

Full Length Research Paper

Agricultural Knowledge and Technology Transfer Systems in the Southern Ethiopia

Tewodros Ayalew* and Tesfaye Abebe

School of Plant and Horticultural Sciences, College of Agriculture, Hawassa, University, P. O. Box 05
Hawassa, Ethiopia.

Received 28 January, 2017; Accepted 15 January, 2018

Agriculture is the mainstay of the Ethiopian economy. However, the growth of the sector is constrained by different factors. Low level of technology development, inefficient technology dissemination, low utilization of improved production inputs and shortage of research proven production practices are among the most important factors hindering the growth of the sector. The objective of this study was, therefore, to assess the status of the current agricultural knowledge and technology transfer systems. For this purpose, a combined effort of literature study, expert elicitation and questionnaire based survey were carried out. The results of the study showed that a multitude of factors are constraining the system in the area. Limited economic capacity and awareness of farmers, lack of motivation of stakeholders, lack of motivation and knowledge level of development agents to support the transfer system are within the limiting factors. Weak linkage amongst the concerned actors, negligence of farmers' indigenous knowledge, and resistance of farmers to newly introduced technologies are also among the main factors hindering the efficiency of the system in their respective orders. Based on the findings of this study, it can be concluded that practicing participatory research approach, capacity building training, and mobilization of farmers are in urgent need for improving the efficiency of the transfer systems. Equipping with knowledge and skill and establishing a motivation scheme for development agents also a central solution to improve the systems. On top of this, timely dissemination of agricultural technologies, and information considering farmers indigenous knowledge needs to get due attention so as to improve agricultural knowledge-information and technology transfer system as well as smallholders' livelihood.

Key words: Agricultural information, agricultural technology, Southern Ethiopia, technology and knowledge transfer.

INTRODUCTION

Agriculture is the mainstay of the Ethiopian economy. The sector contributes 50% of the country's Gross Domestic Product (GDP). It directly supports about 85% of the population and generates 88% of foreign exchange

earnings (Ayalew et al., 2015). The differences in production environment among regions enable the country to produce a variety of crops and rear different species of livestock. However, the production system is

dominated by smallholder farming under rain fed condition. The farming systems are also traditional with subsistence crop and livestock mixed farming system, with an average per capita land area of 0.2 ha in 2008 (Francesconi and Heerink, 2010; Spielman et al., 2010). Although, the country is characterized by diverse agro ecological zone and endowed with ample natural resources which support successful crop and animal production, the agricultural sector has low productivity (Sewnet et al., 2016). By most measures, the growth and innovation of the sector is weak. For instance, between 1996 and 2005, agricultural GDP per capita grew only by 0.48 per year.

Various factors contributed to the low productivity of the agricultural sector and food insecurity in the country. Of all the barriers, the low level of agricultural technology development, dissemination, utilization of modern production inputs and the low adoption rate of proven research technological production packages by smallholder farmers are among the important factors (Sewnet et al., 2016). For instance, only 37% of the farmers use inorganic fertilizers, with a very low application rate of 16 kg per hectare. Moreover, the uses of improved varieties are very limited in the country (Spielman et al., 2010).

In the last decades, agricultural information has increased rapidly; however, the effective transfer of agricultural knowledge and technological package system is a bigger challenge. The main factors affecting the effective transfer of agricultural systems to the end-users are knowledge level of the information users, access to information of end users and readiness of farmers for adoption (Carrascal et al., 1995). Therefore, comprehensive transfer of research knowledge and production technology is demanded to impact the livelihood of the end users; farmers (Sewnet et al. 2016; Carrascal et al., 1995). Agricultural innovation system approach is already recognized as a best means to use as a comprehensive framework for analyzing the status of the agricultural system in developing countries (Klerx et al., 2009). Up-to-date and structured data coupled with open information transfer system in parallel with interactions among the stakeholders are necessary for improved agricultural information transfer system (Bouma, 2010) and agricultural production up-lift (Sewnet et al., 2016; Pezeshki and Dehkordi, 2006). According to Van Crowder and Anderson (1997), knowledge generation is considered as the mandate of researchers and extension agents, but to have effective information system, active participation of farmers, and other

agricultural innovation actors need to be considered in the system.

