Science | Technology | Development

Ghana Journal of Science, Technology and Development | Vol. 9, Issue 2, January 2024
e-ISSN: 2343-6727
DOI: https://doi.org/10.47881/353.967x
Received: November 16, 2022
Accepted: December 8, 2023

Channels and Methods of Communicating Agricultural Innovations to rice farmers in the Northern Region of Ghana

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ABSTRACT

Farmers in Ghana have benefited from technology dissemination programmes of high-yielding crop varieties to enhance their productivity and increase incomes. This study examined the channels and methods used to communicate information on agricultural innovations to rice farmers in the Northern Region of Ghana. Multi-stage sampling technique was used to collect primary data through a survey of 404 rice farmers and key informant interviews with 34 agricultural extension officers, as well as 48 focus group discussions with selected groups of rice farmers coupled with non-participant observations made on the field. The data were analysed using Descriptive statistics such as percentages, means and standard deviations. The empirical results show that fellow (contact) farmers (89.1%), researchers and extension agents (51.4%), and certified seeds and input dealers (42.3%) are the most prevalent channels of agricultural innovation communication in the study area. Farm and home visits (99.0%), and method demonstrations (98.8%), and radio/television/internet broadcasts (98.5%) are also considered to be the most prevalent methods used to communicate information on agricultural innovations like improved rice seeds in the region. Key factors that account for the various channels and methods used include logistical constraints, time constraints, availability of extension personnel, ethical considerations, and acceptability by the farmers. Hence, any new information to rice farmers should be channeled through contact farmers, researchers and extension agents, and likewise, radio or television or via the internet. Since extension teaching methods (ETMs) are not used in isolation, a combination of farm and home visits, and demonstration farms, coupled with radio broadcasts, would enhance innovation communication and uptake. Finally, stakeholders, especially government, should channel more resources to boost the most used/ accepted individual, group and mass ETMs, especially farm and home visits, method demonstrations and radio broadcasts prevailing in the study area.

Key words: *communication channels, dissemination methods, innovation, Northern Region, Ghana.*

INTRODUCTION

Globally, farmers depend on the services of Agricultural Extension Agents (AEAs) in their farming enterprises. In Africa, particularly Ghana, AEAs collaborate with other actors in the rice value chain to transfer agricultural technologies to farmers, using appropriate extension teaching methods [ETMs] (Etwire *et al*., 2019; Azumah *et al*., 2018). These ETMs include farm and home visits, result demonstrations, method demonstrations, frontline demonstrations, group discussions, exhibitions, general meetings, campaigns, conducted tours, printed matter (literature), radio, television, and motion pictures (movies) (Rathod, 2016). The Food and Agriculture Organization [FAO] (2019) as well as the Indian Council of Agricultural Research [ICAR] (2006) indicate that each of these methods has its own strengths and weaknesses. Most of the methods such as farm and home visits, conducted tours and television shows are very good but are rarely used because they are costly (Rathod, 2016).

Hence, a combination of methods serves as an effective way of disseminating agricultural innovations to farmers, because it harnesses the strengths of each method. For example, a radio broadcast can be followed by a group discussion with farmers or farm demonstrations (Rathod, 2016).

Demonstration methods are seen as effective ways of disseminating innovations to farmers. According to the FAO (2019) and Anandajayasekeram *et al*. (2008), method demonstrations are used to teach groups of farmers how a particular practice is performed while result demonstrations are employed to show individual farmers the outcomes of innovations that have been practised for some time. Method demonstrations are effective in teaching because they enable farmers to see, hear, handle, discuss and practice the innovation before adoption, whereas result demonstrations induce the farmers' interest in the innovation. Result demonstrations are as well employed to help farmers compare obstinate innovations with modern ones (FAO, 2019; Ackah-Nyamike, 2007). Azumah *et al*. (2018) discovered that demonstrations, farmer-to-farmer visits, and household extension methods were the most effective agricultural extension methods in Northern Ghana. That is because farmers who are trained by these methods grasp the concepts faster and better than the other methods, and they help to disseminate the innovations to other farmers at less cost. What some authors such as Azumah (2019), Azumah *et al*. (2018) as well as Acheampong *et al*. (2017) consider as sources of information to farmers are actually agents or channels of information to farmers. For Ndimbwa *et* al. (2021), fellow farmers, family relatives and local market places are the sources of farmers' agricultural information. Lucky and Achebe (2013) listed extension agents, research institutions, and mass media as sources of agricultural information for farmers involved in crop production. However, the sources of information refer to where the information emanates or originates from, not the carriers thereof (Rogers, 2003). The agents and the various media they use to communicate the innovation to the farmers and teach them on how to use that information are the channels while the mode or manner of educating farmers serves as the methods (Lamptey, 2021; Rathod, 2016).

