

GENDER GAP IN ACQUISITION AND PRACTICE OF AGRICULTURAL KNOWLEDGE: CASE STUDY OF RICE FARMING IN WEST AFRICA

By ESPÉRANCE ZOSSOU^{†‡§}, AMINOU AROUNA[†], ALIOU DIAGNE[¶]
and RITA AFIAVI AGBOH-NOAMESHIE[†]

[†]*Africa Rice Center (AfricaRice), 01 BP 2031 Cotonou, Benin*, [‡]*Polytechnic University of Abomey, BP 2282 Abomey, Zou, Benin* and [¶]*University of Gaston Berger, BP 234 Saint-Louis, Senegal*

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SUMMARY

Improving farmers' knowledge of new technologies and creating conducive learning opportunities, with particular attention to the marginalized poor (women and youth), are major factors in the move towards sustainable agriculture. To explore the gender gap in agricultural knowledge acquisition and adoption in West Africa, we used baseline data collected in 2013 and 2014 in five countries (Benin, Côte d'Ivoire, Niger, Nigeria and Togo) with 499 surveyed households. The *t*-test and Kruskal–Wallis test were used for analysis. The most quoted source for acquiring knowledge on rice farming methods was 'other farmers', showing the importance of social capital for rural African farmers. In Benin, a gender gap was noted in rice farmers' access to agricultural knowledge sources, with women being more advantaged. In Côte d'Ivoire, Niger, Nigeria and Togo, no significant gender gap was observed in rice farmers' access to agricultural knowledge sources. Regarding the level of knowledge and use of rice farming methods in Côte d'Ivoire and Niger, significant gender gaps were observed. The gender approach to rural development is having impact in West Africa with regard to farmers' access to agricultural information. However, interactive rural learning approaches (such as farmer-to-farmer video) need to be resorted to make the technologies' principles well known and improve the ability of marginalized poor to adopt and or innovate with local or limited resources. This study leads to a better understanding of the relationship between gender, knowledge and use of agricultural technologies in order to enhance marginalized farmers' adoption of improved innovations.

INTRODUCTION

Knowledge acquisition is the process of extracting, structuring and organizing knowledge from one source, usually human experts. It typically refers to the process of acquiring, processing, understanding and recalling information through one of a number of methods. Knowledge acquisition details how people experience new information, how that information is stored in the brain and how that information can be recalled for later use (Wiesen, 2014). Knowledge acquisition and learning are treated as synonymous terms, both referring to a process of gaining knowledge

§Corresponding author. Email: benezos@yahoo.fr

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or skill by studying, practicing, being taught or experiencing something (Kuhn *et al.*, 1995).

Information and knowledge are vital in agricultural development for any community. In sub-Saharan Africa, agriculture is the most important sector of the economy, because it is the main source of vital food and employment. The role of knowledge and information transfer in rural and agricultural development is widely recognized and stressed in regional development policies (Obidike, 2011). Education and training are two of the most powerful weapons in the fight against rural poverty and for rural development. Unfortunately, these are also among the most neglected aspects of rural development interventions by national governments and by donors (Atchoarena and Gasperini, 2003). In sub-Saharan Africa, many rural farmers do not have access to timely and up-to-date knowledge and information which would enable them to achieve optimal yield from their farmlands (Obidike, 2011). Improving farmers' knowledge of new techniques and technologies, in addition to providing them with any physical resources necessary for implementation, can dramatically increase their level of productivity (Rosegrant and Cline, 2003).

Sources of information are important in the acquisition of knowledge. In sub-Saharan Africa, rural farmers are generally illiterate and relatively remote from formal sources of information such as extension stations and libraries (Van Crowder and Fortier, 2000). Extension systems have undergone a deep restructuring, transformed by the trend towards liberalization, with non-governmental organizations (NGOs) and the private sector redefining their roles to fill certain niches.

Despite this, in many rural settings women do not benefit as much as men from extension programmes for farmers (Katungi *et al.*, 2008). Moreover, women are limited by social norms in communicating with men outside their families. In these cases, extensionists can act as interlocutors. To truly speak on behalf of women, these interlocutors need to be women (World Bank, 2008), but the majority of staff within advisory services are men and rural development interventions are male-biased (Katungi *et al.*, 2008). This article explores the gender gap in agricultural knowledge acquisition in relation to sources of information and the use of the acquired knowledge in rice farming in West Africa.

