

Article

Enhancing Farmers' Capacity for Sustainable Management of Cassava Mosaic Disease in Côte d'Ivoire

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Abstract: Cassava Mosaic Disease (CMD) is a major constraint to cassava production in Côte d'Ivoire, causing significant yield and income losses for smallholder farmers. Despite its high prevalence, farmers' knowledge and understanding of the disease remain limited. To address this issue, the Central and West African Virus Epidemiology (WAVE) Regional Center of Excellence provided capacity building for farmers in the major cassava growing regions. This study assesses the impact of the WAVE's trainings and awareness campaigns on farmers' knowledge of the disease and the management methods they adopted. Mixed socio-agronomic data were collected from 290 farmers, and CMD epidemiological parameters were assessed in 82 farms. Data were analysed using propensity score matching (PSM), followed by a Tobit regression model to assess the determinants and intensity of adoption of CMD management practices, using Stata. The results showed that trained farmers had a better understanding of CMD compared to untrained farmers. On average, trained farmers adopted 2.36 disease management practices (DMPs) compared to 1.55 DMPs for untrained farmers. Participation in WAVE's training sessions and a sound knowledge of CMD positively influenced both the adoption and intensity of adoption of DMPs. However, there was no significant difference in CMD incidence between beneficiary areas (54.55%) and non-beneficiary areas (54.95%), likely due to the unavailability of disease-free planting material, inadequate agricultural practices, and high populations of whiteflies (*Bemisia tabaci*). This study shows the importance of awareness campaigns in the sustainable management of crop diseases in general and CMD in particular and suggests the need to train farmers on disease management and provide them with healthy planting materials.

Keywords: awareness campaign; CMD knowledge; impact assessment; PSM; Tobit



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1. Introduction

Cassava (*Manihot esculenta* Crantz) plays a crucial role in ensuring food security in Africa due to its resilience, ease of cultivation, and adaptability to diverse agro-ecological conditions. It serves as a dietary staple for over 500 million people on the continent [1,2].

In Côte d'Ivoire, cassava is the second most important food crop after yam [3], having transitioned from a subsistence-oriented “poor man’s crop” [3] to a strategic commodity crop. Côte d'Ivoire is currently the third-largest cassava producer in the West Africa sub-region with an estimated production of 7.2 million tonnes per annum [3].

Despite its economic and nutritional importance, cassava production in Côte d'Ivoire remains low compared to Nigeria (60.8 million tonnes) and Ghana (25.6 million tonnes). In terms of productivity, Ghana records a yield of 25.1 tonnes per hectare, which exceeds Côte d'Ivoire’s average yield of 5.6 tonnes per hectare by more than fourfold [4]. This low productivity can be attributed to a combination of biotic and abiotic constraints, including fungal, bacterial, viral diseases, pests infestations, salination, and water stress [5,6]. Among the biotic factors, Cassava Mosaic Disease (CMD) represents one of the main threats to cassava cultivation [7].

CMD is a viral disease transmitted by whiteflies (*Bemisia tabaci*) and the use of diseased cassava cuttings [8–11]). It causes substantial yield losses, reaching up to 70% in severely affected fields. Epidemiological surveys conducted in 2016, 2017, and 2020 in the different agro-ecological zones of the country, showed a significant disease incidence, 45.95%, 50.32%, and 51.37%, respectively, which increased over the study period [12]. The persistence and spread of the disease pose significant food security and economic risks for stakeholders within the cassava value chain, particularly for smallholder farmers. Despite these risks, many farmers remain unaware of the symptoms, transmission mechanisms, and management practices of the disease. Consequently, the continued use of infected cuttings and the cultivation of susceptible local varieties contribute to the spread of the disease [6,9].

To address this issue, the Regional Center of Excellence for Transboundary Plant Pathogens, Central and West African Virus Epidemiology (WAVE) “<https://wave-center.org/>” (Accessed on 12 September 2024) launched a capacity-building program in 2020 aimed at strengthening farmers’ awareness of CMD and promoting the adoption of Diseases Management Practices (DMPs). The training was conducted in two phases: (i) theoretical sessions, introducing farmers to CMD symptoms, cause, vectors, and impacts; (ii) practical field visits, during which farmers were tasked with visually identifying CMD symptoms in cassava plots and were trained in management strategies. This intervention was based on the assumption that changes in agricultural practices first require changes in farmers’ knowledge and attitudes [13].

In this regard, the existing literature highlights a consistent positive relationship between training, improved knowledge, and the adoption of CMD management practices. Studies in Benin [11,14] showed that trained farmers were more able to identify CMD symptoms and adopt appropriate control measures. Eni et al. [15] confirmed this trend in Nigeria, where increased knowledge led to more proactive practices, such as roguing and burning infected plants. In contrast, evidence from Ghana [16] highlights how the lack of formal training forced farmers to depend on traditional knowledge, thereby limiting their ability to adopt effective disease management practices. Although informative, most of these studies remain focused on individual behavioural changes following training and often overlook broader structural and contextual factors. For instance, farmers’ adoption decisions can also be influenced by socio-economic characteristics such as education level, access to labour, or land size [17,18], as well as institutional and environmental constraints, including extension services, input access, and perceived risks [19]. Moreover, as noted by

Ajzen [20], farmers' perceptions of the relative advantages and drawbacks of an innovation critically shape both the decision to adopt and the intensity of use.

Despite this knowledge, few studies integrate these multidimensional factors into a comprehensive analytical framework, and even fewer link them with field-level disease prevalence or epidemiological indicators. In Côte d'Ivoire specifically, despite the rising incidence of CMD, no empirical study has evaluated the impact of structured training programs such as those implemented by WAVE. The literature thus far does not provide evidence on whether such interventions improve farmers' knowledge, influence their adoption behaviour, or contribute to disease control in farming conditions. This study addresses these gaps by evaluating the effects of WAVE's CMD capacity-building program through a comparative analysis between trained and untrained farmers. It combines knowledge assessment, adoption behaviour analysis, and epidemiological field data to provide a more holistic and policy-relevant understanding of the program's impact. Specifically, the aim of this study is to achieve the following:

- Analyse farmers' level of knowledge of CMD and adoption of DMPs.
- Identify factors influencing the adoption and intensity of adoption of DMPs.
- Assess the epidemiological parameters of the disease in the study areas.

We hypothesised that farmers who participated in WAVE's training and awareness-raising activities on cassava diseases would have better knowledge of CMD and adopt improved management practices, which would reduce the incidence of the disease in their fields.

