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Research Paper

Analysis of cassava (*Manihot esculenta* Crantz) cropping systems in the Gbadolite region: strengths, challenges, and prospects

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Abstract
The overall objective of this study is to observe cassava farming system in the Gbadolite's region. The methology adopted waq sampling ; the technic used for this study a survey using a questionnaire to collect data. A series of surveys was conducted in the three rural communes of the Gbadolite municipality, which constitue a production region by surveying 10 households per neighborhood using a open –endend and closed-ended questionnaire. It was found that the age of cassava producers in the region varies from 39 to 40 years, producers cultivate local and improved varieties in the region using basic farming technics, the areas under cultivation are small in the region, averaging 0.5 ha per household are low, ranging from 3.11 to 3.43 tons per hectare. Cassava is therefore one the crops that supports the economy of households in the region.

Keywords: Analysis, systems, cultivation, cassava, strengths, challengers, prospects, Gbadolite

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I. INTRODUCTION

Cassava is one of the most suitable crops, as it adapts well to both poor climatic conditions and poor soils that limit the production of other food crops (Vandenput, 1981; N'drin et al., 2019).

Initially adopted as a family reserve crop after its introduction to Africa by Portuguese traders (Okigbo, 1980), cassava is rapidly becoming a dominant food crop in sub-Saharan Africa (Phillips et al., 2004). It tolerates limited soil fertility and is capable of producing high yields under poor conditions (Nweke, 2003).

Africa currently produces more than 50% of the world's cassava production with 118 million tons, and West African production has nearly tripled from 26.01 million tons in 1990 to 76.1 million tons in 2011 (FAO, 2013).

Almost 90% of cassava produced in West Africa is consumed by humans, and the remaining 10% is semi-processed for animal feed on farms (Sanni et al., 2009). Cassava is to African farmers what rice is to Asian farmers or what wheat and sweet potatoes are to European farmers (Oyewole, 2002).

In the DRC, the average annual per capita consumption of cassava is estimated at 450 kg of fresh roots (Khonde, 2001; Chausse et al., 2012). This quantity corresponds to 150 kg of fermented flour. In addition, cassava leaves are consumed as vegetables (Moloba et al., 2019).

The local cassava market is one of the largest in North Ubangi and in the town of Gbado Lite and its surroundings. Cassava (leaves and roots) is the main staple food for most of the local population, as it is consumed in several forms: cooked tubers (songo), kneaded flour (fufu), compact pounded cassava mixture (kutubon), and pounded with cooked plantains (lituma) or chikwangue (Magbukudua et al., 2015; Molongo et al., 2015).

Moreover, Ndonda (2018) estimated that the average annual consumption per Congolese person is 29 kg of these leaves. Chausse et al. (op. cit) estimate that the annual per capita consumption of cassava, all products combined, is approximately 250 kg. This consumption is among the highest in the world.

Around the 1990s, annual production of cassava tubers fell by 24% (FAO, 2009). Extensive emergency programs to combat diseases and pests stabilized production from 14.93 million tons in 2002 to 15.02 million tons in 2011 (MINAGRIDER, 2013). The development and distribution of new improved varieties aim to increase cassava production, with easy access for farmers (Kouassi et al., 2018). After harvesting, the physiological deterioration of cassava tubers is accelerated (Koko et al., 2014).

Despite the stabilization of national cassava production since 2002, Nweke et al. (2000) mention that processing has not been stimulated at the same rate as production, as has been the case in East Africa. To further reduce natural drying time and water content, the use of micro-chipping technology is one of the solutions recommended in rural areas. In addition, rudimentary and tedious artisanal processing has its limitations when faced with large quantities of raw material to be processed. This is one of the weaknesses in the performance of this post-harvest activity.

In the agricultural sector in general, the value chain model has been designed as one of the strategies for greater efficiency (Kumar et al., 2011). Indeed, the value chain approach ensures that there are incentives to promote desired behavior and connects households to growing markets so that they can earn income to purchase food, goods, and services. This allows them to diversify their diets and reduce the risk of relying solely on their own production for food security (USAID, 1992).

