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Stakeholder Involvement in Upscaling of Soil Fertility Research Output in Tharaka-Nithi County, Kenya

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Abstract

Food insecurity in Sub-Saharan Africa has prompted a lot of research in the development of soil fertility technologies; however, few of the recommendations from soil fertility management research have been put into use by the target end-users. The objective of the study was to investigate information exchange pathways used by researchers in upscaling of soil fertility in Maara and Mbeere South Sub-counties in Kenya. Structured questionnaires were used to collect information from 22 researchers and 240 farmers. Data was analyzed using descriptive statistics like frequency, mean, and percentages, while Chi-square, Kendal's correlation coefficient was used to test the magnitude of the relationship between dependent and independent variables. Inadequate resources materials and poor networking among stakeholders were among the challenges that the researchers faced in the dissemination of their research outputs. The findings also showed that there was a positive and significant correlation between farm size and the mass media approach. Researchers and extension agents should use a mixed approach; this is the use of combined individual, group, and mass media approaches to cater to the different preferences based on socio-economic characteristics of farmers.

Keywords: information, dissemination, stakeholders, recommendations, adoption Sub-Saharan Africa, Kenya, soil fertility technologies, food deficits, agriculture, farmers

Introduction

Declining soil fertility is a fundamental impediment to food security among small holder farms in sub-Saharan Africa SSA (Adego et al., 2019, Stewart et al., 2019). Food deficits in many parts of sub-Saharan Africa can be offset by reversing the current trends of declining soil fertility and agricultural productivity (Willy et al., 2019). Nevertheless, the soil fertility replenishment technologies that researchers have generated have not been adopted by the farmers as anticipated (Ajayi et al., 2007). The ultimate purpose of agricultural research is to boost agricultural production and incomes through technologies and information (Danso-Abbeam et al., 2018). This can only be achieved if the researched technology and generated information are adopted and applied effectively at the farm level. Unfortunately, farm-level adoption remains low, despite the many technologies developed on

station and tested on-farm by the National Agricultural Research System in Kenya (Birch, 2018; Jayne et al., 2009). Among the soil fertility amendments recommended to address the challenge of soil infertility and enhance agricultural productivity in sub-Sahara Africa include organic fertilizers such as animal manure, green manure, crop residue, and inorganic fertilizers.

Wide-scale approaches in disseminating research generated knowledge are lacking, retarding the development of soil fertility and land degradation management (Verchot et al., 2007). A major challenge for agricultural research and development is to broaden horizontal and vertical dissemination for increased adoption of the technologies. It has been observed that the channels through which the technologies are being communicated to farmers are grossly inefficient and thus led to the ineffectiveness in the adoption of the recent agricultural technologies (Adolwa et al., 2012). This study, therefore, is set out to understand and evaluate the different communication pathways between researchers and other agricultural stakeholders in order to disseminate the technology and information on a larger scale.

Top-down approaches have been traditionally used to offer extension services. It is a unidirectional flow of information, as shown in Figure 1, that consists of researchers and extension agents directing farmers on the adoption of new practices. This top-down model creates a rigid hierarchy that discourages the feed-forward and feedback of information where the flow of information and technology is linear from researchers through extension agents then to farmers (Hellin et al. 2012). Gibbons et al. (1994) called it ‘mode one science’ where researchers work autonomously without involving farmers and extension workers; the findings were passed on to extension agents for onward transmission to farmers for implementation.

