

Study of the Cassava Production System in the Department of Tivaouane, Senegal

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DOI: <http://doi.org/10.38177/ajast.2022.6301>

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Article Received: 12 May 2022

Article Accepted: 23 July 2022

Article Published: 14 August 2022

ABSTRACT

Cassava plays an important role in improving food security and reducing poverty in rural areas. Despite its importance, its production in Senegal remains low compared to other African countries. Nowadays, it is confronted with numerous constraints. It is in this context that a study was conducted on the cassava production system in the Thiès "cassava granary" region, with the objective of examining farmers' cultivation practices. It was conducted in eight communes located in the department of Tivaouane, some of which are located in the Niayes agro-ecological zone and others in the central-northern groundnut basin. Surveys were conducted among the largest cassava producers in these communes. Analysis of the results showed that cassava is only grown in the rainy season with the same cultivation practices that have been used for years. Of the five varieties listed by the President of the Senegalese Cassava Interprofession, only four are grown in the areas surveyed. The Terrasse (43%) and Kombo (36%) varieties are grown more by our respondents in the Niayes area. Soya (75%) and Wallet "Parydiey" (20% of our sample) dominate in the central-northern groundnut basin.

Keywords: Cassava, Food security, Phytosanitary problems, Varieties, Income.

1. Introduction

In 2018, nearly 280 million tons of cassava were produced worldwide on an approximate area of 24.6 million ha, making the plant, the 4th largest crop production after rice, wheat, and corn. Africa represents 60% of this world's total [13]. Cassava production plays a key role in food security, a current challenge for all countries in the Sahel. In Senegal, for example, the government, by Ministerial Order - N°5737 MAEH of 09/07/2004 had set up a Special Program for the Revival of the Cassava Sector in Senegal (PSRFMS). Indeed, the objective of this program was to contribute to stimulating the economy but also to increase the income of the actors. Cassava is not one of the main crops, but it plays a relatively important role in agricultural activities since it accounts for 25% of total vegetable production [1]. It has been cultivated long before independence and is becoming more and more widespread in the agro-ecological zones. In 2008 (the record year for national production), statistics from the Ministry of Agriculture revealed that cassava was grown throughout the country, mainly in the regions of Thiès, Kaolack, Kolda, Fatick, Louga, Diourbel, and Saint Louis. Thiès, a region with high potential for cassava production, produces more than 90% of the national cassava production [5]. It is one of the regions where agriculture occupies an important place in the socio-economic activity. However, despite its importance and the efforts made by the State, cassava has not yet been a real development in the basic diet of the population. Today, one of the main constraints in the areas of the country where this crop is grown is the more or less considerable decline in production. Except for 2008, Senegal has not yet managed to reach the one million ton mark compared to other countries. In fact, it has dropped from seventh place (2012) to ninth place (2017) among cassava producing countries in West Africa [13]. Thus, a study entitled "Study of the cassava production system in the department of Tivaouane" was conducted in eight (08) communes of Tivaouane distributed in the agro-ecological zones of the Niayes and the center-north groundnut basin, whose general objective is to study the cassava production system in these eight (08) communes.

2. Material and methods

2.1. Presentation of the site

2.1.1. Geographical and administrative location

The study took place in Tivaouane, one of the departments of the Thiès region, located as the crow flies 22 km northeast of the city and about 62 km from Mbour (another departmental capital). Bordered to the west by the Atlantic Ocean, to the north and east by the department of Kébémér (Louga region), to the southwest by the department of Thiès (Thiès region), and to the southeast by the department of Bambey (Diourbel region), the department of Tivaouane, covers 3,217 km² of the national territory and includes four (04) districts: Méouane 1,058 km², Niakhène 867 km², Pambal 670 km², Mérina Dakhar 622 km².

In total, seven (07) communes are concerned by our study; some are located in the Niayes agro-ecological zone and others in the central-northern groundnut basin (CNBA). They are respectively:

- Darou Khoudoss, Taïba Ndiaye, Notto Gouye Diama for the Niayes.
- Chérif Lo, Koul, Méouane, Pambal and Pir for the CNBA.

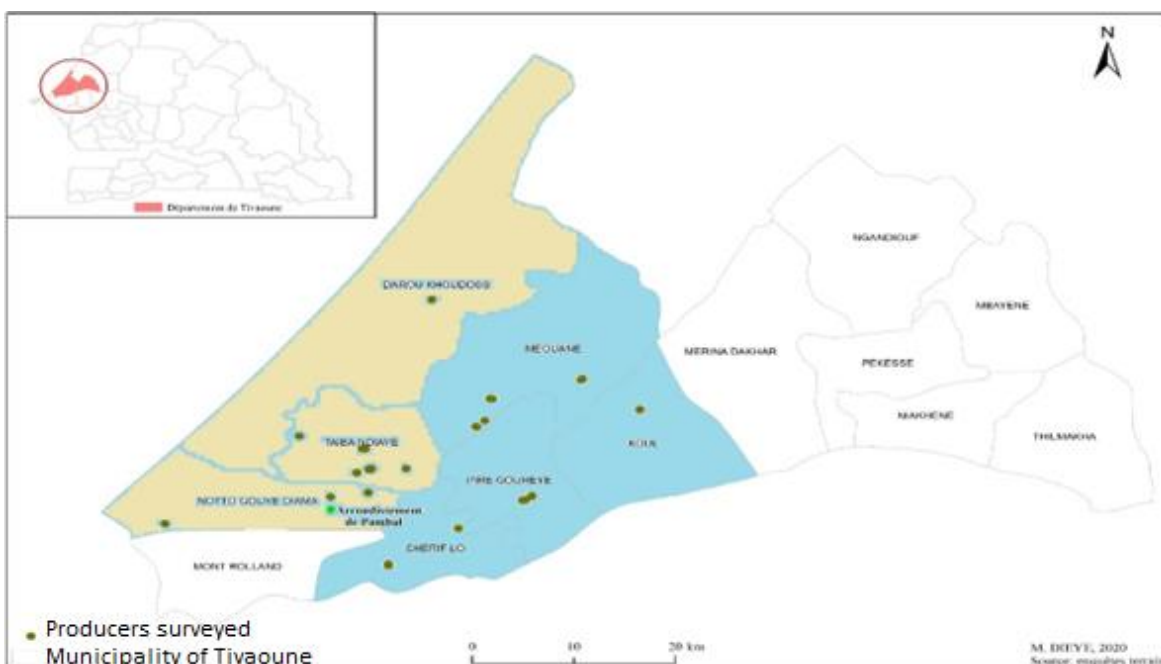


Fig.1. Geographical location of surveyed areas

2.1.2. Biophysical setting

2.1.2.1. Soils

In the department of Tivaouane, we distinguish the following types of soils:

- Leached tropical ferruginous with sandy texture (95%), characterized by their low clay and organic matter content in the surface horizons and their high permeability [3].
- Tropical ferruginous with a sandy-clay texture (Deck-dior).

