

To Cite:

Kure HM, Kaka Y, Jega AA, UmarMohammed I, Sawadogo-Compaore EMFW, Pita JS. Farmers' knowledge and perception status of cassava viral disease and its management technologies in north west and north east, Nigeria. *Discovery Agriculture* 2025; 11: e12da3137

doi: <https://doi.org/10.54905/disssi.v11i24.e12da3137>

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Peer-Review History

Received: 18 November 2024

Reviewed & Revised: 23/December/2024 to 25/July/2025

Accepted: 01 August 2025

Published: 09 August 2025

Peer-Review Model

External peer-review was done through double-blind method.

Discovery Agriculture
pISSN 2347-3819; eISSN 2347-386X



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Farmers' knowledge and perception status of cassava viral disease and its management technologies in north west and north east, Nigeria

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ABSTRACT

Agriculture is an important sector in Nigeria economy, however, with high risk due to natural factors like climate change, pests and diseases among others pose significant threats to food security and livelihoods in northern Nigeria. Many reports indicated that the yields on smallholder farms are relatively low largely due to pest and disease infections hence, pest and disease management is crucial to mitigate crop losses. In this study, an attempt was made to evaluate farmers' knowledge and perceptions of Cassava diseases and management technologies in North West and North East, Nigeria. The study utilizes cross-sectional data collected in 2023 from a randomly selected sample of 536 households (254 in North West and 282 in North East) using structured questionnaire (kobo collect). The data collected from the households were analyzed using descriptive statistics. The result of descriptive statistics indicates that there is mean difference in the adopter and non-adopters socio economic characteristics in the study area. Farmers' knowledge on cassava diseases, symptom identification and the consequences of the disease to be high for both adopters and non-adopters. Findings also reveal low knowledge on the causes, mode of transmission, control and management of the disease among adopters and non-adopters in the study area. Overall, adopters have a good perception about the CDMTs. This study highlights the need to enhance the farmers' access to educational programme, extension services and policy support to enhance cassava disease management and improve livelihood.

Keywords: Cassava farmers, Knowledge, Perception, Cassava disease, Disease management.

1. INTRODUCTION

Cassava, with a *Manihot esculenta*, is a tuber crop that is being used as one of the basic and mainly consumed food in different countries (Fathima *et al.*, 2023). Cassava is an

essential food security crop in many African farming systems and provides more than half of the dietary calories for over 700 million people in Africa (Szyniszewska, 2020; Amelework et al., 2021). Cassava is mainly produced by smallholder farmers whose average cultivation area is less than one hectare (ha) (Mujuru and Obi, 2020; Dzanku et al., 2021). Most of the production is used for household consumption or sold as a food crop to domestic markets (Scott, 2021). It is mainly grown under intercropping systems with other crops such as maize, legumes, and bananas (Monteiro et al., 2020; Ravi et al., 2021).

Cassava is a crop with enormous potentials which provides a stable food base for the populace, components in livestock feeds and raw materials for industries (Amelework and Bairu, 2022). Cassava farming has recorded a resounding success in sub-Saharan Africa out of the numerous stories of crop intervention failures in the region. As a result of this, many African countries have embraced its cultivation with renewed technologies (Sanusi et al., 2020). Nigeria is among such African countries where almost every household in rural areas grows cassava on small farms as one of the staple food crops to feed families and supply the local markets (Nanbol and Namo; 2019). Cassava has high tendency to serve as a relief crop to food insecurity because of its copious consumption in various forms by people and its ability to subsist and give appreciable yields on soils where many other crops fail to perform, thus stimulating its cultivation by many smallholder farmers (Ndjouenkeu *et al.*, 2021). According to Anyeagbunam *et al.*, (2015), cassava has become a very popular crop in Nigeria and is fast replacing other traditional local staples in the country (Oyelere, 2020). FAOSTAT, (2014) maintained that cassava has moved from minor crop to major crop in Nigeria and has gained industrial recognition and importance (Kashyap, and Agarwal, 2020; Amelework et al., 2021). This then presupposed that traditional use or utilization of cassava is changing from primarily human consumption to processing into industrial products as well as for exportation (Udoro et al., 2021).

Cassava is important is not only limited to been a food crop but even more as a major source of income for rural households. As an income crop, cassava generates cash income for the largest number of households' compared with other staples in the same category (Sanusi et al., 2020).

Tropical farmers produce over 233 million tons of cassava on 18.6 million hectares of land (Sajeev et al., 2021). A total of 40 countries in Africa make up more than 50% of the production, while Asia and Latin America contribute to about 34% and 15% respectively (Crippa et al., 2021). Although socioeconomic factors, market conditions and abiotic constraints have negative impact on cassava production, pests and diseases are well known to substantially reduce its yields, resulting in multi-billion dollar crop losses Pathak, 2019; Blesh et al., 2023). According to FAO, (2018a) cassava is a choice crop for rural development, poverty alleviation, economic growth and ultimately food security (Adebayo and Silberberger, 2020; Adu et al., 2023).

