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The impact of global warming on Cassava production in the Kalunga, Loatshi and Lusanza sectors, Luiza territory, in Kasai Central, Democratic Republic of the Congo

Mongala Matanda François¹, Marobo Pongo Hans¹, Ngadi Muangala Esther¹, Idrissa Assumani Zabo¹, Mutambel'Hity¹, Ndombe Tamasala Rombeau¹

¹Higher Institute of Agronomic and Veterinary Studies (ISEAV) of Mulavudi, Democratic Republic of the Congo (DRC)

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ABSTRACT

Cassava is the main food crop in the Luiza territory (Kasai Central, DR Congo), but its production is threatened by global warming.

The aim of this study is to analyse farmers' perceptions of climate change, its impacts on cassava production and adaptation strategies in the Kalunga, Loatshi and Lusanza sectors of the Luiza territory.

The methodology of this study involved a descriptive cross-sectional survey of farmers (63 in Kalunga, 63 in Loatshi and

64 in Lusanza) selected using stratified random sampling. Data were collected via structured questionnaires and analysed using descriptive statistics and Pearson's chi-square test (significance level $p > 0.05$).

The results were as follows: 87.9 per cent of farmers perceived an increase in heat and 83.2 per cent a delay in the rains. The main impacts cited were a decline in yield (90.0 per cent), of which 61.4 per cent estimated the decline to be more than 50 per cent (Table 3a), an increase in mosaic disease (72.6 per cent) and tuber rot (65.3 per cent).

The main adaptation strategies involve delaying the sowing date (62.1 per cent), whilst only 9.5 per cent use improved cuttings. The lack of adaptation is linked to unavailability (68.0 per cent; see Table 4a). The top priority is access to improved cuttings (58.4 per cent).

The chi-squared test shows no significant difference between the three sectors ($P > 0.05$ for all variables, Table 5), indicating uniform exposure.

In short, global warming affects cassava production uniformly across the Luiza region as a whole and in the three sectors surveyed. Improving access to improved, climate-tolerant cuttings and climate information is essential.

keywords: global warming, cassava, farmers' perceptions, adaptation, Luiza, DR Congo.

Introduction

1. Background

Climate change is now one of the major challenges facing humanity, particularly for agriculture in sub-Saharan Africa.

According to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC, 2023), anthropogenic global warming has already reached 1.1°C above pre-industrial levels, and every additional fraction of a degree increases the risk (IPCC, 2023, p. 4).

In sub-Saharan Africa, this rise is leading to a profound disruption of the agricultural seasons, with delayed rains and an increase in the frequency of droughts (IPCC, 2022, p. 12).

In the Democratic Republic of the Congo, over 95 per cent of agriculture is rain-fed and employs more than 70 per cent of the working population (FAO 2021, p. 23).

Cassava (*Manihot esculenta* Crants) is the leading crop, with national production estimated at 40 million tonnes (INS, 2020, p. 45).

In Kasai-Central, it provides both food security and cash income for rural households (Ministry of Agriculture, 2019, p. 8).

However, several authors highlight the vulnerability of this crop. *Fermont et al.* (2009, p. 112) note that whilst cassava is drought-tolerant, 'temperatures above 32°C and poor rainfall distribution significantly reduce tuberisation'.

Similarly, *Munyahali et al.* (2021, p. 67), in a study in South Kivu, showed that a delay in the rainy season of more than 30 days leads to a 35–50 per cent drop in yield.

The territory of Luiza, one of the five territories of Kasai-Central, covers 14,825 square kilometres (CAID, 2022, p. 2). Its climate is classified as AW according to the Koppen classification, with a rainy season from September to April and a dry season from May to August (BULTOT, 1971, p. 33).

The sectors of Kalunga, Loatshi and Lusanza, situated in the central part of the territory, are contiguous and share the same agro-ecological characteristics. Their economy is based on cassava. However, the report by the Luiza District Agricultural Inspectorate (2023, p. 5) notes a continuous decline in yield, falling from 12 tonnes per hectare in 2018 to 7 tonnes per hectare in 2023.

This situation poses a major scientific problem and justifies our research.

2. Problem statement and research question

The problem is the decline in cassava productivity in the Kalunga, Loatshi and Lusanza sectors. Is this decline linked to global warming?

Q1: How do farmers in the Kalunga, Loatshi and Lusanza sectors perceive climate change?

Q2: What is the impact of climate change on cassava production in these three sectors?

Q3: What adaptation strategies are cassava producers in these sectors developing?