- Leached tropical ferruginous with a clay-humic texture (Decks) or hydro morphs with a humic texture in the lowlands rich in calcium and clay.

2.1.2.2. Climatic data

The climate is of the Sudano-Sahelian type. The lowest temperatures (16°C) are recorded between December and February and the highest (35°C) from March to October.

Below is the rainfall (mm) for the department of Tivaouane from 1950 to 2019 (ANACIM, 2019).

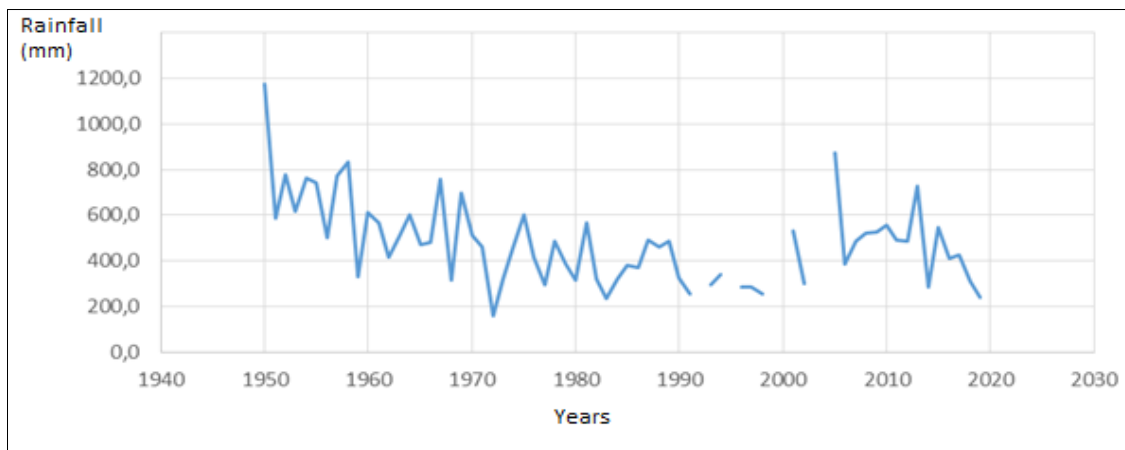


Fig.2. Cumulative rainfall in Tivaouane from 1950 to 2019

2.1.2.3. Vegetation

The vegetation of the area is a shrubby savanna, dominated by species such as *Acacia senegal*, *Andansonia digitata*, *Balanites aegyptiaca*, *Borassus aethiopicum*, *Guiera senegalensis*, *Zizyphus mauritiana* [6]. To these can be added *Anacardium occidentale*, *Guiera senegalensis*, *Casuarina equisetifolia*, etc.

2.2. Materials and Methods

The study focuses on the cassava production system in the department of Tivaouane. It will therefore study through surveys: the cultivation practices of farmers in the area, and the phytosanitary problems encountered in agricultural production.

2.2.1. Survey tools

A questionnaire was designed to collect information for this work. The questionnaire contains two modules. The questionnaire was implemented using the SurveyCTO software (enketo). The field surveys were carried out on tablets made available to us by BAME. Data processing and analysis were carried out in part on Excel software but also on STATA 15. A GPS and a camera were also used for mapping and photography respectively.

2.2.2. Sampling

The choice of the 17 villages is not accidental. Indeed, information obtained from the president of the cassava interprofession during a survey mission in the study area (Tivaouane) allowed us to use purposive sampling (blind sampling), particularly the "snowball" sampling. During the survey, the latter gave us the flagship areas and/or

localities where cassava production remains much more developed. For each village chosen, he put us in touch with an economic operator who put us in touch with four other large producers, generally, the best known because of their reputation. In the end, five large producers were chosen per village.

2.2.3. Field surveys

A field mission was conducted in January 2020 to collect data. The collection of data was facilitated by individual interviews with producers. The surveys were conducted with the support of ISRA BAME and a geographer working in this structure. The questionnaire was completed following interviews with resource persons and the president of the Interprofession du Manioc du Sénégal (IMS). The surveys were sent to 85 producers in 17 villages in eight communes of the department of Tivaouane.

3. Results and discussion

3.1. Results

The data analyses were carried out taking into account the two agro-ecological zones: the Niayes and the central-northern groundnut basin.

The survey revealed that the majority of producers are adults. Indeed, 65% of those surveyed in the Niayes are between 15 and 64 years of age, and 35% are 65 years of age or older. In the surveyed area of the central-northern groundnut basin, 82.2% of the producers surveyed are between 15 and 64 years old, while the remaining 17.8% are in the 65+ age group (Table 1).

Note: Only the economic operators are members of the CODEPROMAT group in Tivaouane. Apart from the latter, none of the other respondents stated that they were members of a cassava association, group, or federation.

Table 1. Age of cassava producers in the Niayes and the central-northern groundnut basin

Agro-ecological zones	Age range	0-14 years	15-64 years	65 + years
Niayes	Surveyed (%)	0	65	35
Centre-north groundnut basin	Surveyed (%)	0	82.2	17.8

3.1.1. Cultivation practices

3.1.1.1. Number and average total area of cassava plots

In the areas surveyed, the total number of cassava plots available to producers varies from one to eight. The analysis of the data reveals that the majority of producers have several plots equal to one and two. Indeed, the proportions are respectively 35 and 27.5% (Niayes surveyed area); 37.8 and 33.33% (center-north groundnut basin). As for the rest of the producers surveyed in the Niayes zone: 12.5%, 10%, 5%, 7.5%, and 2.5% stated that they had several plots equal to three, four, five, six, and eight respectively. In the central-northern groundnut basin, 13.3% of producers surveyed had three plots, 6.7% had four, and less than 5% had five. This is followed by equal proportions of those with six and seven plots, or 2.2% each (Fig.3).