Although Africa is the world's largest cassava producer with 169 million tones (61% of global production), the average yield is paradoxically the lowest at 9 tones/ha compared to Asia with a yield of 21.5 t/ha (Faostat, 2019). Latest report as at 2017 shows that Nigeria is the largest producer of cassava in the world with 59 million tons of tuberous root production, representing about 20% of global production (Otekunrin et al., 2021; IITA, 2021). Cassava is an agricultural produce that can generate foreign exchange for Nigeria, considering her place in production and exportation of cassava products across the globe (Oyekola et al., 2021).

The steady increase in the global population and changes in climate are adding pressure to agriculture as the need to produce more food intensifies. South Asia, Latin America and Sub-Saharan Africa are among the regions facing the detrimental effects of climate change due to changes in the frequency and severity of drought and floods in addition to increases in temperatures and decreasing soil water (FAO, 2018b; WHO, 2018; Vos and Bellù, 2019). Increasing temperature is also anticipated to result in increased abundance of many insect pests through higher rates of growth and population development as well as their spread and migration (Skendžić et al., 2021). Great efforts are therefore being put into increase the management of emerging pests and diseases along with the production of climate-resilient and disease-resistant crops in these regions in an attempt to reduce the risk of hunger (FAO, 2018b; Mrisho et al., 2020; Osumba et al., 2021).

Some of these diseases that attack cassava are cassava mosaic disease (CMD) and cassava brown streak disease (CBSD) both largely propagated through the exchange of infected planting materials among farmers, and resulting in losses of over 1 billion USD annually and resulting to about N100 billion (approximately 250 million USD) loss in Nigeria (Amelework and Bairu, 2022). Currently, CBSD is restricted to East and Central Africa and has not been reported in any West African country (Chen et al., 2019; Ferguson et al., 2019). However, reports of the spread of previously localized virulent strains of CMD to new regions raises concern and necessitates the need for urgent interventions to minimize this trend and ensure continued exclusion of the devastating CBSD from West Africa and/or ensure that the disease is promptly recognized, reported and effectively contained should it be inadvertently introduced into the region

(Eni et al., 2019). Cassava viral diseases are among the major constraints currently affecting cassava production in Nigeria (Otero, 2022).

To reduce these losses, several disease management methods such as planting resistant varieties, planting improved variety, Roguing, good agronomic practices and biological control methods have been recommended by WAVE since 2014 through series of campaigns which has been conducted by the Central and West African Virus Epidemiology in Nigeria and in the member countries in Central and West Africa with the objective of raising awareness and training the actors of the cassava sector (farmers, seed multipliers, extension agents, etc.) on cassava disease identification, its causes, consequences and management technologies. These disease control methods are either too expensive for poor resource farmers or not effective due to the aggressiveness and plasticity of the pathogen. These measures depend to a great extent on farmers' knowledge and perceptions towards crop protection and the availability, affordability, efficacy and sustainability of disease management methods (Valencia et al., 2015).

Several studies have investigated farmers' perceptions and knowledge of various issues associated with agricultural practices and their findings confirm the importance of sharing information between farmers and researchers (Kansiime et al., 2019; Mbinda et al., 2021). Assessment of farmers' perceptions and knowledge on different subjects can assist to display farmers' attitudes and behaviour towards scientific evidence. It is important to understand what farmers know about cassava viral disease, its causes and consequences, the disease control methods they use and their perceived effectiveness of the management technologies. Farmers' participation and engagement in the implementation of plant disease control measures are essential for their acceptance and adoption. This study aims to investigate farmers' knowledge and perceptions of cassava viral disease and its management technologies.

2. MATERIALS AND METHODS

2.1. Description of the Study Area

This study was conducted in North West and North East, Nigeria.

2.2. Nigeria

Nigeria is a country in West Africa that shares land borders with the Republic of Benin in the West, Chad and Cameroon in the East, and Niger in the north. Its coast lies on the Gulf of Guinea in the south and it borders Lake Chad to the NorthEast. Notable geographical features in Nigeria include the Adamawa Highlands, Mambilla Plateau, Jos Plateau, Obudu Plateau, the Niger River, River Benue, and Niger Delta. Nigeria is the most populous country in Africa and has 36 States and a Federal Capital Territory (FCT) located in Abuja. The States are also subdivided into smaller administrative units known as Local Government Areas (LGAs).

The country is disaggregated into six geopolitical zones: north-East, north-West, north-central, south-East, south-West, and south-south. Found in the tropics, where the climate is seasonally damp and very humid, Nigeria is affected by four climate types; these climate types are distinguishable, as one moves from the southern part of Nigeria to the northern part of Nigeria through Nigeria's middle belt. With a population of over 220 million, Nigeria has over 250 ethnic groups of which the three largest are: Hausa, Igbo, and Yoruba, and these ethnic groups speak over 500 distinct languages and are identified with a wide variety of cultures. Agriculture remains an important sector of the economy, as of 2010, even though it used to be the principal foreign exchange earner of Nigeria. The major crops include cowpea, rice, corn, cassava, millet, guinea corn, yam, soybean, sorghum, and melon while the cash crops are cocoa, rubber, cashew, kola nut, and oil palm (Britannica, 2023).

