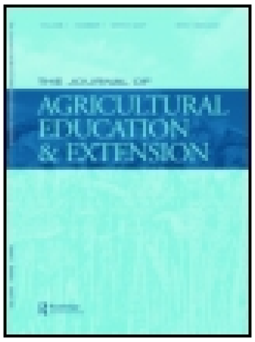

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REVIEW

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The effect of communication media on the uptake of agricultural innovations in selected states of Nigeria

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ABSTRACT

Purpose: Poor uptake of agricultural innovations on weed management practices is a major factor responsible for low productivity. This paper examines how communication media can help improve farmers' adoption behaviour.

Methodology: A sample of 725 Nigerian cassava farmers, exposed to agricultural innovation on weed management practices from varying sources, were asked, through a structured questionnaire, to indicate their knowledge, attitudes, and practices of cassava weed management. The responses were compared with a sample of 190 cassava farmers who were not exposed to the information (control group). The data were analysed using frequency counts, percentages, mean, analysis of variance, and multivariate probit regression.

Findings: Farmers exposed to the agricultural innovation in weed management practices indicated more positive behaviour (57.7%) towards improved weed management practices than the control group (26.8%). The mean knowledge, attitude, practice, and behaviour of the farmers exposed to the innovation through demonstration was significantly higher than for other sources.

Practical implications: On-farm demonstrations as a means of communication will enhance the uptake and effectiveness of agricultural innovation on weed management practices.

Theoretical implications: Findings on the influence of communication media on improved weed control and agronomy are significant, given that there is little well-documented data on how communication media enhances technology and innovation adoption in arable crop farming.

Originality/value: This study generates important data that reinforces the imperatives of communication and media choices, and further underpins the debate that technology alone cannot lead to uptake by farmers but needs to be communicated.

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This article has been corrected with minor changes. These changes do not impact the academic content of the article.

Introduction

The challenge of the rapidly expanding global population with projections of about 10 billion people by 2050 (Bene et al. 2015) raises anxiety about guaranteeing food security soon. Concerning feeding the increasing population, Clapp (2015) noted that only a few countries in the world could be considered self-sufficient in food production, with the African continent accounting for most countries where the food self-sufficiency ratio (SSR) is unacceptable. Nigeria will possibly be among the worst hit by the food insecurity challenge in sub-Saharan Africa, given its population growth rate and the projection to quadruple by the end of this century (Jayne and Ameyaw 2016). Achieving food security in Nigeria requires more investment and innovative agriculture actions since most food-insecure households depend on agriculture for livelihood (Olaniyan and Fadairo 2019). In recognition of cassava's potential as a major food crop in Nigeria and the leading role played by the nation in total global cassava output (Forsythe, Posthumus, and Martin 2016), the crop has been targeted for widespread promotion and dissemination of new varieties by several regional and local development interventions (Ogunyinka et al. 2018; Ohimain 2015). However, despite extensive efforts to improve productivity through the dissemination of improved technologies, adoption rates have been seriously affected mainly by inadequate extension access, insufficient information (Wossen et al. 2017), severe weed competition with plants and poor agriculture practices in cassava farm management (Soares et al. 2016).

The problem of weed competition with cassava plants in particular (Soares et al. 2016) coupled with low adoption of improved methods has left the current average yield of cassava tubers lagging behind potential yields. Burgos et al. (2021) noted that weed competition within the first three months of planting cassava could lead to up to 90% reductions in cassava root yield. Kintché et al. (2017) found that the frequency of weed controls carried out during a particular growing period and the timing of each consecutive control measure influence the cassava root yield. They further revealed that fields weeded two or three times were more productive (16 t/ha) than fields weeded only once (12 t/ha). Kintché et al. (2017) concluded that regular weed control within a given period of the cassava cycle positively influences the cassava root yield.

Farmers are not oblivious of the negative effects of weeds and majority of smallholder farmers adopt manual method involving hand pulling and hoe weeding (Ekeleme et al. 2019). Unfortunately, when solely used, this method is likely to be unsustainable due to drudgery and severe health challenges associated with its regular use. Ramahi and Fathallah (2006) noted that agricultural workers performing manual weeding are exposed to high risks of musculoskeletal disorders in the lower back. The intensity of labour required to weed cassava farms for optimum production is because an average smallholder farmer in Africa cultivates up to 5 ha of farmland (Samberg et al. 2016) and is required to weed five times to achieve the expected root yield. Besides the excessive burden on farmers, the challenge of hoe weeding has been linked to school dropouts among children in farm families. Ekeleme et al. (2019) noted that due to manual weeding, children's education is undermined as parents pull them out of school to support weeding. Therefore, as much as weeding is desirable for a good yield, innovative weed management practices with reduced health risks and higher efficiency are critical.

To address the burden of managing weeds sustainably, the International Institute of Tropical Agriculture (IITA) implemented two projects: The Cassava Weed Management Project and the African Cassava Agronomy Initiative (ACAI). These projects aim to narrow the yield gap in cassava using best practices in cassava weed management among smallholder farmers in Nigeria. The projects developed an innovative toolkit known as *Six Steps to Cassava Weed Management & Best Planting Practices* (CWM&BPPT) to tackle weeds and boost productivity. The toolkit was piloted in Benue and Oyo states in Nigeria. The two states ranked highly among the 16 states that contribute at least 80% of Nigeria's total cassava production (Wossen et al. 2017). To avoid the challenges of effective communication and extension access that have hindered earlier cassava promotion efforts (Wossen et al. 2017), disseminating the toolkit embraced the use of communication media. These include radio, practical demonstration or 'demo' in this paper, video shows or 'video', telephone call-ins, calendars, and pamphlets. Data on the media influence on improved weed control and agronomy are particularly important, given that there is little well-documented, locally specific data on communication media for enhancing technology and innovation adoption in arable crop farming, especially cassava. The empirical data is also vital to identifying choices and designing the best strategies instead of 'one-size-fits-all' interventions in the cassava industry. Therefore, the purpose of this study is to understand communication media's effects on the uptake of Six Steps to Cassava Weed Management and Best Planting Practices toolkit (CWM&BPPT) in Benue and Oyo states, Nigeria. Specifically, the study investigated the influence of selected communication media on farmers' behavioural attributes (knowledge, attitude and use) towards the toolkit, the challenges cassava farmers face in adopting the recommendations, and the factors influencing the effectiveness of the various communication media.