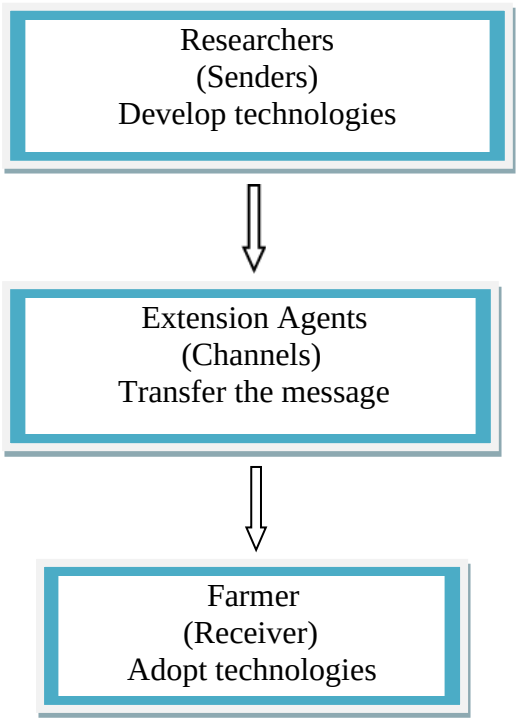

Figure 1. The traditional model of communication on research outputs

For communication to be effective in a development process, it requires interactive participation between partners and interest groups, communities, and official entities (Wheatcraft & Ryan, 2018). Proper participation creates a continuous exchange of information, enhancing understanding, connectivity, and commitment and thus synergies amongst different stakeholders (Usadolo & Caldwel, 2016). In addition, time for knowledge acquisition and integration by the target users is shortened and consequently, its conversion into action hence transforming lives as envisaged by the researchers.

Conceptual Framework Showing Participatory Communication for Upscaling of Soil Fertility Management

According to the framework, see Figure 2**,** knowledge on soil fertility management technologies is generated in established formal institutions and made available for key development actors and extension workers (Arrow 1) as well as to the farmers (Arrow 2). Those inherently superior technologies and practices are taken up by

extension and development agencies that then transfer the technology using different communication channels to the farmers (Arrow 3).