2.2.1. North West and North East

North West and North East encompasses 13 states with a combined population of approximately 70 million people. The regions are characterized by diverse geographical features, including savannas, grasslands and semi-arid savannas. The predominantly muslim population is comprised of various ethnic groups, including Hausa, Fulani and Kanuri. Agricultural and trade are significant economic activities, with mineral resources also present. Figure 1 presents a map of the study area.

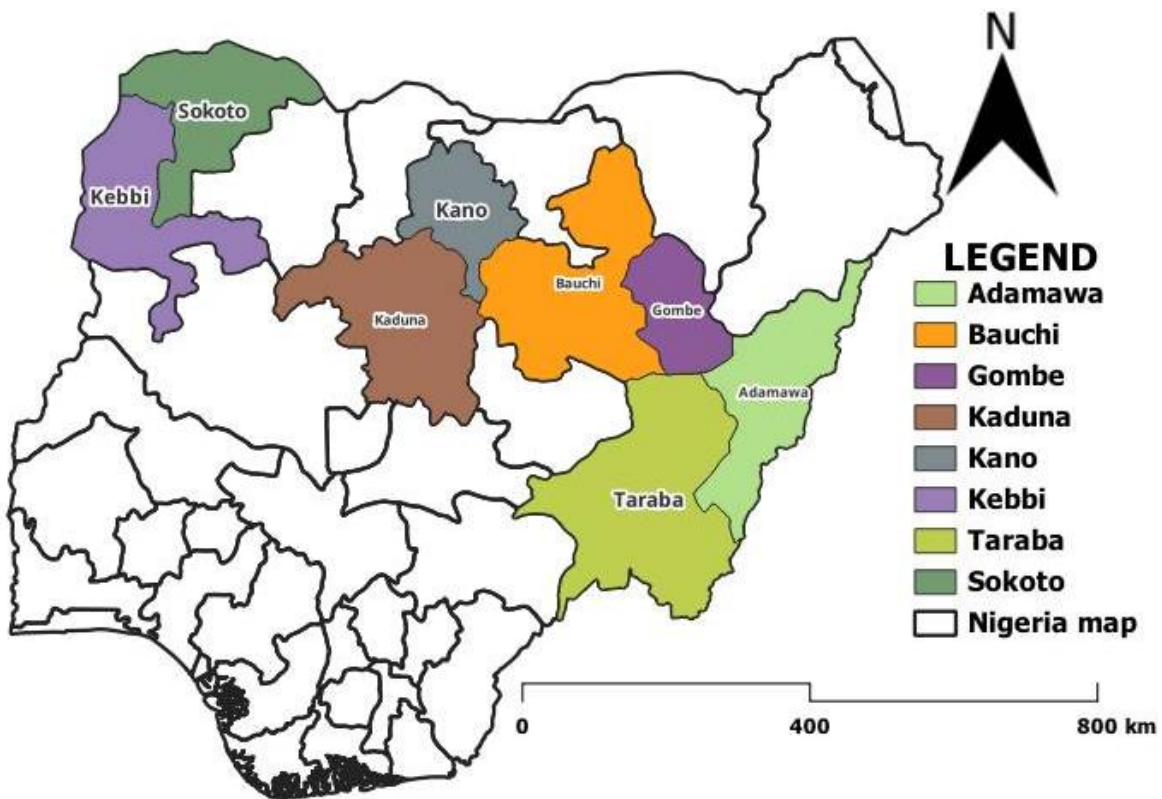


Figure 1: Map of Nigeria Showing Sampled States

2.3. Sampling Procedure and Sample Size

This study employed a Multi- stage sampling techniques to select the study states and sample. First stage involved a purposive selection of four states from each of the two geo political zones based on the active WAVE activities on cassava diseases managements in the areas. Second stage involved a purposive selection of one LGA from each senatorial zone within the chosen states, prioritizing areas with high cassava production intensity and because of the active WAVE activities. Reconnaissance survey was conducted to identify registered participating cassava farmers of WAVE in the Selected LGAs. This was carried out with the assistance of Nigeria Cassava Growers Association (NCGA) and Agricultural Extension Agents. A random selection of 257 WAVE Beneficiaries which was determined by Yamane (1973) method of sample size determination as presented below:

$$n = N / (1 + N (e)^2) \dots\dots\dots (1)$$

Where:

- n = sample size
- N = sampling frame
- e = error or significance level (0.05)

Sample size for States and total respondents sample size were determined by the following formula;

$$n = N / (1 + N (e)^2) \dots\dots\dots (2)$$

Where:

- n = sample size
- N = sampling frame (total number of states)
- e = error or significance level (0.05)

The North West dataset contains 254 farm households and of these, about 48% are adopters i.e adopted at least one of the disease management practices during 2022/2023 cropping season. The area under cassava cultivation is about 1.3 ha for adopters. The result shows that there is mean difference observable in the age of the adopters (41 years) and non-adopters (38 years), although both categories are in their active age. This is supported by the previous studies of Bayissa (2014) who found that the overall mean age of the sampled household head was about 44.6 years; the figure was nearly similar for tef technologies adopters and non-adopters.