With regard to cassava products, their value chain tends to begin with small-scale production units, followed by small-scale processing units for drying and/or grinding cassava. Many constraints hamper the performance of the cassava value chain, the two most important being the perishability of fresh tubers and the presence of cyanogenic compounds in cassava (ARC, 2013).

Due to its perishability, the marketing of fresh cassava is strictly local. Processing strategies have been developed across cassava-producing areas, but the added value obtained has remained low. The strategies developed aim to extend the shelf life of cassava tubers. Thus, after being dried, fried, or processed into flour (gari), cassava has a longer shelf life, which allows it to be marketed in more distant areas (N'dri et al., 2019).

In addition, due to the presence of cyanogenic compounds, cassava is susceptible to physiological deterioration after harvesting. This means that roots older than 48 hours have little commercial value, which limits the radius within which fresh roots can be marketed. With this in mind, this study aims to conduct an agro-economic analysis of cassava cultivation in the Gbadolite region. This study should highlight the strengths, challenges, and future prospects of cassava cultivation in this region.

In view of the above, this study seeks to answer the following main question:

Can cassava cultivation in the Gbadolite region, practiced by the majority of farmers and even forming the basis of their diet, constitute a basis for the region's development?

Specifically, this research will answer the following questions:

- Are the cultivation techniques used in the study area likely to ensure high yields?
- What are the major difficulties facing cassava production in the Gbadolite region?

The purpose of this research is to conduct an agro-economic analysis of cassava (Manihot esculenta Crantz) cultivation in the Gbadolite region of the DRC. Specifically, it aims to assess the current state of cassava cultivation and identify the difficulties encountered in cassava farming in the Gbadolite region.

II. MATERIALS AND METHODS

Study environment

This study was conducted in Gbadolite, located at 4° 17' 41'' North and 21° 2' 18" East at an altitude of 500m (FACET, 2010), as illustrated in Figure 1.

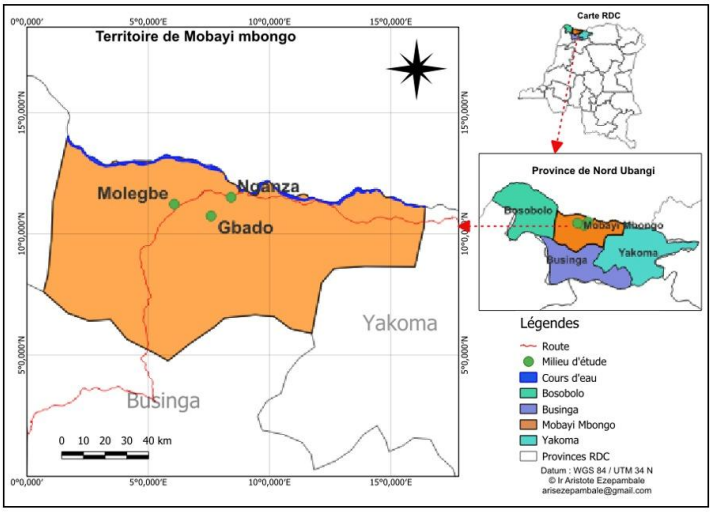

Figure 1: Study site map

The vegetation consists of evergreen tropical rainforest, but due to human activity, it has been replaced by grassy savannas with Imperata cylindrica, Pennisetum sp, Chromolaena odorata, Panicum maximum, and other grasses (Molongo, 2022). The soil is sandy clay. Rainfall is relatively abundant, with an annual average of over 1,600 mm (Molongo et al., 2024; Omasomba et al., 2019).

Equipment

The following materials were required to conduct this study :

- A survey questionnaire
- A Kobocollect application
- R-studio and Excel 2016 software.
- A pen

Methods

In this study, the method adopted was sampling supported by the survey technique, also using a survey questionnaire for data collection (Matabora et al., 2016).

