
Strengthening the Flow of Agricultural Knowledge among Agricultural Stakeholders: The Case of Morogoro Region in Tanzania

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Abstract

Effective agricultural knowledge exchange is important for increased access to agricultural knowledge. However, studies conducted in Tanzania indicate that access to agricultural knowledge among agricultural stakeholders is inadequate. This chapter investigates how to strengthen the exchange of agricultural knowledge can be strengthened. Specifically, the chapter assesses how agricultural knowledge flows, determines how communication channels are chosen and analyses critical factors for effective agricultural knowledge exchange. The study involved different agricultural stakeholders identified through stakeholders' analysis. Random and non-random sampling techniques were used in drawing the sample for the study. The study involved 371 respondents. Key findings indicate that agricultural knowledge sharing, exchange, transfer and dissemination which facilitate the flow of agricultural knowledge. Findings indicate that availability and accessibility of the communication channels, ICT infrastructure, affordability of communication tariffs and ownership of communication tools influenced the choice of communication channels. Likewise, membership in professional groups, accessibility of knowledge sources, affordability of tariffs for, access to agricultural extension services, availability of knowledge and ICT infrastructure influence the flow of agricultural knowledge. It is concluded that effective agricultural knowledge flow increases knowledge accessibility, usage and creation. It is recommended that each agricultural stakeholder should be involved in conducting relevant agricultural knowledge roles so as to enhance the accessibility, sharing, exchange, dissemination and usage of agricultural knowledge.

Keywords: agricultural knowledge flow, agricultural knowledge sharing, agricultural knowledge management, knowledge exchange, agriculture, Tanzania

1. Introduction

Agricultural production is a risk activity; it necessitates people to make rational decisions so as to minimize the impacts [1]. To enhance timely decision-making, agricultural knowledge must be made available on time. For this to be possible, an adequate agricultural knowledge exchange mechanism must be put in place.

Agricultural knowledge exchange becomes effective when stakeholders creating, disseminating, sharing and using knowledge are effectively linked together. Farmers, agricultural research and the agricultural extension and advisory system must be linked together to enhance exchange of knowledge. Moreover, these actors must be linked together with others who play supportive roles in the sector. The linkage is important in enhancing access to and usage of knowledge in a knowledge system. A knowledge system is a network of linked actors, organizations and objects that perform a number of knowledge-related functions that link knowledge and know-how with action [2]. Therefore, different actors in the agricultural sector performing a number of knowledge-related functions form an agricultural knowledge system.

Tanzania has a chain of agricultural research institutes with a key role of generating scientific knowledge [3]. Moreover, the country has an agricultural extension system meant to enhance access to agricultural knowledge among actors [4]. However, studies [5, 6] indicate that access to agricultural knowledge among agricultural stakeholders in Tanzania is still low. This study investigates how agricultural stakeholders in Morogoro region of Tanzania exchange agricultural knowledge among themselves.

The study was conducted in Kilombero, Kilosa and Mvomero districts of Morogoro region in Tanzania. Majority of dwellers in these districts rely on agriculture for a living. Moreover, these districts are potential for food production as they form part of the national grain basket.

1.1. Purpose of the study

The general purpose of this study was to investigate how agricultural knowledge flows among stakeholders so as to enhance access to knowledge. Specifically, the study intends to

- i. investigate how agricultural knowledge flows among stakeholders;
- ii. determine reasons for choice of channels used for agricultural knowledge sharing, exchange, transfer and dissemination;
- iii. analyze factors for effective flow of agricultural knowledge.

2. Literature review

This section covers a review of the literature related to agricultural knowledge exchange. The section also reveals the gaps the chapter intends to fill.

2.1. The flow of agricultural knowledge

There are different forms of flow of agricultural knowledge. Agricultural knowledge flows from one person/organization to another through knowledge sharing, exchange, transfer or dissemination to intended audience. The following sub-sections give detailed descriptions of the different forms of flow of knowledge.

2.1.1. Knowledge sharing

Knowledge sharing involves both sharing of knowledge by the knowledge source and the acquisition and application of knowledge by the recipient; it involves the multi-directional movement of knowledge between different units, divisions or organizations rather than individuals [7]. It involves an exchange of knowledge between two individuals: one who communicates knowledge and one who assimilates it; the focus of knowledge sharing is on human capital and the interaction of individuals [8]. Knowledge sharing is more effective in environments where the learning process is emphasized and implemented [9]. Knowledge sharing is actually learning something from someone. It enhances sharing of know-how, understanding and skills.

For being more effective, knowledge-sharing process requires a knowledge-sharing platform, culture and certain amount of trust between individuals [10]. Knowledge sharing can take place through formal or informal settings [11]. Formal settings involve communicating within the formal organizational structure that transmits goals, policies, procedures and directions and uses formal communication channels [12]. On the other hand, informal knowledge sharing involves sharing knowledge outside the formal organizational structure that fills the organizational gaps, maintains the linkages and handles the one-time situations [12]. Informal knowledge-sharing practices are lateral in nature and facilitate the sharing of private non-codified knowledge [13]. Tacit knowledge, which is difficult to define, codify and express, is most suitably shared through informal settings. To enhance access to agricultural knowledge, it is important to determine how formal and informal knowledge-sharing settings are used to make agricultural knowledge sharing successful.

2.1.2. Knowledge transfer

The terminology knowledge transfer emerged in the 1990s as a process by which research messages were 'pushed' by researchers to users [14]. The term knowledge transfer is used to describe knowledge exchange processes [15]. Knowledge transfer includes a variety of interactions between individuals and groups; within, between and across groups; and from groups to the organization [8]. It is a process through which one unit is affected by the experience of another [16]. It involves the dissemination of knowledge from one location/individual or group to another. Knowledge transfer manifests itself through changes in knowledge or performance of the recipient unit [17]. Knowledge transfer is a one-direction movement of knowledge. Those who generate or own it usually push it to those thought to lack it.