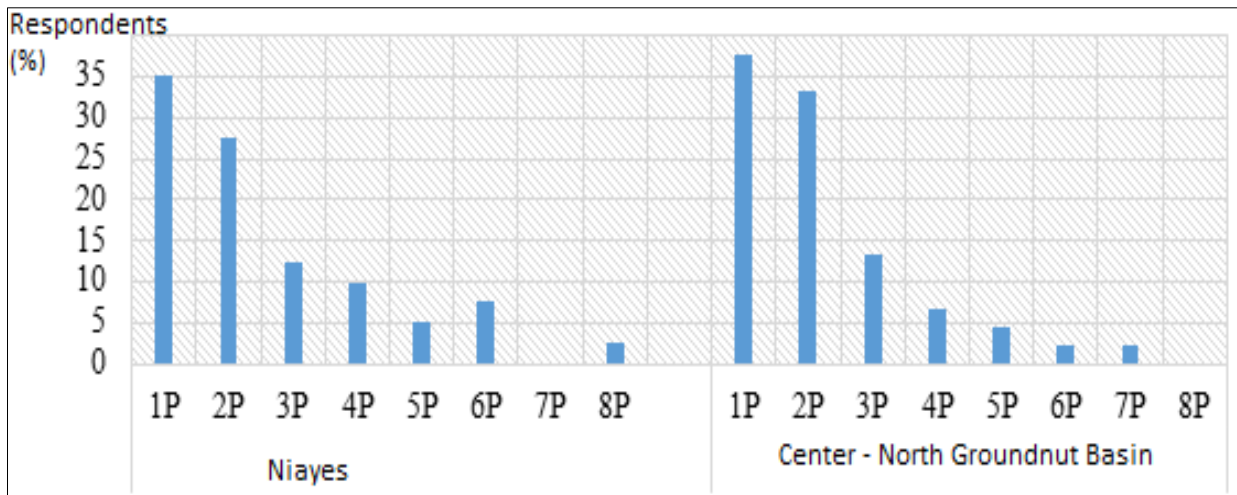


Fig.3. Total number of cassava plots (P) of producers in the zone

As for the total area of the producer's cassava plots, they range on average from 1.5 to 11 ha. Fig.4 shows the average total area according to the number of cassava plots of the producers surveyed in the Niayes zone and the central-northern groundnut basin. In fact, it shows that in the Niayes zone surveyed, cassava producers with one, two, three, four, five, six, and eight plots sow areas of 1.5 ha; 3.4 ha; 6 ha; 8.7 ha; 11 ha; 11 ha; and 8 ha, respectively. At the CNBA, the areas sown by respondents with one, two, three, four, five, six, or seven cassava plots are 2.7 ha; 4.7 ha; 7.4 ha; 4.7 ha; 8 ha; 8 ha; and 6 ha respectively.

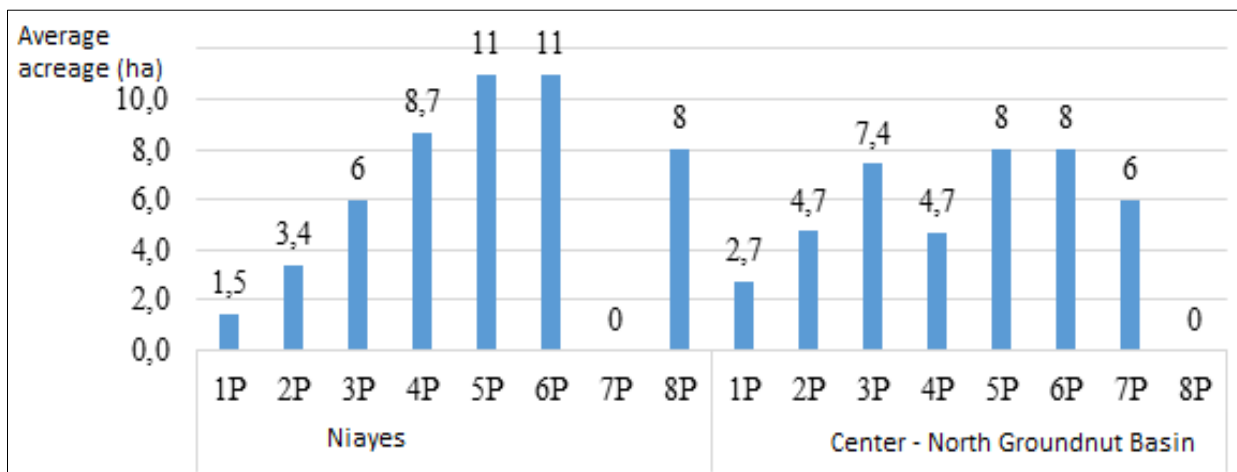


Fig.4. Average total area as a function of the number of cassava plots owned in the Niayes and the central-northern groundnut basin

3.1.1.2. Period of planting of cuttings

The surveys revealed that in the study areas in question, planting is carried out in the same way and during the same period. Indeed, cassava, like groundnuts, is planted as soon as the first rains come, just at the beginning of the winter season.

3.1.1.3. Origin and selection of cuttings

In the surveyed areas of the Niayes and CNBA, various means are used by producers to obtain and select cuttings.

- Source of cuttings

Producers obtain their cuttings by two (02) means: purchase for 40% of those surveyed in the Niayes and 46.7% of those in the CNBA, and self-production used by 60% and 53% respectively. Purchases were made from local producers, at the market, or at institutes/NGOs/projects. 30% of the respondents in the Niayes, compared to 40% of those in the CNBA, buy from a local producer. 2.2% of the producers surveyed in the CNBA said they buy their cuttings at the market. However, 10% of respondents in the Niayes area and 4.4% of those in the CNBA buy from institutes/NGOs/projects.

- Selection of cuttings

Concerning self-production, 57.5% of producers in the Niayes zone, compared to 46% of those in the central-northern groundnut basin, select apparently healthy cuttings for planting. However, only 6% of producers in the central-northern groundnut basin select cuttings randomly (Fig.5).

