

Influence of public agricultural extension on technology adoption by small-scale farmers in Zimbabwe

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ABSTRACT

This paper presents the findings of challenges facing Zimbabwe's extension services and how these have affected the adoption of technologies they render to small-scale farmers. This study uses a critical review of relevant literature on Zimbabwe's primary public extension agency (AGRITEX). Additionally, 21 key informant interviews (KIIs) were conducted to corroborate data collected in secondary research on extension approaches currently in use, the key factors affecting technology adoption, and the technology adoption process of small-scale farmers. The study found AGRITEX's major challenges to be poor funding, poor remuneration and incentives for extension personnel, lack of in-service training, lack of appropriate technology, as well as poor operational resources like transport to reach all farmers. Consequently, services offered to small-scale farmers were compromised, which led to poor adoption of recommended technologies. Furthermore, the study determined that key factors influencing technology adoption are related to the farmers' circumstances, the operating environment, and the attributes of technology itself. As a lasting solution to poor technology adoption, an adaptive extension system that promotes building the capacity of extension workers and researchers, as well as embracing farmers and their indigenous knowledge, is proposed.

Keywords: AGRITEX; extension approaches; small-scale farmers; technology adoption

1. INTRODUCTION

The public extension is the main source of extension services for small-scale farmers in developing countries like Zimbabwe (Mapiye *et al.*, 2021). Zimbabwe's primary agricultural extension agency, the Department of Agricultural, Technical and Extension Services (AGRITEX), is responsible for public rural agricultural extension. AGRITEX falls under the Ministry of Lands,

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Agriculture, Fisheries, Water and Rural Resettlement (MLAFWRR) and is represented at the village, ward, district, provincial and national levels. It was formed in 1980, after Zimbabwe obtained independence, merging the then Department of Conservation and Extension (CONEX) and the Department of Agricultural Development (DEVAG), serving the (white) large-scale, ‘commercial’ farmers and the (black) small-scale, ‘communal’ farmers, respectively (Hanyani-Mlambo, 2002).

The amalgamation of CONEX and DEVAG was not straightforward and encountered problems along the way. Each organisation had its own clientele, way of conducting business and operating principles. It took several years of striving to create in AGRITEX an institution to cater for all farmers. Despite these efforts, however, since creating AGRITEX, the ‘commercial’ farmers never accepted that AGRITEX was competent enough to advise them (Hanyani-Mlambo, 2002). This resulted in AGRITEX concentrating services on the small-scale farming sector and recently on resettled farmers from the fast-track land reform programmes of the early 2000s. Since its inception, AGRITEX has experienced multiple systemic challenges which are complex and multifaceted, including poor funding, high turnover of experienced, competent and skilled staff, as well as mostly disseminating and recommending ‘old’ technologies developed 15 to 20 years ago (Mapiye *et al.*, 2021; Moyo & Salawu, 2018; Muchesa *et al.*, 2019).

As the principal dispensers of technologies and information from technology developers and researchers to farmers, extension workers are responsible for technology adoption by their clients. Most of the technologies recommended by AGRITEX have not been adopted by the small-scale farmers who have primarily depended on their ‘indigenous knowledge’ to sustain their farming enterprises, with some success (Masere, 2014; Masere & Duffy, 2014; Masere & Worth, 2015). However, AGRITEX failed to build on this knowledge and practice.

Drawing on the Zimbabwe experience, the study sought to shed light on the role of extension services in technology adoption by small-scale farmers, determine the key factors affecting farmers’ technology adoption processes and create a framework for a lasting solution to the technology adoption issue. The envisaged framework will incorporate “the collective knowledge of key role-players” (Ngomane, 2010:66), including small-scale farmers, in the development of new technology. This improves the likelihood that farmers may consider and actually adopt the developed technologies. As noted by Masere and Worth (2015), farmers are unlikely to adopt technologies offered unless they are directly involved in its development or its testing in the field – preferably on their own farms.

