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A Perception-Based Survey on Innovation and Technology Adoption by Small-Scale Farmers in Semi-Arid Zimbabwe

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Abstract— *This study was conducted with agricultural extension agents of semi-arid Zimbabwe to gather their perceptions on innovation and technology adoption by small-scale resource-constrained farmers, as well as the effect of their working conditions on the quality of service delivery to small-scale farmers. Data was solicited through focus group discussions (FGDs) and semi-structured interviews (SSIs) with all the public agricultural extension agents operating in the study area. It was found that agents were mainly hampered by lack of in-service training, transport and poor remuneration. Of all disseminated technologies during the last 20 years, respondents assessed that 17% had very low adoption rate, 26% had low adoption, 17% had average adoption, 26% had high adoption and only 13% had very high adoption. Bulky, expensive and risky technologies like tractors, solar driers, metal silos and bee farming were among the least adopted whereas hybrid seeds and value addition were very highly adopted. Reasons for the very low adoption were noted to be lack of capital, markets and information support on how to use new technology. Despite these challenges respondents indicated that small-scale farmers had the capacity to innovate and to adopt technology in the form of indigenous knowledge, willingness and commitment to learn and improve productivity, and labor. Agents suggested the strengthening of farmer-extension-research linkages so that technologies could be developed from some successful indigenous innovations, where possible and also to ensure the development of technology tailor-made to the needs of small-scale farmers, resource-endowments and biophysical conditions of their farming communities.*

Keywords— ***Adoption, indigenous knowledge, innovation, small-scale farmers, technology.***

I. INTRODUCTION

Extension plays an important role of transferring technologies to small-scale farmers for adoption and in fostering development of innovations from among diverse actors [1,2]. Extension is also responsible for taking feedback from farmers to research and technology developers [3]. However, for extension to effectively and efficiently deliver quality service to their clients they need adequate resources and facilities, including transport for their agents to reach farmers and regular appropriate in-service trainings for agents to update their skills [1]. Unfortunately, the primary public extension agency in Zimbabwe, the Department of Agricultural Technical and Extension Services (AGRITEX), is faced with serious challenges hindering its service delivery [1, 4, 5]. Consequently farmers are not receiving optimal extension services from agents, who are poorly remunerated and with little or no motivation to do their job. This has led to less adoption of recommended technology by farmers. For these reasons, this study was conducted in Lower Gweru, a semi-arid communal area in Zimbabwe, to gather perceptions and assessments of agricultural extension agents on innovation and technology adoption by small-scale resource-constrained farmers, as well as the effect of their working conditions on the quality of service delivery they render to small-scale farmers. Lower Gweru communal area was selected from among semi-arid areas in Zimbabwe because it has recorded increased number of technologies disseminated over the last 20 years and it is also dominated by small-scale farmers.

II. MATERIAL AND METHODS

2.1. Study area description

The study was carried out with public agricultural extension agents operating in Lower Gweru Communal area of Zimbabwe, which is located about 40 km north west of City of Gweru, and stretches a further 50 km to the west [4]. Lower Gweru is a developed communal settlement in the Midlands province of Zimbabwe. Gweru's climate is semi-arid to arid with summer rainfall ranging from 450mm to 600mm annually but experiences periodic seasonal droughts and severe dry spells [4]. Farming is the main occupation of the people. Administratively (in terms of extension services), Lower Gweru Communal area falls under Gweru District AGRITEX. Lower Gweru is divided into eight Wards and these are: Sikombingo, Nyama, Mdubiwa, Chisadza, Madikani, Bafana, Nkawane and Communal Ward 16 [4]. Each of these Wards is serviced by two extension agents.