2. Description of the Intervention and DMP Advocated

2.1. Description of WAVE's Training Method

The awareness and training campaigns initiated by WAVE are a key component of cassava viral disease management in Côte d'Ivoire. These campaigns were implemented in the major cassava production regions, particularly in the southern, central, and western parts of the country. Farmers were gathered in public spaces through advertisement on local radio and television stations. The trainers were biologists (WAVE researchers), assisted by extension agents and farmers' associations leaders who had previously been trained by WAVE. The training was then realised in two phases. The first phase was theoretical and allowed the researchers to familiarise the farmers with the symptoms, name, cause, vectors, and impact of the disease and its control methods using images, kakemonos, and PowerPoint presentations. To ensure effective understanding and participation, the training sessions were delivered in French and translated into local languages, when necessary, with support from trained interpreters. They were also interactive, allowing participants to ask questions about different aspects of the training and to share their personal experiences of the disease in the fields. To support farmers' familiarisation with the disease, several informational leaflets were distributed, outlining the key characteristics of CMD. The second phase of the training, conducted on the second day, was more practical and included field visits to cassava plots. During these visits, farmers were guided through hands-on activities aimed at visually identifying symptoms of CMD. Participants were divided into small groups, each supervised by a researcher. Within each group, farmers were asked to identify infected cassava plants, describe the symptoms observed, name the disease, explain its cause, and suggest appropriate management strategies. Researchers facilitated the discussions by offering clarifications and resolving any disagreements that emerged. In addition to CMD vectors such as whiteflies and infected cuttings that contribute to the spread of the disease, the field sessions also highlighted the role of alternative hosts, including certain weed species, in the persistence of CMD viruses. To ensure continuity and effective follow-up, focal points and local agricultural technicians were appointed

in each intervention area to monitor farmer activities and act as intermediaries between farmers and the WAVE team.

2.2. Description of CMD Management Practices Advocated by WAVE

CMD is a viral disease for which there is currently no cure. There are, however, strategies that can prevent or reduce the disease's incidence in the field according to findings from previous studies. Accordingly, six main practices have been recommended by WAVE to farmers: (i) use of healthy cuttings [21,22], (ii) roguing of infected cassava plants to limit inoculum sources, (iii) the replacement of diseased plants with healthy cuttings, (iv) the regular weeding (at least three times per crop year) to eliminate weeds that may serve as virus hosts [21–23], (v) adhering to the standard planting density to facilitate movement within the field when monitoring the phytosanitary status of the plants and to ensure good tuber growth [23], and lastly, (vi) the use of the PlantVillage Nuru application, an AI-driven image recognition tool enabling early and accurate detection of symptomatic plants [24,25]. Farmers were encouraged to adopt as many of these practices as possible for a more effective management of CMD.

3. Methodology

3.1. Study Areas

The study was conducted in three departments, namely, Dabou, Bouaké, and Man in the Grands-Ponts, Gbêkê, and Tonkpi, regions, respectively. These departments were selected based on the importance of cassava cultivation, its socio-economic importance to the population, the disease incidence, and the fact that they had benefited from WAVE's awareness and training programs. Three other departments, Grand-Lahou, Sakassou, and Danané, respectively, were designated as control study areas, based on agro-ecological and regional correspondence, as well as similarity in socio-demographic characteristics of the populations. Villages were then randomly selected within each department according to the availability of farmers for the data collection. The different villages surveyed by department within each region are presented in the Appendix (Table A1) and Figure 1.

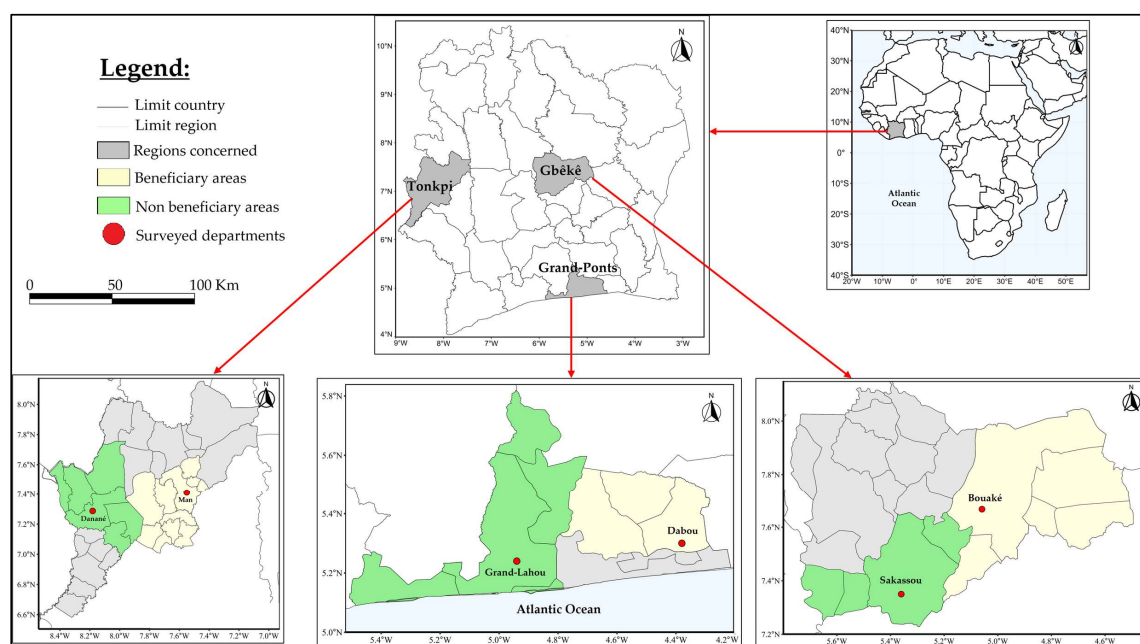


Figure 1. Map of Côte d'Ivoire showing the departments surveyed in 2023 to assess farmers' CMD knowledge.

3.2. Study Population and Sampling

Data were collected from cassava farmers. The initial sample size of 300 respondents was calculated using the Yamane formula [26]:

$$n = \frac{N}{1 + N(0.05)^2} \quad (1)$$

where n is the sample size, N the size of the target population, while 0.05 is the margin of error. For the beneficiary group, the list of farmers who participated in the program were provided by WAVE, and respondents were selected through proportional allocation across intervention departments followed by systematic random sampling. In non-beneficiary areas, local agricultural institutions were contacted for the list of cassava farmers in their respective department. A purposive sampling approach was then used to determine the sample size, and farmers were selected based on their availability and willingness to participate. A total of 290 farmers, 146 beneficiaries and 144 non-beneficiaries, were surveyed, resulting in a 97% response rate in the study. Efforts were made to ensure diversity in the geographic and socioeconomic characteristics of farmers, enhancing the internal validity of comparisons and supporting the generalisability of findings to similar rural contexts. The number of farmers surveyed per department within each region is presented in the Appendix (Table A2).

3.3. Data Collection

Socio-demographic data were collected using a mixed-methods approach. A digital questionnaire was developed with the KoboToolBox software (version 2024.2.4). The questionnaire focused on farmers' knowledge, experiences, attitudes, and management practices regarding CMD. A pre-test was conducted by the enumerators among a group of farmers not included in the study area, to adjust the questionnaire. Subsequently, appointments were scheduled with farmers across all study areas for data collection. Complementing the quantitative survey, seven (07) focus group discussions were conducted with farmers, two (02) in Dabou, two (02) in Bouaké, and three (03) in Man. These focus groups explored farmers' perceptions, beliefs, and challenges related to CMD control practices. The discussions were primarily conducted in French, with local language interpretation provided when necessary.

For the epidemiological data, we elaborated an evaluation form and collected data from 82 cassava fields evenly distributed between treatment (41) and control (41) areas to assess the CMD incidence, severity, and mode of infection. Field assessments were carried out by a team of biologists immediately after the interviews. The epidemiological evaluation followed the WAVE protocol as described by Yoboué et al. [27].