This paper contributes to the growing body of knowledge about using different communication technologies to uptake agricultural innovations. This is especially important given that this field of research has received insufficient attention, particularly in a world where communication technologies are changing rapidly. Important locality-specific data that could help in defining choices of communication media for promoting relevant agricultural technology among farmers in Nigeria were also generated.

Literature review

Cassava production in Africa: issues and situation

Cassava, a perennial root plant, serves the dual purpose of a subsistence and cash crop. It contains about 40% more carbohydrates than rice and 25% more than maize, making it the most affordable source of energy food for both animal and human nutrition (Tonukari 2004). It is also a major source of raw material for animal feed, flour, alcohol, starches, textiles, prepared foods, sweeteners, and bio-degradable products. Cassava's hardy characteristics give it an advantage over maize, rice, and other staples, especially in places characterized by diminishing resource-pool, unpredictable climate and poor market structures. Due to its tolerance for drought and poor soil situations, cassava can be cultivated in generally harsh ecologies though it does well on irrigated farms or in higher rainfall regions (Agricultural Research Council 2014).

Cassava originated from South America and was introduced to Africa in the Democratic Republic of Congo by the Portuguese slave traders to obviate the scourge of famine caused by a prolonged dry spell and locust infestation on farms (Nweke 2005). Today, Africa plays a major role in cassava production, contributing almost half of its global output (Nweke 2005). After maize, cassava is Africa's most important staple food providing the most carbohydrates to people and is a major source of calorie intake for more than five hundred million people (Agricultural Research Council 2014). The Agricultural Research Council (2014) noted that Africa was responsible for nearly 54% of the world cassava harvest during the year 2000, while Asia and the Latin America/Caribbean represented 28% and 19%, respectively. Currently, Nigeria, which produces almost 35% of the total worldwide output and 19% of the total African output, is the leading global producer of cassava, followed by the Republic of Congo and Tanzania (Scott 2021).

Trends in cassava production show that production has more than tripled between 1980 and 2005 (Nhassico et al. 2008) due to the expansion of land size cultivated, improved processing technology, better market linkage roads, the food crisis of the 1980s and population growth (Nweke 2005). Despite increasing output, Shackelford et al. (2018) noted that global average root yields of cassava of 11.6 t/ha remain much lower than potential yields of more than 60 t/ha. This situation of low cassava yields compared to realizable potential is also an issue in Nigeria despite the country being the world's largest producer. The cassava industry's major challenge in Africa has been its neglect by researchers, policy-makers and donor agencies, causing a paucity of information on the crop. According to Nweke (2005), this neglect was due to the perception of cassava as an inferior food and uncompetitive commodity compared with other food items such as rice. Recently, challenges to cassava production include weed competition with plants and cyanogenic glucosides in its leaves and roots that are dangerous for human consumption (Nhassico et al. 2008). Combating cassava weed problems by promoting the best agronomic practices in cassava farming remains critical, especially for Africa, given the projected population increase to nearly 10 billion people worldwide in 2050 (Searchinger et al. 2019).

Conceptual framework

A conceptual framework was developed to understand the links between the agricultural innovation (CWM&BPPT) and cassava issues in Nigeria (Figure 1). In Nigeria, as is common in other cassava producing countries in Africa, the major issue confronting the cassava industry is the low root yield obtained in most smallholder farms. The smallholder farmers who account for the bulk of the cassava root production in Nigeria produce below optimum capacity; the average yield is less than the potential yield. The cassava root yield paradox in Nigeria can be explained by several factors such as weed competition with cassava plants, poor agronomic practices of farmers, depleting soil nutrients, and inadequate production technology. Apart from the poor yield of roots, the impact of these limiting factors on the cassava industry is also manifest in the low income realized by smallholder farmers from tuber sales, which is not usually commensurate with the labour required in the production process. The CWM&BPPT evolved to address these challenges. The toolkit comprises two broad components:

Figure 1. Farmers watching the Six Steps to Cassava Weed Management & Best Planting Practices video in Tarka community, Benue State, Nigeria.

- improved weed management using herbicides and
- good agricultural practices in cassava farming.

It was disseminated to smallholder cassava farmers in two pilot states in Nigeria using different extension communication channels. The overarching goal is to improve cassava farmers' understanding and build their capacity to attain optimum cassava yield. If this is achieved, farmers will make more income. Attainment of this goal, however, hinges on the effectiveness of extension dissemination of the toolkit. The scale-up of the toolkit's extension dissemination in Nigeria needs to be guided by understanding the appropriate communication media mix for engendering effective behavioural change among cassava farmers.