MATERIALS AND METHODS

Data collection

The study used Africa Rice Center (AfricaRice) baseline data collected in 2013 and 2014 in rice-sector development hubs in Africa. These hubs are zones where rice research products are integrated across the rice value chain to achieve development outcomes and impact. In the hubs, AfricaRice and national scientists will introduce, evaluate and validate new rice technologies, and work with development partners to facilitate the training of farmers, dissemination of technologies and establishment of linkages among actors along the rice value chain. Hubs were selected based on rice growing environment (agro-ecosystem). One hub with major agro-ecosystem was

selected per country: irrigated agro-ecosystem in Niger and lowland rainfed agro-ecosystem in Benin, Côte d'Ivoire, Nigeria and Togo.

A stratified random sampling technique was used to select interviewed actors. For village sampling, the stratifying criteria were: (1) rice growing environment (agro-ecosystem), (2) village accessibility and (3) dominant crop. Accessibility in this context is related to road condition to access the village. Due to the high intensity of the field activities, villages with very limited access throughout the year were not selected. Sixteen villages were selected in each hub. A stratified random sampling was also done for households using rice activities and the gender of the household head as selection criteria. A list of all households in each village was made. Ten households were randomly selected from each of the 16 villages with adjustments to include at least 30% of the minority gender. In total, 160 rice-farming households were selected from each hub.

Data collection was automated using tablets and a web-based application that sends collected data to a central database managed by AfricaRice with online access by the national agricultural research system (NARS) partners. The computer-based data collection avoided many biases associated with paper-based questionnaires, such as mistakes in answer recording, changing of values of variables, recoding test answers for numerical variables.

Data processing and analysis

The data used concerned socio-economic and demographic characteristics, rice production, knowledge and use of rice farming techniques and equipment, relationship with farmer organizations, national and international agricultural research and extension services, access to information, etc. Data were processed with STATA 13.1. Considering the level of data collection in the hubs, we focused analysis on five countries (Benin, Côte d'Ivoire, Niger, Nigeria and Togo). The only criterion for the selection of these households was the availability of data required for the study. Some variables in the database needed for the analysis in this paper have missing data and this reduces the sample size from 640 to 499 households. Missing data were due to the fact that data were collected in many rounds and during the last rounds some households have left the villages or could not be met.

We focussed analysis on four main rice farming activities: land clearing, ploughing, crop establishment and weed management. A list of 15 methods related to these pre-harvest activities was presented to households to collect data on their level of knowledge, use and the sources of information on the known methods. These 15 methods were identified during the exploratory phase and a literature search on pre-harvest rice cultivation activities. They were: burning, mulching, uprooting, removing of weeds from the field, weeding, in-line ploughing, level ploughing, weed incorporation into the soil, broadcast sowing, sowing in rows, straight-row sowing, sowing in holes, manual weeding, mechanical weeding and use of herbicide. Each surveyed household was asked if they knew each method. So each household has a score out of 15: the number of methods presented to them that they knew about. In

Table 1. Definition of variables and socio-economic profile of the surveyed households.

Variable	Definition	Mean (SD)	
		Women, <i>n</i> = 101	Men, <i>n</i> = 398
Age	Age in years of the household head	46.80 ^a (12.27)	46.10 ^a (12.56)
Annual rice income*	Annual household income in 10 ³ FCFA ^a	826.67 ^a (705.76)	905.56 ^a (696.56)
Household size	Number of individuals in household	6.56 ^a (8.10)	6.82 ^a (4.53)
Education	0 = none; 1 = coranic literate; 2 = primary/secondary; 3 = tertiary	0.36 ^a (0.63)	0.74 ^b (0.97)
Agriculture as principal activity	1 = yes, 0 = otherwise	0.80 ^a (0.40)	0.89 ^b (0.31)
Group membership	1 = Member of a group; 0 = otherwise	0.61 ^a (0.49)	0.55 ^a (0.50)
Preferred primary source of information	0 = Word of mouth; 1 = town crier; 2 = local and religious organization; 3 = NTIC	0.62 ^a (1.09)	0.94 ^b (1.21)

*The currency exchange rate was US\$ 1 = 528.83 FCFA on 02 December 2014.