Involvement of all innovation actors in the information/knowledge exchange, and the use of farmer's indigenous knowledge and farming systems are crucial (Aflakpui, 2007; Ashraf et al., 2007) to hasten information transfer, technology adoption rate of farmers, and make genuine decision. Therefore, strengthening the linkage between all the innovation actors is important to hasten the agricultural knowledge and technology transfer system and also to increase the effectiveness of the developed and disseminated agricultural technologies (Pezeshki and Dehkordi, 2006). Furthermore, establishing efficient knowledge and information transfer system in agriculture would help to attain efficient operation of agricultural systems (Carrascal et al., 1995).

Technology transfer is the main component of technology development; this is because for the developed technology to be applied effectively, it needs to reach the end-users of the technology with its full package and also the feedback need to reach the developer of the technology so as to involve the idea of all actors on the decision making. Considering technology dissemination as a main part of technology development and research coordination was started in 1960 in Ethiopia (EARO, 1998), and since then a number of efforts were made to improve technology transfer system and linkage between different partners like research, extension, farmers and other stakeholders (ICRA, 2010). Although extension has long history in Ethiopia, the coverage is very low and the linkage of the actors of the system is very poor (Sewnet et al., 2016; Davis et al., 2010), which is the main reason for low adoption of improved agricultural technology/production systems and inputs (Sewnet et al., 2016). Moreover, the extension agents are not accessible for farmers, and the interaction between different agricultural innovation actors is very limited in the country (Gildemacher et al., 2009). This poor linkage of the stakeholders coupled with disregarding farmers' indigenous knowledge in extension program and during the policy development process make the linkage ill-functioning (Kassa and Alemu, 2017; Sewnet et al., 2016). This calls for improvement of the linkage between the different agricultural innovation actors and information and knowledge transfer system, so as to alleviate poverty, improve the livelihood of the smallholder farmers in particular and the overall economic status of the country. Therefore, the main purpose of the current study was to describe the existing agricultural knowledge and the aforementioned issues a combined effort of literature

*Corresponding author. E-mail: teddy1360@yahoo.com.

Author(s) agree that this article remain permanently open access under the terms of the [Creative Commons Attribution License 4.0 International License](https://creativecommons.org/licenses/by/4.0/)

limiting the efficiency of the system, and thereby forward suggestions for improvement of the system. To deal with study, expert elicitation and questionnaire based survey were implemented.

METHODOLOGY

Description of the study area

The study was conducted around Hawassa area, Southern Ethiopia. Hawassa, where the expert elicitation was made is located at about 273 km south of the capital city, Addis Ababa, Ethiopia with a geographical position of 7°4' North latitude and 38° 31' East longitude. The altitude of the area is about 1700 m.a.s.l. The average rainfall of the area is about 900-1100 mm annually, whereas annual maximum and minimum temperature are 27 and 12°C respectively. The site is characterized by sandy loam soil with 7.9 pH value, which is of volcanic origin and described as flovisol. Farmer based survey was conducted in Wondo Genet District, Sidama Zone, Southern Ethiopia. The Wondo Genet district is located in the Sidama Zone of the SNNPR with a latitude and longitude of 7° 1' 0" N, 38° 35' 0" E and an elevation of 1723 m above sea level. Two kebeles-small administrative units namely Banja Fabrica and Wetera Genda were selected from Wondo Genet district. These kebeles are located about 42 and 65 km respectively from Hawassa, the capital of SNNPR state.

Data collection techniques

The data were collected using three approaches. Literature study, expert elicitation, and questionnaire-based survey were carried out to solicit the required data. Each method is detailed next.

Literature study

To elicit data on agricultural information-knowledge and technology transfer system in the world and at country level, published and grey research papers were reviewed indepth. The literature review was useful to obtain general understanding of the research activities and the agricultural information system ahead of the questionnaire-based survey. Moreover, reviewing the secondary information helped to understand the main problems or issues and gaps that need to be emphasized and addressed during this particular study.

Expert elicitation

Following the literature review, interview was conducted with different professionals from the university, Agricultural Research Institute, Regional and Zonal Agricultural offices and nongovernmental organizations. All inclusive information like the way the information reach the farmer, inter-organizational interaction have their involvement level in agricultural information/knowledge and technology transfer system, level of contact they have with farmers, the way the farmers' demands are considered and development agents activities and the interaction farmers and development agents have, etc., were discussed during the interviews. Moreover, the main problematic issues hindering efficient transfer of agricultural information/knowledge and

technology as well as the impact the technologies brought on the technology transfer system, identify the main factors livelihood of farmers were stressed.