Methodology

The study area

The study was conducted in Benue and Oyo states, Nigeria. These states were purposively selected due to their leading roles in cassava production in the northern and southern regions of Nigeria, respectively. The states are described as follows:

Oyo State: Oyo State is located at Latitude N 8°7.174' and Longitude E3°25.1732' in southwestern Nigeria, with its capital in Ibadan. The state, mostly a rainforest region, shares a boundary with Kwara, Osun, and Ogun states in its northern, eastern, and southern parts, respectively. In the west, it is bounded by Ogun State and by the Republic of Benin (Kolawole and Oladele 2013). With a population of about 6,617,70, the state covers about 28,454 km^2 of land and is ranked 14th by size compared with other states in Nigeria (National Population Commission 2007). Oyo State is mainly inhabited by the Yoruba people, primarily farmers. Common food crops grown in the state include cassava, yam, maize, and soybean.

Benue State: Benue State, a woody savanna region, is located in the north-central part of Nigeria at Latitude N 7°19'59.99' and Longitude E 8°45'0.00'. The state population of about 4,253,641 occupies a total land area of 300,955 km^2 (National Population Commission 2007). Its capital is Makurdi and it shares boundaries with Kogi, Nasarawa, and Taraba states to the west, north, and northeast, respectively. It is bounded by Cross River, Ebonyi, and Enugu states to the south (Adaikwu and Ali 2013). The state is home to the famous River Benue, a common border with Cameroon, where the Mokamoun River takes its root. Benue State is inhabited by the Tiv, Igede, and Idoma peoples, known for farming. Commonly grown crops include cotton, cassava, maize, sesame seed, soybean, yam, shea nut, sorghum, millet, peanut, and rice.

Sampling procedure

The study used a causal research design involving project participant and non-participant assessment post-intervention. This provided the basis for assessing how the different media influenced respondents' behaviour towards the CWM&BPPT by comparing the treatment and the control groups. The causal research design has been widely used by researchers attempting to establish a cause–effect relationship between certain variables. In the context of this work, the variables are choice of communication channels and adoption of agricultural innovation. Erickson (2017) rated this research design as unique in that it offers new approaches that can unobtrusively test responses in both the real world (field experiments) and virtual environments (laboratory experiments). Data were collected from 915 smallholder cassava farmers comprising 725 project participants (farmers exposed to the toolkit) and 190 non-participants in the study area. This study did not consider an even split between treatment and control groups in terms of numbers to reach more farmers with the innovation.

Nonetheless, the treatment-control size used in this study is within what is statistically acceptable in causal research design. White and Mark (2020) noted that a 25–30% range of control size is good enough. The respondents were sampled using a multistage sampling procedure. The first stage involved a purposive sampling of 13 Local Government Areas in Oyo State and nine in Benue State based on the prominence of smallholder cassava farming (Figure 2). Using the same rationale, 59 cassava farming communities were sampled, representing 31 in Oyo State and 28 in Benue State. Out of the sampled cassava farming communities in Oyo State, nine were exposed to the toolkit using video (Figure 3), eight with radio, and six with practical demonstration. The other eight communities had no exposure to serve as the control group. In Benue State, 12 cassava producing communities were exposed to the toolkit using video, five using radio, and seven through practical demonstration, while four communities also served as the control.

The intervention content was the same for the radio, video, and practical demonstration channels. The message generally included information on the importance of

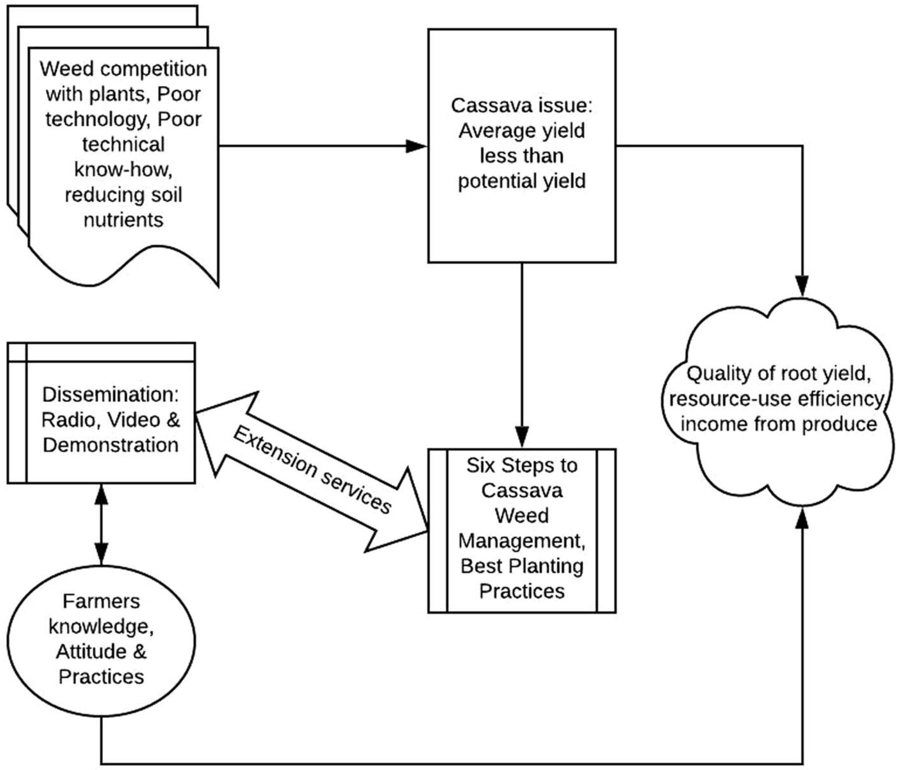

Figure 2. Conceptual framework.

effective weed control in cassava farms and the steps involved starting from land preparation to harvesting. The development and implementation of the video, radio, and demo intervention package were done by the Cassava Weed Management Project, and the African Cassava Agronomy Initiative Project in collaboration with experts from the Agricultural Extension Department at the University of Ibadan and the Agricultural Development Programme officers in Oyo and Benue states. The video on the intervention was shown to target farmers in their groups using the projector and screen. Copies of the video were also shared with the farmers on their mobile phones to reinforce their knowledge of the message. The radio message was broadcast as an advertisement on popular community radio stations in the target communities. In communities where the demo channel was used, demonstration plots were established near the farms of the target farmers.