Note: Different superscript letters in the same line denote populations which are significantly different based on a *t*-test and a significance level of 5%.

n = sample size.

NTIC = New technologies of information and communication.

this study, we refer to this as the knowledge level on the rice farming methods. The same procedure was used for the use of the methods, and the sources of knowledge of the methods.

The *t*-test was used with STATA 13.1 to determine differences between women and men in the whole sample in their: (1) socio-demographic characteristics, (2) access to sources of information and (3) levels of (i) knowledge and (ii) use of the surveyed methods. The *t*-test assesses whether the means of two groups are statistically different from each other. This analysis is appropriate to compare the means of two groups.

Because of the small size of samples at the country level, the Kruskal–Wallis test was used to determine differences between women and men in their: (1) access to sources of information and (2) levels of (i) knowledge and (ii) use of the surveyed methods. The Kruskal–Wallis test is a non-parametric test, alternative to one-way analysis of variance (ANOVA) and used with one nominal variable and one ranked variable. When working with a measurement variable, the Kruskal–Wallis test starts by substituting the rank in the overall data set for each measurement value. It tests whether the mean ranks are the same in all the groups.

RESULTS AND DISCUSSION

Gender differentiation in socio-demographic information

Table 1 shows some summary statistics of the socio-demographic characteristics of the sample. The surveyed household heads were on average 46 years old, both women and men. There was no gender gap for the average annual rice income (about US\$ 1563 for households headed by women and US\$ 1712 for households headed by men). These incomes were used to feed an average of seven individuals

in both women- and men-headed households. There was a gender difference in the literacy rate with the *t*-test at 1%. The average illiteracy rate was about 71% for women and 58% for men (data not shown). This high illiteracy rate is consistent with UNESCO (2010), which showed that sub-Saharan Africa together with the southern Asia accounted for three-quarters (74%) of adults unable to read and write worldwide. Only 7% of female and 22% of male household heads had been educated to primary or secondary level. Considering these statistics, the goals of education for all to increase literacy levels to 50% and achieve gender equity in education by 2015 seem unlikely to be reached (Fink, 2011).

The large majority (about 82% of women and 90% of men) of the surveyed household heads were active in agriculture that provides them the majority of their incomes. This is similar to the finding of Staatz *et al.* (2007) that showed that agriculture employed more than 50% of the population in sub-Saharan Africa (excluding South Africa). Sub-Saharan Africa's rural economy remains strongly based on agriculture relative to other world regions and the agricultural production systems are largely based on smallholder farms (Livingston *et al.*, 2011). However, we observed a weaker representation of women in agriculture as main activity compared to men with the *t*-test at 5%. This can be explained by the fact that in rural areas in West Africa, women are active in small trade which is clearly women's business (Fafchamps *et al.*, 2005).

We observed a high membership of women and men in associations and this is consistent with Whitehouse (2011), who showed that West Africans belong to social networks.

More women (73%) than men (59%) preferred word-of-mouth as the primary source of information. This is a communication strategy that can better reassure users and inspires confidence (Buttle, 1998).

Gender gap in access to sources of information and knowledge on rice farming technologies

The sources of information and knowledge on rice farming technologies can be classified into three main categories: (1) formal sources including national research and extension services, and national and international NGOs; (2) informal sources including personal experiences and other farmers (colleagues); and (3) intermediary sources including farmer organizations that can be formal or informal according to their legal status. Based on the average number of times the agricultural information sources were quoted (Table 2), the main information and knowledge sources are in order of importance: (1) other farmers (average 4.80 across all respondents, cf. gender-disaggregated data in Table 2); (2) personal experiences (1.88); (3) national and international NGOs (1.01); (4) national research and extension services (0.93); and (5) farmer organizations (0.06). This high importance of colleagues in acquiring agricultural knowledge is confirmed by the high percentage of farmers that preferred the word-of-mouth from their peers as the primary source of information (Table 1). These findings reinforce the importance of other farmers in knowledge exchange and confirm the need of an effective participation of farmers in the technologies

Table 2. Average number of times the agricultural information sources were quoted in the acquisition of knowledge related to rice farming methods.