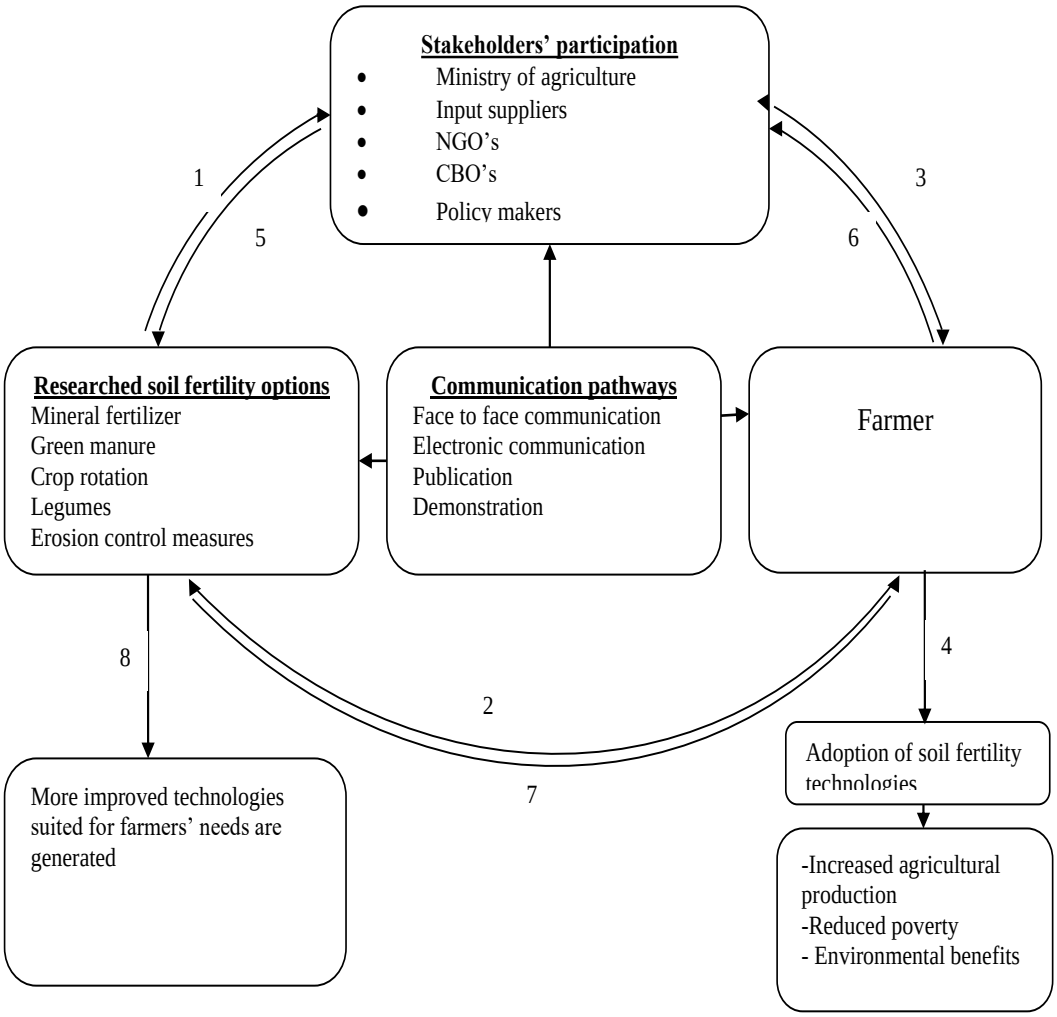

Figure 2. Conceptual framework showing participatory communication for upscaling of soil fertility management

Finally, Arrow 4 indicates the automatic adoption of the generated technologies by farmers eagerly awaiting solutions that address the key constraints in their evolving farming systems. However, according to Rogers (1995), the technology is passed from its source to the end-users through a medium (e.g., print/electronic media, demonstrations, field days), but its diffusion to potential users is dependent to a great extent on the characteristics of the individual user. The backward arrows (5,

6, and 7) represent feedback mechanisms from the extension agents and the farmers. Once the researchers receive feedback from the extension agents and the farmers (Arrow 8), they modify the technologies to suit the local conditions and offer social, economic, and technological solutions. The modified technologies will eventually be adopted by the farmers (Arrow 9). The conceptual diagram shows that effective communication pathways will enhance the utilization of improved soil fertility technologies that will lead to increased agricultural production, improve the livelihoods of the poor and increase environmental benefits.

Without effective participation, poor and vulnerable groups like rural communities will not be heard, and so will be the marginalized and least educated (Naraya et al., 2000). Consequently, knowledge generated over the years will not be recognized or owned, and the sustainability of interventions will be short-lived (O'Connell et al., 2009). Hence, researchers, extension agencies, and farming communities should attempt to develop strategies and functional impetus in the execution and implementation of the newly generated soil fertility technologies. This proposed pathway would boost the smooth feed-forward and feedback process between the researchers' institutions, extension agents, and farmers (Hiwasaki et al., 2016).

Research Methodology

Study Area

The research was carried out in two sub-counties, Maara and Mbeere South, in the Central Highlands of Kenya. The choice of the study area was based on the fact that several research projects on soil fertility management practices had been conducted in the region. Mbeere South lies at the transition between the marginal cotton (LM4) and the main cotton (LM3) agro-ecological Zones (Jaetzold et al., 2006) at an altitude of approximately 800 m. a.s.l. with an annual mean temperature ranging from 21.7 to 22.5^{o}C and average annual rainfall ranging from 700 to 900 mm.

Research Design

A descriptive survey and triangulation approach were adopted as they enabled an in-depth investigation into the subjects under study. The study aimed to collect information from the researchers and farmers on communication methods applied on dissemination of soil fertility management practices.

Sampling Strategy

The target population was made of researchers and farmers. Purposive sampling and snowballing were used to select researchers from different institutions involved in soil fertility management in Maara and Mbeere South sub-counties in the Central Highlands of Kenya. A total of twenty-two (22) researchers were selected, and two hundred and forty (240) farmers were selected for the research. The selected farmers were interviewed using structured and unstructured questionnaires.

Data Collection

The study employed an interview schedule and questionnaires to collect data from farmers and researchers, respectively. Data collected from the farmers include sources of information on Soil Fertility Management (SFM) practices, while data collected from the researchers include Soil Fertility Management practices researched and communication methods and tools used by researchers to disseminate their research findings.

Data Analysis

The first stage of data analysis was data cleaning. The questionnaires were examined to ensure they were complete and had been consistently filled in. All the data was computed using appropriate statistical tools and software to fulfill the objectives of the study. Data collected was first summarised, and a database template containing the collected information was made using a statistical package for social sciences (SPSS) computer software. Descriptive statistics such as frequencies, mean, standard deviation, and cross-tabulations were used to display the data. Rating data were computed using scores. The degree of association or correlation (r) between continuous independent variables and the dependent variable was measured by the use of Karl Pearson's coefficient, while Kendal's tau was used between discrete independent variables and dependent variables.