In addition, the technique used for data collection was mainly questionnaire surveys. A series of surveys was conducted in the three rural municipalities of the Gbadolite Town Hall, namely Gbadolite, Molegbe, and Nganza. For this survey, 10 households were selected for data collection using pen-and-paper and step-by-step sampling techniques (WFP and FAO, 2019). It was conducted by a team of surveyors consisting of two surveyors with a minimum level of state certification and a good knowledge of scientific data collection techniques, and a doctoral student in charge of supervision.

III. RESULTS AND DISCUSSION

Résults

Sociodemographic data

Demographic data are data that determine the characteristics of the cassava-producing population in the region where we carried out the work.

Age of respondents

The age of respondents is recorded in Figure 2.

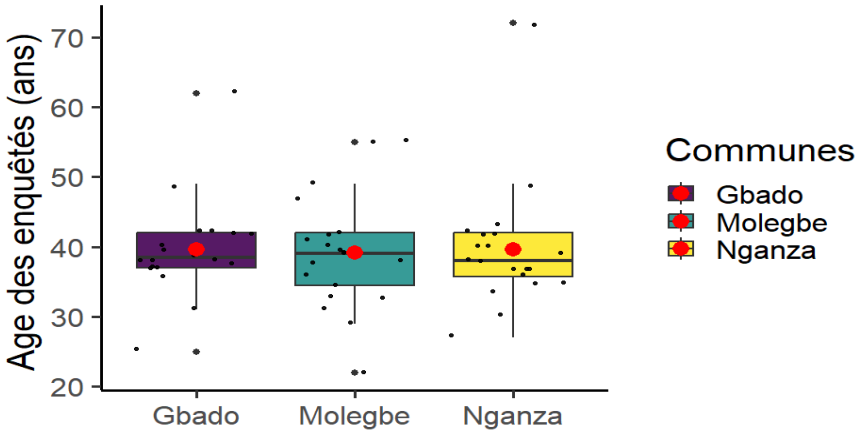

Figure 2: Age of respondents by region

Figure 2 shows that the average age of cassava producers varies very little from one municipality to another, at around 39.2 years in the region. Cassava producers in the municipalities of Gbadolite and Nganza have an average age of 39.2±7 years, while those in Molegbe have an average age of 39.2±8.1 years. Cassava producers in the three municipalities do not differ significantly in age (p-value=0.8635). These producers can be considered mature and experienced actors in their profession.

Educational level of respondents

Figure 3 shows the educational level of respondents.

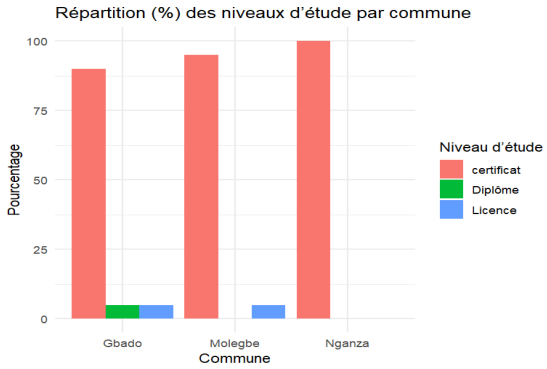

Figure 3: Distribution of educational attainment among respondents in the region (%)

It has been observed that cassava producers in all municipalities are mostly primary school graduates. The activity is carried out almost exclusively by producers with a low level of education in this region. In the municipality of Nganza, all producers have primary education (100%), while in the municipalities of Molegbe and Gbadolite, the figures are 95% and 90% respectively. Production is carried out to a lesser extent by state graduates and licensees. The municipality of Molegbe has 5% with bachelor's degrees, while Gbadolite has 5% with state diplomas and 5% with bachelor's degrees. The municipality of Molegbe has no state diploma or bachelor's degree holders. These results show that cassava producers in the Gbadolite region have a very low level of education, dominated by primary school certificates.

Gender of respondents

Figure 4 shows the distribution of cassava producers by gender.