2.2. Data collection

The study explored perceptions of public agricultural extension agents and the effect of their working conditions on innovation and technology adoption innovation by small-scale resource-constrained farmers. The study population was composed of 16 field extension agents, two extension supervisors, two agricultural extension officers and the district agricultural extension officer. Due to the relatively low study population, all the 21 public agricultural extension agents were part of the study. Data were solicited using semi-structured interviews (SSIs) and focus group discussions (FGDs). The main questions in both SSIs and FGDs guides were about the following themes: job satisfaction level; rating the quality of services rendered to farmers, assessment of farmer capacity to innovate and adopt technology; technologies recommended/disseminated to farmers in the last 20 years; adoption rates for each technologyand reasons for adoption or lack thereof; and strategies aimed at promoting adoption. The collected data were triangulated for consistency with findings gathered from key informant interviews (farmers). The qualitative data gathered were transcribed verbatim and analyzed using the emergent theme approach.

III. RESULTS

Key findings are presented under three major themes namely: Effect of socio-economic characteristics of extension personnel on job performance; Extension personnel's perceptions on farmers' systems and their capacity to innovate and adopt technologies; Strategies suggested by extension agents to encourage technology adoption.

3.1. Effect of socio-economic characteristics of extension personnel on job performance

Findings presented under this theme are summarized under the following sub themes: Demographics of respondents; Quality of extension services rendered to farmers; Job satisfaction of extension agents; Challenges facing public extension agency (AGRITEX) and its workers.

3.1.1. Demographics of respondents

The extension personnel servicing the Lower Gweru Communal area comprised more females (57.1%) than males (42.9%). The majority (61.9%) of the respondents were in between 35 and 50 years old, with only 9.5% above 50 years of age (Table 1). The majority of respondents (66.7%) were educated up to diploma level, 23.8% had a Bachelors degree, and less than 10% were educated beyond the Bachelor's degree level (Table 1).

Table 1: Demographics and working experiences of respondents

Factor	Category	Frequency	Percentage
Gender	Male	9	42.9
	Female	12	57.1
Age group	< 35 years	6	28.6
	35 – 50 years	13	61.9
	>50 years	2	9.5
Working experience	5 – 10 years	9	42.9
	11 -30 years	11	52.4
	>30 years	1	4.7
Qualifications	Diploma	14	66.7
	Bachelors' Degree	5	23.8
	Honors' Degree	1	4.7
	Masters' Degree	1	4.7
Job Satisfaction	Yes	11	52.4
	No	7	33.3
	Indifferent	3	14.3
Rating extension services rendered to farmers	Poor	2	9.5
	Average	4	19
	Good	12	57.1
	Excellence	3	14.3

Source: Extension agents' responses from SSIs.

3.1.2. Quality of extension services rendered to farmers

Four groups emerged from respondents based on how they rated the services they render to farmers. They were asked to rate it as excellent, good, average or poor.

Excellent: 14.3% of the respondents rated their services to be excellent. Their reasons included that they are confident and well qualified for their jobs and have a high affinity for extension and rural development work. They cited no major challenges diminishing the excellence of their service.

Good: The majority of respondents (57.1%) rated their services to farmers to be good. Reasons for this rating included that farmers are getting most of the services they demand, improved farm production (crop yields and animal productivity), and improved quality of life for farmers. Further, these extension agents stated that most farmers quickly adopt techniques, practices and technologies they disseminate to them. The only reason this group did not rate their services to be excellent was due to several challenges that have affected their work especially lack of transport (mobility).

Average and poor: 19% rated their services to be average while 9.5% rated their services to be poor. These two groups cited the challenges they face including lack of resources (including transport) and regular in-service training as reasons for their ratings. They also indicated that the high extension agent-to-farmer ratio overburdens them to the point of compromising their service delivery.

Further, as the next two sections will demonstrate, the issues intimated in the assessment of the quality of services increase in prominence and are cited as inhibiting the quality of service. They openly state that, due to the resource issues, they are not able to meet their objectives without the help of private players.