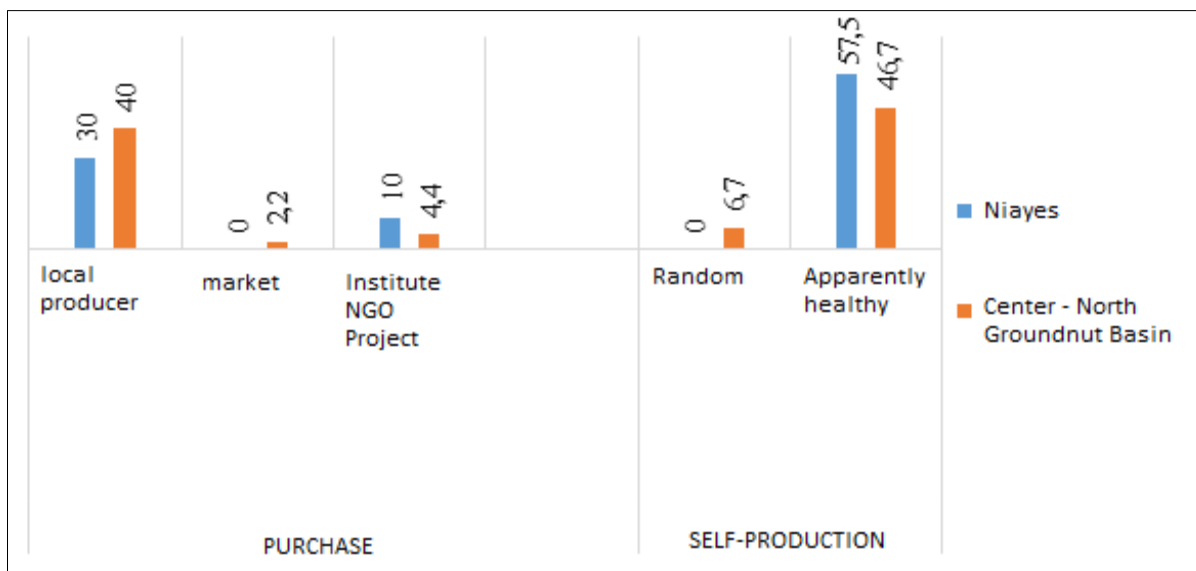


Fig.5. Means of obtaining and methods of selecting cuttings

NB: The selection of cuttings for the following season is carried out well before planting. Indeed, after cutting selected cassava stems, producers keep them by burying them in a hole of not too deep dimensions, depending on the number of cuttings, while waiting for the first rains.

3.1.1.4. Average size, spacing and planting density of cuttings

Measurements on 40/40cm squares are taken by the producers to size the cuttings to be planted. The number of cuttings planted per hectare is called density. This is represented in Fig.6, which shows that the 1m*1m spacing is the one most used by producers (90% in the Niayes zone and 53.3% in the central-northern groundnut basin). Indeed, with such a spacing, 10,000 cuttings are planted per hectare. The other dimensions used by producers in the Niayes are: 1m*1.2m (7.5%) and 0.8m*0.8m (2.5%). Concerning the central-northern groundnut basin:

6.7% reported using spacing of 1*1.5m; 8.9% of 1*1.2m; 4.4% 0.9*0.9m; 13.3% of 0.8*0.8m; 6.7% 0.6*0.6m; 6.7% 0.5*0.5m.

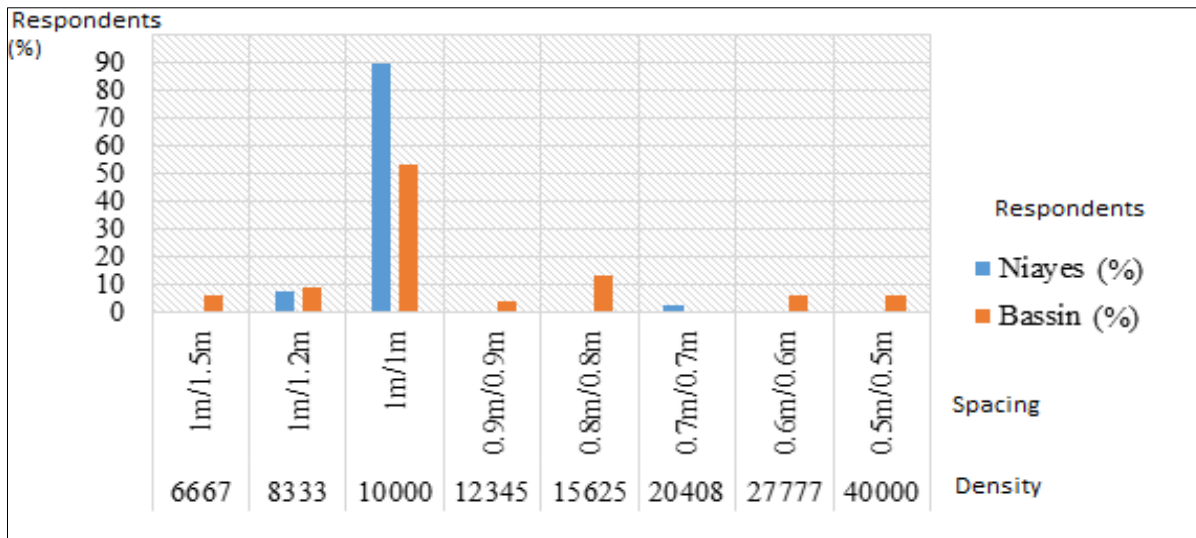


Fig.6. Spacing and planting density of cuttings used by producers

3.1.1.5. Varieties grown

In the areas surveyed, producers grow only local varieties. A total of five were listed. These are : Soya, Wallet "Parydiey", Niaregui, Boss, Kombo and Terasse. These varieties take their names by analogy of some locality or thing. However, it should be noted that some grow only one variety in their plots while others combine two. Following these two criteria, two respective figures were designed. Fig.7 represents the relative value shares of producers growing only one variety on their plot. It shows that Terasse and Kombo are the most widely grown varieties in the Niayes survey area, at 43% and 36% respectively, followed by Wallet and Niaregui, all in equal proportions (10%). In the north-central part of the groundnut basin, the Soya variety, used by 75% of producers, is the one that takes precedence over the others. This is followed by the varieties Parydiey "Wallet", grown by 20%, Kombo and Terasse, all used by 2.5% of those interviewed.