3.4. Theoretical Framework and Outcome Variables

The theoretical framework for the analysis of this study was based on the Knowledge, Attitudes, and Practices (KAP) approach, developed by Schreinemachers et al. [13]. This approach posits that changes in farmers' management practices arise primarily from changes in their knowledge and attitudes regarding CMD. In this context, knowledge refers to farmers' understanding of CMD. Attitudes refer to beliefs about the cause, impacts, and management of the disease. Practices refer to the behaviours, actions, and decisions taken by farmers in the management of CMD. The use of this approach in this study is relevant because it allows for analysis of the correlation between farmers' CMD knowledge and the adoption of management practices, and how this may reduce disease incidence in the field. In this way, three outcome variables have been employed.

General knowledge of CMD (score): To evaluate farmers' knowledge, a series of images depicting healthy and CMD-infected cassava leaves were presented. Farmers were evaluated based on their ability to correctly identify disease symptoms, cause, name of the disease, mode of spread, impacts, and management practices. Each of the six criteria was scored as one (1) point for a correct response, and zero (0) otherwise. The overall knowledge score was computed as the sum of these points, providing an aggregate measure of CMD knowledge per farmer.

Adoption of CMD management practices (score): Given that effective CMD control is enhanced by the combined use of multiple management practices, farmers were advised during training campaigns to adopt as many recommended practices as possible. Following Bett et al. [28], the number of recommended management practices adopted was used as a quantitative outcome variable. Each adopted practice was scored as one (1), and non-adoption was scored as zero (0). The total adoption score per farmer was the sum of points across all recommended management practices.

Incidence of CMD (%): Disease incidence (I) is defined as the proportion of diseased plants out of the total number of plants assessed. It is generally expressed as a percentage (ranging from 0 to 100%) and is used to assess the prevalence of the disease in a given area. Disease incidence (I) per field was calculating using the formula described by Sseruwagi [29]:

$$I(\%) = \frac{\text{Number of diseased plants}}{\text{Total number of plants observed}} \times 100 \quad (2)$$

Incidence by area surveyed was then determined by dividing the number of infected fields by the total number of fields surveyed. The disease severity was then assessed based on a severity scale ranging from 1 to 5 as follows: 1, absence of infection; 2, mild infection; 3, moderate infection; 4, severe infection; 5, very severe infection [9,30]. The mean severity (Sm) per field was calculated according to the following formula [29]:

$$S_m = \frac{\Sigma(\text{score of diseased plants} \times \text{corresponding infection score})}{\text{Total number of diseased plants}} \quad (3)$$

The mode of infection was also included in this study. This makes it possible to determine how CMD is transmitted (whiteflies or infected cuttings) and the responsibility of farmers in the prevalence of the disease in the fields. The mode of infection was determined using the method recommended by Legg et al. [31]. When CMD symptoms were observed only on the lower leaves or on all leaves of the cassava plant, infection was attributed to infected cuttings. If symptoms were observed only on the upper leaves, infection was attributed to whiteflies [30]. The percentages of infection by cuttings (PIC) and by whiteflies (PIW) were therefore calculated according to the following formulas:

$$PIC(\%) = \frac{\text{Number of plants infected by diseased cuttings}}{\text{Total number of plants observed}} \times 100 \quad (4)$$

$$PIW(\%) = \frac{\text{Number of plants infected by whiteflies}}{\text{Total number of plants observed}} \times 100 \quad (5)$$

Epidemiological data were organised and processed using Microsoft Excel, then analysed using R (version 4.3.1). Differences in CMD incidence and severity between trained and untrained farmers were assessed using the Wilcoxon rank-sum test (non-parametric) at a 5% significance threshold. Differences in the mode of infection were evaluated using Fisher's exact test to account for categorical data distributions.

3.5. Econometric Analysis

3.5.1. Definition of the Adoption Index and Adoption Categories

To quantify the overall adoption of the six CMD management practices promoted by WAVE, the adoption index (AI) was constructed [32]. It is used to determine the general level of adoption of several innovations among farmers. In this study, the adoption index enabled the classification of farmers into adoption categories, based on their level of adoption of the six CMD management practices disseminated [33]. The adoption index is expressed using the following formula:

$$\text{Adoption Index}_i = \frac{\sum_{j=1}^6 \text{Adoption}_{ij}}{6} \quad (6)$$

Adoption Index_i = adoption index for individual i , varying between 0 and 1.

- Adoption_{ij} = 1 if individual i has adopted practice j , 0 otherwise.
- $j = 1, 2, \dots, 6$ represent the 6 management practices.
- Denominator 6 is the total number of practices available.

We then defined 5 adoption categories as follows:

$$\text{Adoption categories}_i = \begin{cases} 0, & \text{if } \text{Adoption Index}_i = 0 \text{ (Non - adoption)} \\ 1, & \text{if } 1 \leq \text{Adoption Index}_i \leq 2 \text{ (Low adoption)} \\ 2, & \text{if } 3 \leq \text{Adoption Index}_i \leq 4 \text{ (Moderate adoption)} \\ 3, & \text{if } \text{Adoption Index}_i = 5 \text{ (High adoption)} \\ 4, & \text{if } \text{Adoption Index}_i = 6 \text{ (Full adoption)} \end{cases}$$

To determine whether the proportion of farmers who had achieved a certain level of adoption varied significantly between trained and non-trained farmers, a two-sample independent proportion test was used. Let P_0 and P_1 be the proportions of farmers who reach a given level in the untrained and trained groups, respectively. We test the hypothesis $H_0: P_0 = P_1$ against the alternative $H_A: P_0 \neq P_1$, using the following test statistic:

$$Z = \frac{P_1 - P_0}{\sqrt{\frac{P_0(1-P_0)}{N_0} + \frac{P_1(1-P_1)}{N_1}}} \quad (7)$$

where N_0 and N_1 are the group sizes. The critical value of Z for a threshold of $\alpha = 0.05$ is 1.96. A p -value less than 0.05 indicates a statistically significant difference between the groups.

3.5.2. Impact Assessment Method

In the context of this study, since participation in WAVE training was not randomly assigned, simple mean comparisons may be biased due to self-selection [34]. To address this issue, propensity score matching (PSM) was used to evaluate the effect of WAVE training on farmers' CMD knowledge and disease management. The Average Treatment Effect on the Treated (ATT) is then estimated as follows:

$$\text{ATT} = E[Y(1) - Y(0) | D = 1] \quad (8)$$

where $Y(1)$ is the outcome of a trained farmer and $Y(0)$ the outcome of a non-trained farmer (counterfactual); $D = 1$ indicates actual participation in the training campaigns; ATT measures the average difference in score between the trained farmers and the matched control group. The propensity score $P(X)$ is defined as follows:

$$P(X) = \Pr(D = 1 | X) \quad (9)$$

This was estimated with the logit model using the covariate vector X : sex, age, level of education, household-head status, smartphone ownership, main activity, farm size, production system, farming experience, membership in a farmers' association, and contact with extension services. These variables were selected based on prior impact-evaluation studies [35–38]. Prior to estimating the propensity scores, the multicollinearity using the Variance Inflation Factor (VIF) was assessed for the selected covariates. All VIFs were below the critical value of 5 [39], indicating that the covariates carried independent information for score estimation. Treated farmers were matched with untrained farmers, using the Nearest Neighbour Matching (NNM) technique. Although PSM is most efficient with large samples (over 400) [40], Pirracchio et al. [41] have demonstrated that it remains valid in smaller samples, provided that the statistical power is adequate. To verify this, an ex-post power test was conducted using the `sampsi` command in Stata, focusing on both outcome variables: general knowledge of CMD and general adoption of DMPs. To assess the robustness of the estimation, two alternative techniques were used: radius matching with a calliper of 0.05, and weighted regression using `fweight`. These procedures increase our confidence in the reliability of the estimates.