2. METHODS

The paper utilised both secondary and primary research. Secondary research was conducted through a review of relevant literature, technical reports, government policy documents and journal articles. These data were filtered to distil key elements of extension that could be used as a framework to strengthen Zimbabwe's extension service. The context of the evaluation was identifying the successes and challenges of each extension approach regarding technology adoption. Primary research in the form of key informant interviews (KIIs) was also conducted with all 21 AGRITEX extension personnel operating in the Lower Gweru Communal area. These comprise of 16 field extension agents, two extension supervisors, two agricultural extension officers and one district agricultural extension officer,. The purpose of KIIs was to corroborate data collected in secondary research on extension approaches currently in use as well to identify main factors affecting the adoption of technology by small-scale farmers; and investigate the technology adoption process of small-scale farmers. The main questions asked in the KIIs were on challenges faced by respondents in discharging duties, extension approaches/methodologies used/preferred, their perceptions of farmers' 'indigenous knowledge', and reasons for technology adoption patterns of small scale farmers.

3. FINDINGS

3.1. Problems and challenges facing AGRITEX

AGRITEX, like most extension systems in developing countries, is faced with several multifaceted problems. These problems include lack of appropriate technology, top-down extension approaches, poor remuneration and incentives for extension staff, and weak or no linkages among researchers, farmers and extension staff (Mapiye *et al.*, 2021; Moyo & Salawu, 2018).

Extension services offered in Zimbabwe and other developing countries have been deficient regarding accuracy, relevance and applicability to farmers' problems (Mapiye *et al.*, 2021). There are two main reasons for this. Firstly, AGRITEX generally pursues top-down extension approaches that discourage farmer participation in identifying and defining problems through to developing solutions. Secondly, it has been mostly recommending outdated technologies – some of which were discovered and developed two decades ago (Moyo & Salawu, 2018; Muchesa *et al.*, 2019). It has been observed that this practice has continued to this day, according to KIIs.

One of the major challenges confronting many developing countries' extension systems is poor government funding (Mapiye *et al.*, 2021; Mugwisi, Ocholla & Mostert, 2012). In Zimbabwe, MLAFWRR, the parent ministry of AGRITEX, is financed from the fiscus, which has been restricted over the last 15-20 years due to the country's economic crisis (Mafuta & Kamuzhanje, 2020; Mapiye *et al.*, 2021; Moyo & Salawu, 2018). MLAFWRR also funds other agencies

additional to AGRITEX, straining the budgets even further. Thus, allocations to AGRITEX are inadequate (Mapiye *et al.*, 2021; Moyo & Salawu, 2018; Mugwisi *et al.*, 2012). Donor funding previously available to augment budgets has been withdrawn due to the ‘unstable’ political environment experienced by Zimbabwe over the last decade (Mugwisi *et al.*, 2012).

Inadequate funding resulted in several other challenges, particularly poor remuneration of extension workers and poor operational resources, e.g. transport to reach farmers (Mapiye *et al.*, 2021; Mugwisi *et al.*, 2012; SNV, 2015). Such workers are unlikely to perform their duties adequately. The small-scale farmers suffer the most in these circumstances (Mngumi, 2010).

Another challenge is poor retention of skilled personnel due to the poor working conditions and poor remuneration (Mika & Mudzimiri, 2012; Mugwisi *et al.*, 2012). As discussed earlier, soon after its formation, AGRITEX was crippled by the loss of highly trained, experienced, competent staff. This resulted in low-quality service. The replacement staff, while qualified theoretically, lacked practical and technical expertise or experience (Mika & Mudzimiri, 2012; Mugwisi *et al.*, 2012). Further, in most cases, the replacements were less knowledgeable than the farmers they were supposed to train (Mika & Mudzimiri, 2012); this scenario has continued to this day, according to KIIs findings.