Quantitative survey

Following expert elicitation, a questionnaire-based survey was executed. The questionnaire was filled by agricultural experts from Sidama Zone Agricultural Office of Southern Ethiopia, researchers from Southern Agricultural Research Institute, Research and Development Directorate Office of one public university in the zone, researcher from one public university in the zone and non-governmental organizations. The quantitative survey was conducted to quantify the important parameters related to the objective of the study. Quantification of these important parameters was used to confirm the qualitative information obtained during qualitative data collection stage, assess issues untouched during qualitative data collection stage and present the findings with empirical evidences. The questionnaire was divided into different sections. Under each section of the questionnaire, the respondents were asked to mention the main constraints concerning that particular section of the questionnaire before starting with the next topic to avoid mix-up or overlapping of ideas, so as to contribute for the general prioritization of the constraints. The questionnaire also included sections for listing the main factors inhibiting efficient knowledge and technology transfer and to access opinions of respondent's on the improvement of the system as a whole.

Data management

Relevant information obtained from all data collection stages (secondary data collection, interview, professional and farmers based survey) were systematically organized and summarized. For the quantitative data obtained from the quantitative survey, the questionnaire was tabulated, and Excel spread sheet and descriptive SPSS were implemented.

RESULTS AND DISCUSSION

Socio-economics and education on knowledge-information and technology transfer efficiency

The study revealed that farmers' education level has its own impact on information flow efficiency and rate of technology adoption. Of the surveyed farmers, 55.6% are illiterate, 27.8 got first cycle-primary education, while only 16.7% had secondary education (Table 1). Farmers with lower education levels are less likely to seek for information about improved technologies and application of the technology. As the majority of farmers (55.6%) are illiterate, their interest to learn about and adopt technologies is likely to be low. This is because information seeking, information giving capacity and use of improved technologies were determined by awareness level of farmers. Low education level also limits designing of extension activities, when compared with the so-called model farmers (Adugna, 2013). Farmers' reading and understanding ability of written materials used to transfer

Table 1. Education status of the sampled respondents.

Classification	Frequency (%)
Illiterate	55.6
First cycle primary school	27.8
Secondary school	16.7
Total	100

information. The result supports the previous finding of Soleiman and Saed (2013) who indicated the significant relationship of farmers' education characteristics with the rate of technology adoption. The income level of farmers was also found to influence their purchasing power for production inputs, especially of improved technologies which are relatively expensive. Significant proportion of the respondent farmers indicated that the cost of inputs is among the factors that hinder them from practicing the newly emerging technologies.

Farmers' level of involvement in technology development

When the sample respondent farmers were asked whether they were involved in the development of agricultural technology they use in their farming practice or not, they indicated that none of them were involved in any technology development processes including the one they are using in their production system. According to them, they have never visited a research centre to discuss the problem they are facing on the ground, to share the indigenous knowledge they have and to acquire improved technologies and trainings. This finding is in agreement with the study of Clark (2002) who indicated the lack of opportunities for farmers to invest on technologies to improve agricultural productivity. Sewunet et al. (2016) also revealed the existence of top down approach in the extension and research management system of Ethiopia, where the research and technology transfer system are designed and implemented without consideration of farmers' local knowledge, experiences and opinions. Especially, the poor and marginalized farmers are neglected in the According to the respondent farmers, they did not receive the technologies directly from the research institutions, but from other farmers and sometimes from the offices of agriculture. Since it is necessary that technologies be properly packaged to meet the needs of the targeted clients and achieve the desired productivity (Aflakpui, 2007), non-participation of the research institutions in the technology transfer process could hinder the continuous improvement of technologies through feedback. On the other hand, 44% of the sample farmers indicated absence of training on

production management of the technologies they are already practicing. To ensure the optimal application of technologies the capacity of the farmers need to be strengthened through hands-on training.