3.5.3. Adoption Intensity Model

To identify the drivers of both the adoption and the intensity of adoption of the six management practices, a Tobit regression model was used. Since the adoption variable (the dependent variable) is censored, taking values only between 0 and 6, the Tobit model is particularly appropriate in this context, as it accounts for the limited range of the dependent variable in the estimation process. Moreover, it enables the simultaneous estimation of the likelihood of adoption and the extent (intensity) of adoption [42]. The underlying Tobit model is expressed as follows:

$$y_i^* = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \dots + \beta_k X_k + \epsilon_i \quad (10)$$

y_i^* is the latent (unobserved) variable representing the farmer's true adoption intensity, and y_i is the observed, censored value, bounded between 0 and 6. The explanatory variables ($X_1, X_2 \dots X_k$) include the set of individual, socio-economic, and institutional characteristics hypothesised to influence adoption. All estimations were performed using Stata 12.1.

4. Results

4.1. Descriptive Statistics

The results showed that of the 290 farmers surveyed, 53% were women. In total, 70% were between 41 and 65 years old and more, and 56% had a level of education ranging from primary to higher, with a preponderance of secondary education (25%). They were generally married (70%) and most of them (58%) were heads of their household. The average household size was seven people. Respondents' main activity was agriculture (81%), and they generally had more than 11 years of experience (57%) in cassava cultivation. The majority (55.2%) belonged to an agricultural organisation, but only 34.1% had access to a smartphone.

Data collected from all study areas showed a preponderance of individual farms (63%). Cultivated areas ranged from 0.2 to 15 hectares, with an overall average of 1.31 hectares. On these cassava plots, farmers planted both local and improved varieties. A total of 4% planted improved varieties, and 21% combined local and improved varieties. The farmers do, however, prefer local varieties, which were found to be predominant (75%) in the fields visited. Most farmers (53%) grew cassava in association with other crops, and the main crops associated with cassava were maize (30%), yam (15%), vegetables (14%), plantain (9%), and legumes (4%).

Depending on financial means and the availability of labour, farmers combined or alternated with hired labour (83%), family labour (71%), or community labour (6%). Regarding family labour, it was found that, on average, three people per household were involved in cassava cultivation. This suggests that the members of the households surveyed were not significantly involved in cassava production. However, most farmers (54.5%) were in contact with an agricultural service. The differences in farmer and field characteristics between beneficiary and non-beneficiary areas are presented in Tables 1 and 2.

Table 1. Qualitative variables.

Characteristics	Trained Farmers (<i>n</i> = 146)	Non-Trained Farmers (<i>n</i> = 144)	Chi ² (<i>p</i> -Value)
Gender			
Male	86	49	0.000 ***
Female	60	95	
Age			
[Less than 20]	-	3	0.357 ^{ns}
[20–40]	44	40	
[41–64]	89	87	
[65 and more]	13	14	
Education level			
Unschool	50	78	0.000 ***
Primary	37	38	
Secondary	47	26	
Higher	12	2	
Marital status			
Married	99	104	0.511 ^{ns}
Single	19	13	
Widowed	28	27	
Head of household			
Yes	98	71	0.002 **
No	48	73	
Main activity			
Agriculture	117	118	0.695 ^{ns}
Other activity	29	26	
Farm Type			
Individual	101	81	0.073 ^{ns}
Family	44	62	
Association/community	1	1	
Type of cropping			
Mono-cropping	81	55	0.003 **
Intercropping	65	89	
Varieties cropped			
Local	117	101	0.058 ^{ns}
Improved	6	4	
Both	23	39	
Type of labour			
Salaried	121	119	0.957 ^{ns}
Family	97	109	0.820 ^{ns}
Community	6	11	0.201 ^{ns}
Years of experience in cassava cultivation			
[1–5]	35	32	0.94 ^{ns}
[6–10]	28	28	
[More than 11]	83	84	
Member of a farmer association			
Yes	66	94	0.004 **
No	80	50	
Monitored by an agricultural service			
Yes	87	71	0.079 ^{ns}
No	59	73	
Owns a smartphone			
Yes	59	40	0.023 *
No	87	104	

*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$, ns (non-significant difference).

Table 2. Quantitative variables.

Characteristics	Trained Farmers (<i>n</i> = 146)	Non-Trained Farmers (<i>n</i> = 144)	<i>t</i> -Test (<i>p</i> -Value)
	Mean (Standard Error)		
Household size	6.82 (0.26)	7.27 (0.30)	0.260 ^{ns}
Household members involved in farming	2.89 (0.18)	3.08 (0.15)	0.430 ^{ns}
Area (ha)	0.95 (0.05)	1.68 (0.17)	0.000 ***

*** $p < 0.01$, ns (non-significant difference).

4.2. Level of CMD Knowledge and Management Practices Adopted by Farmers

To address the first objective, this section examines farmers' level of knowledge of CMD, as well as their adoption of DMPs. The results indicate that, across all of the study areas, the disease parameters with which farmers were most familiar were the symptoms (95%) and the impacts (64%). Three major ones were associated with CMD by farmers, namely yield reduction (76%), poor plant growth (42%), and the loss of healthy planting material (7%). However, only 14% of respondents were able to correctly identify and name the disease based on the images presented during the survey, while the majority (84%) were either unaware of its cause or incorrectly attributed it to vectors. Only 16% of respondents were aware that CMD is caused by a virus, and just 39% of farmers were cognisant of the fact that the use of infected cuttings (29.6%) and whiteflies (26.2%) favoured the spread of the disease. The farmers' low knowledge level of CMD's causal agent and mode of spread was revealed during the group discussions, as illustrated by the following comments:

I think it's the phytosanitary products we use that make this disease attack our cassava fields [...] in addition, when the soil is tired and it doesn't rain much in the field, the cassava leaves become like those in the picture you showed. (Interview with a farmer during the focus group held on 4 August 2023, at Débrimou (Dabou).)

There are little white beasts that can be seen behind cassava leaves. When they become many and last in the field, the cassava leaves become deformed, the plant can no longer grow properly and no longer produce normally. (Interview with a woman farmer during the focus group held on 11 August 2023, at Douagouin (Man).)

Related to the six CMD management practices advocated by WAVE, the use of healthy cuttings (52.8%), roguing infected plants (46%), and adhering to standard planting density (38.6%) were the most widely adopted by farmers. Conversely, low adoption rates were observed regarding the use of Nuru application (21%), regular weeding of fields (18.6%), and replacement of infected plants (17.9%). Also, independent of the management practice considered, adoption rates remained higher among trained farmers (Table 3). In one of the training sites, when discussing the management of CMD in his field, a farmer provided the following statement:

In the past, I didn't sort cuttings before establishing a new field. But since the training, I use cuttings with clean, spotless, uncrumpled leaves. Afterwards, when it grows, I don't see much disease in my field. (Interview with a cassava farmer during the focus group held on 10 August 2023, at Gbatongouin (Man).)