Results and Discussion

Social Demographic Characteristics of the Researchers

The mean age of the researchers interviewed was 47 years. Most (50%) of the researchers ranged between 41-50 years of age, while 31.4% were between 51-60 years. About 90.9% of the researchers interviewed were males, while only 9.1%

were females. Overall, 54.5% of the researchers had the experience of more than 15 years, while 22.7% had less than 5 years of experience in research. A higher percentage (45.5%) of the researchers had acquired a masters' degree, while 18.4% had reached the Degree of Doctor of Philosophy (Ph.D.) level, see Table 1.

Table 1

Social Demographic Characteristics of the Researchers who had Participated in SFM Research in Maara and Mbeere South Sub-Counties in the Central Highlands of Kenya in Central Kenya

Gender	**Frequency**	**Percent (%)**
Male	20	90.9
Female	2	9.1
Total	22	100.0
Age		
25-40 years	4	18.2
41-50 years	11	50
51-60 years	7	31.8
Total	22	100
Education		
Certificate	2	9.1
Diploma	3	13.6
Bachelor's degree	3	13.6
Master's degree	10	45.5
Ph D	4	18.2
Total	22	100.0
Years of research		
Less than 5 years	5	22.7
5-10 years	5	22.7
More than 15 years	12	54.5
Total	22	100.0

Note: Numbers in parentheses give the percentage of respondents N=22.
Source: Author.

The results imply that most of the extension researchers are middle-aged, well-educated, and have amassed experience in their areas of specialization on soil fertility management. This indicates that the researchers would be well aware of the various extension methods used to disseminate soil fertility management practices.

Stakeholder Involvement by Researchers in the Dissemination of Soil Fertility Technologies

The majority of the researchers (86.4%) involved farmers and the ministry of agriculture during their field days. During workshops, only 22.7% involved provincial administration, while during excursions, only 4.8% and 9.1 % involved agro-input dealers and provincial administration, respectively.

Table 2

Stakeholder Involvement by Researchers

Activity	Ministry of agriculture	Other Researchers	Farmers	Provincial administration	Agro input dealers	News
Field day	19(86.4)	18(81.8)	19(86.4)	13(59.1)	11(50.0)	16(72.7)
Demonstration	18(81.8)	15(68.2)	18(81.8)	8(36.4)	8(36.4)	10(45.5)
Workshops	16(72.7)	15(71.4)	14(63.6)	5(22.7)	8(36.4)	13(59.1)
FFS	11(50.0)	11(50.0)	12(54.5)	5(22.7)	6(27.3)	5(22.7)
Excursion	9(40.9)	9(40.9)	7(31.8)	2(9.1)	1(4.8)	3(14.3)

Note: Numbers in parentheses give the percentage of respondents.
Source: Author.

Approaches Used in Communication of Soil Fertility Management Practices

Group approach, individual interaction methods, and mass media are some of the extension approaches through which SFM messages can reach farmers. Mass media are those channels designed to reach a large audience. Group approaches such as field days and demonstrations are some of the methods that have been used by research and extension agents. As presented in Table 3, the study findings revealed that the most commonly used approach by researchers was the group approach by 90.5%. The majority, 72.2%, of the researchers have not used the mass media approach at all, while individual contact was moderately used by 70%.

Table 3
Approaches Used by Researchers

	Not used at all		Moderately used		Most commonly used	
Approach	**Frequency**	**%**	**Frequency**	**%**	**Frequency**	**%**
Group	0	0	2	9.5	19	90.5
Individual contact	2	10	14	70	4	20
Mass media	13	72.2	5	27.8	0	0

Source: Author.

Attitude Towards Extension Workers and Researchers

There was a significant relationship between attitude towards researchers and sub-counties (χ^2=18.111, P=0.001), where 24.2% of the farmers from Maara had unfavourable attitudes towards researchers compared to only 8.3% from Mbeere South. The possible reason would be that Mbeere South sub-county is nearer Embu Kenya Agriculture and Livestock Research Organization (KARLO). It is more likely that most of the farmers in Mbeere South may have interacted with the researchers. The majority of the farmers, 53.4% and 50.4%, had favourable attitudes towards extension workers and researchers, respectively. Out of the 120 farmers from Mbeere South, 44.2% had a neutral attitude toward researchers, shown in Table 4.