The survey carried out on agricultural professionals indicated the significance of field day as means of information and technology transfer. This is supported by the report of Aflakpui (2007), who pointed out that organizing field day visit is one of the most effective dissemination methods of agricultural technologies. In relation to this, 83% of the surveyed farmers pointed out that they have a trend of visiting neighbor farmers' field practicing agricultural technologies. Farmers also share the information they have with family members (11%) and relatives (6%) (Table 2). This is in-agreement with the finding of Spielman et al. (2002) which states the potential actors who play a role in sourcing information including public sectors (research, extension, universities, enterprises etc.), private sectors (traders, entrepreneurs, companies), farmers cooperatives, NGOs, farmers, families, rural communities.

Farmers also pointed out different factors constraining them from getting information about the agricultural technologies they are practicing. Of these factors, absence of information about the agro-technology from the original sources, that is, professionals, research institutes takes the great share by contributing about 83% of the reason, whereas, lack of interest of farmers to share the information contributed to 17% of the reasons why information is scarce. This is in agreement with the finding of Day et al. (1994) who explains the extent to which lack of efficient communication hinders dissemination of research results to the desired user and effective application of the technology as proved by research.

Farmers also indicated their own knowledge limitation as a constraining factor to share the information they have. This can be improved through increasing the farmers' awareness and knowledge level. Moreover, the emphasis needs to be given by professionals to reach timely and proper information about the technology they are developing to improve the information system in the area as well as its effective application; because of the developed technologies. Since the absence of efficient communication about the technologies could result in failure and deficiencies in the dissemination of research results thereby the technologies remain without addressing the desired objectives and impacting the end user (Day et al., 1994; Aflakpui, 2007).

Farmers' sources of information about agricultural knowledge and technology

The survey made on the professional based survey

Table 2. Sample respondent indigenous methods of agricultural technologies dissemination.

Items/description	Frequency (%)
Visiting neighbor farmers' fields practicing improved agricultural technologies	83
share the information with family members	11
Share the information with relatives	6.0
Total	100

indicated the use of different means to transfer information about agricultural technologies or best practices, such as written materials (brochure, leaflets, pamphlets, manuals, journals, and proceedings), workshops, training, field day, and demonstration. This is in line with the study of Aflakpui (2007), which presented increasing publication, publishing production guides and farmer's handbooks, publishing in local language so that the farmers could understand it, ensuring the accessibility of publications to technology transfer agents, organizing field days and demonstrations as a means to increase technology adoption rate thereby productivity.

However, the response from sampled farmers showed the dominant use of neighbor farmers and agricultural development agents as a source of information. Information exchange between neighbor farmers contributes 60% of the information sources, which is supported by previous studies of Van Crowder and Anderson (1997) indicating the essentiality of farmers' involvement in technology development and transfer in ensuring acceptability and effectiveness of technologies. Forty percent of the information exchange or transfer is contributed by agricultural development agents. This shows the significant contribution of farmer to farmer or informal information exchange system. This is the appropriate system from the view point of ensuring successful information transfer and application of technology, since it avoids the hierarchical knowledge transfer system, which assign researchers in the top, next extension and farmer knowledge at the bottom of the hierarchy (Douthwaite et al., 2010; Van Crowder and Anderson, 1997). Ensuring the efficiency of farmer-to-farmer information system demands reaching them with tangible information which can be done through increasing farmers' awareness on the importance of having information about the technology they are practicing and also exchanging information with others.

Agricultural knowledge-technology transfer and stakeholders' involvement

In Ethiopia, Research Institutions and Universities are the most responsible actors for technology development,

whereas Agricultural Offices and Non-governmental organizations are involved in technology dissemination. Research institutes and universities perform the pre-scaling up and first phase of dissemination activities through establishing demonstration trial in addition to developing technologies. After developing the technology, it carries out the pre-scaling-up activities. Thereafter, if the technologies become successful on farmers' fields, the technologies will be conveyed to the Office of Agriculture, who then does the scaling up at a region level. The technologies are further disseminated to the agricultural office of the lower administration unit, and then to farmers through extension agents. This clarifies the absence of involvement of all the concerned actors from the initiation of the technology development process. This process is in agreement with Aflakpui (2007) and Van Crowder and Anderson (1997), who described a system where information and knowledge flows from research organizations to farmers through extension agents without full involvement of the stakeholders from the beginning; which is called linear/traditional knowledge and information flow system. This finding is also supported by Clark (2002), who describes linear information flow as top down transfer of technology; in which the agricultural practices are diffused in one direction without any complex information exchange between different actors and without giving room for farmers' knowledge. It is a conventional practice allowing only one way flow of information, which is condemned in the modern approach (Spielman et al., 2010).