Knowledge transfer can take place within an organization or and between organizations. Regardless of whether knowledge transfer takes place on the intra- or inter-organizational

level, it has to be conducted by individual organizational members [15]. This process takes place in formal and informal networks. Formal and informal knowledge transfer networks are derived from formal and informal organizational structures [18]. For improved knowledge accessibility, a clear understanding on how both formal and informal knowledge transfer settings can work together to facilitate knowledge accessibility is important. Moreover, for effective knowledge transfer process, it is important to have a clear understanding on sources and destinations of knowledge.

2.1.3. Knowledge exchange

Knowledge exchange includes both knowledge sharing and knowledge seeking [7]. Knowledge-seeking behavior is the totality of human behavior in relation to knowledge sources and channels, including both active and passive information seeking, and information use [19]. Knowledge exchange aims at autonomous individuals and can occur in systems characterized by high levels of interdependency and interconnectedness among participants [20]. It is a very useful process in a knowledge value chain because knowledge management involves different actors. Some of the commonly known participants involved in knowledge exchange are the producers, intermediaries and users [20].

Unlike knowledge transfer, which in most cases requires a one-way communication, knowledge exchange requires more than one-way communication [14]. It may include both knowledge transfer and sharing. It involves knowledge transfer because knowledge is pushed from a knowledge-rich source to a knowledge-poor recipient. It also involves knowledge sharing because through knowledge exchange a knowledge-rich source interacts with a knowledge-poor source to facilitate a knowledge transfer process from the knowledge-rich source to the knowledge seeker. Moreover, knowledge exchange happens when actors in a knowledge system have adequate information about others knowledge needs and decides to exchange knowledge among them. Face-to-face interactive communication, print materials, mobile phones, electronic mails, Skype calls, seminars, conferences and meetings are commonly used for knowledge exchange.

A clear understanding of agricultural involvements of agricultural actors can help in determining agricultural knowledge needs. This is because agricultural knowledge needs relate to day-to-day agricultural undertakings. It is important to know who needs knowledge before initiating a knowledge transfer process. Moreover, having an understanding of the sources and destinations of knowledge and channels used for the knowledge exchange process is important for strengthening knowledge flows.

2.1.4. Knowledge dissemination

Knowledge dissemination is an active intervention that aims at communicating know-how or skills to a target audience via determined channels, using planned strategies for the purpose of creating a positive impact on the acquisition of knowledge, attitudes and practice [21]. Dissemination is the conscious effort to spread new knowledge to target audiences or the public at large [22]. It involves an interactive process of communicating knowledge to target audiences and aims at enhancing changes among members of the intended audience [23]. The knowledge

dissemination process improves the accessibility knowledge among intended audiences. Unlike knowledge transfer, knowledge dissemination can reach both intended and unintended audiences because mass media tools including newspapers, radio, TV or other public announcement tools are used in disseminating it. Thus, for improving knowledge dissemination, having adequate understanding on who disseminates knowledge and who are the intended audiences is important. Moreover, having an adequate understanding of the most preferred channels for knowledge dissemination is of equal importance too.

2.2. Factors influencing the flow of knowledge

There are several factors influencing the flow of knowledge. Individual, organizational and technological factors are among them [24]. Individual factors may include the willingness to share/disseminate/exchange knowledge, ability to verbalize and codify knowledge and the willingness of the receiving party to accept new knowledge [25]. Organizational factors are related to organizational culture, organizational processes, trust, reward system, leadership and organizational structures [26]. Likewise, communication infrastructure, communication channels and usage of social media may influence the flow of knowledge too [27].

An effective flow of knowledge enhances access to knowledge. Studies conducted in Tanzania [5, 6] (Pinda, 2012a; 2012b) indicate that there is inadequate access to knowledge among actors of the agricultural sector. Having a clear understanding of factors influencing the flow of agricultural knowledge in Tanzania is important for improving access to knowledge. Therefore, this article intends to identify all factors and how they influence the flow of agricultural knowledge among actors in the sector.

2.3. Conceptual framework for the study

The study was guided by the modified knowledge-sharing model [28] presented in **Figure 1**. The model has four dimensions namely organizational, knowledge, individual and technological factors. Organizational dimension has four independent variables namely management support, leadership, policy and culture, and reward system. These variables may positively or negatively influence knowledge exchange.

The knowledge dimension has two independent variables namely knowledge category and nature of knowledge. There are different knowledge categories agricultural stakeholders may use. The extent to which a category is shared depends on its perceived usefulness among users. Nature of knowledge relates to whether it is tacit or explicit knowledge because its nature influences how it is easily shared.

Under individual dimension, two independent variables namely individual attitude (willingness to share knowledge and receive transferred knowledge) and the ability to verbalize and codify knowledge may influence agricultural knowledge exchange among stakeholders. Last is the technological dimension, which works through the communication infrastructure, communication channel and level of usage of communication system. These independent variables may positively or negatively influence knowledge exchange.