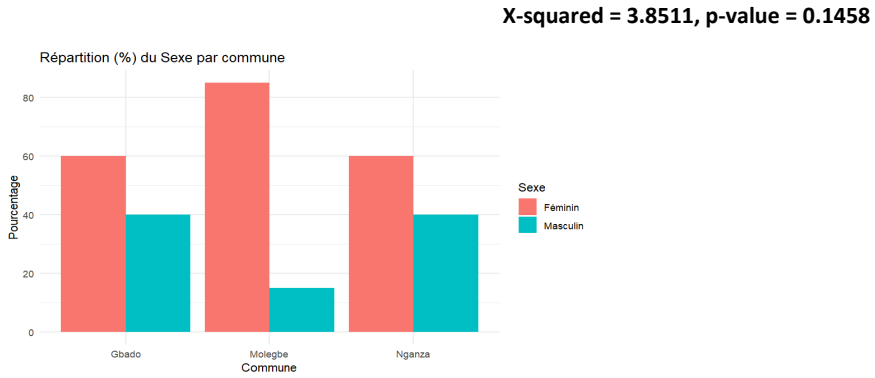

Figure 4: Gender distribution of respondents by municipality (%)

He notes that cassava production is less reliably carried out by men than by women. In the municipality of Molegbe, women account for 85% of producers, while men account for only 15%; in the municipalities of Gbadolite and Nganza, women producers account for 60% and men producers for 40%. These results show that in the Gbadolite region, the majority of cassava producers are women.

Agronomic data

Cultivated varieties

The results for varieties grown in the Gbadolite region are shown in Figure 5.

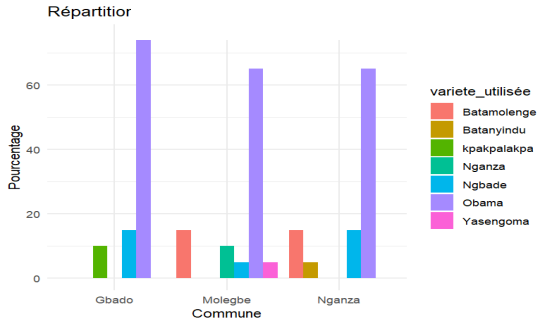

Figure 5: Distribution of varieties grown by municipality (%)

It appears that cassava producers cultivate local and improved varieties. The three municipalities cultivate varieties according to their preferences, which is why certain varieties are grown in one municipality but not in another. In all three municipalities, the improved variety TME 419 (Obama) is predominant. In the municipality of Gbadolite, the improved variety TME 419 is cultivated at 75%, followed by the local varieties Ngbade (15%) and Kpakpalakpa (10%).

In the municipality of Molegbe, TME 419 is cultivated at 65%, followed by local varieties such as Batamolenge (15%), Nganza (10%), and Yasegumba (5%). The same trend was observed in the commune of Nganza, where the TME 419 cultivar accounts for 65%, followed by the local cultivars Ngbade and Batamolenge (15%) and Batanyindu (5%). It is clear from the Gbadolite region that the dominant variety is the cultivar TME 419 (Obama), an improved variety due to its high yield and disease resistance. Producers also grow local varieties because of their highly appreciated organoleptic qualities, thus demonstrating the diversity of the varieties cultivated.

Cultivation techniques

Les techniques culturales ont été évaluées et les résultats sont présentés par la figure 6.

X-squared = 31.667,
p-value = 1.329e-07

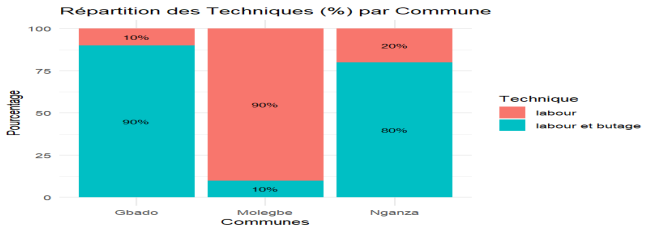

Figure 6: Distribution of farming techniques practiced by municipality (%)

Cassava producers in each municipality practice simple plowing and plowing combined with ridging. Plowing is more common in the municipality of Molegbe (90%), less common in the municipality of Nganza (20%), and least common in the municipality of Gbadolite (10%) when preparing the land. Plowing combined with ridging is more common in the municipalities of Gbadolite (90%) and Nganza (80%). The municipality of Molegbe practices it only 10% of the time. The three municipalities adopt different farming techniques. The population of this region practices few farming techniques adapted to cassava cultivation to increase crop production.