This off-course shows the absence of participatory technology development system. A review research in Ethiopia on the similar topic by Sewunet et al. (2016) discussed the separate administration of research institutions and extension sector resulting with a limited work relationship between these actors. To some extent the different actors are involved during dissemination of the technologies as compared to technology development stage. This might contribute towards the ill-functioning of the agricultural knowledge and information system in the area. This is because the other party involves in the dissemination process without having deep knowledge about that particular technology

because of absence of involvement during the development of the technology.

This might affect the effectiveness of the developed technology as well as the agricultural information/knowledge and technology transfer system (Douthwaite et al., 2000). This is because the actors who are not involved during the technology planning and development process might have low understanding about the technology. The process also clearly shows the negligence of farmers demand and indigenous knowledge which can be solved through practicing participatory research approach. Moreover, pre-research problem assessment needs to get due attention so as to respond to farmers practical problem.

As per the new research structure of Ethiopia, agricultural research activities are executed in a case team bases, in which professionals from all the concerned departments are involved. The case team includes at least agronomist, soil scientist, agricultural extensionists and socio-economic professionals all having their role in technology development and dissemination process. This was designed to develop the technology with its full production package. This of course helps to have uniform understanding by all the concerned actors about the technologies developed. This system found to increase the participation level of different professionals from the beginning of the technology development, and thereby hasten the dissemination of the developed agricultural technologies. For agricultural information/knowledge and technology transfer from research to practice and vice versa to be effective, the involvement of all the concerned stakeholders is crucial. According to the expert elicitation result, different actors were involved directly or indirectly in the information and technology dissemination process as compared to the technology development activity. Once the technology scaling up is done by research institutions, the technology reaches farmers through the office of agriculture and in some places non-governmental organizations also take part in the dissemination process. According to the response of the sampled professionals, office of agriculture, research institutes, NGOs, Universities, administrative peoples at different level, seed enterprises, media, cooperatives and marketing promotion were the stakeholders involved in agricultural information/knowledge and technology transfer system in their respective order. The office of agriculture is the main body who is mainly reaching the information to farmers followed by research institute.

However, the actors apart, research institutions and universities join the process after the technology development and scaling up processes are over. This is in different line with the modern system which gives room for farmers' involvement through actively participating, forwarding their perception about the existing problems,

indigenous knowledge and farming practices of farmers (World Bank, 2006). Moreover, involvement of farmers' indigenous knowledge and their actual demand is negligible during technology development process. The same phenomenon is reported by Sewnet et al. (2016) and Davis et al. (2010). Rather, farmers are mostly involved by giving feedback about the technologies which they already practiced; whether the technology is effective or not. This one way approach, might decrease the acceptability of the technologies by farmers as well as the know-how of the other stakeholders about the developed technology. This can be improved by involving all the concerned stakeholders including farmers from the beginning of technology development since farmer's involvement plays indispensable role to overcome the failure of the developed technologies (World Bank, 2006).

Institutional linkage on agricultural knowledge and technology transfer

In the current research area, the concerned agricultural institutions were not strongly interconnected from the beginning of technology development process, which inclines to one way communication of information-knowledge and technologies. According to the results of this study the stakeholders cooperate in some part of dissemination processes rather than having strong interaction throughout the technology development and dissemination activities. Research institutions and Universities totally take the technology development part. After developing the technology they communicate to the Office of Agriculture about what technology they already developed and the need to give responsibility of technology scaling up at a large scale or regional level to the Office of Agriculture.

This shows the lack of strong linkage among agricultural stakeholders from the beginning of technology development though dissemination of the developed technologies. However, for agricultural information-knowledge and technology transfer system to be effective, it needs to have purposive and strong institutional linkage (Spielman et al. 2010). Similar situation was also described by Spielman et al. (2010), on their study of rural innovation system and networks in Ethiopia, elaborating the linear information-knowledge and technology flow process in which the information-knowledge and technologies only transfers from the scientists to extension agents to farmers. Kassa and Alemu (2017), in their study on "Agricultural Research and Extension Linkages: Challenges and Intervention Options in Ethiopia" noted a similar situation. Spielman et al. (2010) also indicated the importance of having diverse actors and interactions between these different actors to address efficient information-knowledge and technology

transfer and increase agricultural innovation.