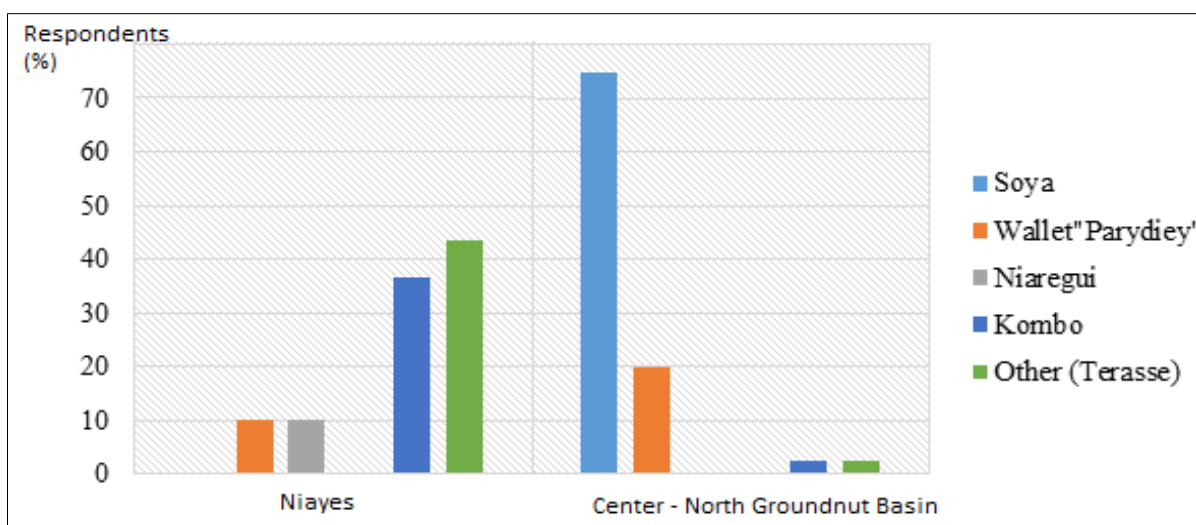


Fig.7. Proportion of farmers planting one cassava variety in their plots

Fig.8 presents the relative shares of farmers planting two cassava varieties in their plots. The analysis shows that in the Niayes zone, the Parydiey-Terasse and Niaregui-Terasse associations are the most common. They are

respectively cultivated by 40% and 20% of respondents. In the central-northern groundnut basin, 80% of producers surveyed use the Soya variety in combination with the Wallet variety "Parydiey". The other 20% revealed the association of the Wallet-Kombo varieties.

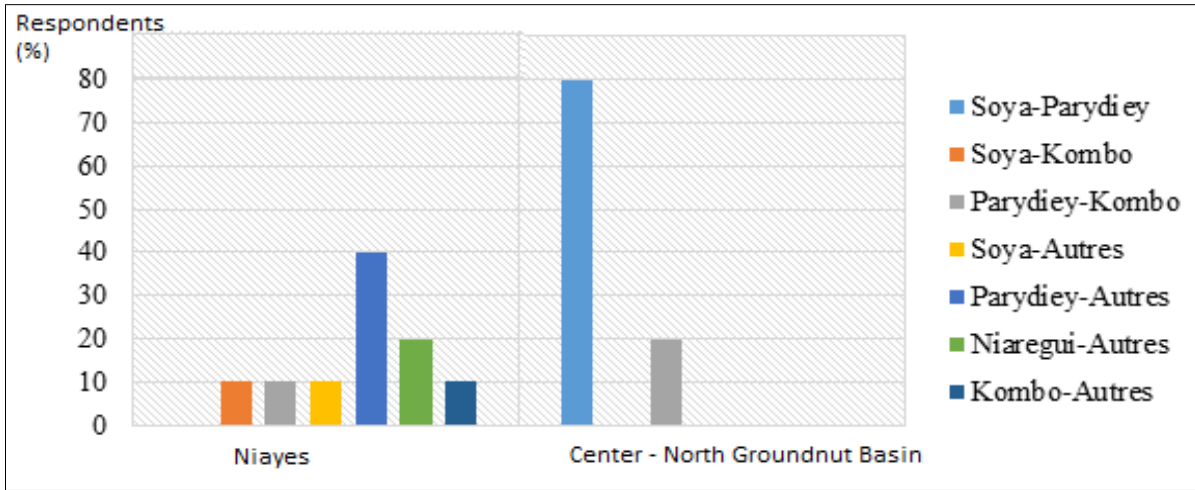


Fig.8. Proportion of farmers planting two varieties of cassava in their plots

3.1.1.6. Preparation of cuttings

Producers were asked whether they used chemical or biological products for the preparation of cuttings.

Fig.9 shows the proportion of users of cuttings preparation products. It shows that 72.5% versus 91% of the producers surveyed in the Niayes and north-central groundnut basin zones do not use products for preparing cuttings. However, it should be noted that in the Niayes zone surveyed, some producers use praline (12.5%), furadan (10%), and granox (5%). In the CNBA, 9% reported using furadan. It should also be noted that the producers carry out this preparation in the same way. In fact, the cuttings are all soaked in a water solution diluted with the product, regardless of their quantity.

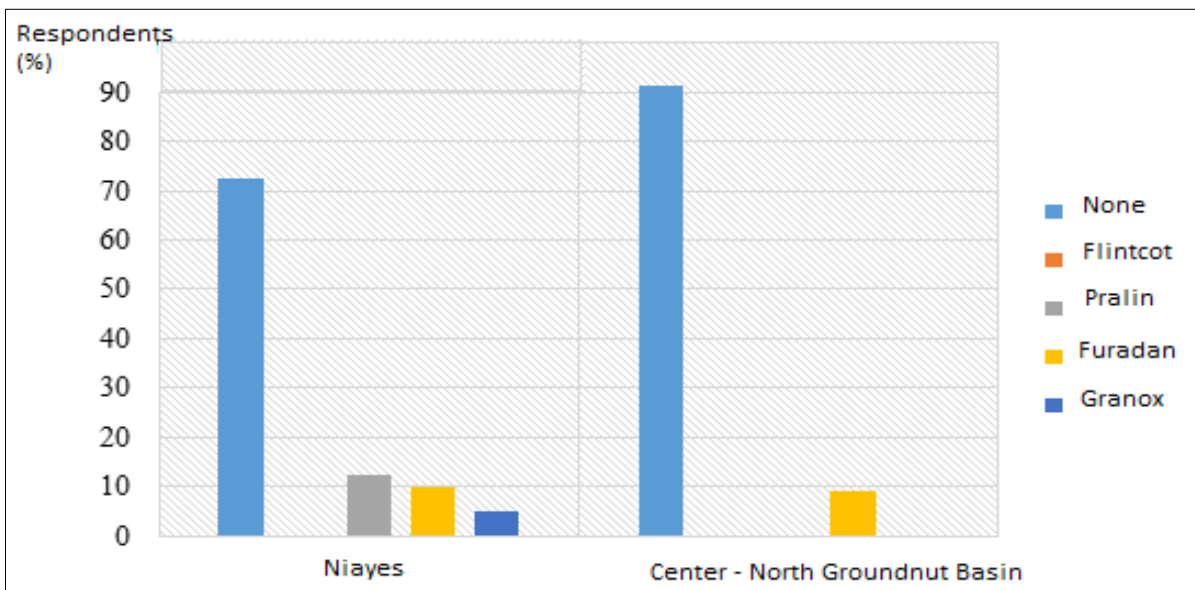


Fig.9. Proportion of users of phytosanitary products for the preparation of cuttings

3.1.1.7. Soil preparation and amendment

3.1.1.7.1. Soil preparation and materials used for the operation

As shown in Fig.10, which presents the number of producers who prepare the soil and the type of equipment used for this operation, 100% of the producers surveyed in the Niayes zone, compared to 88.9% in the central-northern groundnut basin, use plowing. The plow is the preparation equipment most used by them, i.e. 90% in the Niayes and 66.7% in the central-northern groundnut basin. The tractor is used by only 10% of respondents in the Niayes and 22.2% in the groundnut basin.