Area planted

The results relating to the areas sown by producers in each municipality are shown in Figure 7.

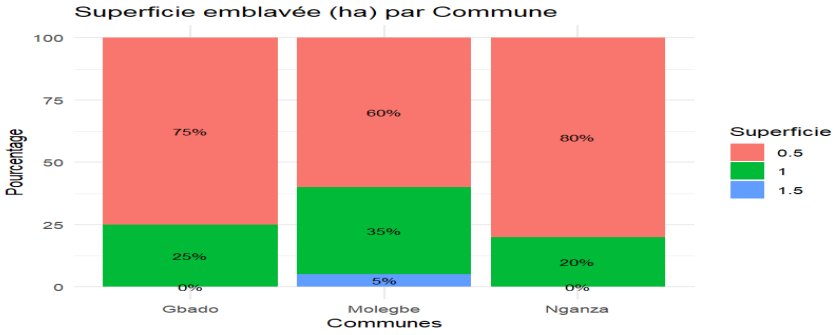

Figure 7: Distribution of areas sown by producers by municipality (%)

The areas sown in the three municipalities varied from 0.5 to 1.5 ha during this study. It was observed in the municipality of Nganza that 80% of households had fields with an area of 0.5 ha and 20% had 1 ha. In the municipality of Gbadolite, 75% of households farmed 0.5 ha and 25% farmed 1 ha. During this survey, the municipality of Molegbe recorded 60% of households with an average of 0.5 ha; 35% with 1 ha and 5% of households farming 1.5 ha.

In view of these results, it can be observed that households in these three municipalities cultivate cassava on small areas of land. Thus, it concludes that the area planted with cassava by households in the Gbadolite region is mostly 0.5 ha.

Challenges encountered in cassava production

The results relating to the difficulties faced by cassava producers in the Gbadolite region are presented in Figure 8.

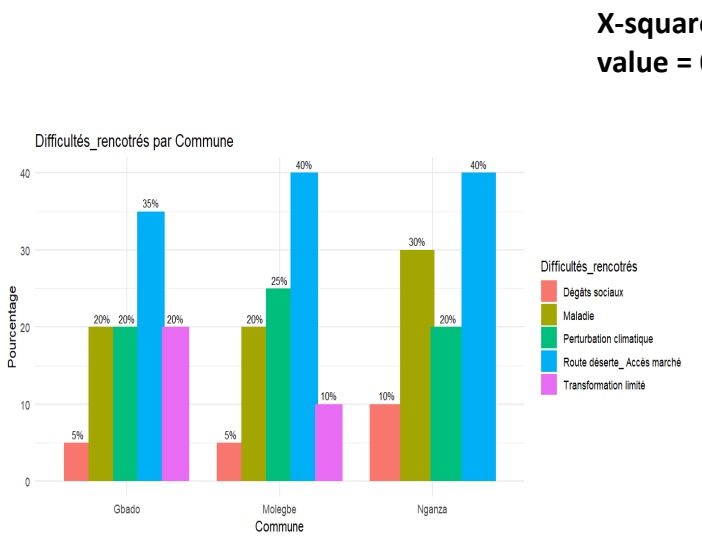

Figure 8: Difficulties encountered by cassava producers by municipality (in %)

Cassava producers face many challenges, including disease, climate disruption, dilapidated agricultural access roads, limited processing facilities, and social unrest. These challenges vary from one municipality to another. Among these challenges, agricultural access roads are the primary challenge faced in all municipalities in the region. Difficulties related to agricultural access roads and market access account for around 40% (for the municipalities of Molegbe and Nganza) and 35% for the municipality of Gbadolite. Diseases (African cassava mosaic virus and tuber rot) that threaten crops were particularly prevalent in the municipality of Nganza (30%). Difficulties due to climate disruption and cassava processing were recorded in the municipalities of Nganza and Gbadolite (20%). Social damage was more frequent in the commune of Nganza (10%) as a result of stray animals and bush fires. These difficulties encountered by farmers are the cause of low cassava production in the Gbadolite region.