3.1.3. Job satisfaction of extension agents

More than half (52.3%) of the respondents indicated that they enjoyed their work. Three reasons were given for this. First, extension work is challenging and interesting because of the positive impact the work has on farmers. Second, extension work comes naturally to them (it is a calling). Third, it allows respondents to interact with different farmers most of whom are co-operative and learns a lot from them. A third (33.3%) of the respondents indicated they do not enjoy their work. They explained that they are frustrated because of lack of resources and sometimes they are forced to use their own resources to get some work done. The respondents who indicated that they are indifferent (14.3%) cited a lot of challenges, especially lack of mobility. They also indicated that if most of their challenges were addressed they would enjoy their work. This aspect of the study underlines the issues raised in the extension agents' assessment of the quality of their services. Approximately 30% raised the issue of resource (specifically transport/mobility), here 33.3% raise the issue again as a key inhibiter to delivering extension.

3.1.4. Challenges facing AGRITEX and its workers

The main challenge facing AGRITEX and its workers is inadequate funding from the government. This challenge cascades into a plethora of problems ranging from lack of transport, lack of materials to use in demonstrating new technology, lack of capacity building opportunities within AGRITEX in the form of in-service training and refresher courses, poor remuneration and lack of travel and subsistence allowances as well as lack of modern training equipment for farmer trainings.

Although the government still has some accommodation in the respective Wards which should help alleviate transport and accommodation woes for field agents, the houses have not been maintained over the last decade. Thus, a considerable proportion of respondents (42.9%) indicated that they prefer to stay in the city and visit farmers when they can. However, this presents a situation that is not ideal for both agents and the farmers.

According to the elderly extension agents who were part of AGRITEX long before the economic challenges started in the early 2000s, they are no longer getting the back-up services and in-service training/refresher courses they used to get regularly previously. They stated that training used to be continuous and regularly conducted; thereby making sure the agents would remain competent and would not lag behind in terms of new advancements in technology. They noted that, currently, a few of the better educated and well-resourced farmers are utilizing new technologies in their operations which the extension agents are yet to learn about/or to disseminate to them. In fact, the respondents explained that there are instances where these "better-educated and resourced" farmers are better versed with new technologies than the extension agents who are supposed to be bringing technologies to them.

Due to the several challenges facing AGRITEX and its workers, respondents indicated that they are failing to execute their mandate and currently most of their work is being dictated by donors, researchers and NGOs operating in the Lower Gweru Communal area. These organizations will use own resources to implement certain programs with farmers including availing transport, training as well as some allowances to extension agents who facilitates and link them with farmers. As these organizations conclude their projects and programs, extension agents will again experience their challenges in accessing farmers due to lack of resources.

Furthermore, respondents indicated that farmers are more eager to participate in programs funded and led by donors/NGOs as opposed to AGRITEX-led programs. Reasons for this include that in donor-funded programs, farmers get inputs and other technologies for free; and they participate in the actual testing of technology in their fields. In other words, they are learning by doing. However, the respondents indicated that while they still participate as facilitators or brokers in this pluralistic extension setup, they are no longer able to meet their own Departmental objectives without private-sector support.

The combination of a poor road network and lack of transport often leads to late delivery of inputs and technologies. Consequently, the adoption of such technologies delivered late into the season is usually poor. This does not reflect well on the agents and may result in loss of trust and credibility by farmers towards agents and the technologies they disseminate.

One respondent indicated that AGRITEX, as an extension service provider, is lagging behind in terms of the technologies they are disseminating to farmers, as some of them are out-dated. The respondent further indicated that agents are actually learning some modern technologies from farmers who, in turn, have learned from private sector consultants. Finally, the respondents indicated that training should be continuous, as new developments and technologies always come up.

3.2. Extension agents' perception on farmers' systems and their capacity to innovate and adopt modern technology

Findings presented under this theme are summarized under the following sub themes: Farmer capacity to innovate and adopt modern technology; Extension agents' perception of farmers' indigenous knowledge/technologies; Assessment of adoption rates for each technology disseminated to farmers.

3.2.1. Farmer capacity to innovate and adopt modern technology

The extension respondents indicated that, despite constraints facing small-scale farmers in adopting technologies or in innovation, they possess some important capabilities and resources. The agents identified capacity in the form of local knowledge and experience, land (including some wetlands), tools and implements, animal traction power, labor, resilience and commitment. Further, the respondents suggested that farmers are literate, open-minded and always willing to learn wherever their livelihoods are concerned. Finally, they perceive the farmers to be very observant and innovative, especially when their livelihoods are at risk.