The availability of local resources to support the media used and the degree to which each media was accessible to the farmers guide the choice of the communication channel in each community. For instance, communities near a community radio station were preferred for radio intervention. Intervention and follow-up activities on the toolkit were carried out using the various media channels in the identified farming communities for twelve months, after which the respondents were selected for post-intervention assessment. Also, to reduce the effects of possible diffusion of messages from participants to non-participants, which might interfere with the outcomes of this study, communities

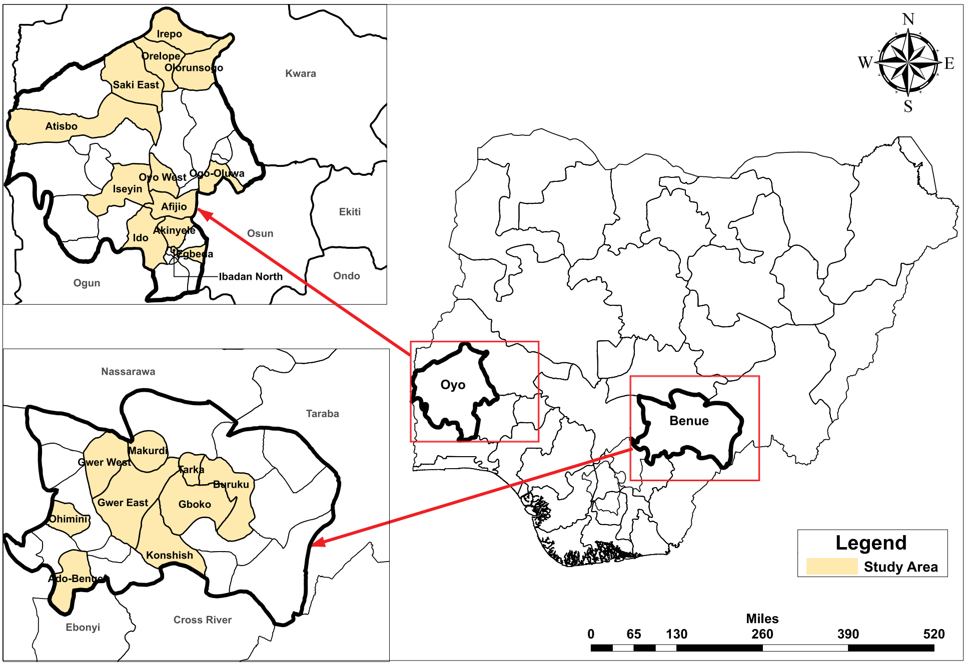

Figure 3. Map showing the study sites.

with considerable distance from each intervention location were preferred as a control. The sampling of respondents post-intervention was guided by Krejcie and Morgan's (1970) table for determining the sample size for a given population. Hence, a representative proportion (30%) of smallholder cassava farmers exposed to the various communication media and from the control communities were sampled using a simple random sampling technique. This gives 303 respondents across the video communities, 196 across radio, 226 across demonstration, and 190 across the control communities in both states. Data were collected between April and July 2020.

Procedures for data collection and analysis

Data were collected using a structured questionnaire using computer-assisted personal interview software [ODK] (Figure 4). The draft questionnaire was subjected to face and content validation procedures by extension communication experts in the IITA and University of Ibadan. A reliability test was also conducted using the split-half method. The reliability coefficient of 0.91 obtained confirmed that the instrument was reliable for the study. Farmers' personal and enterprise characteristics; knowledge, attitude, and practice of the toolkit; and the challenges faced in adopting the toolkit in their cassava enterprises were evaluated. Knowledge of the toolkit was measured by asking respondents 22 knowledge questions derived from the toolkit recommendations. The items were measured using a combination of Yes and No options, and multiple-choice and open-end questions. Correct responses were scored 1 and incorrect 0. Similar procedures were used to gauge the extent of the respondents' use of the

Figure 4. Enumerator with a cassava farmer in Atisbo community, Oyo State, during data collection.

toolkit recommendations on a scale of 20 items. Respondents' knowledge scores were classified as either low or high using the mean score. Attitude towards the toolkit was determined by presenting respondents with 18 attitudinal items on a five-point Likert-type scale of strongly agree to strongly disagree. The most positive attitude was scored 5, while the most negative attitude attracted a score of 1. Respondents were classified as having a favourable or unfavourable attitude using the mean attitude scores as a benchmark. Difficulties in adopting the toolkit were identified by asking respondents to identify what they considered challenges and rank them as severe or mild by awarding 2 and 1, respectively. Weighted mean values for each constraint item were used to discuss the findings. Data collected were analyzed and summarized using descriptive statistics such as frequency counts, percentages, and mean. Analysis of variance and multivariate probit regression were used to test the influence and effectiveness of the various media.

Although the multinomial probit can be used to measure decision choices used by farmers, it is limited in making interpretations for the simultaneous influences of explanatory variables on each dependent variable (the endogeneity problem cannot be addressed using multinomial probit). This is because farmers' decision choices are either substitutive or supplementary to one another (Feleke et al. 2016).