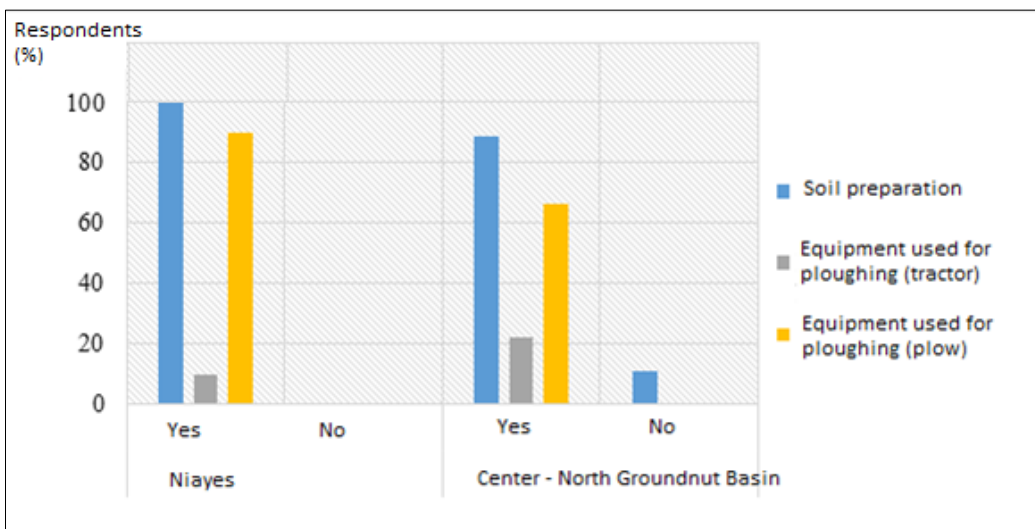


Fig.10. Soil preparation and type of equipment used for the operation

3.1.1.7.2. Soil amendment

As background manure, cattle, horse and donkey manures are used more by farmers, but are not quantifiable by them. Most apply it during the dry season well before planting. However, none of the interviewees said that they carry out preventive soil treatment.

3.1.1.8. Maintenance operations

3.1.1.8.1. Hoeing, ridging and ridging

100% of the producers stated that they carry out weeding operations. The number of times this type of operation is performed varies according to the length of the cycle. In fact, most of them carry out four (in the case of the Niayes) or even five (in the case of the north-central groundnut basin) operations for cycles of eight to ten months. However, these figures are sometimes exceeded, especially for long cycles (> 12 months) (Table 2). However, it should be noted that ridging and mounding are not practiced by farmers in these areas.

Table 2. Frequency of weeding in the cycle

Agro-ecological zones	Frequency of weeding in the cycle	Workforce (%)
Niayes zones	2	2.5
	3	30

	4	47.5
	5	17.5
	6	0
	7	2.5
	8	0
North-central zone of the groundnut basin	2	2.2
	3	4.4
	4	26.7
	5	42.2
	6	8.9
	7	4.4
	8	11.1

3.1.1.8.2. Maintenance Manure Use

Fig.11 presents the types of mineral maintenance manure used by farmers in the study area. In the Niayes zone, only urea and 10-10-20 are used, with proportions of 88.2% and 11.8% respectively. In the CNBA, 6-20-10 and 15-15-15 are used in addition to urea (46-0-0) and 10-10-20. In this zone, the use of urea and 10-10-20 takes precedence over mineral fertilizers, with proportions of 41.7% and 37.5%, respectively, followed by 15-15-15 and 6-20-10, with proportions of 12.5% and 4.2%, respectively, and the remainder undetermined by these (4.2%).

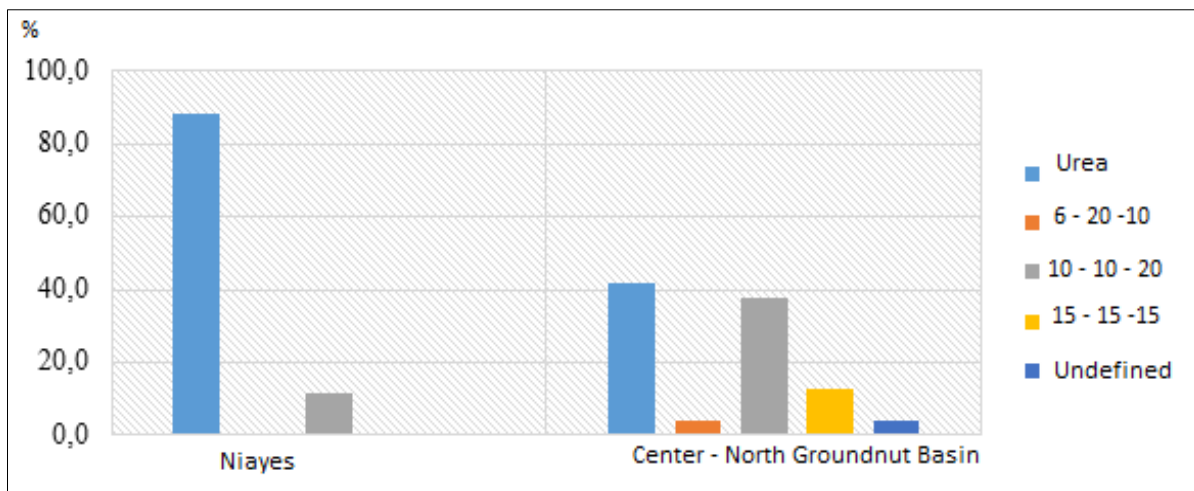


Fig.11. Types of mineral manure used by respondents

3.1.1.9. Harvesting

Harvesting consists of several phases, namely: staking with the daba, uprooting, piling up the dug-up plants and cutting the tubers.

Harvesting method and period

In these areas, the harvesting operation is carried out in the same way. Once the cassava plants have reached maturity, they are dug up and grouped in small piles within the plot. Because of its tediousness, the operation is mostly carried out by hired labor by the producer. The number of workers varies according to the size of the plot. However, most respondents reported hiring an average of seven laborers on a one-hectare plot.

3.1.1.10. Average Yields

Producers were asked about their usual average yields.

NB: The different average yields were calculated through weighing and the number of bags obtained on the cultivated area. Yields vary by variety and cycle.