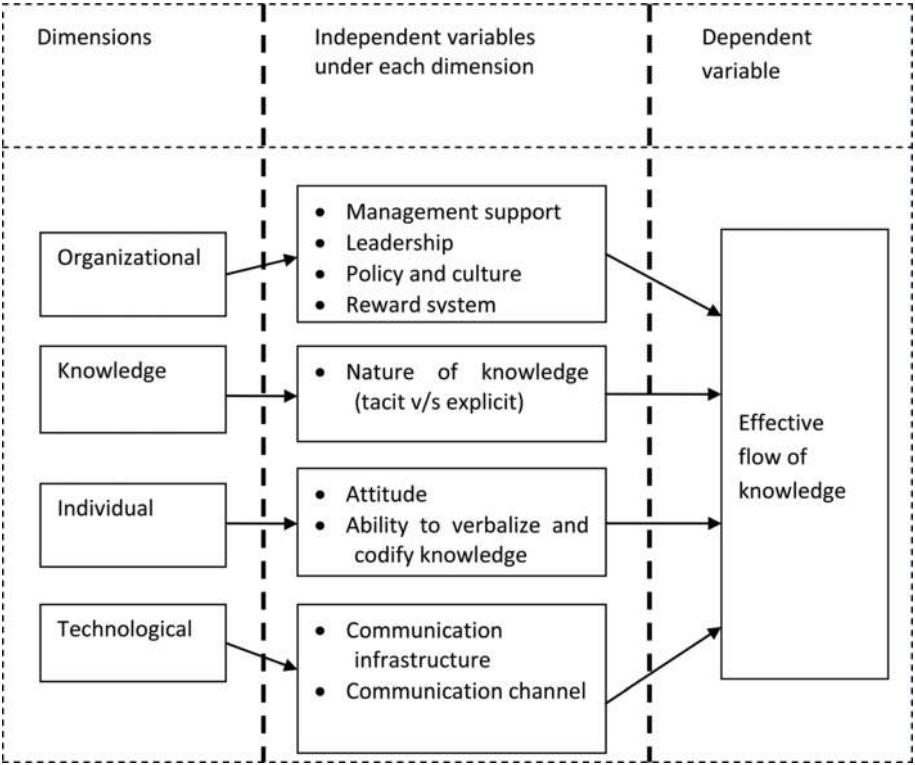


Figure 1. A modified model for flow of knowledge [28].

3. Research methodology of the study

This study was conducted in Morogoro region of Tanzania. The region was established in 1962 after dividing the then Eastern Province into regions. According to the Tanzanian National Census of 2012, the region had a total of 2,218,492 people (1,093,302 males and 1,125,190 females) with a total of 385,260 households; among them, 378,400 households were being directly involved in agricultural production.

Administratively, Morogoro region is divided into six district councils namely Gairo, Kilombero, Kilosa, Ulanga, Morogoro and Mvomero. Morogoro region has abundant agricultural land suitable for crop production and have a good climate favorable for agriculture and other economic investments. Among the six district councils, Kilombero, Kilosa and Mvomero were involved in this study. These three district councils are homogeneous in terms of the major crops grown, availability of agricultural research institutes, and information and communication technology (ICT) infrastructure. Kibaoni, Mang’ula and Lumemo wards of Kilombero district; Rudewa, Chanzulu and Kimamba B wards of Kilosa district; and Wami Dakawa, Mvomero and Hembeti of Mvomero district were purposively selected as the study area. A

sampling frame of all villages from each ward was prepared and one village was randomly selected and included in the study area. Nine villages namely Rudewa Batini, Chanzuru and Kimamba B villages (of Kilosa district), Michenga, Mgudeni and Mlimba A villages (of Kilombero district), and Hembeti, Mvomero and Wami Dakawa villages (of Mvomero district) were included in the study area.

3.1. Selection of respondents for the study

Different agricultural stakeholders identified through stakeholder analysis were involved in the study. When identifying actors, it is important to consider their stake and roles in the sector [29]. The first stage was the selection of a human activity system for research focus where serial (rice and maize) value chain was selected. The second stage involved the identification of actors and initial characterization of all actors. The third stage involved determining who has stake in the two crops and the relationship existing between actors. Fifthly, respondents for the study were selected and integrated in the study as described below.

Farmers, researchers from three agricultural research institutes found in Morogoro region, agricultural extension workers, policy makers, village executives, agricultural input suppliers and information service providers were found to be the major stakeholders of maize and rice value chains in Morogoro region. To select respondents from this population, the study employed both random and non-random-sampling techniques in selecting the sample from agricultural stakeholders.

A sampling frame of farmers from each village was made followed by employing a simple random-sampling technique in selecting a sample of respondents among farmers from each village. Simple random-sampling technique was selected because it can enhance generalization of results. A total of 314 farmers were randomly selected from the nine villages (Table 1).

Name of the village	Sex of the respondent		Total
	Male	Female	
Chanzuru	12 (52.2%)	11 (47.8%)	23
Kimamba B	27 (71.1%)	11 (28.9%)	38
Hembeti	8 (30.8%)	18 (69.2%)	26
Mlimba A	20 (64.5%)	11 (35.5%)	31
Rudewa Mabatini	11 (34.4%)	21 (65.6%)	32
Michenga	18 (64.3%)	10 (35.7%)	28
Mgudeni	24 (48.0%)	26 (52.0%)	50
Mvomero	20 (42.6%)	27 (57.4%)	47
Wami Dakawa	13 (33.3%)	26 (66.7%)	39
Total	153 (48.7%)	161 (51.3%)	314

Table 1. Sample size by sex of farmers.

The study employed a purposive sampling technique in selecting respondents among agricultural researchers, agricultural extension workers, policy makers, village executives, agricultural input suppliers and information service providers. Each head of the agricultural research outreach section of the agricultural research institute, all agricultural extension staff from the nine villages and the head of the agricultural extension unit from the three districts were selected for the study. Three providers of agricultural information services and three warehouse operators (one from each district), nine agricultural inputs suppliers (one from each village) and nine buyers (one buyer from each village) were included in the study too. Moreover, nine village executives and ward councilors from the nine wards were selected too. This made a total of 57 respondents selected among this category of actors.

3.2. Data collection and analysis

The study used structured questionnaire and unstructured questionnaire in data collection. Structured questionnaires were administered to 314 farmers while the unstructured questionnaire was used to collect data from 57 other agricultural stakeholders. Face-to-face interview sessions and in-depth interviews were arranged for data collection from farmers and other agricultural stakeholders, respectively. Data collected through structured questionnaire were edited, classified and coded to make them amenable to analysis. Coded data were then cleaned and analyzed using the Statistical Package for Social Sciences (SPSS). SPSS facilitated the generation of frequencies, percentages and tables. Qualitative data collected through in-depth interviews were analyzed through content analysis and summarized into descriptions and explanations.