Source of knowledge	Mean (SD)											
	Whole sample, <i>n</i> = 499		Benin, <i>n</i> = 139		Côte d'Ivoire, <i>n</i> = 49		Niger, <i>n</i> = 106		Nigeria, <i>n</i> = 102		Togo <i>n</i> = 103	
	Women	Men	Women	Men	Women	Men	Women	Men	Women	Men	Women	Men
National research and extension services	1.06 (0.91)	0.90 (0.89)	1.09 ^a (0.95)	0.64 ^b (0.79)	1.00 ^c (0.00)	0.98 ^c (0.41)	1.00 ^c (0.00)	1.15 ^c (0.36)	0.25 ^g (0.62)	0.34 ^g (0.66)	1.42 ⁱ (1.10)	1.52 ⁱ (0.95)
National and international NGO	1.18* (0.57)	0.96* (0.86)	1.48 ^a (1.13)	0.84 ^b (0.97)	1.00 ^c (0.0)	1.16 ^c (0.53)	1.00 ^c (0.0)	1.14 ^c (0.38)	0.25 ^g (0.62)	0.33 ^g (0.65)	1.27 ⁱ (0.96)	1.53 ⁱ (0.98)
Farmer organization	0.07 (0.25)	0.06 (0.24)	0.14 ^a (0.35)	0.10 ^a (0.30)	0.00 ^c (0.00)	0.05 ^c (0.21)	0.00 ^c (0.00)	0.01 ^c (0.10)	0.00 ^g (0.00)	0.04 ^g (0.21)	0.04 ⁱ (0.19)	0.10 ⁱ (0.31)
Other farmers (colleagues)	5.34 (3.38)	4.67 (3.13)	6.67 ^a (3.76)	5.11 ^b (3.71)	1.50 ^c (1.38)	3.23 ^c (2.90)	3.87 ^c (2.67)	3.88 ^c (2.27)	4.92 ^g (2.35)	5.45 ^g (2.35)	5.11 ⁱ (2.80)	4.92 ⁱ (3.69)
Own experience	1.59 (2.39)	1.96 (2.58)	1.90 ^b (2.68)	3.00 ^a (2.84)	1.83 ^c (2.64)	3.28 ^c (3.15)	0.53 ^c (1.12)	1.26 ^c (1.95)	0.42 ^g (0.90)	0.40 ^g (0.98)	2.19 ⁱ (2.62)	2.54 ⁱ (2.72)

*There was a significantly difference between women and men only for national and international NGOs (according to *t*-test; significance level of 5%).

Note: Different superscripts within the same country and within the same source of knowledge denote populations which are significantly different based on Kruskal–Wallis test and a significance level of 5%.

n = number of households surveyed.

design and extension to attend any sustainable agriculture (Axinn, 1997; Zossou *et al.*, 2012).

Gender gap in access to formal agricultural knowledge sources. There was a gap between women's and men's access to national and international NGOs with women being more advantaged (Table 2). At country level, we did not find any gap between women and men in their access to formal knowledge sources in Côte d'Ivoire, Niger, Nigeria and Togo. However, in Benin we observed a significant gap between women and men in their access both to national research and extension services and to national and international NGOs, with women having more access to these knowledge sources than men. These findings contradict previous studies which showed that in developing countries women have less access to rural development interventions and advisory services because the majority of staff within these services are men, and women are limited by social norms in communicating with men outside their families (Katungi *et al.*, 2008; World Bank, 2008). The significant gap observed between women and men in their access to formal agricultural knowledge sources in Benin may have a bias on the result for the whole sample. One possible explanation for this gender gap in access to agricultural knowledge sources in Benin is that our analysis focused on men and women who are heads of their households. Culturally, in West Africa, the responsibility of the household returns to men who are considered as the 'fathers of the households'. So, a woman who is a household head is either a divorcee or a widow. However, women are increasingly heading rural households in Africa due to male urban migration (Oxfam, 2008). It is supposed that these 'non-married' or 'abandoned' women have more freedom compared to a married woman and are less limited by social norms in communicating with men outside their families. Moreover, with the promotion of the gender approach in rural developing countries, more attention is given to women in development interventions. Indeed, the temporary headquarters of AfricaRice is located in Benin, the country where we noted greater access of women to formal knowledge sources. AfricaRice is a leading pan-African research organization with a mission to contribute to poverty alleviation and food security in Africa through research, development and partnership activities. With the presence of AfricaRice in Benin, a lot of research and development actions are carried out in the rice sector in the rural areas. With the promotion of the gender approach, women in Benin may benefit more from these interventions than men. The non-existence of a significant gender gap in rice farmers' access to formal agricultural knowledge sources in Côte d'Ivoire, Niger, Nigeria and Togo may also be due to the positive impact of the promotion of a gender approach in development programmes in these countries.