Following Lin, Jensen, and Yen (2005), the MVP model for this study is characterized by a set of m binary dependent variables Y_{hj} such that:

$$Y_{hj}^{*} = X_{hj}^{1}B_{j} + u_{hj} \text{ and} \tag{1}$$

$$Y_{hj} = \begin{cases} 1 \text{ if } Y_{hj}^{*} > 0 \\ 0 \text{ if otherwise} \end{cases} \tag{2}$$

Where $j = 1, 2 \ldots m$ denotes the type of communication strategy available; X_{hj} is a vector of explanatory variables, β*j* denotes the vector of the parameter to be estimated, and u_{hj} are random error terms distributed as a multivariate normal distribution with zero mean and unitary variance. It is assumed that a rational h^{th} farmer has a latent variable, Y_{hj}, which captures the unobserved preferences or demand associated with the *jth* choice of communication strategy.

Dependent variables

The dependent variables included in the analysis are the communication strategies used by farmers in the study: Listening to Radio; Watching Video; On-Farm demonstrations, and Control.

Independent variables

The independent variables in the model included socioeconomic variables such as age, gender, education, family size, occupation, farm labour, membership of farmers' organizations, cassava farm size, cassava output and training. These variables were included in the model based on the conceptual framework and previous studies in the area.

Results

Socioeconomic characteristics of the farmers

Table 1 shows the respondents' distribution by their socioeconomic characteristics. Almost half of the project participants (45.8%) and non-participants (51.1%) were less than 41 years old, while a few were above 60. The farmers' average age was 44 for the CWMP project beneficiaries and 42 for the non-beneficiaries. The age distribution suggests that the cassava farmers in the study area were primarily young adults. The younger generation's involvement in farming confers several advantages, including innovativeness and sustainability of the agriculture systems (North and Smallbone 2006). About 70% of the farmers from both categories were male and had an average family size of nine. Male dominance in primary agricultural production processes is well documented in the literature (De Brauw 2015), while females are usually more involved in

Table 1. Socioeconomic characteristics of the respondents.

Variables	Participants		Non-participants	
	F	%	F	%
Age (years)				
≤ 30	153	21.1	44	23.2
31–40	179	24.7	53	27.9
41–50	179	24.7	46	24.2
51–60	115	15.9	29	15.3
> 60	99	13.7	18	9.5
Mean	*44.2 ± 14.4*		*42.6 ± 13.1*	
Sex				
Male	499	68.8	131	68.9
Female	226	31.2	59	31.1
Family size (persons)				
≤ 5	202	27.9	76	40.0
6–10	397	54.8	80	42.1
11–15	88	12.1	27	14.2
16–20	22	3.0	1	0.5
≥ 20	16	2.2	6	3.2
Mean	*9.0 ± 11.9*		*8.8 ± 14.7*	
Educational attainment				
No formal education	125	17.2	29	15.3
Primary	192	26.5	55	28.9
Secondary	286	39.4	78	41.1
Tertiary	109	15.0	26	13.7
Others	13	1.8	2	1.1
Occupation				
Partial farmer	105	14.5	49	25.8
Full time farmer	620	85.5	141	74.2
Types of farm labour used				
Family members	91	12.6	67	35.3
Hired	153	21.1	40	21.1
Both	481	66.3	83	43.7
Membership in Farmer organization	369	50.9	90	47.4
Intercrop cassava with maize	540	74.5	153	80.5
Heard or participated in cassava weed training	686	94.6	60	31.6
Average reported farm size (ha)	*4.4 ± 5.6*		*3.8 ± 5.5*	

processing and marketing activities. The lower involvement of females in primary production is probably due to drudgery associated with land tillage, planting, and weeding operations in producing many crops (Lu 2007). It might also be due to men's frontal roles in the decision-making process, which could have positioned them better than the women to answer questions in this survey (Fadairo and Keita 2021). Regarding education, 65.9% of participants and 70.0% of non-participants had either primary or secondary school education and were full-time farmers (> 70%). Only very few (< 20%) of the farmers from the two groups were not exposed to formal education, suggesting a moderately literate population of farmers in the study locations. This result is consistent with recent findings on the literacy level of farmers in Nigeria (Fadairo, Williams, and Nalwanga 2019), suggesting an increasing awareness of the importance of formal education among the farming population. Education influences the adoption of innovative agricultural practices (Long, Blok, and Coninx 2016). Both family and hired labour was used by most farmers (66.3%) who participated in the toolkit and 43.7% of the non-participants. The use of family labour in farming has been an age-long tradition in smallholder agriculture, caused mainly by poor mechanization. This situation has often underlined the tendency of smallholder farmers to marry more wives and have large households (Ibrahim 2020). More farmers in the CWMP project group (50.9%) belonged to farmers' organizations than the non-participant group (47.4%). Most farmers in both groups (> 70%) practiced intercropping of cassava with maize. Mixed cropping involving maize and cassava is common among smallholder farmers in Nigeria to maximize gain and reduce the space for weed competition with plants (Adeniyan et al. 2014; Ayoola and Makinde 2007). On average, the farm size cultivated (4.4 ha) by the cassava agronomy initiative farmers was greater than that of the non-participating farmers (3.8 ha).