Feedback system on disseminated agricultural knowledge and technologies

After the technology is practiced by farmers, the feedback whether the technology is effective or not flows back to the sources of the technology through different channels. To get feedback whether the technology is effective and the practice as well as the farmers' selection process went well, a team from Zonal Office of Agriculture goes to the area where the technology is disseminated (direct system). This team observes the practice on ground and discusses with district agricultural office, development agents, focal person and farmers and check if it is done properly, from selection of farmers to application of the technology through the impact of the technology in the livelihood of farmers. Finally, the team discusses the feedback to the District Agricultural Office based on the observation result. In other ways, feedback reaches the Zonal Office of Agriculture through report (indirect way).

Farmers also give feedback about the technologies they are practicing; especially, if the technology is not successful they communicate to the office of agriculture. If the technology is effective in the area the neighboring farmers' demand for the technology increases, thereby the information and technology disseminates to a larger scale in the area. In this case, the technology may be disseminated from farmer to farmer or from the source of the technology to farmers, source in this case, is not the owner of the technology but the stakeholders who take the responsibility of disseminating the technology. Farmer to farmer dissemination might be important from an economically, efficient knowledge transfer and technology effectiveness point of view. This is in agreement with the finding of Glenna et al. (2010), stating the dependency of efficiency, acceptability and adoption of agricultural technology on this same issue. This means, if the farmer gets the technology from the neighboring farmer, it reduces the cost of transportation and helps them to get it on time. Furthermore, it increases the information exchanging behavior of farmers and it might increase the efficiency of the information system since they are on the same knowledge level.

Performance of the extension service in the study area

The result of the current study revealed that the extension system in the study area is weakly functioning. A multitude of factors was mentioned for their contribution to the ill-functioning of the extension system (Table 3). Moreover, as explained by the sampled professional respondents, the existing extension system is mostly one

way, which might contribute for not having a well serving extension system in the area. Similar finding was revealed by Kassa and Alemu (2017), stating the implementation of a one-way communication model in Ethiopian agricultural extension system.

According to the current Ethiopian extension system, the development agent workers are the main actors that have frequent contact with farmers, and are expected to give theoretical and technical assistance for farmers. In addition to the aforementioned activities they are also expected to facilitate communication between farmers and other stakeholders working on agriculture, facilitate technology dissemination, capacitate farmers with practice of new technologies and information acquired from different sources, and actively participate in technology transfer process. Aflakpui (2007), in his study that deals with the present outlook and transformation in the delivery of agricultural extension services, the implications for research-extension-farmer linkage, listed role for extension agents which are in agreement with the finding of the present study.

However, according to the respondents, the extension agents are not serving as to the demand of the stakeholders including the farmers. As explained by sampled respondents, lack of motivation is the main reason why the development agents are not serving the system properly. This is in agreement with Sewnet et al. (2016) who stated the weak motivation level of the development agents. This same paper pointed out the weak incentive package designed for development agents as a reason why they lack motivation. Davis et al. (2010), in their study on public agricultural extension system of Ethiopia, also reported that development agents leave their position in search of better incentives instead of striving for agricultural development through working with farmers. A supporting finding was reported by Gebremedhin et al. (2006), stating the high turnover of the development agents due to the aforementioned reasons.

On top of the lack of motivation, knowledge and skill gaps of the development agents are frequently cited as a problem which then affects the efficiency of the extension or information and technology transfer system. According to the respondents from non-governmental organizations the development agent workers are not willing enough to respond to the diverse interest of the stakeholders. This might be explained by the low rate of incentives they receive; which thereby contribute to loss of willingness to serve up to their capacity (Gebrehiwot et al., 2012). Generally stating, the role the development agents are playing is incomparable with what they expected to contribute.

In the meantime, the development agents reasoned out the absence of facilities/infrastructure for the lack of interest to reside and work in the rural areas, where

Table 3. Factors influencing the performance of the extension system in the area

Items/description	Frequency in Percent
Absence of improved input supply	44
Lack of interest of DAs to assist farmers	28
Absence of training on improved production packages	17
Bias during farmers selection for training and input distribution	11
Total	100

DAs: development/extension agents.