Gender gap in access to informal agricultural knowledge sources. Across the whole sample, we did not observe any gender gap in access of rice farmers to informal agricultural knowledge sources. The same result was observed in Côte d'Ivoire, Niger, Nigeria and Togo. However, in Benin, we observed that women were more in relation with their colleagues to acquire information and knowledge on rice farming than men. This

is consistent with Westermann et al. (2005) who found that collaboration, solidarity and conflict resolution all increase when women are present. In addition, norms of reciprocity are more likely to operate in women's and mixed groups. Similarly, the capacity for self-sustaining collective action increased with women's presence and was significantly higher in women's groups.

Finally, for farmers' own experience, we noted a gap between women and men in their access to rice farming knowledge in Benin, with men well above women. This suggests that women may have an aversion to risk in experimenting for the first time with new technologies to develop new knowledge. Further studies are needed to better understand this question.

Gender gap in access to farmer organizations. We observed that within farmer organizations in all surveyed countries, women had approximately the same chances as men to exchange agricultural knowledge and information. This is more understandable because unlike formal agricultural knowledge sources staff, farmer organization leaders are closer to farmers and better understand their problems and socio-cultural realities (Bosc et al., 2003). Effective farmer organizations present important opportunities such as: providing research and extension services to farmers; mobilizing resources for local development; and representing the interests and collective voice of farmers. Farmer organizations are seen as an opportunity for agricultural extension due to their social capital in rural areas (Renay, 2010). However, our study shows that farmer organizations are the last source of knowledge in the rice sector quoted by the households. The real problem may be the level of knowledge of the leaders of farmer organizations in agriculture in general and in rice in particular. The challenge would be to improve farmers' leaders' knowledge in agriculture.

Gender gap in the level of rice farming technologies knowledge and practice. An overall view of the gender differentiation in the whole sample shows no significant difference between women and men in their levels of knowledge and use of rice farming methods. (Table 3)

Specifically, at the country level, we did not observe any gender gap in the knowledge and use of rice farming methods in Benin, Nigeria and Togo. However, in Côte d'Ivoire, we observed a significant gender gap in the levels of knowledge and use of rice farming methods, for men over women. In Niger, a gender gap was observed in the use of methods, with men having a higher level of use of rice farming technologies than women, whereas no significant gender gap was noted in the level of knowledge of rice farming methods. This gender gap observed in some countries, with women having a low level in knowledge and use of rice farming methods, is consistent with many previous studies such as Katungi et al. (2008) and Manfre et al. (2013) who all show less access of women to rural development interventions and advisory services. Most extension agents in developing countries are men, and multiple institutional and organizational problems constrain attempts to train rural women. Women are negatively affected by social constraints that forbid them from communicating freely with men who are not from their families. Furthermore, in

Table 3. Gender differentiation of the surveyed household heads' levels of knowledge and practice of rice farming methods.

Knowledge and practice		Mean (SD)					
		Whole sample*, <i>n</i> = 499	Benin, <i>n</i> = 139	RCI, <i>n</i> = 49	Niger, <i>n</i> = 106	Nigeria, <i>n</i> = 102	Togo, <i>n</i> = 103
Level of knowledge	Women	7.64 (2.84)	9.21 ^a (2.21)	4.17 ^c (1.94)	5.47 ^e (3.02)	6.42 ^g (1.83)	7.73 ⁱ (2.49)
	Men	7.71 (2.64)	8.94 ^a (2.32)	7.27 ^d (2.39)	6.60 ^e (2.55)	6.99 ^g (2.42)	8.53 ⁱ (2.66)
Level of practice	Women	6.46 (2.41)	7.73 ^k (1.92)	4.17 ^m (1.94)	4.33 ^o (2.35)	5.08 ^q (1.62)	6.81 ^s (2.12)
	Men	6.67 (2.33)	7.92 ^k (2.04)	6.30 ⁿ (2.13)	8.90 ^p (2.34)	5.60 ^q (1.66)	7.51 ^s (2.43)

*For the whole sample, there were no significant differences between men and women for either level of knowledge or level of practice (according to *t*-test; significance level of 5%).