Extension workers with little or no technical, practical experience are unable to advise farmers properly. Hence, some farmers spurn them. According to Mugwisi *et al.* (2012), MLAFWRR acknowledged that some farmers were unwilling to work with extension workers because they lacked technical and practical skills. Once farmers lose faith and confidence in people who should advise them, there is little chance that recommended technologies will be adopted (Mika & Mudzimiri, 2012). In such cases, farmers tended to rely on their indigenous experiments or advice from other farmers (Hanyani-Mlambo, 2002; Masere & Worth, 2015).

Zimbabwean small-scale farmers have relied on indigenous knowledge (Hanyani-Mlambo, 2002; Masere & Worth, 2015). It has worked for them over many seasons. The concept of indigenous knowledge is multi-dimensional and appears to be complex to define. In an attempt to define the farmer ‘indigenous knowledge’, Nyiraruhimbi (2012 as cited in Masere & Worth, 2015) posited that indigenous knowledge could be summarised into three definitions: local memory, local practice, and local science. Local memory is the collection of practices handed down from predecessors but which, although remembered, have been discarded or substantially modified. Local practice is knowledge garnered over some time from various second-hand sources (including ancestors, extension agents and messages, and sales representatives) and/or through unstructured trial and error. Local science is knowledge and practices currently in use, or not a result of deliberate and conscious innovation and experimentation conducted by the farmer(s) who use/do not use the practice.

The Zimbabwean small-scale farmers have useful experience devising new technologies; this could be tapped provided they have support from research and extension (Hanyani-Mlambo, 2002; Masere & Worth, 2015). AGRITEX has failed to identify and disseminate successful informal technologies developed by farmers or build on them (Moyo & Salawu, 2018). However, findings from KIIs indicate that extension agents are somewhat divided on their views concerning indigenous knowledge and its related technologies. In fact, 42.9% of respondents mentioned farmers' indigenous knowledge as an 'impediment' to technology adoption as farmers are generally resistant to change and slow in accepting outside help, including new and modern technology. Furthermore, indigenous knowledge is perceived one of the major reasons why farmers have been stagnant and failing to advance to the next level in the value chain, processing their raw crops into more profitable products. The remaining portion of respondents (57.1%) considers indigenous knowledge an asset and valuable source of relevant information, which they are also using and learning from. This is consistent with findings reported by Mugwisi (2017) that the majority of extension workers in Zimbabwe have used farmers' 'indigenous knowledge' on a range of subjects, including soil classification and fertility, weather patterns, and crop protection among others.

3.2. Extension approaches used in Zimbabwe

Many extension approaches have been used and evolved the world over. Driven by its unique circumstances, each country or region has experienced different timelines for the evolution of extension. In pre-independent Zimbabwe, extension began as linear, top-down technology transfer, largely through forced or coerced extension by DEVAG in communal areas. After independence, AGRITEX was formed and introduced different extension approaches, some of which involved farmer participation (Moyo & Salawu, 2018; Nhongonhema, 2010). Further, a number of different extension players emerged after independence.

3.2.1. Top-down extension approaches

These approaches were embedded within the broader rural development agenda and follow a one-way hierarchical transfer of information and technologies from extension agents and research scientists to farmers in order to increase production, grant farmers' access to credit, inputs, and markets (Abbeam, Ehiakpor & Aidoo 2018; Cook, Satizábal & Curnow, 2021; Davis *et al.*, 2019). Various top-down approaches were employed in pre- and post-independent Zimbabwe. These included forced extension, group development area (GDA), radio listening group (RLG), master farmer training schemes, training and visit (T&V) System and the commodity-based approach (Mazwi, Chambati & Mutodi, 2018; Moyo & Salawu, 2018; Nhongonhema, 2010). Some of these approaches are still in use in Zimbabwe; others have been abandoned for several reasons.