However, even though these methods are ineffective against CMD, 4% of farmers opted for the use of insecticides, 3% chose to remove infected plant parts. The differences observed between trained and non-trained farmers are presented in Table 3.

Table 3. Description of farmers' CMD knowledge and management practices adopted.

Outcome Variables	Total Farmers Surveyed (<i>n</i> = 290)	Trained Farmer (<i>n</i> = 146)	Non-Trained Farmers (<i>n</i> = 144)	<i>t</i> -Test (<i>p</i> -Value)
Mean (Standard Error)				
CMD Knowledge				
Symptoms' recognition	0.95 (0.11)	0.97 (0.12)	0.93 (0.18)	0.236 ^{ns}
Knowledge of the name	0.14 (0.02)	0.28 (0.03)	0.00 (0.00)	0.000 ***
Knowledge of the cause	0.16 (0.21)	0.27 (0.03)	0.05 (0.01)	0.000 ***
Knowledge of the modes of spread	0.23 (0.02)	0.43 (0.04)	0.03 (0.01)	0.000 ***
Knowledge of the impacts	0.64 (0.03)	0.65 (0.05)	0.63 (0.04)	0.342 ^{ns}
Knowledge of management practices	0.36 (0.02)	0.51 (0.03)	0.22 (0.01)	0.000 ***
<i>General knowledge of CMD (score/6)</i>	2.49 (0.07)	3.12 (0.09)	1.86 (0.07)	0.000 ***
Adoption of CMD management practices				
Using healthy cuttings	0.52 (0.02)	0.61 (0.03)	0.44 (0.04)	0.000 ***
Roguing infected plants	0.46 (0.03)	0.51 (0.03)	0.38 (0.02)	0.000 ***
Replacing infected plants	0.18 (0.02)	0.25 (0.04)	0.12 (0.01)	0.000 ***
Regular weeding of the field	0.19 (0.02)	0.24 (0.03)	0.16 (0.02)	0.021 **
Adhering to standard planting density	0.39 (0.02)	0.40 (0.04)	0.38 (0.04)	0.532 ^{ns}
Using the PlantVillage Nuru Application	0.21 (0.02)	0.35 (0.04)	0.07 (0.01)	0.000 ***
<i>General adoption of CMD management practices</i>	1.95 (0.08)	2.36 (0.10)	1.55 (0.65)	0.000 ***

*** $p < 0.01$, ** $p < 0.05$, ns (non-significant difference).

4.3. Impact of the Awareness Campaigns on Farmers' CMD Knowledge and Adoption of Management Practices

Propensity score matching yielded a common support sample of 280 farmers, while 7 trainees and 3 non-trainees fell outside the region of common support and were excluded from the analysis (Figure 2). The values obtained for the Treatment Effect on the Treated (ATT) indicate a very significant ($p < 0.001$) correlation between participation in awareness campaigns and improvements in farmers' CMD knowledge and the adoption of DMPs. Related to knowledge, after being matched, trained farmers obtained an average score of 3.12, compared with 1.86 for untrained farmers, giving a difference of 1.3. As for the control strategies adopted, after being matched, trained farmers obtained an average score of 2.36, compared with 1.55 for untrained farmers, giving a difference of 0.81. In other words, participating in awareness campaigns enabled beneficiary farmers to improve their CMD knowledge level and adoption of management practices by 69.9% and 52.2%, respectively (Table 4).

To ascertain the robustness of the findings, in addition of the Nearest Neighbour technique, we also analysed the results of the calliper test and weighted regression. The results of these two tests were also very close to each other and to the nearest neighbour. Similar results were obtained for the robustness check related to the adoption of CMD control strategies. This robustness analysis confirms that the estimated impact of participation in awareness campaigns is stable and reliable, thereby reinforcing the validity of the findings (Table 5).

Table 4. Estimation of the impact of awareness campaigns using the Nearest Neighbour technique.

Variables	Mean of the Variables		ATT	ATT (%)
	Trained Farmers	Non-Trained Farmers		
General CMD knowledge	3.12	1.86	1.3 ***	69.9
General adoption of DMP	2.36	1.55	0.81 ***	52.2

*** $p < 0.01$

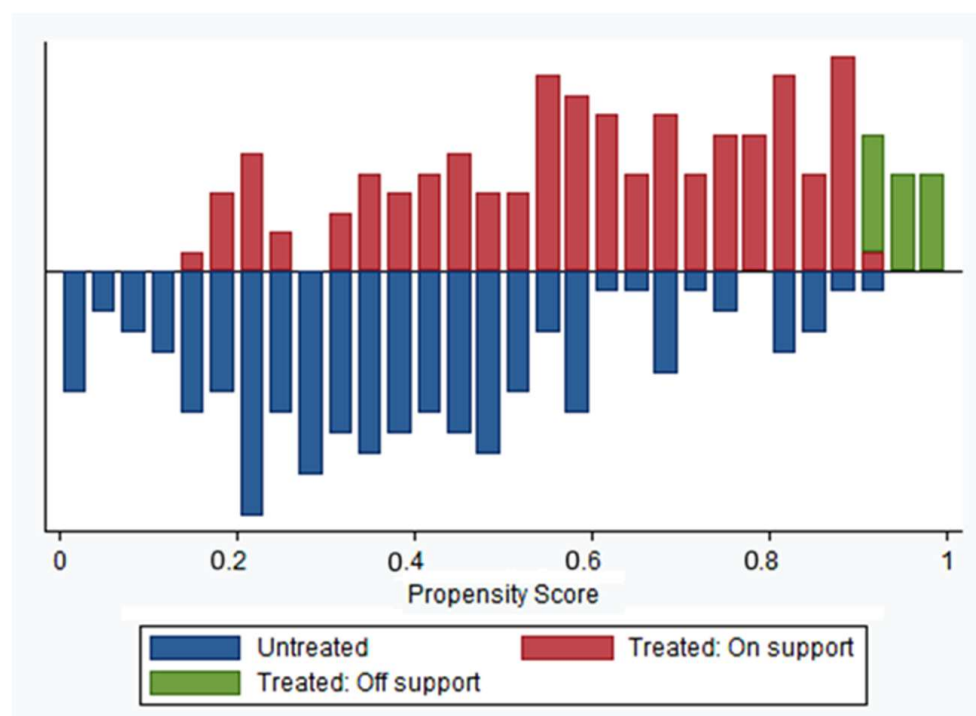


Figure 2. Graph illustrating the significant overlap in the distribution of propensity scores between trained and non-trained farmers.

Table 5. Comparison of ATT estimates by algorithms.