3.2.2. Extension agents' perception of farmers' indigenous knowledge/technologies

The general perception of extension personnel towards farmers' indigenous traditional knowledge is that it is valuable, helpful and a useful source of information; that has and still continues to serve farmers well. Respondents posited that farmers' indigenous knowledge and experiences complements extension agents' skill sets.

The respondents also noted that indigenous knowledge and its associated technologies are very low cost in nature and are accessible and affordable to all farmers, unlike most modern technologies. The respondents identified some of the successful innovations and indigenous practices developed by farmers including: seasonal climate forecasts through studying local indigenous indicators; crop rotations; intercropping cereals with runner crops like pumpkins to reduce erosion; seed retention for main crops like maize (open pollinated varieties), cowpeas, beans and groundnuts; curing maize cobs by smoke for maize seed; use of ash, zumbani and gumtree leaves in grain storage for repelling weevils; castration of bulls to control livestock breeding; control of maize stalk borer and aphids using sand and donkey manure, respectively.

Despite the numerous advantages of farmers' indigenous knowledge, respondents noted its three major drawbacks. First, it is not documented and can only become more useful if it is recorded adequately (including visually) and developed further with help from scientists. Second, it has been an impediment to technology adoption as farmers are generally resistant to change and slow in accepting outside help including new modern technology. Third, it is perceived to be one of the major reasons why farmers have been stagnant and failing to advance to the next level of processing their raw crops.

3.2.3. Assessment of adoption rates for each technology disseminated to farmers

The respondents indicated that technology adoption is generally declining because of the poor service delivery by AGRITEX due to economic hardships facing the country. Similarly, farmers have also been affected by these economic challenges. This has resulted in some respondents indicating issues of false adoption, whereby farmers adopt some technologies only because they are given it free of charge. This is most apparent where high cost technologies are concerned, such as instances where NGOs were supplying some few samples of technologies to farmers. Table 2 shows a variety of technologies disseminated to Lower Gweru farmers and the adoption rates for each as perceived by respondents. Five adoption rate categories emerged namely: very low, low, average,

high and very high. These adoption rate categories were estimated and agreed upon by respondents during FGDs as follows: Very Low – less than 20 %; Low – from 20 % to 45 %; Average – 45 % up to 60 %; High – 60 % up to 80 %; Very High – 80 % up to 100 %. Of all disseminated technologies during the last 20 years, respondents assessed that 17% had very low adoption rate, 26% had low adoption, 17% had average adoption, 26% had high adoption and only 13% had very high adoption. Bulky, expensive and risky technologies like tractors, solar driers, metal silos and bee farming were among the least adopted whereas hybrid seeds and value addition were very highly adopted

Table 2: Technologies disseminated to Lower Gweru Communal area farmers and the respective adoption status for each