Forced extension. This so-called form of extension was prevalent in the 1960s and 1970s, during the period of 'white rule', where indigenous farmers were coerced to dip their cattle and construct contour ridges and storm drains and were prohibited from pulling sleighs. The main objectives

were to protect natural resources and minimise soil erosion (Nhongonhema, 2010). Given its objectives and methods, it can be argued that this was, in fact, not genuinely extension. It appears to have had no vision to improve the lot of farmers but primarily was aimed at controlling land degradation and animal diseases (Nhongonhema, 2010). Due to its coercive nature, the targeted farmers were rebellious and failed to accept even its technically correct aspects. They viewed it as a punishment from colonial masters (Nhongonhema, 2010). As noted by Cloete *et al.* (2019), there is no real extension service when there is a general mismatch between farmers and agricultural extension officers on the conceptualisation of extension objectives and teaching methods. Consequently, this approach was abandoned soon after independence in 1980.

Group development area (GDA). GDA was used not only in Zimbabwe but also in many sub-Saharan countries including, Botswana and Malawi. It involved local people participating in community development projects usually funded by governments or donors (Hanyani-Mlambo, 2002; Marume, 2010). It was used as a cost-effective means of increasing coverage of small-scale farmers with extension messages (Hanyani-Mlambo, 2002). At its inception, GDA enhanced the diffusion of extension messages in previously inaccessible areas (Hanyani-Mlambo, 2002; Marume, 2010). GDA ostensibly included and accommodated large numbers of farmers (Marume, 2010). However, GDA had two major constraints: channelling services where they were most needed without precluding services to deserving but less needy farmers; and financial dependency on government or donors, which led to failure when support was withdrawn (Hanyani-Mlambo, 2002).

Radio listening group (RLG). RLG involves farmers gathering in teams to listen to extension radio programs targeting their specific geographic areas (Hanyani-Mlambo, 2002). After the broadcasts, farmers gather to discuss issues raised in the programs, thereby assisting each other to better understand the information before applying it in practice (Hanyani-Mlambo, 2002). After initiating fast track land resettlement in 2000, this approach was modified to include TV and radio programs, like *Murimi wanhasi* (Today's farmer), to provide the newly settled farmers with relevant agricultural information. During such programs, farmers could also phone in to air their problems and immediately get answers from the subject matter specialists meant to be participating in the programs. However, in most instances, the program did not adequately address the farmers' concerns; relevant experts were not always available, and some of the issues under discussion were irrelevant to many small-scale farmers because of their limited resources (Hanyani-Mlambo, 2002).

Master farmer training schemes. This approach involves targeting so-called 'progressive' farmers with extension services providing relevant information and technologies which the farmers were expected to spread to other farmers (Ndoro *et al.*, 2017). It was developed with the objective of producing a critical mass of farmers after going through a series of training sessions over a period

of 2-3 years and was predicated on the principle of ‘trickle-down’ (Pazvakavambwa & Hakutangwi, 2006). After independence, AGRITEX upgraded the master farmer training scheme to include the advanced master farmer training program. Farmers were examined periodically for the Ordinary Master Farmer or Advanced Master Farmer Training Scheme. Master Farmer certificates and badges were awarded to farmers who adopted and practiced recommended technologies (Mika & Mudzimiri, 2012; Ndoro *et al.*, 2017). These schemes remained at the core of AGRITEX’s work, and over 300 000 master farmers and up to 50 000 advanced master farmers across Zimbabwe have been trained (Pazvakavambwa & Hakutangwi, 2006; Mika & Mudzimiri, 2012).

Despite the general success of the master farmer training schemes, the approach has some notable drawbacks. It appears to favour the few better-off farmers over the majority of poor (communal) farmers, thereby increasing the income gap between the better-off farmers and the poor (Ndoro *et al.*, 2017). Although it was developed to be inclusive of all farmers, the master farmer approach failed in this respect because it resulted in resentment among farmers who were expected to follow the master farmer’s examples (Mika & Mudzimiri, 2012), not dissimilar to the approach and outcomes of the Indian Green revolution.