Variables	Estimation Algorithm		
	Nearest Neighbour Matching (NNM)	Radius Matching	Weighted Regression (Fweight)
General knowledge of CMD	1.3	1.27	1.28
General adoption of DMP	0.81	0.79	0.83

4.4. Analysis of Factors Influencing the Adoption and Intensity of Adoption of DMP

In line with the second objective, this section investigates the determinants of both the adoption and the intensity of adoption of DMPs. Farmers were first classified into different adoption categories based on the number of practices adopted. The intensity of adoption of CMD management practices ranges from 0 to 6, with an average of 1.95 practices adopted per farmer across all study areas. On average, trained farmers adopted 2.36 practices out of 6, compared to 1.55 for non-trained farmers. These results are in line with those obtained from the independent two-sample proportion test (Table 6). This analysis showed that 69.2% of the farmers who received training mainly fell into the categories of moderate adoption (56%), high adoption (6.2%) or full adoption (7%). Conversely, 78.5% of untrained farmers were in the low-adoption category.

Furthermore, the results of the Tobit model indicate that our model is highly significant ($p < 0.01$). The Pseudo R² value (0.5552) remained relatively high, suggesting that the model explains 55.52% of the variation in the adoption intensity. Four key factors were identified in the model as contributing positively and significantly to the increased adoption of CMD management practices by farmers. In this way, participation in awareness and training campaigns by farmers resulted in a 23.2 percentage point increase ($p < 0.001$) in the number of practices adopted. Similarly, the use of salaried labour led to an increase of 8.8 percentage points ($p < 0.01$). A minimum primary education level also favoured greater adoption

by 7.4 percentage points ($p < 0.01$), and good CMD knowledge increased the number of management practices adopted by 4.2 percentage points ($p < 0.001$) among farmers.

The details of the results obtained from the Tobit regression model used are presented in Table 7.

Table 6. Distribution of farmers by adoption category.

Adoption Categories	Interpretation	Total Farmers Surveyed ($n = 290$)	Trained Farmers ($n = 146$)	Non-Trained Farmers ($n = 144$)	$p > z $
Non-adoption	The farmer does not use any of the proposed practices	19	01	18	0.000 ***
Low adoption	Adoption limited to one or two practices	157	44	113	0.001 ***
Moderate adoption	Adoption of three to four practices by the farmer	95	82	13	0.000 ***
High adoption	Virtually complete implementation of the proposed practices (five)	09	09	0	0.002 **
Full adoption	Full use of all recommended practices	10	10	0	0.000 ***

*** $p < 0.01$, ** $p < 0.05$.

Table 7. Estimation of the Tobit model for the intensity of adoption of CMD management practices.

Variables	Coef.	St.Err.	t -Value	p -Value	[95% Conf	Interval]
Education level						
Unschool	0	-	-	-	-	-
Primary	0.074	0.026	2.82	0.005 ***	0.022	0.125
Secondary	0.051	0.028	1.86	0.064	-0.003	0.106
Higher	0.07	0.051	1.38	0.170	-0.030	0.170
Main activity						
Other activities	0	-	-	-	-	-
Cassava production	-0.025	0.026	-0.93	0.351	-0.077	0.027
Farm type						
Community	0	-	-	-	-	-
Family	-0.101	0.130	-0.77	0.440	-0.358	0.156
Personal	-0.035	0.129	-0.27	0.789	-0.288	0.219
Age						
[Less than 20]	0	-	-	-	-	-
[20 to 40]	-0.177	0.103	-1.71	0.088 *	-0.381	0.026
[41 to 64]	-0.166	0.103	-1.61	0.108	-0.369	0.037
[65 and more]	-0.176	0.107	-1.64	0.102	-0.388	0.035
Type of cropping						
Intercropping	0	-	-	-	-	-
Mono-cropping	-0.03	0.022	-1.39	0.165	-0.074	0.013
Experience in cassava cultivation						
1 to 5 years	0	-	-	-	-	-
6 to 10 years	0.027	0.033	0.82	0.412	-0.038	0.091
11 years and more	-0.018	0.027	-0.66	0.512	-0.072	0.036
Knowledge of CMD (score)	0.042	0.01	4.14	0.000 ***	0.022	0.062
In contact with an extension officer	-0.007	0.021	-0.35	0.730	-0.048	0.034
Participated in awareness campaigns	0.232	0.026	8.96	0.000 ***	0.181	0.283
Acreage	-0.012	0.012	-0.97	0.332	-0.036	0.012
Type of labour						
Salaried	0.088	0.03	2.96	0.003 ***	0.030	0.147
Community	0.007	0.047	0.14	0.889	-0.086	0.099
Family	0.039	0.026	1.54	0.124	-0.011	0.090
Constant	0.289	0.164	1.76	0.079 *	-0.034	0.612

Table 7. Cont.

Variables	Coef.	St.Err.	t-Value	p-Value	[95% Conf	Interval]
Mean dependent var		0.375			SD dependent var	0.227
Pseudo r-squared		0.5552			Number of obs	290
Chi-square		197.062			Prob > chi2	0.000
Akaike crit. (AIC)		−110.131			Bayesian crit. (BIC)	−33.063

*** $p < 0.01$, * $p < 0.1$.

4.5. Evaluation of CMD Epidemiological Parameters in Farmers' Fields

4.5.1. Incidence and Severity

Consistent with the third objective, this section presents the key epidemiological features of CMD observed in the study areas. It focuses on disease incidence, severity, and mode of infection, helping us to better understand how the disease spreads and manifests in farmers' fields. Across all study areas, the prevalence of CMD was found to be significant, with an average incidence of 54.75%. Despite a higher average number of whiteflies per field in beneficiary areas (34.34) compared to non-beneficiary areas (30.26), the incidence of CMD was slightly lower in the areas that received training and awareness campaigns (54.55%) than in the non-beneficiary areas (54.95%). However, this difference was not statistically significant ($p > 0.05$). A mean severity of 2.9 was also recorded across all study areas, with non-significant ($p > 0.05$) differences between beneficiary areas (2.86) and non-beneficiary areas (2.94).

4.5.2. Mode of Spread and CMD Symptom Severity

In all study areas, the main mode of CMD spread was through infected cuttings (97.33%), compared to only 2.67% by whiteflies. In beneficiary areas, 96.59% of CMD infections were attributed to the use of infected cuttings, while 3.41% were caused by whiteflies. In non-beneficiary areas, these proportions were 98.08% and 1.92%, respectively, indicating no statistically significant difference between the two groups ($p > 0.05$). The differences observed in the disease's epidemiological parameters across the study areas are presented in Figure 3 and Table 8.