Table 4
Attitude Towards Extension Workers and Researchers by Farmers in Maara and Mbeere South Districts in Central Kenya

	Attitude towards extension worker		Attitude towards researchers	
Attitude	**Maara**	**More South**	**Maara**	**More South**
Favourable	63 (52.5)	64 (54.2)	64 (53.3)	57 (47.5)
Neutral	49 (40.8)	48 (40.7)	27 (22.5)	53 (44.2)
Unfavourable	8 (6.7)	6 (5.1)	29 (24.2)	10 (8.3)
Total N	120(100)	118(100)	120(100)	120(100)

Note: Numbers in parentheses give the percentage of respondents.
Source: Author.

Mass Media Used by Researchers to Communicate to Smallholder Farmers and Extension Workers

Posters were the researchers most often used (61%) print media to communicate to the farmers, while manuals (57.1%) were the most often used to communicate to the extension agents, Table 5. None of the researchers used journals to communicate to the farmers; however, 27.3% had often used journals to communicate to the extension officers. At least 30.8% of the researchers most often used books to communicate to the extension agents. Brochures and reports had most often been used to communicate to the extension agents by 46.2% of the researchers.

Table 5

Mass Media Used by Researchers to Communicate to Smallholder Farmers and Extension Workers on Soil Fertility Management in Mbeere South and Maara Districts in Central Kenya

	Smallholder Farmers				Extension workers			
Mass media	**Most often%**	**Often used %**	**Rarely used %**	**Not used at all%**	**Most often %**	**Often used %**	**Rarely used%**	**Not used at all%**
Reports	25.0	8.3	16.7	50.0	46.2	30.8	15.4	7.7
Journals	0	0	0	100.0	0	27.3	45.5	27.3
Magazines	9.1	9.1	18.2	63.6	36.4	36.4	18.2	9.1
Newsletters	0	41.7	25.0	33.3	33.3	50.0	8.3	8.3
Posters	61.5	30.8	7.7	0	33.3	50.0	8.3	8.3
Manuals	7.7	30.8	30.8	30.8	57.1	35.7	7.1	0
Books	0	10.0	20.0	70.0	30.8	38.5	15.4	15.4
Pamphlets	46.7	26.7	13.3	13.3	46.7	40.0	6.7	6.7
Radio	0	9.09	9.09	81.8	0	0	20.0	80.0
Website	0	0	0	100	0	20.0	40.0	40.0

Note: (0%) of the researchers used the website to communicate to the farmers, while 40% often used the website to communicate to the extension agents.
Source: Author.

Challenges that Hinder Effective Communication of SFM Practices as Perceived by the Researchers

The findings in Table 6 reveal the general constraints that impede the success of dissemination and Knowledge sharing of SFM research findings among agricultural stakeholders as stated by the researchers. The majority of the researchers (60%) indicated that lack of adequate resource materials was most critical, while poor networking among stakeholders was perceived as most critical by 50%. A low level of education was moderately critical (50%), implying that the level of education was not a major hindrance to information transfer. This can be overcome by the use of proper communication strategy, media mix, and audio-visual aids.

Table 6

General Constraints that Impede Successful Dissemination of SFM as Perceived by Researchers

	Percent (%) Respondents			
Constrain	**Not critical**	**Least critical**	**Moderately critical**	**Most critical**
Inadequate resource materials	0	10	30	60
Poor networking among stakeholders	0	10	40	50
Little participation of stakeholders on research innovation	0	18.2	45.5	36.3
Ineffective policies	5	20	45	30
No opportunity to attend short term courses on communication skills	0	35	30	35
Limited time available	5	25	40	30
Inadequate communication skills	10	15	50	25
Lack of basic infrastructures, e.g., computer	15	5	65	15
Low level of education of target groups	10	30	50	10

Source: Author.