Improvement in farmers' behaviour towards the CWM&BPPT

Table 2 presents a comparative assessment of the farmers exposed to the CWM&BPPT agricultural innovation (using video, radio, and demo) and the control group in terms of their behavioural attributes towards the toolkit. The table shows that all the toolkit participating farmers were better-off in their knowledge, attitude, practice, and overall behaviour towards the intervention than non-participant farmers. For all the parameters (except for attitude), more than half the project participants performed above average, while the non-participant farmers were mostly at a low ebb for each parameter (except for knowledge). For instance, 56.4% of the farmers exposed to the toolkit adopted and practiced the recommendations, while most non-participant farmers (67.4%) were still involved in the old practices. These results show a clearer improvement in the behaviour of the farmers exposed to the Cassava Weed Management Project intervention towards the project recommendations than those not directly exposed. Hence, suggesting a positive influence of the communication media used in the intervention. The potency of video messages shared by mobile phones for encouraging uptake of innovation was explained by Birukila et al. (2017) where an audio-visual clip about polio vaccine safety was found to enhance the spread and use of behavioural health messages in low-literacy communities in Northern Nigeria. In a similar vein, Sousa, Nicolay, and Home (2019), Saaka et al. (2021) and Hollywood et al. (2018) confirmed the effectiveness of video, radio and demonstration channels, respectively, for delivering behaviour change interventions to various target audiences.

Table 2. Farmers knowledge, attitude, and practice of Six Steps to Cassava Weed Management & Best Planting Practices toolkit by media channels used for intervention.

Attributes	Categories	All Participants (%) Video+ Radio+ Demo	Non-participants (%) Control	Statistic
Knowledge	Low	10.6	42.1	Min = 13,
	High	89.4	57.9	Max = 18,
				Mean = 17.3 ± 8.5.
Attitude	Unfavourable	52.6	80.0	Min = 21,
	Favourable	47.4	20.0	Max = 90,
				Mean = 55.6 ± 6.8.
Practice	Low	43.6	67.4	Min = 0,
	High	56.4	32.6	Max = 20,
				Mean = 11 ± 4.7.
Behaviour	Unfavourable	42.3	73.2	Min = 44,
	Favourable	57.7	26.8	Max = 116,
				Mean = 84 ± 8.8.

Source: Data generated by the author from a Field Survey

Constraints faced by farmers in utilizing the CWM&BPPT

The results in Table 3 show the various constraints the farmers faced in using the recommended technology. Generally, the constraints are classified into 14 categories. The most-mentioned constraint was non-availability of recommended herbicides, indicated as a severe constraint by about 36% of respondents. This suggests the inability of the herbicide companies to meet up with the expectation of the respondents. It is only recommendations that are available that can be utilized. This result resonates with the submission of Loevinsohn et al. (2013) that farmers' decisions about a new technology adoption are influenced by the dynamics of the technology features and the range of situations and environments. The foregoing justifies the argument of the Unified Theory of Acceptance and Use of Technology (UTAUT), which emphasises facilitating conditions as an important construct in determining user intention and behaviour towards any technology or innovation (Venkatesh, Thong, and Xu 2012). Facilitating conditions in this context would be providing support services that could make the recommended herbicides easily accessible to the target farmers.

The next major constraint is the relatively high cost of the recommendations. This was mentioned as a severe constraint by about a third of the respondents (30%). Economic issues dominate the decision of farmers to either adopt or decline to adopt based on the cost of the technology. The third major constraint category is the low compatibility of the recommendations with local conditions mentioned as severe by about 19% of the respondents. This corroborates that any technology adopted must be understood and compatible with current local practices. The degree to which an innovation is perceived as being consistent with the existing values, needs and past experiences of potential adopters (compatibility) has been emphasised in the Technology Acceptance Model (TAM) as a key factor influencing the adoption behaviour of people (Lee, Kozar, and Larsen 2003).

Influence of communication channels on farmers' behaviour towards the CWM&BPPT

Table 4 reveals the difference in respondents' knowledge, attitude, practice, and behaviour towards the toolkit influenced by the media channels used. It is important to note

Table 3. Constraints faced in utilizing the cassava agronomy recommended practices.

S/N	Statements (paraphrased)	Negligible (%)	Mild (%)	Severe (%)	Mean
1	Recommended herbicides not readily available	42.5	21.5	36.0	0.93
2	Venue not conducive for the training	65.2	20.0	14.8	0.50
3	Poor and ineffective delivery by the facilitator	68.4	14.0	17.6	0.49
4	Training materials not very explicit	59.6	23.1	17.4	0.50
5	Tools used not user friendly	57.4	25.4	17.3	0.60
6	Poor compatibility of recommendations with local conditions	56.9	23.7	19.3	0.62
7	Recommendations are expensive to adopt	42.5	27.1	30.4	0.88
8	Timing of the training was not appropriate	65.0	18.8	16.2	0.51
9	Process not interactive or participatory	70.4	13.3	16.3	0.46
10	Too much use of unfamiliar/technical terms	70.2	13.7	16.2	0.46
11	messages disseminated not understandable	67.8	15.0	17.3	0.50
12	Inadequate funds	77.9	22.1	0	0.44
13	Lack/poor access to tractors	97.3	2.7	0	0.05
14	Herdsmen attack	98.3	1.7	0	0.03

Source: Data generated by the author from a Field Survey

Table 4. Difference in respondents' knowledge, attitude, practice, and behaviour towards the Six Steps to Cassava Weed Management & Best Planting Practices toolkit as influenced by channels used.