Note: Different superscripts in the same country within the same variable (knowledge/practice) denote populations which are significantly different based on Kruskal–Wallis test and a significance level of 5%.

n = number of households surveyed.

RCI = Côte d'Ivoire.

sub-Saharan Africa, women have very little leisure time compared to men (Baden and Milward, 1997) and this may have a negative impact on their availability to effectively communicate with agricultural advisory staff. This calls for new rural extension and learning approaches such as farmer-to-farmer video, several studies of which have shown its effectiveness (Chowdhury *et al.*, 2011; Zossou *et al.*, 2009, 2010). Farmer-to-farmer videos are less male-biased than conventional extension approaches. Video has proved a powerful medium for farmer-to-farmer extension and can give voice to rural women and help to overcome gender bias and gender blindness in rural development and in sustainable agricultural production in sub-Saharan Africa.

In Benin, despite the observation of women having more access to the formal agricultural extension sources, there was no significant effect on their levels of knowledge and use of rice farming methods. The use of a technology is often related to a certain availability of financial resources and it has been shown by Baden and Milward (1997) that there is some evidence of a link between female headship and poverty. In this study, the women surveyed were the head of their households and are likely to be vulnerable to poverty because of their lack of property rights and dependence on men. This vulnerability of women to poverty may explain their lack of financial support to acquire and use rice farming technologies even if they have information on the effectiveness of these technologies. Farmers' innovations are often shaped by capital limitations and mainly rely on locally available resources, of which knowledge is a key one (Zossou *et al.*, 2009).

IMPLICATIONS AND CONCLUSIONS

Except the case of Benin where we noted a possible bias due to the presence of the AfricaRice headquarters, we did not observe a significant gender gap in the access

of rice farmers to formal agricultural knowledge sources. In other words, women and men seem to have approximately the same chances to access formal sources of knowledge. This finding contradicts the male-bias in rural interventions in Africa showed by World Bank (2008). This proves that the gender approach in research and development interventions is having impact in rural areas in West Africa. In fact, an increasing number of agricultural development policies highlight gender inequalities as a critical constraint to growth and recognize the contributions of women to the sector; many African countries have established a policy architecture for more gender-equitable development (Manfre *et al.*, 2013).

With regards to informal sources, no significant gender bias was observed in Côte d'Ivoire, Niger, Nigeria and Togo. However, in Benin we observed that women are more in relation with their colleagues compared to men. In this country, we also noted a significant gap between women and men in their knowledge improvement through personal experiences, with men more active in personal experiences. This last point needs further investigations to clarify this aversion to risk observed with women in improving their knowledge with self-experiences.

The most quoted source in acquiring knowledge and information on rice farming technologies was 'colleague farmers'; while the least quoted source was farmer organizations. This shows the importance of enhancing farmer organizations' leaders' capacity as potential actors in achieving extension objectives because of their social capital in rural areas.

Results show a significant gender gap in the level of knowledge and use of rice farming technologies in some countries (Côte d'Ivoire and Niger). In Benin, despite the women's high access to agricultural knowledge, no positive impact was observed on their level of rice technique use. The vulnerability of women to poverty and lack of financial support may explain this situation. To overcome this gender bias in agricultural technology use, it is important to resort to new rural extension and learning approaches that can improve the ability of rural farmers to innovate with local resources, based on their endogenous and newly acquired knowledge. Farmer-to-farmer video is such a method for which several studies have shown its effectiveness. Once farmers know and understand the basic principle of a new technology, they are able to innovate based on the underlying principles and using locally available resources (Zossou *et al.*, 2009). Moreover, video is considered a powerful tool to solve the problem of participant selection bias in conventional training and to dilute the leadership power issue within farmer organizations. It gives a fair chance to community members to learn and reduces the dependence on group leaders. It is an excellent way to illustrate the principles of technologies and encourage rural people to create their own innovations. Farmer-to-farmer video has proven valuable, reliable and complementary to other agricultural extension approaches in African rural areas. This study shows a high percentage of farmers who preferred word-of-mouth from their peers as the primary source of information. This is an important point that shows again the opportunity that farmer-to-farmer video provides to agricultural extension, as farmers are actors in the video and this makes it more convincing. Future research will need to reach more surveyed samples in countries to draw relevant conclusions.

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