4. Findings and discussion

Both male and female farmers were selected for the study. Findings in **Table 1** indicate that 161 (51.3%) of the farmers were female and 153 (48.7%) were male making a total of 314 farmers. Among the 57 agricultural stakeholders, three were heads of agricultural research institute outreach units while the other three were heads of the agricultural extension departments. There were nine agricultural extension staff, three providers of agricultural information services, three warehouse operators, nine agricultural inputs suppliers, and nine buyers. Moreover, there were nine village executives and nine ward councilors.

Findings in **Table 2** show that farmers involved in the study had informal to secondary level of education. Majority of the farmers (220, 70.1%) had primary education; others (42, 13.4%) had secondary education; 38 (12.1%) had informal education; few (14, 4.5%) had adult education; while none had tertiary education. With respect to the level of education by sex of respondent, findings indicate that 112 (73.2%) male farmers as opposed to 108 (67.1%) female farmers had primary education, and 27 (17.6%) male farmers as opposed to 15 (9.3%) female farmers had secondary education. Findings also indicate that seven (4.6%) of the male farmers as opposed to seven (4.3%) of the female farmers had adult education, and the other seven (4.6%) male farmers as opposed to 31 (19.3%) female farmers had informal education.

4.1. How agricultural knowledge flows among stakeholders

Agricultural stakeholders were asked to mention how agricultural knowledge flowed among them. It was found that there were different ways through which agricultural knowledge flowed. Among the farmers, 289 (92%) mentioned that agricultural knowledge flowed among them through knowledge sharing (**Table 3**). Others, 281 (89.5%) mentioned that accessing agricultural knowledge from different sources enhanced the flow of agricultural knowledge among stakeholders, while 195 (62.1) farmers mentioned that reporting observed farm-related problems to a third party enhanced the flow of agricultural knowledge among stakeholders (**Table 3**).

Agricultural knowledge sharing, exchange, transfer and dissemination were the main means of flow of agricultural knowledge among non-farmers respondents. Agricultural researchers mentioned to transfer knowledge to farmers through agricultural extension staff but they shared knowledge with colleagues and peers through seminars and conferences. They also disseminate research findings to a wider audience through publications. Agricultural extension staff and NGOs mentioned to transfer, share and exchange agricultural knowledge with farmers and input suppliers. They also mention to report to supervisors on different agricultural issues. Input suppliers and buyers shared agricultural knowledge among themselves and with farmers. Councilors and village executives reported to disseminate knowledge during meetings. Agricultural information service providers disseminated agricultural knowledge to wider agricultural stakeholders through radio/TV broadcasts and newspapers.

Findings in **Table 3** indicate that the farmers shared agricultural knowledge to different recipients, accessed it from different sources and reported farm-related problems to different

Level of education by sex of respondents

Level of education	Sex of the respondent		Total
	Male	Female	
Informal education	7 (4.6%)	31 (19.3%)	38 (12.1%)
Adult education	7 (4.6%)	7 (4.3%)	14 (4.5%)
Primary education	112 (73.2%)	108 (67.1%)	220 (70.1%)
Secondary education	27 (17.6%)	15 (9.3%)	42 (13.4%)
Total	153 (100%)	161 (100%)	314 (100%)

Table 2. Demographic characteristics of respondents.

Knowledge flow processes	Frequency distribution
Sharing knowledge	289 (92%)
Accessing knowledge	281 (89.5%)
Reporting observed farm-related problem	195 (62.1%)

Table 3. Knowledge flow processes among farmers.

stakeholders. The following sections give details of sources of knowledge used by farmers and other stakeholders.

4.1.1. Sources of agricultural knowledge used by agricultural stakeholders

Agricultural knowledge flowed from knowledge sources to different destinations. Respondents were asked to mention knowledge sources from which they accessed agricultural knowledge. Findings in **Table 4** summarize the sources used by farmers for acquiring agricultural knowledge. It was found that majority of the farmers (305, 97.1%) acquired agricultural knowledge from fellow farmers. Others, 193 (61.5%) acquired agricultural knowledge from radio sets, 152 (48.4%) through mobile phones, 120 (38.2%) from village-based agricultural advisor and 105 (33.4%) farmers from input suppliers. Findings indicate that 102 (32.5%) of the farmers acquired agricultural knowledge from agricultural extension agents, 80 (25.5%) from TV sets, 66 (21%) from demonstration plots while 63 (20.1%) from farmers’ groups. Findings indicate further that 50 (15.9%) farmers accessed agricultural knowledge from trainings and seminars, 43 (13.7%) from print materials, 33 (10.5%) from buyers, 27 (8.6%) from village executives and 12 (3.8%) from agricultural shows/farmers’ field day.

Among non-farmers respondents, it was found that agricultural extension officers, councilors, employees from NGOS, researchers, ward councilors and village executives accessed agricultural knowledge from human-based knowledge sources like farmers, colleagues, partners and supervisors. Likewise, buyers and input-suppliers mentioned to use human-based sources of knowledge. They mentioned to access knowledge from agricultural extension officers, farmers and whole buyers/sellers of harvests and agricultural inputs.

Sources of agricultural knowledge	Frequency distribution
Fellow farmers	305 (97.1%)
Radio set	193 (61.5%)
Mobile phones	152 (48.4%)
Village-based agricultural advisor	120 (38.2%)
Input supplier	105 (33.4%)
Agricultural extension officer	102 (32.5%)
TV set	80 (25.5%)
Demonstration plots	66 (21%)
Farmers’ group	63 (20.1%)
Trainings and seminars	50 (15.9%)
Print materials	43 (13.7%)
Buyers	33 (10.5%)
Village executives	27 (8.6%)
Agricultural shows/farmers’ field day	12 (3.8%)

Table 4. Sources of agricultural knowledge (N = 314).