Correlation Between Socio-Economic Characteristics and Preference of Extension Approaches Used in the Communication of SFM Practices

Kendal's tau test was done between the independent and dependent variables to test their correlation**.**

Table 7
Measurement of Variables for the Purpose of Correlation Interpretation

	Values of Variables			
Variable	**1**	**2**	**3**	**4**
Age	Continuous			
Farm size	Continuous			
No. of non-formal trainings	Continuous			
Years of farming experience	Continuous			
Gender	Male	Female		
Education level	No formal education	Primary Education	Secondary Education	Tertiary Education
Farm size	<0.4ha	0.41-1.21 ha	1.21-2.023 ha	>2.024ha
Wealth status	Rich	Average	Poor	
Social participation	Yes	No		

Source: Author.

Table 8
Correlation between Socio-Economic Characteristics of Farmers and Preference of Extension Approaches in Mbeere South and Maara Sub-Counties in Central Kenya

Independent variables	**Correlation Coefficient**		
	Individual farmer interaction	**Group approach**	**Mass media**
Age	0.105	-0.042	0.102
Farm size	-0.058	0.109	0.153**
No. of non-formal trainings	-0.044	0.070	0.097
Years of farming experience	0.086	-0.066	0.094
Gender	-0.041	0.123*	-0.078
Educational level	0.154**	-0.007	0.006
Wealth status	0.108	-0.117	-0.129*
Social participation	-0.002	0.096	-0.048

Note: *significant at P<0.05 **significant at P<0.01. Source: Author.

The findings in Table 8 show a positive and significant correlation ($P \leq 0.01$) between education level and individual farmer interaction. The positive correlation implies that the higher the education levels of the farmer, the greater the preference for individual farmer interaction approach. Farm size was positively and significantly ($P \leq 0.05$) correlated with the preference of the mass media approach. Conversely, wealth status was negatively and significantly ($P \leq 0.01$) correlated with the mass media preference. This implies that the wealthier the farmer, the lesser the preference for the mass media approach in teaching on the use of SFM practices. On the other hand, there was a positive and significant ($P<0.05$) correlation between gender and preference for group approach. This implies that female farmers preferred a group approach more than male farmers.

Discussion

Observation in this study has indicated that the Ministry of Agriculture, researchers, farmers, agro-input dealers, NGOs, and provincial administration have been involved in almost all the extension approaches that the researchers have used. Responding to the decline in soil fertility in the region requires multiple stakeholders to participate and plan for changing conditions and uncertainty. The uptake of research products needs more players than researchers, extension officers, and farmers, as suggested in the Agricultural and Knowledge information (AKIS) knowledge triangle (EU SCAR AKIS, 2019). Thus, other stakeholders, farmers, researchers, agro-input dealers, NGOs, and provincial administration play a vital role in promoting and implementing SFM practices. The adoption of conservative soil technologies in Italy was positively linked to the participation of stakeholders (Salvia et al., 2018). De Vente et al. (2016) emphasize that farmers' involvement in research may build trust and confidence and are likely to adopt innovations (Baumgart-Getz et al., 2012) and then use communication networks to inform other farmers of its benefits. Other studies have recognized farmers as a source of knowledge that guides scientific research in agriculture (Dolinskaa, & Aquino, 2016l; Goulet, 2013). In addition, the involvement of stakeholders reduces professional enclosure and effectively incapacitates the linear transfer of technology. The approach undoubtedly shifts from doing research for farmers to working with farmers.

The findings of the study also indicate that the group method approach is the most commonly used method by researchers in the dissemination of soil fertility

management practices. The findings are in accordance with Ghanghas (2011) findings, who reported that the most commonly used approach is group contact methods such as farmer field schools (FFS), field days, and demonstrations. A study by Baral et al. (2018) alluded that the farmers highly preferred the group extension method as it helped in increasing social networks among farmers. Group extension methods are also considered advantageous, possibly because of delivering the information to a great number of farmers at the same time at a lower cost as well as being able to get their feedback **(**Khatam et al., 2013***).*** However, individual contact methods were ranked highest in the effectiveness of dissemination of agricultural information to maize growers of Central Punjab (Arshed et al., 2012). Although individual contact has its strength, its main disadvantage is that it covers a limited number of farmers in the community. Nevertheless, different extension methods have been effective in different situations and at different levels in the adoption process (Baral et al., 2018).