The training and visiting (T&V) system. The T&V system was developed for the World Bank by Daniel Benor to improve the effectiveness of agricultural extension services through comprehensive, structured training, delivery and administrative systems. This system involved training frontline extension agents by subject matter specialists; extension agents passed on the new skills, information and technologies to farmers. Extension agents were expected to transfer standardised technologies. The training held fortnightly was strict, regimented and hierarchically structured with follow-up by local extension workers and specific farmers using predetermined technology packages. The T&V system requires sound administrative systems, infrastructure and readily available, well-trained staff. Although this system achieved some success in some areas, it was later abandoned mainly for four reasons: its top-down inflexible nature; its rigid mode of operation; ineffectual feedback communication; and failure to cater for many farmer groups, particularly resource-constrained farmers (Cook *et al.*, 2021).

Commodity based approach. The commodity-based approach centralises all the functions (extension, research, input supply, marketing and pricing) of a particular commodity under one administration and usually comprises an interdisciplinary staff complement that partners with farmers who grow the crop and sell it to the administration or company (Bell *et al.*, 2015; Mazwi *et al.*, 2018). In return, the company supplies extension, inputs, credit, quality management (standards) and marketing services, and loan repayments collection (Bell *et al.*, 2015).

In Zimbabwe, this approach is usually organised through parastatal organisations or private firms with an exclusive focus on a commodity, particularly an export or a cash crop (e.g. cotton, maize, wheat and tobacco). Zimbabwe's Reserve Bank used this approach to promote the increased production of important staples, mainly maize and wheat (Hanyani-Mlambo, 2002). In horticulture, the approach has been widely used to establish out-grower schemes and provide research, extension and input credit services to interested farmers (Mazwi *et al.*, 2018). Despite the success of this approach, it had one major disadvantage in that the organising parastatal or marketing companies became a monopoly that gave them unfair advantages which they used to dictate terms that benefitted them at the expense of the participating farmers, most of whom are resource-constrained and poor (Bell *et al.*, 2015; Hanyani-Mlambo, 2002).

3.2.2. Participatory approaches

From the mid-1980s to the 1990s, a strong bias grew towards participatory approaches such as farmer field schools and community-based programs. These approaches entail extension agents working in collaboration with farmers in analysing farmers' agricultural systems to identify problems and develop solutions (Moyo & Salawu, 2018). The main goal for the emergence of participatory approaches was to encourage two-way dialogue between farmers and extension workers or scientists, as well as to dispel the notion that extension agents have all the knowledge and must instruct farmers (Cook *et al.*, 2021).

The Kukuraya "Trying" project. The Kukuraya project in Chivi district, Masvingo Province, is one example of the success of participatory approaches in Zimbabwe. It was driven by the United Kingdom Intermediate Technology Development Group (ITDG) and the German Development Cooperation (GTZ) (Hanyani-Mlambo, 2002; Moyo & Salawu, 2018). It was used mainly for promoting the adoption of soil and water conservation techniques. Farmers organised themselves into groups of 70 to 80, which participated in identifying local soil and water conservation technologies to promote within the project area (Hanyani-Mlambo, 2002). Further, the groups were exposed to soil and water conservation technologies unfamiliar to them. Farmers would decide which soil and water retention technologies they wanted to test and would meet regularly to share information (e.g. results and problems encountered) during field days and other platforms (Hanyani-Mlambo, 2002; Moyo & Salawu, 2018). Eventually, farmers would adopt the technologies that they preferred either wholly or parts thereof (step-wise adoption) (Hanyani-Mlambo, 2002). This project also trained AGRITEX staff to implement such approaches in other areas (Hanyani-Mlambo, 2002).