Recipient of agricultural knowledge	Frequency distribution
Fellow farmers	281 (96.2%)
Agricultural extension staff	82 (28.1%)
Village-based agricultural advisor	74 (25.3%)
Input suppliers	68 (17.5%)
Farmers' group	39 (13.4%)
Buyers	27 (9.2%)
Village executives	16 (5.5%)
Agricultural researchers	11 (3.8%)

Table 5. Recipients of agricultural knowledge ($N = 314$).

It was found that non-farmers respondents used different ICT-based agricultural knowledge sources. Agricultural extension officers, researchers and NGOs mentioned to use computers, Internet, mobile phones, radio and TV sets. Buyers, input suppliers, ward councilors and village executives mentioned to use mobile phones, radio and TV sets only.

Results indicate that non-farmers used print materials as sources of agricultural knowledge too. Letters, newspapers, books, leaflets and booklets were the paper-based agricultural knowledge sources used by agricultural extension officers, input suppliers, ward councilors, employees from NGOs, researchers and village executives. Buyers mentioned to mainly use newspapers as sources of knowledge on agricultural marketing.

4.1.2. Recipients of agricultural knowledge

Flow of agricultural knowledge involves a source and a destination or recipient. Farmers were asked to mention the destinations or recipients of knowledge. Findings in **Table 5** indicate that 281 (96.2%) farmers mentioned that fellow farmers were the recipients of knowledge. Others, 82 (28.1%), 74 (25.3%) and 68 (17.5%) reported that agricultural extension staff, village-based agricultural advisors and input suppliers were their recipients of knowledge, respectively. Findings in **Table 5** indicate further that 39 (13.4%) farmers mentioned farmers' group as their recipients of knowledge. Others, 27 (9.2%), 16 (5.5%) and 11 (3.8%) reported buyers, village executives and agricultural researchers as their agricultural knowledge recipients, respectively.

Among non-farmers respondents, agricultural extension staff and researchers reported that farmers, colleagues and supervisors were the recipients of agricultural knowledge. Employees of NGOs mentioned farmers, colleagues, partners, donors and the government as their major recipients of agricultural knowledge. Input suppliers and buyers reported farmers and colleagues as knowledge recipients. Agricultural information services providers mentioned the wider agricultural community as their recipient of agricultural knowledge.

4.2. Channels through which agricultural knowledge flowed

Agricultural stakeholders were asked how agricultural knowledge flowed among themselves. Findings in **Table 6** indicate the communication channels used by farmers for different

Channel	Frequency distribution
Face-to-face oral communication	305 (97.1%)
Radio set	193 (61.5%)
Mobile phones	152 (48.4%)
TV set	80 (25.5%)
Print materials	43 (13.7%)

Table 6. Channels mostly used for agricultural knowledge flow among farmers ($N = 314$).

agricultural knowledge flow processes. Findings indicate that 305 (97.1%) farmers motioned to use face-to-face oral communication as a channel through which agricultural knowledge flowed. Others used radio sets (193, 61.5%), mobile phones (152, 48.4%), TV sets (80, 25.5%) and print materials (43, 13.7%) as communication channels.

Findings from non-farmers agricultural stakeholders indicate that various channels were used so as to facilitate flow of agricultural knowledge. All of them mentioned to use face-to-face oral communication and mobile phones for sharing and exchanging knowledge. This was possible during oral conversations with colleagues and supervisors or during trainings, meetings, conferences and seminars. Agricultural researchers, extension staff, agricultural information services providers and employees from NGOs reported to use virtual communication channels, mostly Skype and emails. Other communication channels preferred by majority of the non-farmers stakeholders were leaflets/brochures, notice boards, radio and TV sets.

4.2.1. Factors influencing preference of communication channels

Findings indicate that the preference of communication channels used among agricultural stakeholders was different. Stakeholders were asked to mention reasons after their preference to some communication channels. Among farmers, several factors were mentioned to influence their preference. Findings indicate that 303 (95%) of the farmers mentioned that the availability and accessibility of the communication channels was the main factor for preference. Others, 279 (88.9%), mentioned their preference to some communication channels to be influenced by the level of development of ICT infrastructure. Findings indicate further that 206 (65.6%) of the farmers mentioned that the affordability of tariffs for communication influenced their preference to some communication channels while 153 (48.7%) of the farmers used some communication channels because they owned some communication tools (**Table 7**).

Factor stimulating accessibility of agricultural knowledge	Frequency distribution
Availability and accessibility of communication channels	303 (95%)
Well-developed ICT infrastructure	279 (88.9%)
Affordability of tariffs for communication	206 (65.6%)
Ownership of communication tools	153 (48.7%)

Table 7. Reasons for choice of channels.

Preference of communication channels among non-farmers agricultural stakeholders was influenced by different factors. Access to ICT infrastructure and availability and accessibility of ICT tools influenced the usage of virtual communication channels among agricultural research employees from NGOs, agricultural information services providers and agricultural extension staff. Moreover, availability, convenience and suitability of communication channels for a communication process were found to influence the choice of communication channels among non-farmers agricultural stakeholders. Likewise, the affordability of tariffs for communication was also found to influence the preference of communication channels among all non-farmers agricultural stakeholders.

4.3. Factors influencing the flow of agricultural knowledge

Agricultural stakeholders were asked to mention factors influencing the flow of agricultural knowledge among them. Findings in **Table 8** indicate the factors mentioned by farmers to influence the flow of agricultural knowledge. It was found that 262 (83.4%) of the farmers mentioned that membership in farmers' group influenced knowledge flow. Others, 219 (69.7%), 206 (65.6%) and 205 (65.3%), mentioned the accessibility of agricultural knowledge sources, affordability of tariffs for communication and access to agricultural extension services, respectively, to influence the flow of agricultural knowledge among agricultural stakeholders.