Table 1. Descriptive Statistics of Dummy Variables by Farm Households

Variables	North West				North East			
	Adopters		Non-adopters		Adopters		Non-adopters	
	F	%	F	%	F	%	F	%
Sex								
Male	107	88.0	131	98	104	90	140	84
Female	14	12.0	2	2	12	10	26	16
Marital Status								
Married	103	85.1	115	86	105	90.5	138	83.1
Single	18	14.9	18	14	11	9.5	28	16.9
Hired labour								
Yes	90	74	104	78	91	78	116	70
No	31	26	29	22	25	22	50	30
Family labour								
Yes	99	82	120	90	106	91	147	89
No	22	18	13	10	10	9	19	11
Extension service								
Yes	91	75	107	80	91	78	135	81
No	30	25	26	20	25	22	31	19

Source: Field survey data 2023

Table 2. Descriptive Statistics of Continuous Variables by Farm Household

Variables	North West				North East			
	Adopters		Non-adopters		Adopters		Non-adopters	
	Mean	Std	Mean	Std	Mean	Std	Mean	Std
Age	41.46	14.75	38.35	12.07	41.34	11.96	41.19	11.94
Educational level	10.63	5.79	10.56	5.45	11.61	5.21	9.79	5.79
House hold size	9.22	4.77	8.99	4.96	9.37	5.84	9.42	5.64
Farm size	3.04	4.92	3.64	3.66	4.55	3.75	5.22	8.38
Cassava farm size	1.30	1.01	1.47	1.49	1.36	1.23	1.73	4.04
Yrs of farming exp	18.53	11.51	15.05	9.72	16.17	8.14	16.70	7.98
Yrs of cassava farming	8.00	7.41	9.25	7.15	10.80	7.19	10.95	7.11
Distance to market	5.97	5.74	8.09	8.58	9.43	9.79	10.99	13.19

Source: Field survey data 2023

The North East dataset contains 282 farm households and of these, about 41% are adopters i.e. adopted at least one of the disease management practices during 2022/2023 cropping season. The result shows that the area under cassava cultivation is about 1.36 ha for adopters. The result of this study shows that no difference is observed in the age and household size for both categories of farmers. This

implies that the respondents are more likely to adopt the technologies since young farmers may have a better education. Larger household size implies more active family labour.

3.2. Descriptive Analysis: (Farmers Knowledge and Perception of Cassava Diseases and Management Practices)

Table 3 to 11 presents the results of our survey, highlighting farmers knowledge and perception of cassava disease and management practices by the respondents.

3.2.1. Major cassava diseases and pest in the area

The major diseases identified by farmers in the area are presented in Table 3. The result shows that majority of adopters and of non-adopters in North West and North East report that viral diseases (CMD) is the most prevalent disease of cassava in the study area with the photos provided during the survey. Followed by whiteflies and mites which were reported by both the adopters and non-adopters as the most prevalent pest in the study area. The seriousness of these diseases merits the urgent attention of extension agents to enlighten other farmers on how to combat them.

Table 3: Major Cassava Diseases and Pest in the Study Area

Cassava diseases	North West				North East			
	Adopters		Non-adopters		Adopters		Non-adopters	
	N	%	N	%	N	%	N	%
Fungi	8	7	7	5	16	14	5	3
Bacterial	19	16	11	8	25	22	11	7
Viral (CMD, CBSD)	99	82	94	71	76	66	100	60
Mites	34	28	44	33	32	28	45	27
White fly	48	40	32	24	14	12	11	7
Others	2	2	5	4	4	3	20	12

Source: Field survey data 2023

3.2.2. Major cassava diseases and pest that cause most damage in the area

The major diseases identified by farmers that cause most damage in the area are presented in Table 4. The result shows that majority of adopters and of non-adopters in North West and North East report that viral diseases (CMD) is the most prevalent disease of cassava that cause most damage in the study area, followed by cassava pest (white fly and mites) which was reported by both the adopters and non-adopters as the most prevalent pest in the study area. The seriousness of these diseases merits the urgent attention of extension agents to enlighten other farmers on how to combat them.

Table 4: Disease and Pest that Cause the most Damage

Cassava diseases	North West				North East			
	Adopters		Non-adopters		Adopters		Non-adopters	
	N	%	N	%	N	%	N	%
Fungi	3	2	0	0	4	3	1	1
Bacterial	6	5	3	2	6	5	4	2
Viral (CMD, CBSD)	69	57	73	55	58	50	117	69
Mites	17	14	28	21	25	22	22	13
White fly	28	23	16	12	14	12	10	6
Others	1	1	5	4	1	1	10	6
Don't know	0	0	4	3	4	3	5	3

Source: Field survey data 2023

3.2.3. Cassava farmers' knowledge on causes of disease (CMD)

The knowledge of cassava farmers of the causes of cassava disease is presented in Table 5. Analysis of the results in Table 5 indicates that in both North West and North East the knowledge of most farmers on the causes of cassava disease was high for adopters and low for non-adopters, as majority (41%) of the adopters were of the opinion that the diseases is cause by a pest (whiteflies), virus (32%) and the use of infected cuttings (27%) while majority (30%) of the non-adopters report that they don't know the causes of the disease only few were of the opinion that the disease is caused by lack of rain, whiteflies and virus, some respondents even report that the disease is cause as a result of harvesting cassava leaves.