Lamptey (2021) and Rathod (2016) recognized research institutions as the main source of information on agricultural innovations to farmers and extension agents as the main channels of agricultural innovation communication to farmers in this country. Other agents/channels of

innovation communication to farmers include contact farmers, produce aggregators, input dealers, and processers (Lamptey, 2021; Etwire *et al*., 2019). Generally, innovation communication channels refer to the various media, agents or institutions through which an innovation passes before it gets to its intended users or target audience. Hence, television, radio, video, telephone, magazines, newsletters, leaflets, bulletins, journals, person-to-person contacts, and community fora are all considered channels of innovation communication (Lamptey, 2021; Rathod, 2016).

Innovation is an idea perceived as new by individual(s) while communication is the transfer of information or knowledge from a source through a channel to a receiver. Communication involves giving of feedback from the receiver through the (same) channel to the source of information for the necessary course of action (Rogers, 2003). Until recently, communication of agricultural innovations has been in the public sector through the research-extension-farmer linkages. Of late, however, various actors, such as Non-Governmental Organizations (NGOs) and Farmer-Based Organizations (FBOs) in the rice value chain in Ghana collaborate with extension agents to beef up government's efforts (Lamptey, 2021; 2018; Etwire *et al*., 2019).

The agricultural innovations disseminated for adoption in the Northern Region of Ghana include Jasmine-85 (Saa Rice), African Agriculture (AGRA) rice, Nabogo rice, GR-18, Faro-15, New Rice for Africa (NERICA), Mandii, Digang, and Afife (Togo Marshal).

Some innovation communication channels also serve as innovation communication methods, depending on their approaches. However, to avoid complications in classification, some authors do not separate innovation communication channels from methods (Azumah, 2019; ICAR, 2006), and even information sources. Thus, for Yohanna, Ndaghu and Barnabas (2014) farmers' families, extension workers, input dealers, radio and television shows, research institutions, and the mass and print media remain the major sources of agricultural information. Innovation communication methods refer to the various procedures or practical approaches used to teach farmers how to use the innovation, which could likewise be individual, group or mass media methods (Rathod, 2016; Rogers, 2003). Azumah *et al*. (2018) classified both channels and agents of innovation communication as sources of information on agricultural technologies to farmers in Northern Ghana, which should not have been the case. That is because researchers (research institutions) are the main sources of agricultural innovations to farmers while extension officers and their collaborators in the agricultural value chain serve as agents or channels of innovation communication to farmers (Lamptey, 2021; Rathod, 2016; Rogers, 2003). This study therefore aimed at examining the various channels and methods of communicating information on improved rice variety seed innovations from researchers to farmers in the Northern Region of Ghana.

MATERIALS AND METHODS

Study Area

This study was carried out in the Northern Region of Ghana using primary data from 404 rice farmers. The Northern Region used to be the highest producer of paddy rice in this country, followed by Upper East and Volta Regions respectively, until the year 2020 when Volta Region took the lead (MoFA, 2021; Lamptey, 2021; MoFA, 2018). That was partly due to the rippling effects of the national fertilizer subsidy programme, and splitting of the then Northern Region into three separate regions (Northern, North East and Savannah Regions) in this country (MoFA-IFPRI

2020; MoFA, 2020; 2018). The annual paddy rice produced in the Northern Region is far below the national average yield or the estimated yield for the region (MoFA, 2021; MoFA-IFPRI, 2020; 2016). Grass, shrubs and trees constitute the vegetation of the region. The vegetation cover used to be dense until recently when climate change and climate variability have adversely affected the region. The region has arable land suitable for commercial rice production. Despite this great opportunity, the region is one of the economically poorest regions in this country due to small farm sizes and low productivity. Yet, it is a haven of several rice development projects and agricultural technologies promoted in Ghana (Azumah, 2019; Martey *et al*., 2013).