Table 4. Sampled farmers practices of applying recommended technologies.

Response	Frequency Per cent
Apply the full recommended package	17
Apply only part of the recommended package	83
Total	100

actually the farm is situated in the cases of Ethiopia. This is in line with the report of Davis et al. (2010), discussing lack of the basic infrastructure and resources including fund, operation equipment and input at the farmer training center (FTC) and Woreda/District level.

Technology adoption behavior of farmers

According to the sample respondents, although previously, resistance was observed to shift from the local practice to the research proved and newly introduced technologies, these days' farmers are showing interest towards new technologies. They actively participate in visits of demonstration trials and farmers' field days, and these shows their interest to learn about and adopt emerging technologies. Currently, farmers complain about shortage of improved agricultural technologies, which is again an indicator of their interest towards adoption of improved farming practices, although farmers are interested in adopting new technologies. The majority of them do not apply the full package of the recommended technologies (Table 4). Effective application of the full package of technologies is inhibited by different factors of which economic capacity and knowledge level of farmers takes the major share. Even though, different factors are contributing towards the substandard application of recommended technologies the low income level of the farmer takes the major share in inhibiting the correct application. The income sensitiveness of the farmer might be explained by low market price of the produce which inhibits the farmers' capacity as well as interest to invest on production inputs.

The poor system of information flow and farmers' resistance were also found to limit adoption of technologies to some extent. Resistance of farmers might also be associated with high cost of production technologies. In some cases, farmers also want to keep on following their own local practice at least till they see the advantage of the new practices over the local one. The other factor affecting effective application of the new technologies is the weakness of the development agents in providing technical assistance and advice to farmers. Quality of technologies also found to affect farmers adoption rates of newly emerging technologies and agricultural information-knowledge seeking behavior of the farmers. On top of this, absence of farmers' involvement during the development of the technologies is blamed by the respondent for declining technology adoption behavior of farmers. Therefore, farmers' involvement during the development of technologies might help in its acceptance. The finding of Adesoji and Tunde (2012) supports the current result, which witnessed the contribution of farmers' involvement in technology development process for increased technology adoption rate.

Conclusion

The study conducted in Hawassa area, southern Ethiopia to describe the current status of agricultural knowledge and technological packages transfer system, indicated the weakness of the existing system. In the study area, the system is still dominated by one way or linear agricultural knowledge-information and technology

communication pathway; which does not allow the involvement of all stake-holders across the stages of the system, especially of the practitioners of the technologies. This shows the urgent need to improve the efficiency of the existing agricultural knowledge-information and technology transfer system. The factors hindering efficiency of the system extends from the initiation of the technology development process through knowledge and technological packages dissemination stage. Thus, to improve the system, the research problem selection and technology development process needs to consider the concerned stakeholders especially of the farmer and development agents. The motivation and responsibility taking behavior of the concerned stakeholders should be improved in the way that it strengthens the linkage among actors so as to have a common understanding on each process of the system, thereby improving the development and dissemination efficiency of the technologies and its impact on the livelihood of the rural poor. Besides, motivation and knowledge and/or skill level of the development agents, awareness and income of the farmers should be improved.

CONFLICT OF INTERESTS

The authors have not declared any conflict of interests.