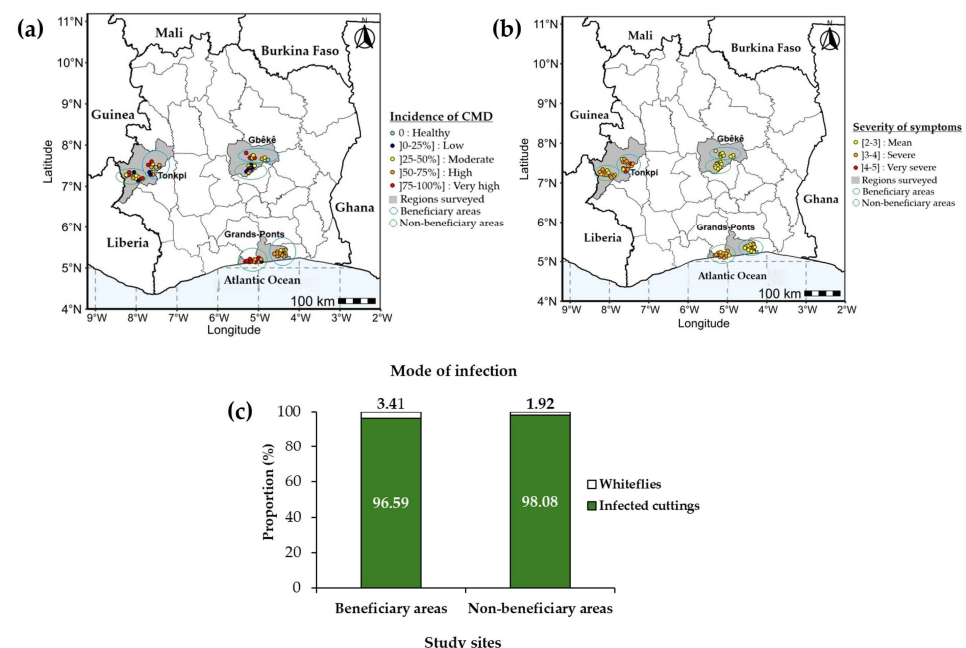


Figure 3. Epidemiological parameters of CMD in the surveyed field in Côte d'Ivoire in 2023. (a) Incidence. (b) Mean severity. (c) Mode of infection.

Table 8. Evaluation of CMD epidemiological parameters in the study areas.

CMD Parameters		Beneficiary Areas Fields Surveyed (<i>n</i> = 41)	Non-Beneficiary Areas Fields Surveyed (<i>n</i> = 41)	(p-Value)
		Frequency/Mean (Standard Error)		
Incidence		54.55 (3.83)	54.95 (4.75)	0.929 ^{ns}
Severity		2.86 (0.10)	2.94 (0.09)	0.555 ^{ns}
Mode of infection	Cuttings	96.59	98.08	0.094 ^{ns}
	Whiteflies	3.41	1.92	
Number of whiteflies per field		34.34 (5.36)	30.26 (3.98)	0.974 ^{ns}

ns (non-significant difference).

5. Discussion

This study evaluated how WAVE's training and awareness campaigns influence farmers' knowledge of CMD, the adoption of DMPs, and ultimately, epidemiological outcomes in cassava fields. From the results obtained, the following interpretations can be deduced.

5.1. Training and Improvement of CMD Knowledge Among Farmers

The results indicate that training has a strong and positive impact on farmers' understanding of Cassava Mosaic Disease. Beneficiaries of the awareness campaigns demonstrated not only a better recognition of symptoms and impacts, but also a deeper comprehension of the disease name, cause, modes of spread, and recommended management practices. In contrast, farmers who were not trained generally showed very limited knowledge. Their understanding of CMD was often restricted to visible symptoms and impacts. These findings align with several studies from other West African countries and beyond. Frimpong et al. [16] in Ghana found that only 22.4% of cassava farmers were able to recognise CMD symptoms. Moreover, 58.2% were unfamiliar with the disease's specific name and instead described it using general expressions such as "curled leaves", "yellowing of leaves", "mottled leaves", and "leaf drop and stunted growth". In a similar research study, Houngue et al. [11] in Benin found that while all surveyed farmers could visually recognise CMD symptoms, most were unaware that the disease was caused by a virus. Also, Eni et al. [15] in Nigeria reported that over two-thirds of cassava farmers did not know the origin of CMD symptoms, and 71.29% ignored the role of whiteflies in disease transmission. These findings highlight that field experience alone is not sufficient to build comprehensive knowledge, thereby reinforcing the need for structured and targeted training programs.

In this regard, Ahoya et al. [14] demonstrated the effectiveness of awareness campaigns in Benin, reporting a 32.5% increase in CMD-related knowledge following training. By comparison, our findings suggest an even greater impact (69.9%), which may be attributed to the content, intensity, or delivery methods used in the training model employed in Côte d'Ivoire. The importance of well-designed learning approaches is further supported by Tambo et al. [43], who showed that digital tools such as SMS, radio, and video projections significantly enhanced maize farmers' knowledge of Fall Armyworm and increased their adoption of appropriate management practices in Uganda. Similarly, Muhangi et al. [44] showed that raising awareness about Banana Bacterial Wilt significantly improved farmers' understanding of its symptoms, transmission modes, and control strategies.

Beyond Africa, Yang et al. [45] demonstrated in China that integrated pest management training significantly improved vegetable farmers' ecological knowledge and disease control practices. These findings from different contexts suggest that farmer education,

especially when participatory and adapted to local realities, plays a crucial role in helping farmers to understand plant diseases and adopt effective management practices.

5.2. Factors Influencing Adoption and Intensity of Adoption of DMPs Among Farmers

The findings reveal that the overall adoption of CMD management practices among cassava farmers remains limited, particularly for certain practices. While the promotion of six practices by the WAVE initiative led to some adoption, especially among trained farmers, adoption levels remain uneven. Practices such as the use of healthy cuttings, roguing of infected plants, and adhering to standard planting density were more frequently implemented, suggesting that farmers tend to prioritise strategies perceived as simple, low-cost, and directly impactful. Conversely, the replacement of infected plants, regular weeding, and the use of the Nuru mobile app were less adopted, likely due to economic and logistical constraints, as previously demonstrated by Rogers [18]. These observations are consistent with results from other West African countries. In Benin, Ahoya et al. [14] found that even among trained farmers, the adoption of practices like Nuru application and the use of healthy planting materials (29%) remained limited, despite relatively better uptake of field monitoring (51%) and compliance with planting density (51%). Similarly, Eni et al. [15] highlighted that Nigerian cassava farmers often relied on removing or burning infected plants, indicating a preference for visible, manual control methods. In Ghana, Frimpong et al. [16] emphasised the lack of reliable information sources, which led many farmers to rely on personal experience rather than recommended practices. After observing the presence of CMD, 45.6% of the surveyed farmers immediately contacted an extension officer, 19.1% resorted to cultivation or field sanitation practices, 26.5% took no action, and 8.8% applied pesticides. These findings suggest that, while training is beneficial, it may not be sufficient on its own to ensure widespread adoption. The decision to adopt a practice also appears to be shaped by its perceived accessibility, cost-effectiveness, and compatibility with existing farming routines.

This was confirmed by the Tobit regression results, which provided deeper insights into the factors that drive the adoption and intensity of adoption of CMD management practices. Expectedly, participation in awareness campaigns emerged as the most influential variable. This finding reinforces the idea that structured training initiatives do more than just increase disease recognition, they also encourage practical engagement with management strategies. As previously noted by Schreinemachers et al. [13], better knowledge of crop diseases leads to the adoption of more effective control measures. Similarly, Tambo et al. [43] showed that awareness campaigns significantly increased the number of Fall Armyworm management practices adopted by beneficiary farmers, who implemented on average two more practices than non-beneficiaries, raising adoption rates from approximately 53% to 55%. In Togo, Koubi et al. [46] also found that farmers' participation in training and awareness programs on the recognition and management of cassava diseases increases the likelihood of adopting relevant technologies by 32%.