Sampling and data collection

Purposive sampling was used to select the study area, which is one of the major contributors to the rice basket of this country (MoFA, 2021; 2017). Purposive sampling was also used to select Tolon, Kumbungu, Savelugu and Nanton Districts in the Northern Region, where the rice production technologies under study have been consistently promoted (MoFA, 2020). Cluster sampling was then used to select 14 out of 28 rice producing zones in the four districts. Simple random sampling was subsequently used to select 48 out of 96 rice growing communities, and 410 out of about 2000 improved rice variety farmers, across the 14 selected zones (Table 1). The proportion of the sample assigned to each district was based on the estimated population of rice farmers in each district obtained from a sample frame of MoFA (2020). Krejcie and Morgan (1970) statistical table was used to obtain a total sample of 384 respondents from an estimated population of about 1,000,000 rice farmers in the region. The sample size was appropriate enough to prevent any erroneous conclusions in this study (Smith, 2019). According to Smith (2019) a sample size of between 250 and 500 is appropriate enough for a scientific analysis of this nature. However, we adjusted this sample size to 410 to cater for some design effects that might have arisen in the study. After data cleaning, 404 questionnaires were found to be consistent and reliable for the analysis.

The study employed both qualitative and quantitative methods of data collection. For the quantitative data, semi-structured questionnaires were administered to 410 rice farmers with the aid of smartphones and through one-on-one interviews. For the qualitative data, 48 focus group discussions were held with rice farmers and 34 key informant interviews were conducted with agricultural extension officers. Non-participant observations made on the field were also an important source of data. Questionnaire, interview and discussion guides were used as research instruments.

TABLE 1. Sample Size per District

District	Sample Size	Percentage	Zones Selected
Tolon	116	28.92	Four Zones
Kumbungu	112	27.32	Four Zones
Savelugu	120	29.27	Four Zones
Nanton	62	15.12	Two Zones
Total	410	100	Fourteen Zones

Source: Authors' construction, 2020

Statistical methods of analysis

The quantitative data was carefully collected with a questionnaire and processed with Statistical Package for Social Science (SPSS) version 20.0. The quantitative data was analyzed by percentages, means, and standard deviations, and the results were presented in tables. The qualitative data from the focus group discussions and key informant interviews as well as non-participant observations made on the field were recorded with smartphones, transcribed, coded, and put into various themes with respect to the study objective. The transcripts were exported into NVivo 9 qualitative data analysis software and analysed on the basis of the major themes and content analysis (Baffour-Kyei *et al*., 2021; Lamptey, 2021). The outcome of the qualitative data analysis was carefully incorporated into the quantitative data, consistent with Owusu *et al*. (2021). That helped to interpret results of quantitative analysis.

RESULTS AND DISCUSSIONS

Data on 404 rice farmers from the study area were analysed descriptively and the results were presented in frequency tables. A summary of the demographic and socioeconomic characteristics of the farmers used in the study were first discussed, followed by the various innovation communication channels and methods used to communicate the innovations (improved rice variety seeds) in the study area, based on the viewpoints of both farmers and extension officers.

Summary of the socioeconomic characteristics of improved rice farmers

The socioeconomic characteristics of rice farmers that the study considered are age and educational level, sex and household status, farmers' access to social amenities as well as farmers' access to researchers and extension agents/service.

Age and educational level of improved rice farmers

The results in Table 2 show that the mean age of the farmers was approximately 40 years, corroborating with what was reported by Azumah *et al*. (2017) and Ragasa *et al.* (2013) but significantly less than the national and regional average ages (55 and 45 years respectively) of farmers in Ghana (GSS, 2014). It is also lower than what was estimated by Bruce *et al*. (2014) (48 years) for the same area. Thus, farmers who adopted improved rice varieties were in economically active life and could therefore farm for more than twenty years before they become aged and weak to be able to farm. It also implies that farming of improved rice varieties is attractive to the young adults, possibly due to incentive packages associated with the Planting for Food and Jobs (PFJ) programme as well as other rice development projects in the region (Lamptey, 2022; MoFA, 2017; Martey *et al*., 2013).

Majority (70.5%) of the farmers had no formal education. According to MoFA (2020), about 67% of rice farmers in the Northern Region are illiterate in English. The mean level of education of the farmers was 2.7 years, which means that the educated farmers had an average of about three years of formal education. That is corroborated by MoFA (2020), the Ghana Statistical Service [GSS] (2019) and Donkoh *et al*. (2019) that majority of the inhabitants (farmers) in the study area are uneducated. That could negatively affect farmer adoption of agricultural innovations.