Findings in **Table 8** indicate that 126 (40.1%), 125 (39.8%) and 123 (39.2%) of the farmers mentioned the availability of agricultural knowledge, access to a reliable power source and airing agricultural radio/TV programs during relevant hours to influence the flow of agricultural knowledge. Likewise, 114 (36.3%), 67 (21.3%) and 26 (8.3%) of the farmers mentioned ownership of communication tools, usage of most suitable language repackaging knowledge and a well-developed ICT infrastructure to influence the flow of agricultural knowledge. Findings from **Table 8** also indicate that 10 (3.2%) of the farmers mentioned that an efficient feedback mechanism was important for the effective flow of agricultural knowledge.

Reason limiting agricultural knowledge usage	Frequency distribution
Membership in farmers' group	262 (83.4%)
Accessibility of knowledge sources	219 (69.7%)
Affordability of tariffs for communication	206 (65.6%)
Access to agricultural extension services	205 (65.3%)
Availability of agricultural knowledge	126 (40.1%)
Access to a reliable power source	125 (39.8%)
Airing agricultural radio/TV programs during relevant hours	123 (39.2%)
Ownership of communication tools	114 (36.3%)
Usage of most suitable language repackaging knowledge	67 (21.3%)
Well-developed ICT infrastructure	26 (8.3%)
Efficient feedback mechanism	10 (3.2%)

Table 8. Factors influence the flow of agricultural knowledge.

A Pearson correlation analysis was run to determine the correlation of some farmers’ demographic characteristics and some agricultural knowledge flow processes (**Table 9**). Findings indicate that there was no significant correlation between agricultural knowledge sharing and farmers and farmer’s age ($r = 0.011$ at 0.842 level of significance), level of education ($r = -0.091$ at 0.108 level of significance) and farming experience ($r = 0.003$ at 0.959 level of significance). Findings in **Table 9** indicate that there is no significant correlation between reporting observed farm-related problems and farmers age ($r = 0.005$ at 0.936 level of significance) and farming experience ($r = -0.009$ at 0.875 level of significance). However, there is negative correlation between reporting observed farm-related problem and farmer’s level of education ($r = -0.302$ (**)) at 0.000 level of significance). Findings indicate that there is a significant positive correlation between accessing agricultural knowledge and farmer’s age ($r = 0.203$ (**)) at 0.000 level of significance) and farming experience ($r = 0.138$ (*) at 0.014 level of significance). However, findings indicate that there is a negative correlation between accessing agricultural knowledge and farmer’s level of education ($r = -0.194$ (**)) at 0.001 level of significance).

Findings also indicate that several factors influenced the choice of communication channels among non-farmers agricultural stakeholders. Among agricultural researchers, village executives, extension staff and employees from some NGOs implementing agricultural-related interventions, access to office ICT infrastructure and facilities, top management support, knowledge-sharing culture, rewards associated with knowledge sharing and accessibility of transport facilities influenced the flow of agricultural knowledge among them and with other stakeholders. Agricultural inputs suppliers, ward councilors and buyers of agricultural produce mentioned access to a reliable power supply and well-developed ICT infrastructure and affordability of tariffs for communication as factors which influence the flow of agricultural knowledge. Findings indicate that agricultural information service providers (radio and TV stations and other media houses) mentioned that taxes paid for their services and availability of sponsorship for some services

Agricultural knowledge flow process	Correlations	Demographic characteristics		
		Age group	Level of education	Years in farming
Sharing knowledge	Pearson correlation	0.011	-0.091	0.003
	Sig. (two-tailed)	0.842	0.108	0.959
	N	314	314	314
Reporting observed farm related problem	Pearson correlation	0.005	-0.302**	-0.009
	Sig. (two-tailed)	0.936	0.000	0.875
	N	314	314	314
Accessing knowledge	Pearson correlation	0.203**	-0.194**	0.138*
	Sig. (two-tailed)	0.000	0.001	0.014
	N	314	314	314

*Correlation is significant at the 0.05 level (two-tailed).

**Correlation is significant at the 0.01 level (two-tailed).

Table 9. Correlation between agricultural knowledge flow processes and some farmers’ demographic characteristics.

influenced the dissemination of agricultural knowledge. Likewise, mobile phone operators mentioned that high duties, which always increase operation costs (and consequently the communication tariffs paid by customers), have a great influence on increasing the rate of agricultural knowledge flow. It was also found that the availability, convenience, suitability of communication channels and affordability of tariffs for communication process influenced the flow of agricultural knowledge among stakeholders too.

5. Discussion of findings, conclusion and recommendations

The agricultural sector involves different stakeholders involved in performing activities directly or indirectly related agriculture. Farmers, agricultural researchers, agricultural extension staff, village executives, councilors, agricultural input suppliers, buyers of agricultural produce and agricultural information services providers are some stakeholders in the sector to mention a few. These stakeholders come from both the private and public sector and each performs agricultural knowledge-related processes in the agricultural knowledge system. They are involved in generating knowledge through research, using it and setting policies and regulations related to agricultural knowledge management [30]. Among farmers, both males and females are involved in farming. Findings from this study indicate that there are more female than male farmers. This is supported by other studies [31, 32] which also indicate that more females are involved in farming than males. Moreover, findings indicate that most farmers had primary level of education. Primary education is an important predictor of adopting new farming technology [33].

5.1. The flow of agricultural knowledge among stakeholders

Agricultural knowledge flows among and between stakeholders through multiple processes. Findings in **Table 3** indicate that sharing and accessing knowledge and reporting farm-related problems to a third party are the main processes through which agricultural knowledge flows among farmers and between farmers and other stakeholders. All these processes involve a transfer of knowledge from one point to the other. They involve a knowledge transfer because a variety of interactions between individuals and groups; within, between, and across groups; and from groups to the organization are conducted [8].

Among non-farmers agricultural stakeholders, knowledge exchange, sharing, transfer and dissemination are found to be the major processes used to enhance knowledge flow. Through the knowledge exchange process among agricultural stakeholders, it is possible to have collaborative research on priority thematic issues identified as priorities by majority of stakeholders [34]. In a knowledge-sharing process, each side has a role to play [7]; the sources transfer knowledge to another person known as the receiver or recipient of knowledge who receives it and uses it to fill the knowledge gap. Agricultural knowledge sharing is meant to enhance access to knowledge and skills needed for agricultural production [35]. Agricultural knowledge dissemination is a one-direction flow of knowledge. It is a knowledge push process, which spreads knowledge to a wider target audience or to public [22]. Agricultural

knowledge dissemination is commonly adopted by the mass media in facilitating access to knowledge to the public.