Technology	**How disseminated**	**Adoption rate**	**Reasons for adoption rate**
Conservation agriculture	Demonstrations and training	High	Improved yields on maize and sorghum. Helpful especially to farmers without draft power as there is no need for ploughing.
Treadle pump	Demonstration	Low	Despite subsidies offered by Donor it was still costly and unaffordable to farmers. Poor water source also resulted in poor adoption.
Poultry (Layers production)	Training and pamphlets	Average	Relatively high costs of setting up and feed. Benefits like manure and eggs for income generation led farmers who afford the costs to adopt.
Bee farming	Demonstrations and training	Very low	Considered high risk by farmers. Male farmer-dominated adoption.
Value addition	Demonstrations	Very high	Nutritional benefits, increased income from selling multiple products from sweet potatoes.
Thermal compost	Demonstrations	High	Cheap source of fertilizer and highly favored by farmers without cattle.
Artificial Insemination and animal breeding	Pioneer farmer groups. Training and demonstrations	Low	High costs of semen and fridges, and unavailability of semen. Some farmers particularly with few animals were skeptical of this technology.
Crop protection herbicides (IPM)	On-farm trials and training	Low	They are expensive and cultural beliefs (myth) that they deplete nutrients status of the soil and unavailability of information on how to use.
Seedbed management	Demonstrations	High	High quality seeds and minimized incidence of diseases.
Metal Silos	Demonstrations	Very low	Highly regarded but costly for farmers
Groundnuts roasters	Training and demonstration	Low	Highly regarded because it is easier, smarter, faster and less risk of getting burnt; saves fuel as large quantities are processed at once. The cost of technology is high.
Livestock feeds (Silage)	Demonstrations	High	Easy to make, reduce wastages and its cheaper supplements for livestock.
Moisture conservation	On-farm trials and demonstrations	Average	Resulted in better yields even in low rainfall seasons.
Solar driers	Demonstrations	Very low	Highly regarded because its ability to preserve surplus produce but very costly for farmers.
Cell phones	Network providers	Very high	Useful in conveying messages on time. No information distortions as farmers get message from agents directly.
Crop simulation models/outputs	Training, pamphlets and demonstrations	Low	Highly regarded due to climate variability and change but too sophisticated for farmers to use outputs without experts' help.

Fertilizer and manure application rates	On-farm trials, pamphlets and field days	Average	Although yields increased, costs of optimal fertilizer rates are high for most farmers and most farmers do not have own enough cattle to enable them to apply optimal manure rates.
Soil amendments (liming)	Demonstrations and pamphlets	High	Farmers' soils were very acidic and lime improved yields greatly.
Hybrid seeds	Demonstrations, pamphlets and on-farm trials	Very high	Increased yields compared to retained open pollinated varieties (OPVs).
Drip irrigation	Look and learn tours and demonstrations	Low	Highly regarded but lack of funding by most farmers hampered adoption.
Tractors	Training, demonstrations and on-farm trials	Very low	Highly received (other farmers hire them occasionally) but very expensive for most farmers.
Livestock dehorning	Demonstrations	Average	Improved health of cattle and reduced injuries due to less fights.
Castration of bulls	Demonstrations	High	Less painful to cattle, easy to use.
Seasonal climate forecast (SCF)	Training by Meteorological Officers	High	Farmers depend on SCFs for crop management decisions; more so these days because of climate variability and change.

Notes: The adoption rate categories were estimated and agreed upon by respondents during FGDs. Very Low – less than 20 %; Low – from 20 % to 45 %; Average – 45 % up to 60 %; High – 60 % up to 80 %; Very High – 80 % up to 100 %. (Source: Extension agents' responses from SSIs and FGDs.

3.3. Strategies suggested by extension agents to encourage technology adoption

Extension agents perceived farmers to adopt less expensive, simpler technologies and those technologies they participated in developing as opposed to expensive, sophisticated technologies or those imposed on them by technology developers and extension agents. Further, respondents indicated that farmers will not consider adoption when they do not have adequate information including performance of technologies in their own farm conditions. Thus, respondents proposed that where possible technologies should be developed from farmers' own indigenous knowledge and practices. This entails that baseline surveys should be undertaken to determine their farming practices and problems. Additionally, farmers should be involved from the problem definition stage to the solution (technology) development stage.

Respondents also suggested that affording farmers ample time to learn new technologies, and the best way to support learning among farmers is by observing the effect of a technology on field operations and production. Thus participatory on-farm trials, demonstrations, shows, field days and look-and-learn tours should be utilized for farmers to see firsthand the tangible evidence of performances of technologies.

The presence of a willing and committed extension support system may result in improved adoption of recommended technologies. Such an extension system will provide farmers such information support to guide decision-making on technology adoption. Respondents highlighted a caveat to this extension system in the form of the need for extension agents to be technically competent to assist farmers where needed, as well as to link them with other key stakeholders. Respondents, thus, suggested that extension agents should be trained regularly and kept abreast of the latest technologies and market trends for them to offer services better and to offer them more confidently. They highlighted that sometimes farmers may consult them about certain technology with the hope of getting informed advice, but only to discover that the agents do not even know about the technology. In addition to regular training, respondents indicated that they need to be approachable, credible, and impartial for farmers to trust them and the technologies they disseminate.