Farming systems research and extension (FSRE) approach. FSRE involved AGRITEX and the Department of Research and Specialist Services engaging farmers to determine their farming problems and conducting on-farm trials to test possible solutions (Hanyani-Mlambo, 2002). FSRE was developed in response to the limitations of earlier extension approaches such as T&V and master farmer training schemes. Although the latter was technically correct, what they offered and

the way they offered it was not relevant to small-scale, resource-constrained farmers (Cook *et al.*, 2021). FSRE, however, centred on such farmers and addressed farmers' problems through a systems approach involving multidisciplinary and iterative processes between farmers, extension and research (Hanyani-Mlambo, 2002; Marume, 2010). With farmers as the focal point of FSRE, extension and research programs were driven by needs in the context of farmers' specific farming systems, not the priorities of research institutions and AGRITEX (Hanyani-Mlambo, 2002). The major drawbacks of this approach included that it was slow in incorporating its findings into actual practice and it required more resources (time, funds and effort) to meet the varying specific requirements of different farming systems (Hanyani-Mlambo, 2002).

3.2.3. Information and Communication Technology Revolution

Currently, AGRITEX is working with a number of development cooperation partners like Mercy Corps and Zim-Agricultural Income and Employment Development (ZimAEID) in utilising mobile telephones to adopt information and communications technology (ICTs). Working in collaboration with Mercy Corps, AGRITEX has developed a short message service (SMS) platform to deliver agronomic and marketing information on selected crops to farmers, including pre-planting, growing, harvesting and post-harvesting (SNV, 2015). AGRITEX has seen an increase in the number of similar collaborations in recent years. The public extension agency currently has an implementing partnership with Econet Services through *EcoFarmer*, a service that provides crop insurance, agricultural information, financial services and market linkages to small-scale farmers (SNV, 2015). There are also other complementary platforms such as *EMkambo*, Zimbabwe Farmers' Union (ZFU) bulk SMS and emails, as well as newsletters that have been quite effective in reaching small scale farmers (SNV, 2015). These e-platforms are set to increase efficient and equitable information flow across all actors – farmers, extension agents, researchers, government and private sector (Mapiye, 2021; SNV, 2015). However, the extent to which these platforms are used by extension workers still needs to be established. One key challenge with the SMS facilities is the character input limits. While coding information and the use of abbreviations can partly address this issue, it may also present other problems. For one, some farmers (e.g. those who are less literate, less educated, elderly) and even some extension workers may not easily comprehend the codes and thus potentially distorting the messages. Secondly, conscious efforts to build awareness and tech-literacy within AGRITEX and the small-scale farmer community will be required. However, this presents cost implications, reverting to the resource challenges in financing ICT adoption for extension (SNV, 2015).

3.3. Key Informant Interviews findings

3.3.1. A summary of demographics of respondents

The majority (61.9%) of the respondents were in the middle age group of between 35 and 50 years old, with only 9.5% above 50 years of age. The majority (57.1%) of respondents have more than 15 years of working experience. The majority of respondents (66.7%) are educated up to diploma level, 23.8% have a Bachelors, and less than 10% have progressed past the Bachelor’s degree. These findings are similar to findings reported by Davis *et al.* (2019) and Muchesa *et al.* (2019). The demographics of respondents seem to indicate that the extension personnel are mature and capable of handling the rigours of tedious extension work. Further, the respondents had basic educational qualifications to perform their duties effectively.

3.3.2. Extension approaches used by KII respondents in technology dissemination

Respondents indicated that they had used all the main extension approaches at some point in the course of their work. The choice of which approach to use was determined by prevailing circumstances and objectives to be met (Table 1). This finding is similar to findings by Campbell and Barker (1997), who postulated that the appropriateness of an extension approach is circumstance-based, as what could be appropriate for one farmer group may not be appropriate for another, even if they farm in the same agro-ecological region. Thus the diverse circumstances of small-scale farmers mean there cannot be a single extension approach that will get the job done all the time.

