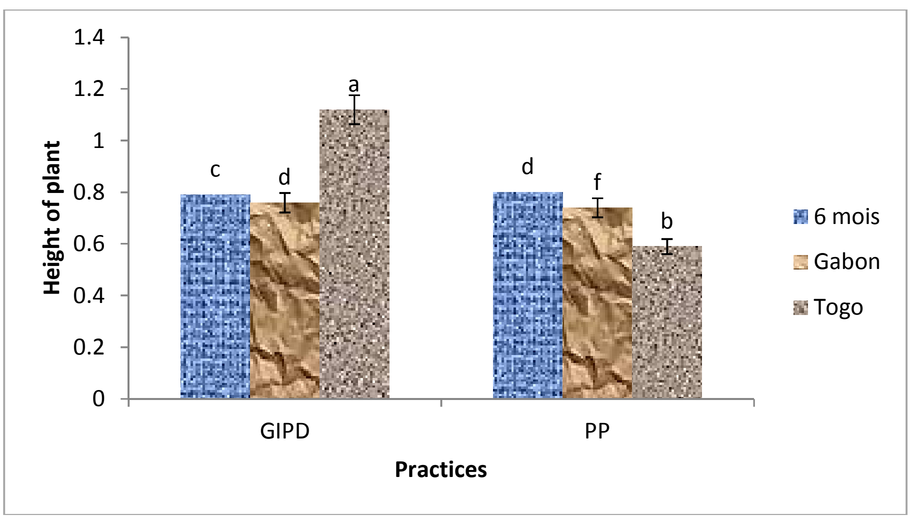

Fig. 3. Height of plant at three month

a,b, c, d, e and f mean values on the same row with different superscripts differ significantly (P<0.01)

3.1.3 Number of leaves

There is a highly significant difference (p = 0.000743) in relation to the number of leaves according to different accessions and not significant (p = 0.103) according to cultural practices. The 6 mois accession has a large number of leaves according to the practices (Fig. 4.).

3.2 Agro-Morphological Characterization

3.2.1 Agro-morphological characterization at six, nine and 12 months

The study of the composition of these 4 axes (Fig. 5) shows that 17 of the 47 descriptors have a partial contribution and 12 descriptors are the most relevant for the explanation of the variability. These relevant characteristics are expressed by Togo accession with test values greater than or equal to 13%. According to the test values, the first axis describes the agro-morphological variation between the 3 accessions. The following six descriptors: apical leaf color, leaf color, plant habit, plant shape, root constriction, and tuber shape explain the variability between these 3 accessions.

The main contributions (PC> 13%) to the first axes of correspondence come from the accession Togo. Par against: length of internode, stem shape, length of the stipules, margin of the stipules, color of the root pulp, color root cortex and peeling ability are characters that are not variable.

The second axis explains the variability between the "6 months" and "Gabon" accessions.

The root rot of the Togo accession on the traditional farming practice plot explains the 3rd axis. There is a series of variation observed for all accessions on the two axes of correspondence and explains 96.51% of the global variability (Fig. 5).

This explains why there is a great agro-morphological variation much more marked by the "Togo" accession. These observations made it possible to understand that the cultural techniques adopted have no impact on the morphological characters of the accessions but they affect growth and productivity.

3.2.2 Tuber yield assessment

The number of tubers per plant (NT / P) and the number of marketable tubers per plant (CNT / P) vary according to the cropping technique (Table 1). There was a highly significant difference (P = 3.55e-09) between the number of tubers per plant and the number of tubers marketable per plant (p = 5.8e-11) according to cultural practices. However, depending on the accessions, it is not significant respectively the number of tubers per plant (p = 0.388) and the number of tubers marketable per plant (p = 0.069). The "6 mois" accession has the highest yield (10 tubers per plant) according to improved practice compared to the "Gabon" accession that has the best yield (7 tubers per plant) in traditional farming practice.