	Groups	Sum of Squares	df	Mean Square	F	*p*-value
Knowledge	Between groups	99.825	3	33.278	53.774*	0.000
	Within groups	563.723	911	0.619		
	Total	663.548	914			
Attitude	Between groups	1953.717	3	651.239	14.634*	0.000
	Within groups	40,541.594	911	44.502		
	Total	42,495.311	914			
Practice	Between groups	4953.487	3	1651.162	96.358*	0.000
	Within groups	15,610.552	911	17.136		
	Total	20,564.039	914			
Behaviour	Between groups	1196.246	3	3732.082	56.763*	0.000
	Within groups	59,896.508	911	65.748		
	Total	71,092.754	914			

*Significant at 5%. Data generated by the author from a Field Survey

that the content delivered in each channel was the same. This means that the influence (whether the content was persuasive and/or informative) was dependent on how the content was delivered. There was a statistically significant difference between the channels as determined by the one-way ANOVA for knowledge ($F = 53.774$; $p < 0.001$); attitude ($F = 14.634$; $p < 0.001$), practice ($F = 96.358$; $p < 0.001$), and behaviour ($F = 56.763$; $p < 0.001$) towards the toolkit. The results imply that the channels are different in their influence on the farmers. Hence, as confirmed by the Duncan Multiple range test (Table 5), the various communication channels deliver in statistically significantly different ways regarding the respondents' knowledge levels, attitude, practice, and

Table 5. Duncan's multiple range test showing mean separations for knowledge, attitude, practice, and behaviour towards the Six Steps to Cassava Weed Management & Best Planting Practices toolkit as influenced by channels used.

Variable/ Channels	N	Subset for alpha = .05			
Knowledge		1	2	3	4
Control group	190	16.7000			
Radio	196		17.2296		
Video show	303			17.5182	
Demo	226			17.5664	
Sig.		1.000	1.000	0.519	
Attitude					
Control group	190	54.0211			
Radio	196	54.8944	54.8944		
Video show	303		55.5752		
Demo	226			58.2041	
Sig.		0.169	0.284	1.000	
Practice					
Control group	190	8.1632			
Radio	196		9.8911		
Video show	303			11.9337	
Demo	226				14.5796
Sig.		1.000	1.000	1.000	1.000
Behaviour					
Control group	190	78.8842			
Radio	196		82.3036		
Video show	303			87.3673	
Demo	226			87.7212	
Sig.		1.000	1.000	0.646	

*The mean values for groups in homogeneous subsets. Data generated by the author from a Field Survey behaviour. For instance, the influence of demonstration and video on farmers' knowledge of cassava agronomy differs significantly from the radio and control groups. The mean influence of demonstration (17.6) and video (17.5) on the respondents' knowledge was significantly higher than in the radio (17.2) and control (16.7) groups. A similar trend was observed for other parameters such as attitude, practice, and behaviour towards the cassava agronomy initiative.

Factors influencing media channels effects on farmers' responses towards the CWM&BPPT

The regression model (Table 6) is a good fit for the model, as attested to by the log-likelihood and Wald's chi-square, which is statistically significant at the 1.00 percent level. The correlation coefficients are statistically different from zero in four out of the six combinations of the dependent variables (media methods) included in the model. The Wald's test for the hypothesis that all coefficients in each equation are jointly equal to zero is rejected, suggesting that the variables included in the model explain significant portions of the variations in the dependent variables. The respondents' family size influenced all the media channels; however, the influence is positive for radio and video but inverse for demonstration and control groups. In essence, larger families were likelier to listen to the radio or watch videos. In comparison, smaller families were more likely to be attuned to demonstrations. Also, possession of a larger cassava farm size and higher cassava output increased the likelihood of using radio as a medium. However, the education level of the respondents does not need to be high for radio to be effective as a medium; neither do the respondents need to be a member of a farm organization to use radio. In other words, both the literate and non-literate farmers had the same degree of likelihood to listen to radio and ditto for the farmers who either did or did not belong to an association. This finding is consistent with earlier reports on radio listenership by farmers in Nigeria (Fadairo, Olajide, and Yahaya 2011; Fadairo and Oyelami 2019), which asserted a preference for radio as a communication channel among all categories of farmers. As regards the video, while larger families were more likely to watch videos, participation in training and being a part-time farmer also increased the likelihood of watching videos.

Table 6. Factors influencing the effectiveness of media channels.

Variable	Radio σ_1	Video σ_2	Demo σ_3	Control σ_4
Age	−0.2114	−0.1894	−0.0744	0.5283***
Gender	0.1781	0.0996	−0.5231***	−0.0266
Family size	0.3127***	0.3958***	−0.3014***	−0.3762***
Education	−0.1094**	−0.0517	−0.0995**	0.2084***
Occupation	0.1526	−0.4056**	0.1056	0.3227***
Farm labour	−0.1526**	−0.0159	0.0329	0.1717**
Membership of farmers Organization	0.6678***	−0.7782***	0.2909**	0.0691
Cassava farm size	0.4062***	−0.1659**	0.1315**	0.3298***
Cassava output	0.1602***	−0.0381	−0.0396	−0.1362***
Training	0.1761	2.0971***	1.4603***	1.7938***
Constant	0.1180	0.5236	−0.7174	−3.8305***
Wald chi (36)	343.32			
Prob > chi^2	0.0000***			
Log likelihood	−1215.2996			
No. observation	562			

*, **, *** indicate significance at the 10%, 5%, and 1% alpha levels, respectively.

Table 7. Correlation coefficients of the media channels.

Parameter	Coefficient	Standard error
σ_{21}	−0.2302***	0.0761
σ_{31}	0.0495	0.0738
σ_{41}	0.1047	0.0735
σ_{32}	0.2337***	0.0795
σ_{42}	0.1439*	0.0828
σ_{43}	0.2873***	0.0703

*, **, *** indicate significance at the 10%, 5% and 1% alpha levels, respectively. LRT $\sigma_{21} = \sigma_{31} = \sigma_{41} = \sigma_{32} = \sigma_{42} = \sigma_{43} = 0$; Chi2(6) = 32.564; Prob > chi2 = 0.0000

However, respondents do not need to be a member of a farmer organization; neither do they need to have a large farm size before using video as an effective medium.