3. Objectives

3.1. General objective

To analyse the impact of global warming on cassava production in the three sectors.

3.2. Sub-objectives

- 1) To identify the causes of rising temperatures and delayed rains in this part of the Luiza region;
- 2) To determine the consequences of rising temperatures on cassava productivity in these three sectors;
- 3) To propose strategies to be adopted by the communities in the Kalunga, Loatshi and Lusanza sectors to address the decline in cassava yields and the rise in disease incidence.

4. Hypotheses

H1: Climate change is the cause of rising temperatures and delayed rainfall.

H2: Climate change is the underlying cause of the decline in yields and the rise in disease incidence.

H3: Adapting to changes in the cropping calendar is an adaptation strategy.

5. Significance and scope

- Scientific significance and scope:
 - This work will serve as a reference for future researchers;
 - This study identifies the real problem, meaning we no longer have to work in the dark;
 - In short, the significance of this topic lies in transforming a farmers' complaint (we are no longer producing well) into quantified scientific evidence to attract concrete solutions to Luiza.
- Spatial scope: three neighbouring sectors within the Luiza area.
- Temporal scope: 2016–2026.

I. Literature review

This chapter presents the basic concepts of our study. It is structured around four points: global warming, cassava cultivation, the relationship between the two phenomena, and adaptation strategies.

I.1. General information on global warming

Global warming is defined as the sustained increase in the average temperature of the climate system (IPCC, 2023, p. 2). It is caused by rising levels of greenhouse gases.

In Central Africa, the effects are already visible. According to Boko et al. (2007, p. 45), cited by the GIES, the temperature in Central Africa rose by 0.7°C during the 20th century. Samba and Nganga (2011, p. 23) note that in Congo-Brazzaville, the start of the rainy season has shifted from September to October. In Kasai, Kisauzi et al. (2018, p. 21) observed a delay of 20 to 40 days in the onset of the rainy season and an increase in periods of drought lasting 7 to 15 days.

The consequences include disruption to the agricultural calendar, reduced soil fertility and an increase in pest infestations (FAO, 2016, p. 14).

I.2. General information on cassava cultivation

I.2.1. Importance

Cassava is the third most important source of calories in Africa after rice and maize (FAO, 2021, p. 9). In Kasai-Central, it is the main crop used for fufufu.

I.2.3. Varieties grown in Luiza

Local varieties include: Rulenda, Ntalama, Kumbaja Bana and Kamanga, which have a long growing cycle (12 to 18 months) but are susceptible to mosaic disease; and the improved varieties developed by INERA: Banzala and Mayoyi, which are resistant to mosaic disease but have not been widely adopted (INERA, 2018, p. 12; Kapalay, 2020, p. 15).

I.3. The relationship between global warming and cassava production

Several studies demonstrate this link. Munyahali et al. (2021, p. 65) in South Kivu found that 'a 30 per cent water deficit reduces yield by 40 per cent'. In Eastern Kasai, Tshomba (2022, p. 42) demonstrated a negative correlation between delayed rains and cassava yield ($r = -0.78$).

The main impacts are:

- a) Decline in yield: water stress reduces tuberisation (El-Sharkawy, 2004, p. 81).
- b) Increased incidence of disease: heat favours the whitefly (*Bemisia tabaci*), a vector of mosaic virus (Legg et al., 2011, p. 34). Legg explains: ‘a 2°C increase doubles the whitefly population’ (p. 36).
- c) Root rot: heavy, concentrated rainfall causes asphyxiation and bacterial rot (Boher and Agbobli, 1992, p. 28).

I.4. Farmers’ adaptation strategies

‘Adaptation is the adjustment of natural or human systems’ (IPCC, 2014, p. 5). The strategies identified are:

- Modification of the cropping calendar: sowing later (Kisauzi et al., 2018, p. 29).
- Building higher ridges to prevent flooding (Fermont et al., 2009, p. 118).
- Use of early-maturing and resistant varieties (INERA, 2018, p. 14).
- Crop rotation and agroforestry (FAO, 2016, p. 33).

However, in Kasai, access to these adaptation measures is limited by a lack of guidance and the cost of improved cuttings (Munyuli et al., 2020, p. 51).

I.5. Theoretical framework

Our study draws on Chambers’ theory of vulnerability (1989, p. 12), which defines vulnerability as exposure to risk + sensitivity – adaptive capacity. Farmers in Kalunga, Loatshi and Lusanza are exposed (climate), sensitive (dependence on cassava) and have low adaptive capacity.