Table 5: Cassava Farmers' Knowledge on Causes of Cassava Disease (CMD)

Causes of Cassava diseases	North West				North East			
	Adopters		Non-adopters		Adopters		Non-adopters	
	N	%	N	%	N	%	N	%
A virus	43	36	30	23	32	28	28	17
The whitefly	60	50	33	25	38	33	23	14
The use of infected cuttings	40	33	18	14	24	21	16	10
Lack of rain	20	17	27	20	38	33	44	27
Soil moisture	7	6	10	8	11	9	8	5
Mineral deficiency	4	3	7	5	11	9	13	8
Other (Specify)	6	5	9	7	1	1	10	6
Don't know	16	13	41	31	12	10	33	20

Source: Field survey data 2023

3.2.4. Cassava farmers' knowledge on mode of transmission of cassava disease

The result in Table 6 reveals that majority of the adopters in North West and North East were of the opinion that cassava disease are transmitted through the use of infected planting materials (54%) and whiteflies (40%). Majority (63%) of the non-adopters have low knowledge about the mode of transmission of the disease as only few (30%) of non-adopters were of the opinion that the disease are transmitted through the use of infected plant and whiteflies.

Table 6: Cassava Farmers' Knowledge on Mode of Transmission

Transmission methods	North West				North East			
	Adopters		Non-adopters		Adopters		Non-adopters	
	N	%	N	%	N	%	N	%
Through the white fly	47	39	26	20	48	41	16	10
Through the use of infected cassava cuttings	63	52	41	31	64	55	38	23
Don't know	44	36	77	58	30	26	86	52
Other (Specify)	3	2	3	2	0	0	3	2

Source: Field survey data 2023

3.2.5. Cassava farmers' knowledge on consequences of the disease

The result in Table 7 shows that majority of adopters and non-adopters in North West and North East were of the opinion that the disease (CMD) leads to decrease in yield, Poor plant growth and lack of healthy planting materials as the consequences. This implies that even with non-adopters knowledge on the consequences of the disease they are not adopting the technology which could be as a result of lack of access to resources, inadequate extension service, therefore there is need for training of farmers on the causes, control measures and management of the disease.

Table 7: Cassava Farmers' Knowledge on the Consequences of the Disease

Consequences	North West				North East			
	Adopters		Non-adopters		Adopters		Non-adopters	
	N	%	N	%	N	%	N	%
Poor plant growth	63	52	53	40	73	63	61	37
Decrease in yield	99	82	98	74	91	78	105	63
Lack of healthy plant material	36	30	16	12	19	16	7	4
Other (Specify)	0	0	0	0	1	1	0	0
Don't know	9	7	20	15	6	5	18	11

Source: Field survey data 2023

3.2.6. Cassava farmers' knowledge on control of disease

Analysis of the results in Table 8 on knowledge of cassava farmers on the control of cassava diseases reveals that majority of adopters in North West and North East have high knowledge on the control of the disease, they were of the opinion that the disease (CMD) can be control through removal of infected plants, destruction of infected plant and replacement of infected plants. Majority of the non-adopters have low knowledge on the control method of the disease while only few of the non-adopters were of the opinion that that the diseases can be control by removal of infected plants, destruction of affected plants and replacement of infected plants.

Table 8. Cassava Farmers' Knowledge on Control of the Disease

Control methods	North West				North East			
	Adopters		Non-adopters		Adopters		Non-adopters	
	N	%	N	%	N	%	N	%
Removal of infected plants	80	66	49	37	73	63	30	18
Destruction of infected plants	65	54	36	27	58	50	22	13
Replacement of infected plants by healthy cuttings	46	38	26	20	28	24	18	11
Analysis of the plants concerned with the Nuru application	3	2	2	2	1	1	0	0
Consultation with agricultural agents	6	5	1	1	2	2	4	2
Use of inputs	1	1	4	3	1	1	0	0
I do nothing	14	12	60	45	15	13	73	43
Other (Specify)	2	2	1	1	1	1	9	5

Source: Field survey data 2023

Table 9: Cassava Farmers' Knowledge on Management of the Disease

Management practice	North West				North East			
	Adopters		Non-adopters		Adopters		Non-adopters	
	N	%	N	%	N	%	N	%
Use of healthy plant material	79	65	55	41	61	53	42	25
Regular monitoring of fields (removal, destruction, and replacement of infected plants)	78	64	53	40	60	52	42	25
Regular cleaning of the fields	27	22	27	20	18	16	20	12
Respect of the planting density (1mx1m)	16	13	6	5	2	2	3	2
Other (Specify)	2	2	2	2	1	1	5	3
Don't know	8	7	36	27	10	9	47	28

Source: Field survey data 2023

3.2.7. Cassava farmers' knowledge on management of the disease

Analysis of the results in Table 9 on knowledge of cassava farmers on the management of cassava disease reveals that majority of adopters and non-adopters in North West and North East have high knowledge of the management of the disease, they were of the opinion that the disease (CMD) can be managed through Regular monitoring of fields (removal, destruction, and replacement of infected plants), Use of healthy plant material and Regular cleaning of the fields, although large number of the non-adopters still report to have low knowledge on the management of the disease.