TABLE 2. Age distribution and educational levels of respondents

Age range of improved rice variety farmers	Percent
19 to 25 years old	8.20
26 to 30 years old	14.10
31 to 37 years old	25.00
38 to 44 years old	17.80
45 to 51 years old	20.30
52 to 58 years old	9.20
59 years of age and above	5.40
Total	**100.00**
Mean age of improved rice variety farmers	39.69
Standard deviation improved rice variety farmers' age	10.65
Educational Level of Farmers	
Attainment of formal education among improved rice variety farmers	70.54
No attainment of formal education among improved rice variety farmers	29.46
Total	**100.00**
Mean level of formal education among improved rice variety farmers	2.67
Standard deviation of improved rice variety farmers' educational level	4.69

Source: Field data, 2020 N = 404

Sex and household status of farmers

The results in Table 3 show that most of the farmers (90.1%) were male and the majority (80.2%) of them were household heads. That is consistent with Gomda *et al*. (2018), who reported that about 90% of respondents were male and 96% of them were household heads. Similarly, 80% of the non-household heads were male. It means that the proportion of improved rice variety farmers who were household heads (80.2%) in the study area was lower than what was reported for farmers in the Northern Regions (96%) by Gomda *et al*. (2018). The low percentage of females involved in improved rice farming (9.9%) in the region shows that improved rice farming was male-dominated, corroborating Bruce *et al*. (2014) and Ragasa *et al*. (2013). Most females in the study area normally help their husbands and sons to farm rice rather than own their personal farms (Donkoh et al., 2019; Martey *et al*., 2013).

TABLE 3. Sex and household status of improved rice variety farmers

Sex	Percent	Household status	Percent	Male	Female	Total
Male Farmers	90.10	Household heads	80.20	79.00	21.00	100.00
Female Farmers	9.90	Non-Household heads	19.80	80.00	20.00	100.00
Total	**100.00**		**100.0**			

Source: Field data, 2020 N = 404

Improved rice variety farmers' access to social amenities

Social amenities such as electricity, pipe borne water, good road network, internet connectivity, community centres, markets, schools, banks, hospitals, radio and television stations, among others, enhance innovation communication in rural communities. They help in extension service delivery and retention of agricultural extension staff in rural communities (Rogers, 2003).

Results from Table 4 reveal that majority of the farm households, constituting 77.7%, had access to electricity, corroborating GSS (2019), who found that about 67.9% of residents in the Northern Region of Ghana had access to electricity.

The results also show that 46.8% of the farmers belonged to farmers associations in their communities. It means that about half of the farmers had a social network of sharing information on improved rice varieties and supporting one another to farm or market rice while the others were on their own. Individualism among the farmers could hinder the effective communication of information on improved rice variety seeds in the study area, because agricultural innovations diffuse faster in homogenous societies than in heterogeneous societies (Rogers, 2003).

Group membership served as social capital and collateral for obtaining loans, corroborating Donkoh *et al*. (2019). However, in reality, the availability of financial institutions and farmer unions in the study area did not necessarily guarantee farmers' access to credit to farm rice (GSS, 2019). We realised from the focused group discussions that some farmers were simply not interested in the loan. That explains why many of the farmers (55.2%) had no access to credit/funds to farm rice. Majority of the farmers, constituting 74.5%, had access to good road network, which meant that they had less difficulties in going to their farms or market centres to obtain inputs or sell their produce. That could enhance farmer adoption of improved rice variety seeds innovations in the region.

TABLE 4. Improved rice variety farmers' access to social amenities

Access to Water and Electricity	**Percent**
Households with no access to the national grid of light/electricity	22.30
Households with access to the national grid light/electricity	77.70
Total	**100.00**
Households with no access to pipe born water	80.00
Households having access to pipe born water	20.00
Total	**100.00**
Non-membership of farmers' association in farming community	53.20
Membership of farmers' association in farming community	46.80
Total	**100.00**
No access to bank loans/farm credit/funds to farm	55.20
Access to bank loans/farm credit/funds to farm	44.80
Total	**100.00**
Access to farm input like fertilizers, seeds, agro-chemicals on credit	35.40
No access to farm input like fertilizers, seeds, agro-chemical on credit	64.60
Total	**100.00**
Access to good road network in farming community	74.50
No access to good road network in farming community	25.50
Total	**100.00**
Source: Field data, 2020	N = 404