The literature shows that cassava, although hardy, is affected by climatic conditions. Few studies exist specifically on LUIZA and its three neighbouring sectors, hence the originality of our work.

II. Study area and methodology

II.1. Study Area

The study was conducted in the territory of LUIZA, in the province of Kasai-Central, in the DRC. It covers 14,825 km² with an estimated population of 1.2 million inhabitants (CAID, 2022, p. 2). The climate is of the AW type (Bultot, 1971, p. 33): 1,400 mm/year, with a dry season from May to August. The average temperature is 25.5°C. The soils are sandy-clay ferrallitic, favourable for cassava.

Three contiguous areas have been selected for their high cassava production and accessibility:

- Kalunga: 25 km from the centre of LUIZA, with approximately 4,500 cassava producers;
- Loatshi: 70 km away, with around 4,200 producers;
- Lusanza: 52 km away, with around 4,100 producers;
- Estimated total population: 12,800 (Luiza Agricultural Inspectorate, 2023, p. 5).



II.2. Methodology

Type and period of study:

Descriptive cross-sectional survey, conducted from 15 June to 30 July 2026, during the dry season and harvest period.

Sampling:

The sample size was calculated using Yamane’s formula (1967, p. 886): $n = N / (1 + N \times e^2)$ where $e = 0.07$. For $N = 12,800$, $n = 190$. Proportional distribution:

- Kalunga: 63 producers (33 per cent);

- Loatshi: 63 producers (33.2);
- Lusanza: 64 producers (33.6 per cent).

Inclusion criteria:

Having been a cassava producer for ≥ 5 years, residing in the area, and giving free consent.

Data collection:

A structured questionnaire comprising 12 closed-ended questions (see appendix), administered face-to-face in Tshiluba and French. Average duration: 10 minutes. A pre-test was conducted with 10 key producers (group leaders, agronomists) who were interviewed.

Varieties studied:

- Independent: perceived warming (heat, delayed rains, drought);
- Dependent: reduced yield, diseases, rot;
- Adaptation: changes to planting dates, ridging, varieties.

Data processing and analysis:

Data entered into Excel 2016, analysed using SPSS 26. Descriptive statistics (frequencies, %). Chi-square test to assess the association between climate perception and reduced yield (significance level $p < 0.05$).

Ethical considerations:

Anonymity, verbal consent, authorisation from the Luiza district administrator.

III. Results

The data relate to 190 producers surveyed: 63 in Kalunga, 63 in Loatshi and 64 in Lusanza. The response rate was 100 per cent.

III.1. Characteristics of the farmers

Table 1: Profile of respondents (n=190).

Variable	Category	Number	%
Gender	Male	112	58.9
	Female	78	41.1
Age	18–35 years	54	28.4
	36–50 years	89	46.8
	51 years and over	47	24.7
Area under cassava	<0.5 ha	81	42.6
	0.5–1 ha	92	48.4
	1 ha	17	8.9
Common variety	Local	128	67.4
	INERA Enhanced	18	9.5
	Both	44	23.1

The majority are men aged 36–50 with small plots (<1 ha), who still use susceptible local varieties.

III. 2. Perceptions of global warming

Table 2: Farmers' perceptions of climate change.

Perception	Yes	No	%Yes	%No
Increased heat over the last 10 years	167	23	87.9	12.1
The rainy season starts later	158	32	83.2	16.8
More droughts during the peak season	142	48	74.7	25.3

There is no significant difference between the three sectors ($p=0.42$). The consensus is unanimous: the climate has changed. Farmers in LOATSHI (further away) report more delayed rains (83.2 per cent).

III.3. Impacts on cassava production

Table 3: Reported impacts on cassava.

Reported impact	Yes	% compared to 190
Decline in yield over the last 5 years	171	90
Increase in mosaic	138	72.6
Increase in root rot	124	65.3
Compulsory replanting	131	68.9
Total citations	564	Not included

Among those experiencing a drop in yield ($n=171$).

Climate–yield association: The chi-square test shows a significant association between the perception of delayed rains and a decline in yield: $\chi^2 = 18.7$; $p = 0.0001 < 0.05$. Those who perceive the delay are four times more likely to experience a decline.

III.4. Adaptation strategies

Table 4: Adaptation strategies ($n=190$).

Strategy	Number	%
Change in planting date	118	62.1
Higher/raised ridges	67	35.3
Change of variety	38	20
No adaptation	41	21.6
Uses improved cuttings	18	9.5

Reason for not using improved cuttings ($n=172=190-18$ who already use improved cuttings).