It is found that all of the three knowledge flow processes involve knowledge transfer. Knowledge exchange and knowledge sharing are multi-directional processes involving a knowledge sources which knows what is needed and the recipient which seeks knowledge, receives and uses it to fill the knowledge gap. On the other hand, knowledge dissemination is a one-direction process because recipients do not seek for it before it is disseminated as they just receive it and may or may not use it.

5.1.1. Agricultural knowledge sources from which stakeholders receive knowledge

Regardless of the mode through which knowledge flows, it must come from a known knowledge source and flowing towards a known recipient. Among farmers, knowledge is accessed from fellows, agricultural radio/TV programs, input suppliers, agricultural extension staff, demonstration plots and farmers' groups. Likewise, agricultural knowledge is accessed from print materials, trainings/seminars, print materials, buyers, village executives and agricultural shows/farmers' field days. These sources are convenient and easily consulted and believed to be rich in knowledge [35, 36].

Among non-farmers agricultural stakeholders agricultural knowledge sources used are classified as human-based, paper-based and ICT-based sources. Human-based knowledge sources include farmers, peers, partners and supervisors consulted directly mainly through face-to-face oral communication or through some ICT tools. Letters, newspapers, books, leaflets and booklets were the paper-based agricultural knowledge sources while computers, Internet, mobile phones, radio and TV sets were the ICT-based knowledge sources.

5.1.2. Recipients of agricultural knowledge

Agricultural knowledge flows from knowledge sources to recipients. Among farmers, the major recipients of agricultural knowledge are fellow farmers. This indicates that farmers mainly shared and exchanged agricultural knowledge among them. Moreover, it indicates that there are some farmers who have accumulated much knowledge from several sources including farming experience. Other recipients of agricultural knowledge mentioned by a relatively low number of farmers are extension staff, village-based agricultural advisors, input suppliers, buyers, village executives, agricultural researchers and farmers' groups. Few farmers mentioned to share knowledge with this category of recipients because they were few, not relevant or not easily reached. All recipients are expected to use acquired agricultural knowledge because they either intentionally access it or are obliged to work on it.

Among majority of non-farmers agricultural stakeholders, recipients of agricultural knowledge are farmers, colleagues and supervisors were the recipients of agricultural knowledge. Among NGOs, farmers, colleagues, partners, donors and the governmental institutions are the major recipients while farmers and colleagues were the major recipients among input suppliers and buyers. It is also found that agricultural information service providers disseminate agricultural knowledge to the public. Depending on the mode of knowledge flow, recipients

may either use/be obliged to use or not use it. Recipients may not use received knowledge if disseminated to them without being in need of it [37].

5.2. Factors influencing the choice of communication channels for agricultural knowledge flow

Agricultural stakeholders use different communication channels for agricultural knowledge flow. Findings indicate that face-to-face oral communication and radio sets are used by more than 60% of the farmers followed by mobile phones (which is used by approximately 50% of the farmers, **Table 6**) while TV sets and print materials are used by few farmers. All of the non-farmers agricultural stakeholders mentioned to use face-to-face oral communication and print materials for sharing and exchanging knowledge. Some agricultural researchers, agricultural extension staff, NGOs, input suppliers and buyers mentioned to use virtual communication channels (Skype, mobile phones, and emails) for exchanging or sharing agricultural knowledge. Virtual communication channels facilitated knowledge between virtual teams [38].

The choice of communication channels through which agricultural knowledge flowed was influenced by several factors. Among farmers, availability and accessibility of the communication channels, level of development of ICT infrastructure, affordability of tariffs for communication and ownership of some communication tools were found to influence the choice of channels used for either sharing or exchanging agricultural knowledge. Likewise, among non-farmers agricultural stakeholders access to ICT infrastructure and availability and accessibility of ICT tools, affordability of tariffs, availability, convenience and suitability of communication channels for a communication process influence the choice of communication channels.

Without considering other factors, people use communication channels which are available and easily accessible [39]. This applies to ICT- and non-ICT-based channels. For ICT-based channels, the availability and accessibility of a channel is explained by the level of development of ICT infrastructure and accessibility of ICT tools. Since the flow of knowledge involves some costs, then the affordability of costs associated with a specific communication channel influences the choice of communication channels. When those sharing agricultural knowledge afford costs associated with the process, then affordable communication channels are more likely to be used [40]. Likewise, those who afford to own communication tools are more likely to use such tools for enhancing knowledge flow. For example, those owning agricultural books are more likely to read them than non-owners. Also, those owning ICT tools are more likely to use for either sharing or exchanging agricultural knowledge than for non-owners. Moreover, communication channels, which are more convenient and suitable for a knowledge flow process, are more likely to be used for either knowledge sharing, exchange or dissemination.

5.3. Factors influencing the flow of agricultural knowledge among stakeholders

There are several factors known to influence the flow of agricultural knowledge among agricultural stakeholders. Membership in farmers'/professional group and accessibility of agricultural knowledge sources influence the flow of agricultural knowledge. The flow of agricultural knowledge is known to be higher among farmers found in groups [41] because each farmer

can be either a knowledge source or a recipient. Moreover, providers of agricultural knowledge services find it easy to reach more farmers or other actors when they were in groups than as individuals [41].

Likewise, the affordability of tariffs for communication influences the flow of agricultural knowledge. Some knowledge flow processes are not free of charge. The recipient or the one disseminating knowledge has to pay some fee so as to communicate knowledge. In most cases, it is only when such costs are low and affordable then the knowledge flow process becomes high. Affordability can equally relate to one's ability to own communication tools too. If communication tools are owned, then the level of usage of such tools among owners becomes higher, hence increasing the possibilities of using them for sharing or exchanging agricultural knowledge.