REFERENCES

- Adesoji S, Tunde A (2012). Evaluation of the linkage system of Research- Extension-Farmers in Oyo State, Nigeria: Lesson for Agricultural Extension Administrators. *J. Agric. Ext. Rural Dev.* 4(20):561-568.
- Adujna E (2013). A review on United efforts: the challenges for improved research, extension and education linkages. *Educ. Res. Rev.* 8(12):792-799.
- Aflakpui G (2007). Present outlook and transformation in the delivery of agricultural extension services: Implication for research-extension-farmer linkage *Outlook on Agric.* 36(1):35-39.
- Bouma J (2010). Implication of the soil paradox for soil science, Burlington: Academic Press 106:143-171.
- Carrascal MJ, Pau LF, Reiner L (1995). Knowledge and information transfer in agriculture using hypermedia: A system review. *Comp. Electron Agric.* 12:83-119.
- Clark N (2002) 'Innovation systems, institutional change and the new knowledge market: implications for third world agricultural development. *Econ. Innovation New Technol.* 11(4-5):353-368.
- Day D, Dosa M, Jorgensen C (1994). The transfer of research information within and by multicultural teams. *Information Process. Manage.* 31(1):89-100.
- Davis K, Swanson B, Amudavi D, Daniel A, Flohrs A, Riese J, Lamb C, Elias Z (2010). In-Depth Assessment of the Public Agricultural Extension System of Ethiopia and Recommendations for Improvement IFPRI Discussion Paper 01041 December 2010.
- Douthwaite B, Keatinge JDH, Park JR (2000) 'Why promising technologies fail: the neglected role of user innovation during adoption,' *Res. Policy* 30:819-836.
- Ethiopian Agricultural Research Organization (EARO) (1998). Research-extension-farmers Linkage Strategic document, EARO, Addis Ababa, Ethiopia.
- Francesconi G, Heerink N (2010). Ethiopian agricultural cooperatives in an era of global commodity exchange: does organization form matter?. *J. Afr. Econ.* 20(1):153-157.
- Gebrehiwot WG, Kifle A, Deribe K (2012). Challenges of Development Agents (DAs) Performance in Technology Dissemination: A Case from Southern Nation, Nationalities and Peoples Regional State (SNNPRS). *Ethiopia. Sch. J. Agric. Sci.* 2(9):208-216.
- Gebremedhin B, Hoekstra D, Tegegne A (2006). Commercialization of Ethiopian agriculture: Extension service from input supplier to knowledge broker and facilitator. IPMS Working Paper No. 1. Improving Productivity and Market Success of Ethiopian Farmers project. Nairobi, Kenya: International Livestock Research Institute.
- Gildemacher PR, Kaguongo W, Ortiz O, Tesfaye A, Weldegiorgis G, Kinyae PM, Nyongesa M, Struik PC, Leeuwis C (2009). 'Improving potato production in Kenya, Uganda and Ethiopia: A System diagnosis,' *Potato Res.* 52:173-205.
- Glenna L, Jussaume R, Dawson J (2010). How farmers matter in shaping agricultural technologies: Social and structural characteristics of wheat growers and wheat varieties. *Agric. Hum. Values* DOI 10.1007/s10460-010-9275-9
- Kassa B, Alemu D (2017). Agricultural Research and Extension Linkages: Challenges and Intervention Options. *Ethiop. J. Agric. Sci.* 27(1):55-76.
- Klerx L, Hall A, Leeuwis C (2009). 'Strengthening agricultural innovation capacity: are innovation brokers the answer?. *Int. J. Agric. Resour. Govern. Ecol.* 8(5/6):409- 438.
- ICRA (2010). Multi-stakeholder linkages in rural innovation process in Amhara region, Ethiopia, Working Document Series P 137.
- Pezeshki-Read GH, Dehkordi EK (2006). 'linking Agricultural Research with Extension: Iranian Agricultural Research' Attitude towards Collaboration with Extension Workers. Published by the Asian Productivity Organization 1-2-10 Hirakawacho, Chiyoda-ku, Tokyo 102-0093, Japan. pp. 78-87.
- Sewnet Y, Edo E, Dereje D (2016). A review of Agricultural Research Extension and Farmers linkage in Ethiopia. *Agric. Biol. J. N. Am.* 7(3):116-120.
- Soleiman R, Saed F (2013). Affective Factors in the Wheat Farmers' Adoption of Farming Methods of Soil Management in West Azerbaijan Province, Iran. *Int. J. Agric. Manage. Dev.* 3(2):73-82.
- Spielman D, Davis K, Negash M, Ayele G (2010). Rural innovation systems and networking: findings from a study of Ethiopian smallholders. *Agric. Hum. Values* DOI 10.1007/s10460-010-9273-y.
- Van Crowder L, Anderson J (1997). Linking research and education: why is the problem so persistent and pervasive?. *J. Agric. Educ. Ext.* 3(4):241-249.
- World Bank (2006). Enhancing Agricultural Innovation: How to Go Beyond the Strengthening of Research Systems. World Bank, Washington DC. © World Bank. <https://openknowledge.worldbank.org/handle/10986/24105>