TABLE 1: Extension approaches used by extension agents

Extension approach	Circumstances	Reasons/Assumptions for using the approach
Linear	Demonstrating a new technology. Training farmers e.g. the Master Farmer Training. When dealing with those farmers who do not want to participate in extension activities. Time and resources are limiting	Extension agents will be one with all the information or expertise as the technology is new to the farmers. Useful when farmers are following a designed and standardised program of training
Advisory	When farmers are the ones demanding a service or they need expert advice on how to use a technology	Farmers will have shown they are empowered to know what kind of help they need hence agents can only advise on best methods or practices as opposed to start lecturing the farmers
Facilitation and Learning	When there are different actors within an innovation network or project coming together to learn, share experiences, discuss their	This approach promotes interactive learning between partners in the innovation network. It usually results in the development of tailor-made

	problems and find solutions to their challenges. When time and resources are not limiting. When promoting the sharing of information among farmers and other key actors in extension.	technologies or interventions which are easily adopted. It strengthens the farmer-extension-researcher linkages
Participatory	When farmers have information or when their input/perspective is sought. Farmer participation is needed in testing performance of new technology against farmers' practice through participatory on-farm trials. When agents want to convert laggards of a technology and promote adoption	This approach offers farmers and extension agents a platform for testing technologies in farmers' conditions. Most farmers especially the elderly and illiterate learn by doing and observing thus participatory on-farm trials offer them that chance.

Source: Extension agents' responses from KIIs.

Respondents indicated that, historically, the linear extension approach was probably the only extension approach used because of its underlying assumption that the extension agents know everything; the farmer's view was not important. Using the linear approach, information or technology was developed by researchers and passed to extension agents for dissemination to the farmers (Abbeam *et al.*, 2018; Cook *et al.*, 2021). Examples of linear extension approaches used by the respondents included the training and visit (T&V) approach and master farmer training approaches. The master farmer approaches involve following a pre-designed two-year training programme on a number of subjects, including agronomy, animal husbandry, horticulture and farm management. Upon completion and meeting the requirements, farmers are given certificates. Despite their exclusion of farmers' views (Koutsouris, 2012) and its coercive nature, linear approaches recorded some success and are still being used by agents under various circumstances, including when resources and time are constraining factors (Table 1). Singh (2009:6) suggested that linear technology transfer extension approaches are "likely to be successful in relatively homogenous, low-risk, natural and social environments, where farmers live under similar conditions, perceive the same kinds of challenges and share a common set of beliefs and values". The respondents also indicated that with time, farmers' views, knowledge and experience were beginning to be considered within AGRITEX. This was mainly because of poor adoption of technologies disseminated by linear extension approaches and the realisation that farmers understand the biophysical conditions of their farms better than extension and researchers. This resulted increased the use of participatory approaches and co-learning innovation approaches. Thus, on-field participatory approaches like farmer field schools (FFSs), on-farm trials, demonstrations, look-and-learn tours and innovation teams are now a common feature within the

AGRITEX. Similarly, Cloete *et al.* (2019) and Kulyakwave *et al.* (2021) found demonstrations and look-and-learn tours to be the most preferred extension approaches.

Respondents stated that they would use FFSs and look-and-learn tours in disseminating and encouraging technology adoption by farmers. They indicated that look-and-learn involves introducing new technology by taking farmers to where the technology has been used, and the results are there for other farmers to observe. These approaches are noted for strengthening farmers' social and technical competencies, thus enabling them to make informed decisions on factors affecting their farming systems (Worth, 2012, 2014). However, respondents were quick to indicate that they use look-and-learn tours only when resources permit it, as transport is usually needed to take farmers to locations where the technology being introduced is being used.