In terms of demonstration plots, smaller families and female farmers were more likely to use demonstration as a medium for accessing information on innovation. As for the control sites, in addition to smaller family size, other factors that affected the influence of the zero treatment on the respondents' behavioural traits included: the age of the respondents, level of education, occupation, type of farm labour, training in cassava weed management method and cassava farm size. In other words, the respondents' use of family and hired labour, use of other family members, cultivation of bigger cassava farm sizes and participation in training (through the diffusion of lessons) influenced effectiveness in the group.

Table 7 shows the relatedness of the various media used in the model. Only four of these are statistically significant. These are the relationship between video and radio σ_{21} which is negative and significant at 5%, thus suggesting that both radio and video media are substitutes that do not flow together as media to be used simultaneously for this process. The use of video and demo (σ_{32}), control and video (σ_{42}), as well as control and video (σ_{43}), are, however, positive and statistically significant, suggesting that they are all complementary media that can be used together effectively. It is to be noted that the relationship between control and video is statistically significant at 10%, while the other two are highly significant at the 1.00% level.

Further discussion

Effectiveness of the CWM&BPPT

Improving farmers' behaviour towards innovative agricultural practices is the overall purpose of every extension communication effort (Leeuwis 2013). Hence, extension workers constantly seek to know how to reach clientele with relevant messages effectively and efficiently. Differences in culture, norms, social values, and value systems from one community to another (Olawoye 2019) means that extension interventions should be tailor-made (including innovative technology and its communication methods) for different social systems to achieve effective technology uptake and continued adoption. This is more critical as adoption or non-adoption of agricultural innovation has been partly hinged on information factors (Wossen et al. 2017). In this study, most cassava farmers who were directly exposed to the toolkit fared better in all their behavioural attributes than non-participant farmers (Table 2). The fact that the CWMP participants were significantly better than the non-participants across the parameters of knowledge, attitude, practice, and behaviour towards improved agriculture practices for cassava production (Table 5) further establishes that the improvement witnessed by the project participants was not marginal but clear. Also, given the similarity of the CWMP participant and the non-participant farmers in socioeconomic characteristics (Table 1), the differences in their responses to the IITA CWMP project can be adduced mainly to the effects of the 'treatment' received by the participant farmers. Hence, the various communication media used for disseminating recommendations on improved weed management and good agricultural practices for cassava farming can be adjudged effective.

Media use for promoting CWM&BPPT: what are the right choices?

The media channels used in this study vary in their impact and effectiveness in promoting behavioural change among the cassava farmers (Table 4). Demonstration and video media had the highest degree of impact on the farmers' knowledge and overall behaviour towards the disseminated technology. For promoting attitudinal change and practice of improved weed management and good agricultural recommendations of CWMP, the demo was positively outstanding among other media channels, while video followed. Generally, radio was the least effective among the media channels used in this study (Table 5). This implies that radio might be more relevant for creating awareness about agricultural innovation among farmers than for transferring skills or practical-based agricultural recommendations. This supports Nwagbara and Nwagbara's (2017) assertion on the relevance of radio in agricultural development.

From the preceding, demo was the best medium for disseminating the CWMP recommendations on improved weed management and good agricultural practices in cassava farming to the farmers in the study locations. Video may be the next alternative when demo is unavailable or impossible to use. This result is consistent with Parimi, Kotamraju, and Sudini (2018). In a study in Anantapur (India), they observed that crop farmers responded better to field demonstrations. The demo was most likely effective due to its advantages in terms of direct physical contact with extension workers, better interactivity of the medium, and its convincing potential as farmers could see how outcomes would look in their situation (environment) (Mgbenka, Agwu, and Ajani 2013). However, due to the shortage of extension workers, as evident by the low margin of extension agents and farm family ratio in most parts of Africa, the continued reliance on the demo medium may not be feasible. For example, on average and across Nigeria, the Agricultural Development Programmes's extension agents: farm families ratio ranged from 1:1700–1:2132; 1:3385; 1:2950 and 1: 3011 between 2008 and 2012 (Haruna and Abdullahi 2013). This implies that extension workers must renew emphasis on video as an alternative to one-on-one contact with farmers in agricultural technology dissemination. In addition, following the assertion that combining two or more extension methods enhances the effectiveness of innovation dissemination (Kassem 2014) in extension work, this study shows that Demo and Video are complementary and can be used together effectively.

Conclusion and recommendations

The dissemination of agricultural innovation on the Six Steps to Cassava Weed Management and Best Planting Practices toolkit was effective in the study locations. The communication media used for the innovation dissemination effectively promoted positive behavioural change among the cassava farmers. This is evident from the clear difference between the farmers exposed to the innovation and those that were not, in terms of knowledge, attitude, and use of the improved weed management practices. While the practical demonstration mostly influenced good agricultural practices among the cassava farmers involved in the project, the radio elicited a minor effect. Video messages shared by mobile phones to encourage the uptake of innovation had a moderate effect on the uptake of agricultural innovation among the sources used in the study. Understandably, due to the associated cost of personnel, the practical demonstration is expensive and may be difficult to rely upon for innovation dissemination, especially in communities with a low extension worker-farmer ratio. Therefore, a communication media mix of practical demonstrations and video shows/messages shared via mobile phones would produce optimum effects on farmers' behavioural change towards agricultural innovation. Hence, it is recommended that agricultural extension practitioners prioritize this combination for disseminating good agricultural practices in cassava farming to farmers.

Ethical considerations

The researchers obtained permission to conduct the study from the village authorities. Individual verbal consent was also obtained from the study participants before participating in the survey. All information was kept confidential, and the data were analyzed anonymously.

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