Among farmers, agricultural extension staff play an important role in enhancing access to knowledge. They are designed to build and strengthen the capacity of rural farmers and other stakeholders through enhancing access to knowledge [42]. To easily reach more stakeholders and enhance access to agricultural knowledge among them, agricultural extension staff should have access to transport facilities. Transport facilities help agricultural extension staff meet more stakeholders within limited time and hence disseminating or exchanging knowledge with more stakeholders.

Other factors, availability of agricultural knowledge, having a well-developed ICT infrastructure and a reliable power sources and airing agricultural radio/TV programs during relevant hours influence the flow of agricultural knowledge. Agricultural knowledge can only flow from one point to the other when it is available. Reliable sources of power are important for ICT-based channels. Available agricultural knowledge can only be shared, exchanged or disseminated through ICTs if such tools are connected to a source of power. Radio and TV sets, computers and mobile phones are among the tools that can only work when connected to a source of power. When broadcasting agricultural knowledge through radio and TV sets, it is important to consider the relevance of time to the target audience of the radio/TV agricultural programs. Without time consideration, few or none of the intended audience can access broadcasted contents. Moreover, a well-developed ICT infrastructure is important for such broadcast to reach more of the intended audience. Likewise, wide wired and wireless phone connections are important for enhancing the flow of available agricultural knowledge among agricultural stakeholders.

Likewise, the usage of most suitable language for repackaging knowledge influences the level of flow of agricultural knowledge. Using unknown or foreign language to repackaging agricultural knowledge limits some stakeholders from accessing knowledge [43]. Very important agricultural knowledge found in an unknown language will not be accessed, shared or exchanged among stakeholders. Therefore, repackaging knowledge in a-not-known and difficult language is like burying it.

An efficient feedback mechanism is important for increasing the flow of agricultural knowledge among agricultural stakeholders. Communication channels enhancing immediate feedback are preferred more than those that do not [39]. Moreover, such channels are more likely to enhance effective agricultural knowledge flow among stakeholders.

To enhance agricultural knowledge flow, communities and organizations should cultivate a knowledge-sharing culture. Community/organizational culture is expressed in terms of leadership, sociability, solidarity, trust, core beliefs, values, norms and social customs [44]. When all these elements of community/organizational culture support the creation and sharing of knowledge, then the level of knowledge accessibility becomes high. Communities and organizations should create platforms through which members can share and exchange knowledge among them. In agricultural organizations, the top management has a strong role to play so as to enhance knowledge-sharing culture, hence increasing the flow of agricultural knowledge. The top management in agricultural institutions can create a rewarding system so as to promote knowledge sharing, exchange and dissemination. This in turn increases the level of flow of agricultural knowledge.

Equally, the availability, convenience, suitability of communication channels to sharing and exchanging agricultural knowledge may influence the level of flow of agricultural knowledge. Agricultural stakeholders use the most available, convenient and suitable communication channels for sharing, exchanging or disseminating agricultural knowledge [39]. This in turn increases the level of flow of agricultural knowledge.

For agricultural information services providers, the affordability of taxes paid for their services and the availability of sponsorship play an important role in increasing the rate of dissemination of agricultural to mass. Governments exert some taxes or duties to media houses. When such taxes or duties are too high, the operational cost of such houses becomes higher limiting them from disseminating agricultural knowledge. Sponsors are important for cushioning the impacts of high taxes and duties on disseminating agricultural knowledge. However, this is only possible when sponsorship is available.

Findings also show that there is correlation between demographic characteristics and some agricultural knowledge flow processes. There is negative correlation between reporting observed farm-related problem and farmer's level of education ($r = -0.302^{**}$) at 0.000 level of significance). This indicates that as farmer's level of education increases, the ability to handle problems found at farms increases. Likewise, findings indicate that there is a negative correlation between accessing agricultural knowledge and farmer's level of education ($r = -0.194^{**}$) at 0.001 level of significance). This tells that as the farmer's level of education increased, the level of accessing agricultural knowledge declined. In other words, educated farmers thought they had most of the knowledge needed for production that accessing it from a third party was not important. Findings also indicate that there is a significant positive correlation between accessing agricultural knowledge and farmer's age ($r = 0.203^{**}$) at 0.000 level of significance) and farming experience ($r = 0.138^{*}$) at 0.014 level of significance). This tells that the level of accessing agricultural knowledge is higher among old farmers than young ones. In other words, old farmers enhance more flow of agricultural knowledge than young ones.

5.4. Conclusion and recommendations

An effective agricultural knowledge flow is important for increased accessibility, usage and creation of knowledge, hence improving agricultural productivity. Agricultural knowledge

sharing, exchange, transfer and dissemination are important processes facilitating the flow of agricultural knowledge among agricultural stakeholders. For these processes to be effective, suitable and convenient communication channels should be available to enhance the flow of knowledge from the source to the recipient. Paper-based, human- and ICT-based communication channels are commonly used for the flow of agricultural knowledge. Availability of agricultural knowledge and accessibility of knowledge sources are important for enhanced agricultural flow. Well-developed ICT infrastructure, access to power sources and an effective feedback mechanism play an important role in enhancing adequate flow of agricultural knowledge. For agricultural knowledge to be understandable, sharable and exchangeable, it should be repackaged using appropriate languages. Communities and organizations should have strategies to enhance a continuous flow of agricultural knowledge among members. In order to improve the flow of agricultural knowledge, the involvement of different stakeholders is inevitable. Each agricultural stakeholder should be involved in conducting relevant agricultural knowledge-related roles so as to enhance the accessibility, sharing, exchange, dissemination and usage of agricultural knowledge. In order to increase the flow of agricultural knowledge, the Government in partnership with the private sector should widen the ICT and agricultural communication infrastructure.

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