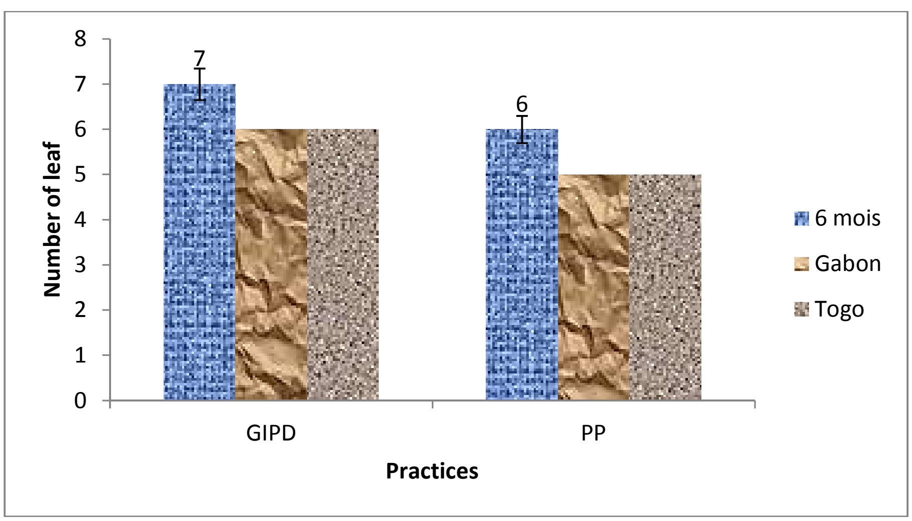

Fig. 4. Number of leaves at 10cm of Apical

a, b, c, d, e and f mean values on the same row with different superscripts differ significantly (P<0.01)

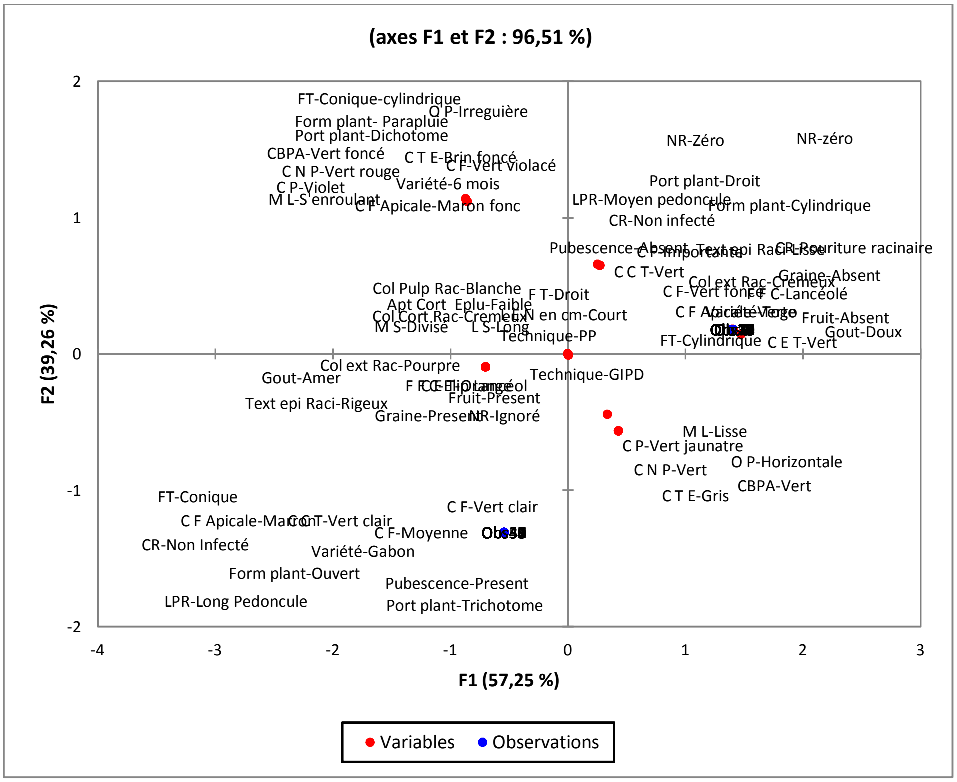

Fig. 5. Multiple analysis of correspondence of agro-morphological descriptors

Mean tuber weight showed a highly significant difference (p = 2.46e-11) depending on cropping practices (Table 2). Mean weights at harvest revealed a highly significant difference (p = 2.46e-11) depending on cropping practices and accessions (p = 0.00016). The "Togo" accession; "6 mois" and "Gabon" have respective yields 8.9 kg / plant, 7.4 kg / plant and 4.5 kg / plant according to improved practice while they have respectively 3.8 kg / plant, 4.1 kg / plant and 3.3 kg / plant according to traditional farming practice.

4. DISCUSSION

The 34 descriptors used in this study allowed an evaluation of the agromorphological structuring of the 3 accessions tested according to cultural practices. The analysis of variance revealed that the difference between the means of the circumferences was highly significant as well according to the accessions (p = 7.28e-06) and to the Cassava practice system (p = 2e-16). The seedlings resulting from the improved practice have the largest diameter (2.88 ± 2.48) whereas the PP (traditional farming practice) plants have the mean diameter between (2.03 ± 1.84).

The heights of the plants considered according to cultural techniques show a significant difference (p = 0.0075). Depending on the accessions, the difference is highly significant (P = 0.00074), (Fig. 3.). Improved practice has resulted in taller plants in height compared to traditional farming practice.

There is a highly significant difference (p = 0.000743) in relation to the number of leaves according to different accessions and not significant (p = 0.103) according to cultural practices. The 6 mois accession has a large number of leaves according to the practices (Fig. 4).