Rice farmers' access to researchers and extension agents/services

Majority of the improved rice variety farmers had access to researchers (75.74%) and agricultural extension agents of MoFA (79.7%) mainly because the improved rice variety seeds were jointly disseminated by staffs of SARI and MoFA. That contradicts McNamara *et al.*'s (2014) assertion of poor farmer access to extension staff in Ghana. The mean extension visit per year was 3.1, meaning each farmer had a minimum of three extension visits in a year. That was plausible, considering the high ratio of farmer to extension services in Ghana (MoFA, 2017; GSS, 2014; McNamara *et al*., 2014). Also, 26.5% of the farmers had access to NGO extension services, which

implied that communication of information on improved rice variety seeds in Ghana was not a preserve of MoFA (Lamontagne-Godwin *et al*., 2017).

TABLE 5. Improved rice farmers' access to researchers and extension agents/services

Response* **	**Percent**
Access to innovation researchers	75.74
Non-access to innovation researchers	24.26
Access to agricultural extension agents of MoFA	79.70
Non-access to agricultural extension agents of MoFA	20.30
Mean agricultural extension visits to rice farmers per year	**3.10**
Standard deviation of agricultural extension visits per year	**3.24**
Access to NGO/private extension services	26.50
Non-access to NGO/private extension services	73.50

Source: Field data, 2020 *** = Multiple responses/several options for respondents N = 404

Channels of communicating improved rice variety seed innovations to farmers

Data on the various channels of communicating information on improved rice variety seeds among farmers in the study area were analysed and the results presented in percentages as shown in Table 6. Different channels were used to communicate the various varieties to the farmers at different times in different communities. The improved rice variety seeds promoted to farmers in northern Ghana, included Jasmine-85, AGRA, Nabogu, GR-18, Faro-15, NERICA, Mandii, Digang, and Afife. Individual farmers gave multiple responses by choosing as many channels (from a list of eight alternatives) they perceived to have helped them most, to adopt the varieties. In order of priority, respondents rated "farmer-to-farmer" (89.1%), agricultural extension officers and researchers from SARI (57.4%), and certified seeds and input dealers (43.3%) as the innovation communication channels that helped them most in the adoption process. The farmers rated NGOs and FBOs as the least (13.9%) channel through which they got information on the innovations, contrary to the findings of Azumah *et al*. (2018).

The results however show that farmer-to-farmer channel of information flow on improved rice variety seeds spread faster than from researchers and agricultural extension officers as well as certified seeds and input dealers, corroborating (Buadi *et al.*, 2013). This meant that contact farmers played a major role in promoting the adoption of improved rice variety seeds in the study area. That is because in homogenous societies such as the study area, channels of communication are more open among the farmers than between farmers and change-agents (Rogers, 2003). This results from similarities in socio-economic characteristics of the farmers compared with those of the change agents.

Information from key informant interviews and focus group discussions with the farmers show that agricultural extension officers of MoFA collaborated with researchers from SARI to promote improved rice variety seeds in the study area. They usually worked with contact farmers in the various communities who link them up to the farmers. Most of the farmers however, did not get information on the improved rice variety seeds directly from the researchers and extension officers as shown in Table 6.

The extension officers also trained leaders of farmer groups in the various

communities to help promote improved rice variety seeds. The researchers and extension officers, therefore, served as facilitators while the contact farmers and leaders of farmer groups served as front-liners in promoting the rice variety seeds. That helped to overcome logistic constraints of the AEAs and other challenges confronting extension service delivery in the region (MoFA, 2018; Lamontagne-Godwin *et al*., 2017; McNamara *et al*., 2014). This finding is in tandem with Etwire *et al*. (2019) who found that farmers in the study area were encouraged by researchers and AEAs to engage in peer extension by sharing their knowledge gained from innovation dissemination projects with other farmers.

The presence of other innovation communication channels in the study area also helped to promote the improved rice variety seeds among the farmers, except that some of them worked independent of the AEAs of MoFA. That seemed to have undermined the primary role of MoFA as extension service providers to farmers.