3.2.8. Perceptions of farmers on the causes of cassava viral disease

Table 10 shows farmers perception on the causes of the disease. The perception of respondents towards the causes of cassava disease was analyzed under different farmers' categories. The result reveals that majority of both adopters and non-adopters have positive perception towards the use of poor quality planting materials, poor aeration, drought/high temperature, planting in muddy or waterlogged soils and poor hygiene as they agreed to the fact that it is the major causes of the disease, while other respondents report negative perception towards old plant age, late planting, late harvesting and application of herbicide as they disagreed to the fact that it is the major causes of the disease. On the other hand a good number of the non-adopters have positive perception towards the causes of the disease, while a large number of them still reported to have no knowledge on the causes of the disease. The low knowledge implies that there is need for information dissemination in these regions for better understanding of the causes of the disease and the management practices of the disease.

Table 10: Farmers Perception about the Causes of the Disease

Rank	Statement	North West		North East	
		Adopters	Non-adopters	Adopters	Non-adopters
		Total score (Mean score)	Total score (Mean score)	Total score (Mean score)	Total score (Mean score)
1	Cassava viral diseases are caused by the use of poor-quality planting materials	317 (2.62)	279 (2.09)	286 (2.47)	339 (2.04)
2	Poor aeration promotes cassava viral diseases	299 (2.47)	249 (1.87)	279 (2.41)	297 (1.79)
3	Drought and high temperatures can lead to cassava viral diseases.	283 (2.34)	290 (2.18)	261 (2.25)	392 (2.36)
4	Planting in muddy or waterlogged soils causes infections.	271 (2.24)	284 (2.14)	264 (2.28)	378 (2.28)
5	Cassava viral diseases are caused by poor hygiene on the field	262 (2.17)	266 (2.00)	261 (2.25)	334 (2.01)
6	Older plants are more attacked by cassava viral diseases	235 (1.94)	260 (1.95)	220 (1.89)	296 (1.78)
7	Late planting can lead to cassava viral diseases	231 (1.91)	247 (1.86)	222 (1.91)	286 (1.72)
8	A late harvest can lead to cassava viral diseases.	228 (1.88)	252 (1.89)	211 (1.82)	291 (1.75)
9	Viral symptoms observed on cassava leaves result from the application of herbicides.	205 (1.69)	207 (1.56)	191 (1.65)	256 (1.54)

Source: Field survey data 2023

Numbers in parenthesis are mean scores

3.2.9. Perceptions of farmers on consequences, management and the management technologies of cassava disease

The perception of respondents towards consequences, management and the management technologies was analyzed under different farmers categories (Table 11). The result revealed that the perception of majority of the adopters was positive in respect of the statement about the consequences of cassava diseases, as they agree to the statements that; Cassava viral diseases prevent rooting; cassava viral

disease results in poor quality tubers; Cassava viral diseases result in loss of planting material. This shows that high proportions of the adopters are aware of the consequences of the disease. On the other hand a good number of the non-adopters reported positive perception on the consequences of the disease but majority of them reported to have no knowledge on the consequences of the diseases. The low knowledge reported by the non-adopters implies that there is need for information dissemination in these regions for better understanding of the consequences of the disease and the management practices of the disease.

The result also reveals that majority of the adopters have positive perception towards the management of the disease as they agree to the statements that; There is no control for cassava viral diseases; No cassava variety is resistant to viral diseases. This result shows that cassava disease cannot be control but can be managed by various ways as majority of the adopters agree to the statements that; Cassava viral diseases can be managed by breaking the affected part; The use of cassava diseases management technologies helps to reduce the incidence of cassava viral diseases; The use of cassava disease management technologies increases productivity. On the other hand a few number of the non-adopters reported positive perception on the management of the disease but majority of them reported to have no knowledge on the management of the diseases. The low knowledge reported by the non-adopters implies that there is need for information dissemination in these regions for better understanding of the importance of the management practices of the disease.

The result of the findings revealed that significant proportion of the adopters believes in the potentiality of the management technologies which are complexity, acceptability, affordability as they disagree to the statements that; The management practices taught by the agricultural officers are complex to understand; The use of integrated approaches to viral diseases control in cassava is more expensive than using chemicals; The management practices of cassava viral diseases are not culturally accepted in my community; and agree to the statement that; The management practices can easily be integrated into the traditional farming system while majority of the adopters reported that the management technologies (improve variety) are not accessible at all time as they disagree to the statement that; The management technologies are accessible at all times.