As shown in Fig.12 presenting the average yields of producers of a variety obtained, when there is no loss, the best average yields are obtained with the varieties Kombo (12 months), Terrasse (12 months) and Niaregui (≥ 12 months) compared to the others in the surveyed area of Niayes. They are in the order of 4,170 kg/, 4,488 kg/ha and 4,000 kg/ha. As for the CNBA, the best yields are obtained with the varieties Soya (cycle: 8-10 months) and Wallet (cycle: 12 months), i.e., 8,900 kg/ha and 11,200 kg/ha respectively in the central-northern groundnut basin.

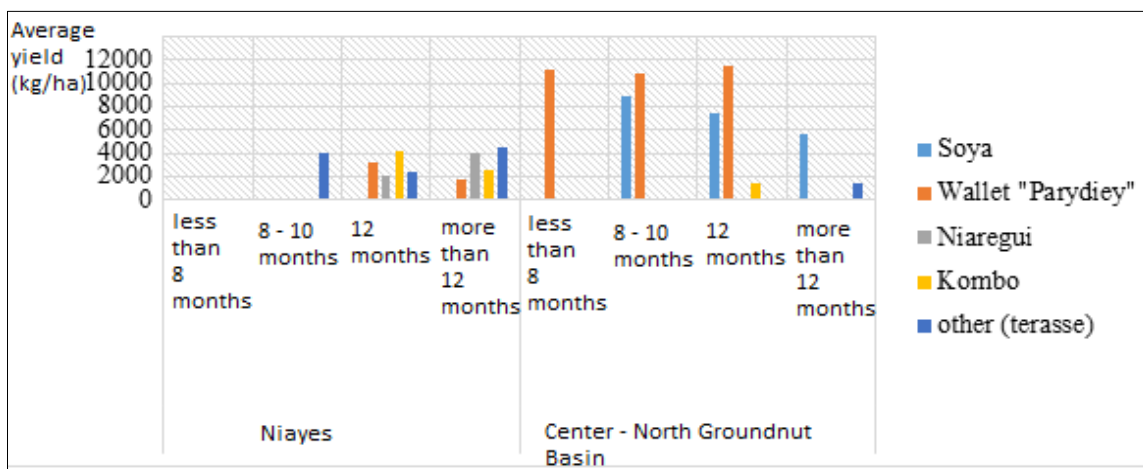


Fig.12. Average yields obtained by producers of one cassava variety

As for producers combining two cassava varieties in their plots, the results in Fig.13 show that in the Niayes zone, when there is no loss, the best yields of 6,430 kg/ha and 6,400 kg/ha were obtained respectively by those interviewed combining Soya-Terrasse and Parydiey-Terrasse. For the CNBA, producers growing Parydiey-Kombo had the highest yield, at 6,400 kg/ha, harvested between the 8th and 10th month.

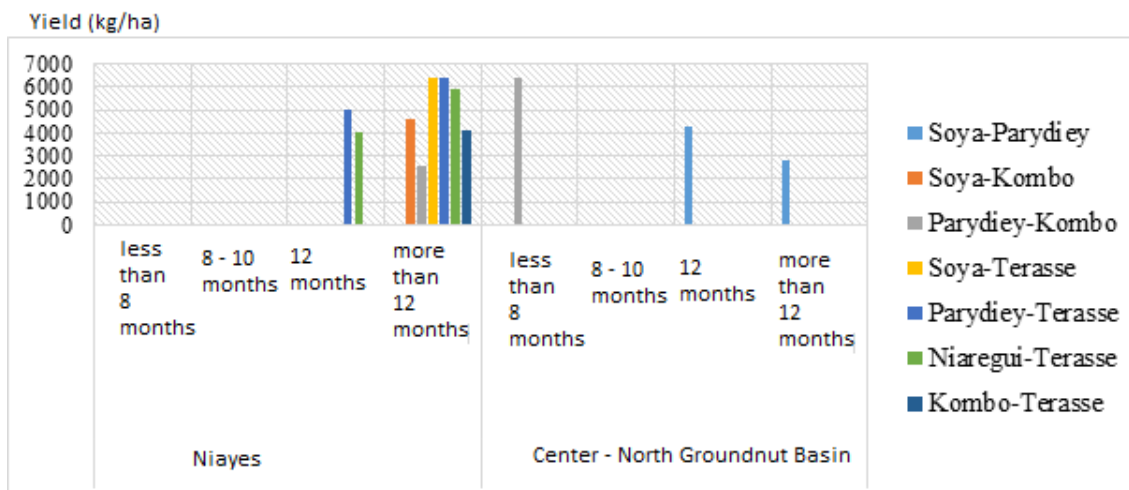


Fig.13. Average yields obtained by producers of two cassava varieties

3.1.1.11. Packaging

In both zones, the main type of packaging is by bag. Indeed, many of the respondents said that they sell in bulk, with only a few saying that they sell in detail. However, the bags differ in weight depending on the size of the cuttings. Fig.14 shows the different types of bag weights used for packaging and "backfilling" of cuttings.

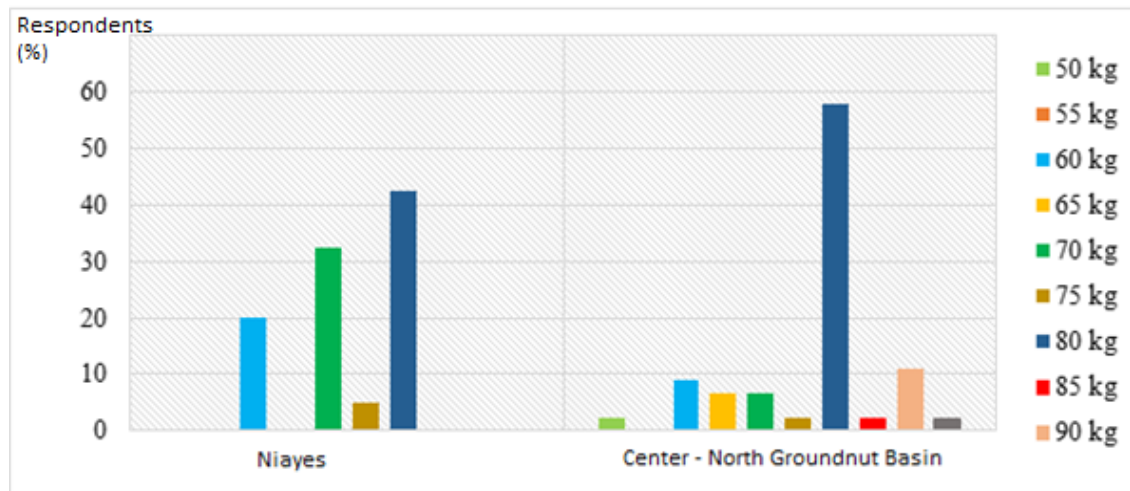


Fig.14. Approximate weights of the bags used for packaging

3.2. Discussion

The results showed that producers with one and two cassava plots are more numerous. There are several possible explanations for these results. Indeed, it should be emphasized that the producers surveyed do not only cultivate cassava. Because of the decline in cassava yields observed in recent years, producers do not hesitate to grow other crops as a means of diversification. In the Niayes area, for example, farmers are also growing crops such as eggplant, tomato, bissap, and mango. In the north central part of the groundnut basin, groundnuts, millet and cowpeas are the other crops that provide income for farmers.