TABLE 6. Channels of communicating improved rice variety seed innovations to farmers

Prevailing Innovation Communication Channels/Agents*	**Percentage**
Farmer-to-farmer (fellow farmers/contact farmers)	89.11
AEAs of MoFA and SARI researchers	57.43
Certified seeds and input dealers	42.33
Mass Media (radio/television/internet)	39.11
Others (Political and religious leaders)	35.15
Market women and produce aggregators	33.40
Rice Processing Companies	18.07
NGO and FBO Service Providers	13.86

Source: Survey data, 2020; **Note:** * = multiple choice/responses/options N=404.

Methods of communicating improved rice variety seed innovations to farmers

The various agricultural innovation communication methods, otherwise known as Extension Teaching Methods (ETMs), were categorized into individual, group and mass media methods in tandem with FAO (2019) specification. There were eighteen methods identified, five of which were individual methods, seven were group methods, and six were mass media methods. Different ETMs were used to promote the various varieties to the farmers at different times in different communities. That was because AEAs were not the sole agents of innovation dissemination in the study area. The results in Table 6 show that all the ETMs have been used to promote improved rice variety seeds in the region. That confirmed that the region was a haven of improved rice varieties in Ghana (AGRA-SSTP, 2016; Ragasa *et al*., 2013).

The results also show that the farmers considered individual ETMs such as farm and home visits (99.0%), result demonstrations (98.3%) and telephone calls (76.2%) as those that mostly helped them to adopt the improved rice variety seeds. Similarly, the group ETMs that helped them most in the dissemination process were method demonstrations (98.8), meetings/discussions (94.3%) and community fora/durbars (88.6%). Furthermore, the farmers considered mass media methods such as radio/television /internet broadcasts (98.5%), telephone messages (62.1%) and publications/ journals (59.4%) as the most useful to them. Top on all the lists of the individual, group and mass media methods were farm and home visit, method demonstrations and radio broadcasts. The findings imply that a combination of these three methods of

promoting improved rice variety seeds in the study area would be the best.

The farmers rated the individual methods higher than all the other ETMs, indicating that the individual methods were more preferred to the group and mass methods of teaching farmers. That is in tandem with Azumah *et al*. (2018) and MoFA (2018) but contrary to Rathod (2016), who stated that individual ETMs, especially farm and home visits, were not commonly employed by agricultural extension officers due to the high costs involved. Since the individual methods were mostly preferred by the farmers, it meant that the farmers received individual attention at the household level. That, coupled with the method demonstrations and radio broadcasts gave the farmers a better understanding of the knowledge imparted to them by the AEAs and other promoters of the rice varieties. That enabled the farmers to hear, see and feel the innovations disseminated to them.

Mass media methods were usually used to create farmers awareness of innovations followed by a group or an individual method or both, to disseminate the rice seeds (FAO, 2019; Rathod, 2016). Access to electricity in all the communities, presence of Simli Radio at Dalung and Might FM at Savelugu and SARI as well as UDS at Nyankpala may have accounted for farmers getting education on improved rice variety seeds via radio and print media. That is consistent with GSS (2019), and GSS (2014), that 52% of women and 78% of men aged 15-49 years listened to the radio at least once a week, and 51% of women and 66% of men watched television at least once a week. It further confirms GSS (2014) report that farmers' exposure to print media in Ghana is much less common; with 9% of women and 17% of men reading a newspaper or magazine at least once a week.

TABLE 7. Methods of communicating improved rice variety seed innovations to farmers

Innovation Communication Methods*	**Percentage**
Individual Contacts	
Farm and home visits	99.01
Result demonstrations	98.27
Telephone calls	76.24
Personal correspondence	65.10
Office visits	60.15
Group Contacts	
Method demonstrations	98.76
Meetings/discussions	94.31
Community fora/durbars	88.61
Conducted tours/field trips	86.63
Field days/symposia	77.23
Conferences/seminars/workshops	64.36
Short courses/interviews	50.74
Mass Media Methods	
Radio/television/internet broadcasts	98.51
Telephone messages (text messages)	62.13
Publications/journals (academic publications and research Journals)	59.41
Newsletters (graphics, magazines)	54.85
Exhibitions/leaflets/handbills	53.26
Posters/billboards/seculars/bulletins	51.24

Source: Field data, 2020; **Note:** * means multiple response, no totals; N=404

Extension Officers' choice of Innovation Communication Channels and Methods

Results in Tables 6 and 7 show that different innovation communication channels and methods were used to communicate information on improved rice variety seed innovations to the farmers in the region. According to the agricultural extension officers interviewed, several factors accounted for the various channels and methods used. These included logistical constraints, times constraints, availability of extension personnel, ethical consideration of the various channels and methods, acceptability and adaptability, socio-cultural, socio-economic and demographic features of the target audience.