The number of tubers per plant (NT / P) and the number of marketable tubers per plant (CNT / P) vary according to the cropping technique (Table 1). There was a highly significant difference (P = 3.55e-09) between the number of tubers per plant and the number of tubers marketable per plant (p = 5.8e-11) according to cultural practices. However, depending on the accessions, it is not significant respectively the number of tubers per plant (p = 0.388) and the number of tubers marketable per plant

Table 2. Yield of the accessions according to the two practices

Yield	Accessions	IP	TFP	P value (Cultural practice)	P value (Accession)
NT/P	6 mois	12	9	3.55e-09 *	0.388
	Togo	8	5	3.55e-09 *	0.388
	Gabon	6	7	3.55e-09 *	0.388
NTC/P	6 mois	7	3	5.8e-11*	0.069
	Togo	7	3	5.8e-11*	0.069
	Gabon	4	4	5.8e-11*	0.069
PMT	6 mois	7.4 kg	4.1 kg	2.46e-11 **	0.00016**
	Togo	8.9 kg	3.8 kg	2.46e-11**	0.00016**
	Gabon	4.5 kg	3.3 kg	2.46e-11**	0.00016**

NT/P= Number of tuber per Plant, NTC/P= Number of marketable tuber per Plant, PMT= Mean weight of tuber, IP= Improved practice, TFP= Traditional farming practice

(p = 0.069). The "6 mois" accession has the highest yield (10 tubers per plant) according to improved practice compared to the "Gabon" accession that has the best yield (7 tubers per plant) in traditional farming practice. Root length and width are also economically important, since plants with roots too long and too thick may indicate plants with more than one vegetation cycle.

The 34 descriptors used in this study allowed an evaluation of the agromorphological structuring of the 3 accessions tested according to cultural practices. The series of variation observed at 96.51% of the global variability on the 2 axes of correspondence with a partial contribution of 17 descriptors out of 17/34 explains that there is great morphological differentiation between the accessions according to their origin. This differentiation is marked much more by the accession introduced "Togo" which contributed to 57,25% in the global variability. On the other hand, there is relatively little differentiation in the extent of the morphological space between the "6 months" and the "Gabon" local accession. Similar study demonstrated that there is no significant difference in the morphological space occupied by each set of accessions from a given location [11].

[11] Showed an overall variation of 66% in the first two factorial axes with a partial contribution (CP> 10) of 9 out of 20 descriptors and the same observation was made with respect to morphological diversity as high among populations according to different ethnic groups. On the other hand [12]. Obtained an overall variation of 55% with a partial contribution (CP> 18) of 15 out of 27 descriptors. He noted that there is no differentiation between accessions. We note, however, the variability in the quality and number of descriptors involved in the three types of studies. This may, however, influence the nature of the results.

Of the three accessions studied, the seedlings resulting from the GIPD or improved practice are more robust and have a faster growth in height compared to the seedlings resulting from the peasant practice. This difference could be explained by the reduction of maintenance work and the increase in the density of crop plants that have led to intra and interspecific nutritional competition in traditional farming practice. [13] Have shown that weed-yield loss can be minimized when weeding 3 and 5 weeks after planting.

Agricultural yield is one of the main objectives in agricultural production and varietal selection. The 12-month harvest showed productive and early accessions. Of the 3 accessions studied, the "Togo" accession in the improved practice has the best yield (8.9kg) followed by "6 months" (7.4kg) and "Gabon" (4.5kg). [14] in a similar study showed that it is an improved accession (TMS 30572) that has the best yield at 33%, followed by a local accession ("udukanani") with 31% [12] in a similar study showed that the local accessions Bagbogo (18 kg) and Gbakoa (13kg) give the best yield compared to those introduced TMS30995 (6 kg) and TMS50395 (3 kg). In our case the accession introduced "Gabon" was not very productive. Which could justify that it would be a long cycle accession. However, it has been introduced in order to improve yields.Tuber rot of one foot of Togo accession (7.71%) in traditional farming practice cannot justify the difference between accessions. In general, Cassava roots are rotting more and more after 12 months of planting. In the case of this study, rotting of the sole foot of accession would be caused by rodent wounds such as rats and grasscutters in search of food. Both collections revealed a wide range of agro-morphological diversity and showed the existence of high morphological variability among cassava accessions [7]. Morphological traits offer a quick and efficient evaluation tool to assess germplasm diversity and were capable of separating accessions according to sampling locations in both clustering methods [15-27].

5. CONCLUSION AND PERSPECTIVES

The results of this study revealed the differences between farmers' practices and those recommended in agricultural production on the cassava model. Root length and width are also economically important, since plants with roots too long and too thick may indicate plants with more than one vegetation cycle. Furthermore, morphological characterization and the establishment of yield between the accessions are significant subsidies to choose improved practice for the development.

The same study could be done in the others agroclimaticals areas of CAR, taking account the soil fertility.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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