III.5. Comparison across sectors

Table 5: Comparison across sectors using the chi-squared test ($n = 190$).

Variable tested	Kalunga $n = 63$	Loatshi $n = 63$	Lusanza $n = 64$	χ^2	P-value	Interpretation
Perceives an increase in heat	87.3%	88.9%	87.5%	0.08	0.96	No difference;
Decrease in yield	90.5%	88.9%	90.6%	0.12	0.94	No difference
Uses improved cuttings	12.7%	11.1%	4.7%	2.71	0.25	Not significantly different.

All $P > 0.05$. Therefore, there is no significant difference between Kalunga, Loatshi and Lusanza. The whole of the Luiza district in general, and the three sectors in central Luiza, are affected in the same way.

Discussion

Our results show that 87.9 per cent of farmers in Kalunga, Loatshi and Lusanza perceive an increase in heat and 83.2 per cent a delay in the rains. These perceptions are consistent with scientific observations in Kasai. Kisaizi et al. (2018, p.21) had already reported a 20–40-day delay in the rainy season in Kasai-Central. Similarly, the fact that 74.7 per cent of our farmers reported pockets of drought confirms the findings of Samba and Nganga (2011, p.23) in Congo-Brazzaville. Farmers' perceptions are therefore a good indicator of actual climate change, as demonstrated by Kapalay et al. (2020, p. 6).

The most alarming impact is the decline in yields reported by 90 per cent of respondents, 61.4 per cent of whom experienced a loss of more than 50 per cent. This figure is higher than that found by Tshomba (2022, p. 42) in Kasai-Oriental (a 35 per cent decline) but is similar to that reported by Munyahali et al. (2021, p. 65) in South Kivu (40–50 per cent). The difference may be explained by the greater vulnerability of Luiza's sandy-clay soils, which retain little water (Bullot, 1971, p. 33). The significant association between delayed rains and reduced yield ($p=0.0001$) confirms the direct role of climate, beyond conventional agronomic factors (Fermont et al., 2009, p. 110).

The increase in mosaic disease (72.6 per cent) and rot (65.3 per cent) is consistent with the literature. Legg et al. (2011, p. 36) explain that heat increases the population of whiteflies, which are vectors of mosaic disease. Boher and Agbobli (1992, p. 28) demonstrated that waterlogging caused by heavy, concentrated rainfall promotes bacterial rot, which corresponds to our field observations in Lusanza, a lower-lying area.

With regard to adaptation, 62.1 per cent change the planting date, which is a classic avoidance strategy (FAO, 2016, p. 33). However, only 9.5 per cent use improved cuttings, compared with 23 per cent at the national level (INERA, 2018, p. 12). The main reason (68 per cent not available) highlights Luiza's isolation and the lack of a seed distribution chain. This is the same constraint identified by Munyuli et al. (2020, p. 51) in Kasai. The low adaptive capacity can therefore be explained by Chambers' vulnerability theory (1989, p. 12): high exposure, high sensitivity, low capacity.

Limitations of the study: The study is based on perceptions, with no local meteorological data (there is no weather station in Luiza). The sample is limited to three contiguous sectors and cannot be generalised to the whole territory.

Conclusion and recommendation

This study, conducted amongst 190 farmers in the Kalunga, Loatshi and Lusanza sectors of Luiza Territory, shows that global warming is a reality experienced by farmers and has a direct impact on cassava production.

Our three hypotheses are confirmed:

1. Farmers clearly perceive an increase in temperature and a delay in the rains.
2. The climate is causing a significant drop in yields and an increase in diseases.
3. Adaptation strategies remain limited and traditional.

In light of this situation, we recommend:

1. For farmers in Kalunga, Loatshi and Lusanza:

Systematically adopt raised ridges (40–50 cm) to limit rot and delay planting by 2–3 weeks until after the first useful rains.

2. For the government and partners (Luiza Agricultural Inspectorate, INERA Gandajika, FAO):

Establish a distribution system for improved, disease-resistant cuttings (Banzala, Mayoyi) and install a manual weather station in Luiza town centre to broadcast forecasts via community radio.

3. For future research:

Conduct a study involving actual agronomic measurements of yields (t/ha) and analysis of satellite climate data to precisely quantify losses in Luiza.

Cassava will remain the cornerstone of food security in Luiza, but without rapid adaptation, the districts of Kalunga, Loatshi and Lusanza risk a food crisis within the next five years.

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