The officers explained that they did not work in isolation in communicating information on the improved rice varieties to the farmers. Rather, they worked in tandem with SARI and NGOs to harness the necessary logistics, professional expertise and best practices in reaching out to farmers. That confirmed Etwire *et al.'s*. (2019) assertion that AEAs collaborate with other actors in the rice value chain to transfer agricultural technologies to farmers, using appropriate extension teaching methods. Lamptey (2021) also found that other actors like processors, aggregators, NGOs and farmer Based Organizations (FBOs) worked on the side to complement public extension service delivery in promoting the improved rice varieties to the farmers in the region. There is therefore complementarity in the extension service delivery among the various actors in the rice value chain.

The extension officers had this to say;

We are normally overwhelmed by the huge numbers of farmers we serve in this region. The ratio is less than the national average of one officer to about one thousand five hundred farmers. Ours is about two thousand, five hundred farmers to one extension officer. Our staff are therefore unable to attend to all of them, due to time and logistic constraints, since the farmers do not pay for our services. So, we are constrained by the little fuel and other allowances we occasionally get from the government. Hence, we sometimes rely on donors, NGOs, FBOs, contact farmers, for assistance. (Excerpts, KIIs, Northern Region, 2020.)

Similarly, Azumah *et al*. (2018) noted that lack of funds for transport was one of the factors reducing extension workers access to farmers in the region.

The Extension officers further reiterated:

Sometimes, some improved rice varieties are introduced to our farmers without our knowledge, but we do not consider those who promote such varieties as our competitors. They rather complement our efforts, and we are okay with that. Besides, some of our farmers stay in border towns and are able to get improved rice varieties introduced in some of our neighbouring countries with or without our knowledge. Other farmers also depend on their families and friends in other regions or countries for improved rice seeds and we do not begrudge them at all. What we seek is the ability to regulate the influx and proliferation of improved rice seeds across our regions or borders. We are also not in the position to control the smuggling of farm inputs such as improved seeds and agrochemicals in and out of this country. (Excerpts, KIIs, Northern Region, 2020).

These assertions are collaborated by Lamptey (2022) and Ragasa *et al*. (2013) who respectively found that NERICA and Jasmine rice were cultivated by some farmers in Ghana prior to their official release by MoFA in 2009. That was because NERICA was released in La Cote de Ivoire three year before it was released in Ghana. Then also, an incomplete strain of Jasmine called *Saa rice* was in

circulation in Ghana before Jasmine was officially introduced to the farmers for adoption (Lamptey, 2021).

The narrations above confirm Lamontagne-Godwin *et al*. (2017) assertion that extension service delivery, which is the responsibility of the state, has been saddled with challenges such as inadequate funding, inadequate extension staff, poor logistics, lack of motivation of extension staff, and farmers' overdependence on public extension staff. These have led to some extension officers engaging in other duties beside their core mandate. *For example, some of our officers have become farmers, loan contractors, immunization agents for Ghana health service, polling agents for electoral commission, and even traders. Excerpts, KIIs, Northern Region,* 2020.

The KII revealed that donor funded and NGO supported projects normally come with better logistics, incentives and motivational packages both for officers and the farmers. Thus;

The packages fade out when the projects face out. So, we train contact farmers who become our mouth piece in the communities. They transfer the knowledge we give them to other farmers and they help those farmers to adopt innovations. This process goes on all the time in the communities. These contact farmers are easily accessible to the farmers because they live with them in their respective communities. They are trained to use their local dialects, simple tools, equipment and resources to help solve farmers' problems. This helps us cut down cost of transportation, time and service delivery. The farmers seem to understand their fellow contact farmers better, when they communicate to them than when we do, due to cultural and language barriers. Excerpts, KIIs, Northern Region, 2020.

The agricultural extension officers then explained as follows:

We also use radio to transmit information to farmers because radio reaches out to the masses faster, as many people receive the information at the same time. We normally send our jingles or recorded messages to the radio stations to be aired at a fee. That one is less expensive and can be repeated at regular intervals for farmers to listen again and again, relative to the live radio presentation. However, the live presentations enable farmers to phone in to ask questions for clarification. Excerpts, KIIs, Northern Region, 2020.