Tuber yield in municipalities

The yield of tuberous roots is shown in Figure 9.

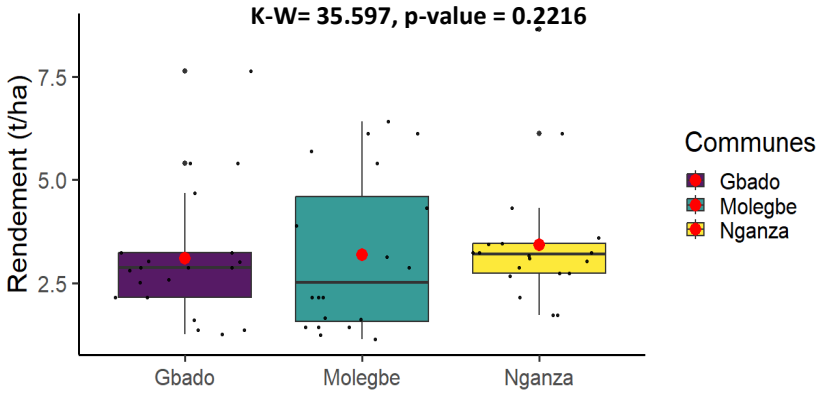

Figure 9: Tuber yield in different municipalities (T/ha)

The tuber yield in these municipalities varied between 3.11 and 3.43±1.54 t/ha. The municipality of Gbadolite recorded a yield of 3.11±1.5 t/ha; 3.18±1.86 t/ha in the municipality of Molegbe and 3.43±1.54 t/ha in the municipality of Nganza. These yields do not differ significantly (p-value=0.2216) and are quite low. The difficulties encountered by producers in the region may be one of the causes. Production distribution is heterogeneous across all municipalities: Molegbe (58.3%), Gbado (51.1%), and Nganza (44.8%).

IV. DISCUSSION

The present study aimed to analyze cassava cultivation in the Gbadolite region from demographic, agronomic, and socioeconomic perspectives. The results obtained are as follows:

discussed in light of the literature in order to verify the hypotheses formulated and understand the implications for local agricultural development.

1. Sociodemographic characteristics of producers

The average age of producers (≈ 39 years) indicates an active and relatively experienced agricultural population. Similar observations are made by Nweke (2003), who points out that cassava cultivation in Africa is dominated by adults of productive age, capable of performing demanding agricultural work.

The high participation of women (60 to 85% depending on the region) also confirms the central role of women in the cassava sector in sub-Saharan Africa. According to Sanni et al. (2009), women are heavily involved in the production, processing, and marketing of cassava, which promotes their economic empowerment. This finding corroborates your results.

Bamba & Kouadio also attest that in Côte d'Ivoire, as cassava is mainly a female crop, weeding and harvesting are carried out in groups, on community plots, or by paid workers, often young people from the village, as the work is too physical and too time-consuming to be done by a woman alone.

The majority of producers with a low level of education (predominantly primary school level) agree with the conclusions of Ndonda (2018), who states that in rural areas of the Congo, agricultural activities are mainly carried out by people with little education. This has an impact on the adoption of agricultural innovations (Kouassi et al., 2018), which is consistent with the difficulties observed in your study regarding the use of improved farming techniques.

2. Production systems and cultivated varieties

The improved variety TME419 (Obama) dominates in the region. This phenomenon can be explained by its high resistance to viral diseases, as noted by Patil et al. (2015). In addition, it is more productive than local varieties and is able to adapt to the agro-ecological conditions of the region (Mahungu et al., 2003).