Concerning the origin of cuttings for planting, the proportions of producers using self-produced cuttings are much higher than those of buyers in the surveyed areas of the Niayes and the north-central groundnut basin. The cuttings that appear to be healthy and vigorous are those used for planting. This is reflected in the lack of financial means of some of them, who claim that the cost of cuttings is expensive.

As for the choice of the density of cuttings, the most used by the respondents is 1m*1m. This choice could be explained by the fact that it is more conducive to obtaining large tubers. Indeed, planting too tightly or too widely would not be ideal, as the tubers would not be able to develop normally and consequently would require more expenses (cuttings, labor during harvesting) or there would be poor management of the space. This is in contradiction with the results of [12], who consider that the low density is best suited to production intended to supply a market where the preference is for the marketing of large tubers. For the latter, the spacing of 1.3m*1.3m would be the most favourable for obtaining better yields.

As for the choice of variety(ies) grown, the results revealed that the local varieties Kombo and Terrasse are the most widely grown in the Niayes, while Soya is the most popular in the central-northern groundnut basin. The

motivation for these choices stems from the fact that in the Niayes, the above-mentioned varieties, especially Terrasse, give good yields. In the central-northern groundnut basin, despite the low yields obtained with the Soya variety, producers still insist on using it. The choice is explained by the uniqueness of this variety in this zone, but also by the high cost of cuttings for the others. Our results are in line with those of [7], who found that Soya is the variety used by 90% of CNBA producers. The results also show that the Parydiey-Terasse and Soya-Parydiey associations are the ones most used in the areas surveyed in the Niayes and the north-central groundnut basin, respectively. The explanation that could be given is that in the event of attacks, losses are not so considerable. It should be noted that this association of varieties has the advantage of maintaining soil fertility, thus allowing for better productivity of the land (increased yields for example). However, the lack of control of the latter would lead to competition (especially with the plant population) and would also make maintenance work difficult (weeding, etc.).

With regard to soil preparation, the results showed that ploughing with a plow is used more than plowing with a tractor. The non-use of tractors can be explained by the fact that tractors are expensive to rent (25,000 to 30,000 FCFA per hectare). However, it is clear that the plows used by these producers are outdated, and most of them date from the time of the Agricultural Program (from 1960 to 1980). The objective of this program was to supply production factors to cooperatives that comprehensively grouped the agricultural population. Thus, the delivery of cattle traction and tillage equipment to members was done in the form of subsidies (about 50% of the price of the equipment). The National Development Bank of Senegal (BNDS) provided this financing through short- and medium-term loans (2 and then 5 years) to the cooperatives.

Most of the producers stated that they did not use products for the preparation of cuttings for planting, due to a lack of financial resources. These results are in line with those of [7], which showed that phytosanitary pre-treatment is carried out on average by 1/3 of the producers. As for the frequency of weeding, it differs according to the length of the cycle and varies from four to eight. The high frequency of weeding can be explained by the fact that some producers only harvest two years after planting. These results are out of step with those of [9], [8], for whom three weedings are sufficient for weed control. Mounding and ridging are not known in the area, which explains their non-use.

Urea and 10-10-20 are the main maintenance fertilizers used by the respondents. This could be because these two are the most familiar to producers in these zones. These results are consistent with those of [7], which stated that urea and NPK 10-10-20 are generally the most applied fertilizers, by 40% and 53% of the producers, respectively. However, the timing and doses of application are not respected and vary among growers. Most of the respondents chose to apply fertilizer between 30 and 45 days after planting. In fact, fertilization is carried out between 15-30 days after planting for 60% of producers and 60-90 days for 33% of producers [7]. However, according to [4], fertilization should only be done two months after planting. Harvesting is a labor-intensive operation, due to its difficulty. The producers surveyed in these areas proceeded directly by digging up after the cassava had reached maturity. These results are in complete contradiction with those of [8], who state that the stem should be cut 25 to 35 cm from the ground with a machete before digging up the tubers. Harvesting time differs among producers.

Some, for financial reasons, harvest even before the end of the cycle (maturity), while others, to obtain large tubers (and better yields), prefer to leave the plant a little longer. These results are supported by those of [10], for whom the lengthening of the crop cycles also constitutes an alternative for producers to face the deficit of fertilizers. The results of the approximate weights of the weighing bags used for packaging by the respondents revealed that many of them oriented their choices to the weighing bag estimated at 80kg. Such a choice would, on the one hand, attract customers or, on the other hand, result from buyers' preferences. These results are supported by [11], who found that the appearance of the bag was important to the success of the sale.

4. Conclusion and Perspectives

Through this study, we have been able to show with the analysis of the cultivation practices of cassava producers in these areas. We can also note that :

- Climate change, which must be taken into consideration even if cassava is relatively resilient. The decrease in rainfall noted in recent years can affect the productivity of cassava, which can certainly resist up to 500mm;
- the decrease in cultivable areas due to the inextensibility of land, leading to the impracticality of fallowing, rotation, etc.
- the depletion of mineral elements in the soil (low soil fertility) due to poor cultivation practices (e.g., non-respect of fertilization rates);

However, given the results of this study, we propose the following perspectives:

Concerning the State

Launching programs or projects for the creation and improvement of cassava varieties, so that new short-cycle varieties, at affordable prices, are subsidized for the benefit of producers;

Supporting CODEPROMAT to revive cassava cultivation in the area; support to encourage, for example, the professionalization of producers, but also the processing of cassava;

Techniques

Carry out diagnostic studies on the cassava value chain in Senegal in order to identify the actors involved and the main problems in order to propose sustainable solutions;

Carry out awareness campaigns among farmers on the practice of rotation to reduce disease or parasite pressure; practicing crop association, given the lack of land, in order to maintain and/or improve yields (e.g., legumes + cassava) and techniques such as ridging.

Declarations

Source of Funding

This research did not receive any grant from funding agencies in the public, commercial, or not-for-profit sectors.

Consent for publication

Authors declare that they consented for the publication of this research work.

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