These findings show that extension officers, contact farmers and radio are the key channels of innovation communication in the study area. As Azumah *et al*. (2018) identified, fellow farmers, research centres, agricultural extension officers, the social media, and middlemen were the main channels of communicating innovations to rice farmers in Northern Ghana.

They further indicated:

We normally follow up the radio broadcasts with home and farm visits or group discussions at the community levels. However, these are time-consuming and costly compared to the radio broadcasts. Yet, they give famers the opportunity to directly engage with us to agree on relevant channels and methods of disseminating the innovations to them. Method and result demonstrations are normally preferred to other methods of innovation dissemination in this region. Because they give our farmers the opportunity to practice how things are done and to see the outcome for themselves before they adopt. Excerpts, KIIs, Northern Region, 2020.

This shows that extension officers may use one or a combination of several methods to disseminate innovations to farmers but farmers normally form their own opinions about agricultural innovations and make their own judgments and choices. So, the officers choose the dissemination methods and innovations that best suit the farmers,

corroborating Rogers (2003). The outcome of the KIIs therefore confirmed the findings from the farmers.

The study revealed that the prevailing innovation dissemination methods used to promote improved rice varieties to farmers in the Northern Region of Ghana were radio broadcasts, home and farm visits, group discussions, as well as method and result demonstrations. Azumah *et al*. (2018) also discovered that field demonstrations, farmer-to-farmer visits, and house-to-house teaching of farmers were the most predominant methods of educating farmers in Northern Ghana. Lamptey (2021) noted that these methods help to disseminate innovations faster and better than the other methods. Although farm and home visits are considered to be very costly and are rarely used, they are among the most prevailing innovation dissemination methods in the region of recent.

CONCLUSIONS AND POLICY IMPLICATIONS

This study examined the channels and methods of communicating information on improved rice variety seed innovations to farmers in the Northern Region of Ghana. Farmer-to-farmer (89.1%), researchers and extension officers (51.4%), and certified seeds/input dealers (42.3%) were the most predominant channels (agents) of innovation communication among farmers. NGOs/FBOs were the least (13.9%) channels of communicating information on improved rice variety seed innovations to farmers in the study area. Farm and home visits (99.0%), and method demonstrations (98.8%), and radio/television/internet broadcasts (98.5%) were also considered to be the most prevalent methods used to communicate information on agricultural innovations like improved rice seeds in the region. Empirically, individual ETMs helped the farmers better than group methods and mass media methods. Specifically, farm and home visits (99.0%), result demonstrations (98.3%) and telephone calls (76.2%) were the individual ETMs that were mostly used by extension officers to communicate information on improved rice variety seed innovations among the farmers. These were followed by group methods like method demonstration (98.8%), meetings/discussions (94.3%) and community fora/durbars (88.6%). Similarly, radio/television/internet broadcasts (98.5%), telephone messages (62.1%) and publications/journals (59.4%) topped the mass media methods. However, office visits (60.2%), short courses/interviews (50.7%), and posters/billboard/seculars/bulletins (51.2%) were considered the least individual, group and mass ETMs used respectively, to communicate information on improved rice variety seed innovations in the study area. Key factors that accounted for the various channels and methods used included logistical constraints, times constraints, availability of extension personnel, ethical consideration of the various channels and methods, as well as acceptability by the farmers.

Since other stakeholders in the rice value chain have also, as a matter of necessity, became channels of innovation communication in the study area, the government of Ghana should seek to foster and facilitate close collaboration between MoFA and those stakeholders to enhance extension service delivery in the region. Moreover, the government should channel more resources to boost the most used individual, group and mass ETMs, especially farm and home visits, method demonstrations and radio broadcasts prevailing in the study area. Thus, various ETMs and channels should not be used in isolation when reaching out to rice farmers, since the said channels and methods complement one another in the innovation dissemination process.

ACKNOWLEDGEMENTS

We are grateful to all rice farmers and agricultural extension officers in the Northern Region of Ghana for providing the necessary information for this study. We are also grateful to the anonymous reviewers for your time spent on providing valuable feedback for this paper. Our profound gratitude likewise goes to the Editorial Board for considering our paper worthy of publication in this highly esteemed journal.

COMPETING INTEREST

The authors declare no competing interests.

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