However, the persistent presence of local varieties such as Batamolenge and Nganza confirms Berry's (1993) observations that producers often maintain traditional varieties for their organoleptic qualities (taste, texture, suitability for processing).

The dominant techniques, notably simple plowing or plowing combined with ridging, remain rudimentary. These traditional practices, which are often poorly adapted, partly explain the low yields observed in farming communities. The adoption of modern techniques (fertilization, varietal selection, plant health management) can increase cassava productivity by a factor of 2 to 3, which is not the case in the areas under review (FAO, 2013). The difference between simple plowing in the commune of Molegbe (90%) and combined plowing with ridging in the commune of Gbadolite (90%) shows significant technical heterogeneity, confirming the conclusions of Kumar et al. (2011) on technical and organizational fragmentation in rural value chains in the DRC.

3. Cultivated areas and productivity

The average area planted with cassava (≈ 0.5 ha) indicates a system that is essentially subsistence-based, geared towards self-consumption with some surplus being sold. This small farm size is typical of rural areas in the Congo, which severely limits economies of scale, mechanization, and access to markets (Chausse et al., 2012).

4. Yields

The yields recorded (3.11 to 3.43 t/ha) are very low compared to the potential yields of 10 to 25 t/ha for improved varieties in Africa (Vernier et al., 2018) and 20 to 30 t/ha under sustainable intensification (FAO, 2013). The causes identified in our study are viral diseases, poor farming techniques, lack of inputs, and limited processing, all of which are well documented in the literature. Patil et al. (2015) and Nzinga (2012) confirm that mosaic and brown streak cause huge losses of up to 40 to 70% of yields.

5. Major constraints on cassava cultivation

Producers are mainly confronted with a lack of roads and difficulties in accessing markets (35 to 40%). This finding is consistent with USAID (1992), which confirms that the lack of adequate infrastructure limits the marketing of perishable products such as cassava; the viral diseases mentioned are consistent with the observations of Nweke (2003) and Patil et al. (op. cit).

The persistence of CMD and CBSD in the DRC is well documented by Mahungu et al. (2003); climatic disturbances partly explain the decline in production in certain areas, as shown by Kouassi et al. (2018) in Ivory

Coast; low processing, the lack of processing units is a major limitation in the value chain, as pointed out by ARC (2013). This lack contributes to post-harvest losses, as tubers can only be stored for 48 to 72 hours after harvest (Koko et al., 2014). These constraints support the hypothesis that current cassava production cannot sustainably support the region's development.

6. Economic and social implications

This study has shown that cassava plays a fundamental role in household income, but that current conditions do not allow it to become a competitive sector. The results confirm that households are heavily dependent on cassava for both food and income, but low productivity and constraints limit economic profitability. This finding corroborates that of Chausse et al. (2012), who emphasize that the cassava sector in the DRC is strategic but insufficiently structured to support regional economic development.

Thus, cassava cultivation has real potential to contribute to the socioeconomic development of Gbadolite, provided that it is modernized and supported by appropriate agricultural policies.

V. CONCLUSION

The purpose of this study is to conduct an agro-economic analysis of cassava cultivation in the Gbadolite region.

Based on a representative sample of 60 producers in the municipalities of Gbadolite, Molegbe, and Nganza, several aspects were analyzed: socio-demographic characteristics, varieties grown, cultivation techniques, difficulties encountered, and production levels.

The results show that cassava cultivation in Gbadolite relies mainly on an adult population with low levels of education and a high proportion of women, confirming its social and nutritional importance in households. The improved Obama variety dominates cultivation due to its productivity and disease resistance, while local varieties continue to be grown for their organoleptic qualities.

However, despite this potential, production faces countless difficulties: persistent viral diseases, poor cultivation techniques, small areas (≈ 0.5 ha), lack of inputs, degraded road infrastructure, absence of modern processing units, and climatic disturbances. These factors explain the very low yields observed (3.11 to 3.43 t/ha), which are significantly lower than African averages and agronomic potential.

In view of these factors, it is clear that cassava cultivation in its current state cannot, on its own, be a driver of sustainable development.

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