Table 11. Farmers Perception about the Management of the Disease and the Management Technologies

Rank	Statements	North West		North East	
		Adopters	Non-adopters	Adopters	Non-adopters
		Total score (Mean score)	Total score (Mean score)	Total score (Mean score)	Total score (Mean score)
Consequences of the disease					
1	Cassava viral disease results in poor quality tubers	267 (2.21)	299(2.25)	319 (2.75)	399 (2.40)
2	Cassava viral diseases prevent rooting	294 (2.43)	279 (2.10)	268 (2.31)	285 (1.72)
3	Cassava viral diseases result in loss of planting material	249 (2.06)	229 (1.72)	276 (2.38)	308 (1.85)
4	Viral diseases of cassava can lead to 100% yield loss if left untreated.	234 (1.93)	257 (1.93)	263 (2.27)	308 (1.85)
Management of the disease					
1	Cassava viral diseases can be managed by breaking the affected part	312 (2.58)	241 (1.81)	301 (2.59)	304 (1.83)
2	No cassava variety is resistant to viral diseases	299 (2.47)	229 (1.72)	293 (2.53)	289 (1.74)
3	The management practices can easily be integrated into the traditional farming system	283 (2.58)	241 (1.78)	299 (2.58)	307 (1.85)
4	There is no control for cassava viral diseases	280 (2.31)	242 (1.82)	299 (2.58)	278 (1.67)
5	The plant infected by cassava viral diseases	241 (2.00)	256 (1.92)	240 (2.07)	320 (1.93)

	always recovers at the beginning of the rains				
6	Chemicals are effective in controlling cassava viral diseases	211 (1.74)	250 (1.89)	188 (1.62)	307 (1.85)
	Management technologies				
	The use of cassava diseases management technologies helps to reduce the incidence of cassava viral diseases.				
1		318 (2.63)	234 (1.76)	294 (2.53)	293 (1.77)
2	The use of cassava disease management technologies increases productivity	319 (2.64)	266 (2.00)	290 (2.50)	263 (1.58)
3	The management technologies are not culturally accepted in my community	222 (1.83)	211 (1.59)	250 (2.16)	278 (1.67)
4	The use of integrated approaches to viral diseases control in cassava is more expensive than using chemicals.	248 (2.05)	194 (1.46)	231 (2.00)	237 (1.43)
5	The management technologies are accessible at all times	248 (2.05)	215 (1.62)	225 (1.94)	286 (1.72)
6	The management practices taught by the agricultural officers are complex to understand	231 (1.91)	212 (1.59)	236 (2.03)	265 (1.60)

Source: Field survey data 2023

Numbers in parenthesis are mean score

4. DISCUSSION

This result reveals that the average household size was about 9 members for adopters and 8 members for non-adopters. This agrees with the finding of Setsoafia *et al.*, (2022) and Zegeye *et al.*, (2022); who found out that on average, adopters have a larger family size than non-adopters. In addition, based on the gender of the household, the result also shows that about 88% adopters and 98% non-adopters were all found to be male, and this shows that males were dominant in cassava production than their female counterparts. This could be attributed to various reasons, which could be the problem of economic position of female headed households, including shortage of labor, limited access to information and required inputs due to social position. This agrees with the findings of Bayissa, (2014); Zegeye *et al.*, (2022) found Out that of these interviewed farmers, 27 (19%) of them are female headed and the remaining 113(81%) are male headed households. For two groups, the corresponding figures are 11 and 27 for adopters and non-adopters respectively. These figures show that male headed household of adopter is higher than that of the female headed.

Furthermore, the result of our findings also shows that the groups do not vary in terms of their marital status and educational level. Majority (85%) of the adopters and (86%) of the non-adopters were married. The result of this study reveals that on average, both adopters and non-adopters attained secondary education (about 10 years of schooling). This suggests that education might be uncorrelated with decision to adopt. This agrees with the findings of Asfaw and Shiferaw (2011); Kachilei and Ngeno (2021); Zegeye *et al.*, (2022) who report that an average mean level of education in terms of the number of years spent in school as 10 years. This indicate that most of the household heads are fairly educated with the result showing that 54.67% of the household heads attained the secondary level of education.

There is no significance difference observed in the household access to extension services. This implies that extension alone may not be sufficient to drive adoption and also they may require additional support or incentives. This disagrees with findings by Setsoafia *et al.*, (2022); Zegeye *et al.*, (2022) who reported that institutional factors such as extension contact are higher for adopters than non-adopters. This may show that households getting extension services are expected to have access to information on agricultural technologies and their profitability. Moreover, the average walking distance to the main market is lower for adopters. This agrees with the findings of Bayissa, (2014) Setsoafia *et al.*, (2022); Zegeye *et al.*, (2022) who reported that on average, the adopter households are

located near to the market and urban centers than their counterparts significantly. This simple comparison of the two groups of smallholders suggests that adopters and non-adopters differ significantly in some proxies of physical, human and social capital.