Strengthening farmer-extension-research linkages was suggested as a way promoting learning from each partner's experiences and to find common ground on how to develop technologies tailor made for farmers' conditions. Respondents indicated that research and extension should build on successful indigenous technologies or innovations developed by farmers.

Despite the willingness of small-scale farmers to adopt modern technology, the cost of a technology presents one

of the major challenges. In this vein, respondents proposed the use of cheaper and locally available resources as a way of reducing the costs of developing technology and, hence, its price. This will make the technologies available to farmers at prices they can afford, thereby enhancing the chances of adoption.

Another suggestion was the availability of credit facilities at lower interest rates or with relaxed repayment conditions to enable farmers to adopt. Affordability of technology can also be achieved by downscaling certain technologies to level that can be utilized at the small-scale level. Respondents noted that downscaling of technology can also encourage adoption, as some technologies are just too bulky to be utilized on the generally small farm sizes that characterize small-scale farmers hence small-scale farmers do not even consider them.

IV. DISCUSSION

The majority of the respondents were in the middle age group of between 35 and 50 years old and they have more than 10 years extension work experience. These middle-aged extension agents tend to be mature and capable to handle the rigors of tedious extension work [1, 6]. The study also found that the minimum education level of respondents was the diploma level with a third attaining either a Bachelors or a Masters degree. This concurs with findings reported by [1, 6] who suggested that agricultural extension agents had the basic educational qualifications to perform their duties effectively.

The challenges confronting AGRITEX and its extension personnel are consistent with findings by [1, 4]. Similarly, [7] noted that the majority (78%) of Lesotho extension workers perceived lack of infrastructure, transport and facilities to be the main constraint to efficient extension delivery. These challenges result in reduced contact between farmers and agents. Without adequate contact there is little or no chance of farmers considering technology, much less adopting it. There is a positive correlation between technology adoption and farmer contact with extension agents [8]. However, [9] argued that accessibility of extension services alone is not enough, as extension agents should also have the resources and credibility to convince farmers, for without trust and credibility an agent's recommended technologies are easily dismissed.

AGRITEX has failed to offer induction courses and in-service training for many years due to lack of resources and this has affected the competences of their personnel [1]. Similarly, about 72.3% of extension agents in Imo State of Nigeria had not attended any in-service training since they were employed [6]. Extension workers perceive lack of appropriate in-service training as a major constraint in equipping them with the essential skills and competencies to adequately advise farmers [1, 7, 9].

The finding that extension personnel perceive the farmers to be very observant and innovative, especially when their livelihoods are at risk as highlighted by their resilient indigenous knowledge systems, is in total agreement and consistent with findings by [10 - 12]. As such, respondents valued farmer engagements in technology developments or testing technologies in farmer's own fields, as partners. This concurs with the argument by [1, 11] that farmers must be viewed by extension and researchers as equal partners, possessing different, but valuable experiences and skill sets to theirs. This entails iterative learning between farmers, extension agents and researchers [1, 13]. This iterative learning entails the need for extension to be flexible enough to determine and respond accordingly to the dynamics that surround farmers, their systems and their circumstances [1].

The pluralistic extension setup currently obtaining in Lower Gweru Communal area, where other actors like donors, research institutes and NGOs are "dictating" operations should not be seen as a negative by AGRITEX agents. In fact the setup should be embraced by extension agents where their role becomes more of facilitators or brokers. In these roles, extension agents assist in disseminating new technologies by acting both as a repository of information regarding technology experts and new technology opportunities and as a conduit between actors [14]. For extension agents to perform this role effectively, they need to possess good communication skills, ability to empathize, listen and value farmers and other actors' insights, impartial and technically competent [1, 4].