The results of the study also suggest that most of the farmers had a positive inclination towards the agents, and hence attitude may have no negative implication in information exchange between the farmers and researchers. Farmers' attitude towards learners will not only affect their interaction with the researchers but also their desire to learn more on soil fertility issues. Favorable attitude will make farmers perceive the researchers as teachers who want to educate them, professionals providing support, or as facilitators of a continuous and mutual learning process. These perceptions will always have a strong bearing on the interaction between scientists and farmers (Chambers 2005). Case studies from New Zealand showed that attitude of the researchers towards the farmers determined the success or failure of the research approach (Bruges and Smith, 2008). However, local stakeholders' perceptions are highly susceptible to change and can be changed through face-to-face communication and building of trust. Although other factors matter, attitudes were one of the factors that influenced the decision to take up a new agroforestry technology among smallholder farmers in sub-Saharan Africa (Meijer et al., 2015).

The results in this study indicate that posters and pamphlets were the most commonly used form of mass media in the transmission of SFM to farmers by the researchers. The findings are in agreement with Surudhi et al. (2018), who reported that posters and leaflets were the widely adopted mass contact methods by extension agents. The poster as a visual media has quite an important role in

creating awareness among the farmers. The accessible and precise information content of the leaflet may contribute to its acceptance among the farmers. While electronic mass media, particularly radio, has been playing a significant role in providing fast information and knowledge about agriculture globally (Khan et al., 2017) the study expressed the scanty use of the media by the researchers. This is in line with the findings of Melak and Negatu (2012), who found that radio or television programmes are rarely used by extension agents. This was probably because of the need to pay for airtime as well as the technical skill needed to prepare for the programme and presentation. Internet was not used at all to reach the smallholder farmers in this study. This was probably because of the low level of computer literacy among the farmers and lack of internet accessories, including laptops, computers, android phone services, among others. However, Aldosari et al. (2019), in their study in Pakistan, reported that the Internet could be a useful source of agricultural information.

The major challenges that impede the dissemination of SFM in the study area are inadequate resource materials, poor networking among stakeholders, little participation of stakeholders in research innovation, and ineffective policies in descending order. This is in line with Albore (2018), who reported inadequate budget for implementing the extension system, weak linkage of research-extension farmer, absence of public-private partnership in extension service delivery, and absence of supportive national agricultural extension policy in Ethiopia. According to Belay and Dawit (2017), earlier empirical studies in developing countries have identified weak links between research and extension as the major factor limiting the flow of information, knowledge, useful new technologies, and resources among actors in the technology-delivery utilization system.

Farmers with more education seem to prefer individual interaction as compared to those with less education in this study. The rationale behind it is that education gives farmers the ability to perceive, deduce and respond to new information much faster than their counterparts without education and thus may prefer individual attention for their specific individual training needs (Dessale, 2019). Wealthier farmers can afford costs associated with newspapers, radio, television, and the Internet as a means to obtain farm-related information from different sources (Getaw & Godfrey, 2014) and hence the higher preference for mass media interaction. As farm size increases, the probability of getting new information may increase, influencing the tenacity to receive information from different sources such

as mass media. Farmers with more landholdings are likely to increase productivity and efficiency by adopting invented technologies (Amare & Simane, 2017)

Conclusion

Based on this study, it is evident that there is stakeholder involvement in disseminating SFM practices. However, it should be enhanced. It can also be concluded that the researchers rarely used radio and the Internet to disseminate their research outputs. Inadequate resources and poor stakeholder involvement were quoted as major hindrances in the dissemination of soil fertility technologies. The study also concludes that the socio-economic characteristics of farmers determine the preference of the approaches used by researchers in the dissemination of research output. Researchers should be encouraged to use radio as a means of dissemination as other studies have termed it the most popular means of communication. In addition, the Internet is one of the fastest means of communication and should be upheld as a means to reach farmers and other stakeholders considering the increased acceptance of technology and its application.

Furthermore, farming is no longer termed as a vocation for the illiterate but has become a lucrative business for the elites. A mixed approach, this is the use of combined individual, group, and mass media approach should be applied in the dissemination of new soil fertility technology to cater to the different preferences based on socio-economic characteristics of farmers. More resources should also be channeled towards the dissemination of research output, as this is what would make research a valuable adventure.

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STATEMENT OF NO-CONFLICT OF INTEREST

The authors declare that there is no conflict of interest in this paper.

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