The result also shows that the level of education of the household head is higher for CDMTs adopters (about 11 years of schooling) than that of non-adopters which is 9 years. This agrees with the findings of Zegeye *et al.*, (2022) who reported that on average, adopters have a higher education level. This may point out that education of the households' head matters adoption decision of improved technology. In addition, based on the gender of the household, about 90% adopters and 84% non-adopters were all found to be male, and this shows that males were dominant in cassava production than their female counterparts. This agrees with the findings of Bayissa (2014); Zegeye *et al.*, (2022) found Out that of these interviewed farmers, 27 (19%) of them are female headed and the remaining 113(81%) are male headed households. For two groups, the corresponding figures are 11 and 27 for adopters and non-adopters respectively. These figures show that male headed household of adopter is higher than that of the female headed

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This study agrees with past studies of Setsoafia *et al.*, (2022); Zegeye *et al.*, (2022) who found out that on average younger farmers are more likely to adopt new technology and larger household size (9 persons) are more likely to adopt the new technology. No difference is also observed in the marital status as majority (91%) of the adopters and (83%) of the non-adopters were married. The result also shows that the level of education of the household head is higher for CDMTs adopters (about 11 years of schooling) than that of non-adopters which is 9 years. This agrees with the findings of Zegeye *et al.*, (2022) who reported that on average, adopters have a higher education level. This may point out that education of the households' head matters adoption decision of improved technology. In addition, based on the gender of the household, about 90% adopters and 84% non-adopters were all found to be male, and this shows that males were dominant in cassava production than their female counterparts. This agrees with the findings of Bayissa (2015); Zegeye *et al.*, (2022) found Out that of these interviewed farmers, 27 (19%) of them are female headed and the remaining 113(81%) are male headed households. For two groups, the corresponding figures are 11 and 27 for adopters and non-adopters respectively. These figures show that male headed household of adopter is higher than that of the female headed

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The low knowledge on the causes of CMD by the non-adopters is as a result of lack of dissemination of information, knowledge and training on the disease identification and management. Therefore, it is suggested to provide knowledge on the disease management in these regions. This is in consistent with the findings by Houngue *et al.*, (2018) who reported that, 98.60% of farmers reported that they did not know the causes and vectors of CMD.

This low knowledge by the non-adopters suggests lack of knowledge dissemination. This is in consistent with the findings by Houngue *et al.*, (2018) who reported that farmers in the three major AEZ of Benin already know how to recognize the symptoms of CMD but do not realize how CMD could affect cassava yields or how it could spread through the use of infected cuttings or the whitefly vector. This is in consistent with the findings by Houngue *et al.*, (2018) who stated that Most (62.43%) farmers said that they believe CMD reduces yields; 37.57% reported that they believe, based on their observations in their fields, that CMD prevents cassava from rooting. The low knowledge by the non-adopters implies that there is need for training of farmers in these regions on the control

measures of the disease. This is consistent with the findings by Chikoti *et al.*, (2016); Houngue *et al.*, (2018); Ebewore and Isiorhovoja, (2019). The low knowledge by the non-adopters implies that there is need for training of farmers in these regions on the management practices of the disease. This is consistent with the findings by Houngue *et al.*, (2018); Ebewore and Isiorhovoja, (2019).

5. CONCLUSION

The analysis revealed that respondents (adopters and non-adopters) have high knowledge on cassava diseases and the consequences of the disease. Findings also reveal differences in knowledge on the causes, mode of transmission, control and management of the disease among adopters and non-adopters in the study area. This implies that despite non-adopters high knowledge on the consequences of the diseases, they have low knowledge on the control and management practices of the diseases, therefore there is need for training of farmers on the causes, control measures and management of the disease. Overall, adopters have a positive perception about the CDMTs (roguing, good agronomic practices, use of resistance variety and biological control). However, biological control was rarely an option for disease management. Supply of improved varieties and disease free planting materials was still a challenge, which resulted in farmers depending on their local unimproved varieties. Therefore this study highlights the need to enhance the farmers' access to educational programme, extension services and policy support to enhance farmers knowledge on cassava disease, management and improve livelihood.

Acknowledgement

The authors are grateful to the diligent extension agents and enumerators who meticulously collected high-quality and informative data, thereby contributing to the existing body of knowledge. We would also like to express our heartfelt thanks to the gallant cassava farmers for generously sharing their valuable insights and time. Lastly, we would like to give special recognition to the University of Félix Houphouët Boigny, Abidjan, Cote d'Ivoire, for the technical support to conduct this revealing study.

Author contributions

All authors read and approved the final manuscript.

Funding

This work was supported, in whole or in part, by the European Union (EU) through the Biorisks project executed by the Regional Center of Excellence for Transboundary Plant Pathogens, Central and West African Virus Epidemiology (WAVE) and the Conseil Ouest et Centre Africain pour la Recherche et le Développement Agricoles (CORAF), the Bill and Melinda Gates Foundation and the United Kingdom Foreign, Commonwealth and Development Office (FCDO; INV-002969; grant no. OPP1212988) through a subgrant from the Université Félix Houphouët-Boigny (UFHB) to Kebbi State University of Science and Technology Aliero.

Conflict of interest

The authors declare that there are no conflicts of interests.

Ethical approval

The ethical guidelines for Human Subjects are followed in the study.

Informed consent

Oral informed consent was obtained from individual participants included in the study.

Data availability

The data supporting the reported results are accessible from the leading author upon reasonable request.

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