Further, the pluralistic extension setup has the potential to improve the farmers-extension-research/donor linkages which respondents suggested as a strategy to improve technology adoption by farmers. Furthermore, in such a setup most farmers feel encouraged to share their indigenous knowledge that maybe helpful to all partners including technology developers. Thus, engagement is the key; farmers genuinely engaged and working within their indigenous framework will create the demand [11]. Such an engagement may awaken farmers' interest to learn more about new technologies and participate in the testing them in their own fields before considering adoption.

Consistent with findings by [4] and [12], respondents perceived small-scale farmers to have developed successful innovations including seasonal climate forecasting, crop protection and soil and water conservation through their own indigenous knowledge,

practices and experiences. Conversely, the caveat issued by respondents regarding farmers' indigenous knowledge, that it is backward, conservative and can be an impediment to modern technology adoption, was also noted by [15]. Such thinking is the reason why farmers' indigenous knowledge have been ignored by most scientists and modern technology developers.

The major reasons for high adoption were simplicity of use, low cost of acquisition, improved production, and low risk of use. These findings concur with [4, 9, 16], who found that low cost technologies with high expected benefits, as well as short payback periods are more likely to be adopted. Conversely, low adoption rates were reported for bulky technologies (e.g. tractors) and expensive technologies including solar driers and metal silos and also for high-risk technologies such as bee farming [4].

The cost of a technology presents one of the major challenges to technology adoption by small scale farmers. This finding concurs with [4] and [9] who found the lack of capital and credit facilities to acquire and utilize technologies to be one of the critical reasons inhibiting adoption. Thus, making credit available at lower rates becomes particularly important where bulky technologies, which require high initial costs of setting up, are concerned. Such costs may be prohibitive to most small-scale farmers, but with affordable credit facilities, farmers may actually consider adoption. Similarly, technology developers should be encouraged to allow farmers to buy on hire-purchase or to acquire the technologies and pay later or to enter into contract farming.

The most preferred methods of disseminating technology used by respondents were observations, field days and demonstrations. The nature of learning (observation, discussions and sharing experiences) afforded in demonstrations, on-farm trials and field days are very powerful methods to use even with illiterate or less educated farmers [17]. Similarly, [11] and [13] proposed that effective learning in small-scale farming systems occurs when it is more interactive, experiential, field-based and participatory in nature. This nature of learning is beneficial to the development of farmers' decision-making, leadership, and management abilities [18].

Respondents also indicated that they use the farmer groups as entry points into a community for introducing new technology as they believe if the group adopts the technology, the members of the group then can spread the information and also encourage other farmers to consider adoption. This farmer to farmer extension within farmer groups is one of the most appropriate and effective modes of disseminating new innovations [7, 19].

Respondents highlighted that farmers often lack all the necessary information to make informed decision on technology adoption [11, 20]. Such information includes input and output markets, prices of products produced as result of using technology and how to utilize technologies properly [1, 4]. In addition to understanding the technical efficacy of the technology, [21] argues that the introduction any technology (or change to a farming system) should also be analyzed in terms of how it will affect the management, economic and sustainability aspects of the farming enterprise.

V. CONCLUSION

The perceptions of agricultural extension agents on the innovation and technology adoption processes/behaviors of small-scale farmers are of paramount importance in addressing poor and non-adoption of technologies. For one, extension agents play a pivotal role in fostering productive relationships between farmers and other key actors like scientists and technology developers. As shown in this study, extension agents are responsible for disseminating the majority of technologies in small-scale farming systems and have regular contact with farmers. This phenomenon makes them both a valuable source of information regarding the circumstances of small-scale farmers and potentially being part of the solution in enhancing farmer innovations (indigenous knowledge) and adoption of modern technology. As already shown in this study, extension agents suggested potential strategies aimed at addressing the poor technology adoption challenge. The potential of extension agents can actually be fulfilled by empowering them through regular in-service trainings about relevant up-to-date modern technologies so that they may be competent in offering farmers information support on how to utilize these technologies. Further, extension agents also need to be better resourced so as to be able to reach many farmers with technologies.

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