Beyond training, other socio-economic variables significantly influenced adoption behaviour. Farmers who had access to extension services and attained at least a primary level of education adopted a greater number of practices, highlighting the critical role of education and advisory support in enhancing farmers' ability to understand and implement agricultural innovations. This supports the conclusions of Kebede et al. [47] and Chirwa [48], who argued that educated farmers are better positioned to assess the relevance of new technologies and to adjust their farming decisions accordingly. Access to salaried labour also positively affected adoption. This suggests that labour availability may be a constraint for some farmers, particularly for practices that are time or effort-intensive, such

as roguing diseased plants or regular field monitoring. When labour is accessible, either through household members or hired workers, adoption becomes more feasible.

On the contrary, age and experience had a negative effect on adoption intensity. Older farmers, while often rich in practical field knowledge, may be less inclined to change established routines or adopt new tools, especially digital ones like the Nuru app. Alene et al. [49] similarly observed that advanced age often limits the capacity to effectively implement new agricultural practices, possibly due to physical limitations or a lower propensity to take risks. Finally, disease-specific knowledge, beyond mere exposure to training, emerged as a significant driver of adoption. This highlights the need to deepen farmers' understanding not just of what to adopt, but also why these practices are important. Effective interventions should therefore go beyond promoting recommended actions to fostering a clear comprehension of disease transmission mechanisms, symptom development, and the long-term benefits of integrated management strategies.

5.3. Effect of Trainings on CMD Epidemiological Parameters Assessed in the Study Areas

The results show that although trained farmers had better knowledge of CMD and adopted disease management practices at higher rates than non-trained farmers, the incidence and severity of the disease observed in their fields remained very similar to those recorded among non-trained farmers. This finding suggests that increased knowledge and behavioural change alone are not sufficient to achieve short-term reductions in CMD prevalence (Table 8).

Several structural and agronomic factors may explain this apparent paradox. One major limitation is the widespread unavailability of healthy planting material. In all study areas, farmers continue to rely on informal seed systems, often reusing infected cuttings from previous harvests. This was confirmed by field observations, where more than 97% of CMD transmission was linked to infected planting material. Another key constraint is the continued use of cultivation practices that favour the disease's spread. Most farmers grow local cassava varieties that are highly susceptible to CMD. In addition, cassava is often intercropped with vegetables such as tomato, okra, and eggplant, which are also known hosts of the virus [50]. Furthermore, whitefly populations, one of the primary vectors of CMD, were found to be higher in the fields of trained farmers compared to non-trained farmers. The high vector pressure may have offset the potential benefits of the adopted management practices, particularly in the short term. As highlighted by Sseruwagi et al. [29] and Legg et al. [51], elevated whitefly densities contribute to rapid and widespread CMD transmission, even in fields where improved practices are implemented. These findings underline the importance of complementary and sustained interventions. This involves improving access to CMD-resistant planting materials through certified partners, strengthening integrated pest and vector management (e.g., via crop diversification), exploring biotechnological options like salicylic acid applications [52], and ensuring ongoing technical support and field monitoring to translate knowledge into effective disease control.

6. Conclusions

This study aimed to assess the impact of the trainings and awareness campaigns conducted by the Central and West African Virus Epidemiology (WAVE) center on farmers' Cassava Mosaic Disease (CMD) knowledge and adoption of its management practices. In line with the research objectives, the results obtained demonstrate an overall positive effect. Farmers who participated in the intervention showed significantly higher levels of knowledge about CMD, as well as a greater likelihood of adopting disease management practices (DMPs) compared to their non-trained counterparts. However, this increased

awareness alone did not translate into widespread or effective adoption. Adoption levels, including the intensity, varied significantly across farmers and were influenced by several interrelated factors, including education level, access to extension services, labour availability, and above all, the accessibility and affordability of the promoted practices. This suggests that behaviour change requires more than information alone. Moreover, the epidemiological assessment of CMD in the surveyed areas showed no significant difference in disease incidence between the fields of trained and untrained farmers, despite the farmer's higher levels of knowledge and reported adoption of practices. This points to systemic barriers such as the persistent use of infected cuttings, the unavailability of certified healthy planting materials, the widespread preference for local (but often CMD-susceptible) varieties, intercropping of cassava with alternative virus host crops, and the uncontrolled presence of whiteflies. From a policy perspective, investing in farmer field schools, local innovation platforms, and community-based seed systems will be crucial to bridge the gap between knowledge and practice. In parallel, tailored communication strategies, using local languages, community radios, traditional leaders, and farmer networks, are essential to reach diverse farmer profiles and foster lasting behavioural change. Finally, interventions should also integrate ecological considerations, such as vector control and well-planned crop associations, to reduce virus transmission and enhance the long-term sustainability of disease management efforts. In this study, the data collected relied on farmers' self-reports, which may be subject to recall or social desirability bias. Moreover, epidemiological observations were based on a single visit per field, which does not account for seasonal or temporal fluctuations in disease pressure. While the ex-post power analysis confirmed a sufficient sample size, results should still be interpreted with caution given the moderate size of the treated and control groups. To strengthen causal inference in future evaluations, the use of randomised controlled trials (RCTs) should be considered, to reduce potential selection bias. Future research should also aim to assess the long-term effects of CMD management practice adoption on disease incidence, cassava yields, household income, and farmers' overall well-being.

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Institutional Review Board Statement: This study was conducted in accordance with the Declaration of Helsinki, and the data collection protocol was examined and approved by the Department of Sociology of the University Peleforo GON COULIBALY (UPGC) of Korhogo (Côte d'Ivoire), which provided a written research authorisation. However, at the start of each interview, we reminded

participants of the context of the study and the confidential nature of the information's to be collected. It was with their verbal consent that we realised the interviews.

Data Availability Statement: Data are contained within the article.

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Abbreviations

The following abbreviations are used in this manuscript:

CMD	Cassava Mosaic Disease
WAVE	Central and West African Virus Epidemiology
KAP	Knowledge Attitude and Practices
DMP	Disease Management Practices
ANADER	Agence Nationale d'Appui au Développement Rural

Appendix A

Table A1. Villages surveyed in 2023 to assess the farmers' knowledge on CMD in Côte d'Ivoire.

Regions	Departments	Villages	Total
Grands-Ponts	Dabou	Armébé, Débrimou, Bouboury, N'gatty, Gbougbo, Kpass, Vieil Aklodj, Okpoyou	08
	Grand-Lahou	Sicor V1, Sicor V2	02
Gbêkê	Bouaké	Sessenouan, Sessety, Koffikoffikro, Sinanvessou, Diedoukpli, Tchêlêkro, N'zanikro, Sakassou-Ottokoukro, Bamoro	09
	Sakassou	Angamankro, Sando	02
Tonkpi	Man	Gbatongouin, Douagouin, Guianlé, Kassiapleu, Petit Gbapleu, Klapleu, Glondouin, Gbepleu, Kondopleu, Kiélé, Kiriao	11
	Danané	Zoleu, Téapleu-Cavaly, Trodeleupleu, Petit Danané	04

Table A2. Number of farmers participating to the KAP survey on CMD per regions and departments in Côte d'Ivoire.

Study Areas	Region of Grand-Ponts		Region of Gbêkê		Region of Tonkpi	
	Department	Farmers Surveyed	Department	Farmers Surveyed	Department	Farmers Surveyed
Beneficiary areas	Dabou	44	Bouaké	46	Man	56
Non-beneficiary areas	Grand-Lahou	44	Sakassou	46	Danané	54
Total farmers surveyed		88		92		110

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