According to the respondents, farmers also formed their own groups, usually known as study circles, where they meet regularly to discuss their problems, challenges, experiences and possible solutions (innovations) to their problems. They then consult extension agents to check the soundness of the farmer innovations and advise accordingly. Under such a scenario, the extension agents indicated that they would use the advisory extension approach – responding to the initiative of the farmers. Respondents also indicated that they use the farmer groups as entry points into a community for introducing new technology since they believe if the group adopts the technology, the members of the group then can spread the information and 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 (Hailemichael & Haug, 2020; Stevens & Ntai, 2011).

Respondents indicated that they use facilitation and learning approaches in projects or programmes involving diverse stakeholders. The usual stakeholders are the research institutes, NGOs, seed houses, fertiliser companies and donors. Engagements provide innovation platforms where farmers, extension and other partners learn from each other. As noted by Davis *et al.* (2019), an innovation system helps in knowledge creation, sharing and accessibility among actors, simultaneously encouraging the learning process. Respondents indicated that in such a setup, most farmers feel encouraged to share their indigenous knowledge that may be helpful to all partners, including technology developers. For this reason, Katanga *et al.* (2007) argued that farmers must be viewed by extension and researchers as equal partners, possessing different but valuable experiences and skillsets to theirs.

The availability of such organisations within rural farming communities of Zimbabwe points to a pluralistic extension system, where AGRITEX and its workers play the roles of facilitators and 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 (Johnson, 2008). For extension agents to perform this role effectively, they need to possess good communication skills, the ability to empathise, listen and value farmers and other actors' insights, impartial and technically competent (Masere & Worth, 2015). Respondents indicated that these organisations have the resources (including technology and transport) and have helped AGRITEX and its agents in reaching out to farmers with technical and other specialised services. Further, respondents indicated a need for strengthening and coordinating these multi-actor linkages to ensure a win-win situation for all parties, including farmers and technology developers.

3.3.3. Small-scale farmers' technology adoption process

According to the KIIs, many factors affect technology adoption by small scale farmers, regardless of the extension approach used. These include: technology attributes (e.g. potential improvement in productivity after adoption, simplicity to use, cost of acquiring technology, risks associated with the technology); farmer circumstances (e.g. demographics, the scale of operation/land size, perception about the technology, affordability, access to credit facilities, availability and accessibility of knowledge and information support about the technology) and their operating environment (e.g. climatic factors, soil factors, slope, location in relation to road networks). This finding concurs with Chi and Yamada (2002), who identified five qualities that technology must possess for it to be easily adopted, namely: relatively advantage, compatibility, complexity, trial ability, and observability. It is submitted that, for a technology to be adopted, all these factors have to be considered and the conditions necessary for adoption met.

According to respondents, farmers are rational business people who carefully consider these factors and conditions. Consideration appears to happen in a hierarchical way, determined consciously or unconsciously by the farmer. When the most important adoption factor for that particular farmer is satisfied, the decision to adopt will hinge on the next important factor, and so on until the last factor is satisfied. The importance given to any one factor and ranking criteria of the factors in terms of importance is different for each farmer – something extension must ever bear in mind. However, it is submitted that the most crucial factor to consider will be how the farmer perceives a technology. Thereafter, the farmer may look at his circumstances to see if they permit adoption. If the farmer has the material/financial capacity to adopt, he/she may proceed to do so; if not, he/she may consider using credit. This introduces a new round of consideration, influenced by the farmer's willingness to take a risk. This is an iterative process where the desire to adopt influences the willingness to take financial risk and the willingness to take financial risk influences the willingness to adopt. If these two factors align positively, the farmer may then proceed in adopting the technology.

3.4. Towards an appropriate extension system that can be effective for technology adoption by small-scale farmers in Zimbabwe

The plethora of top-down extension approaches and the few participatory efforts employed by pre- and post-independent Zimbabwe have not led to effective technology adoption. This is explained partly by virtue of the nature of being top-down; by design (most notably being centralised), top-down approaches exclude the very farmers they aim to assist from any meaningful involvement in the process (Moyo & Salawu, 2018; Tuttle *et al.*, 2013). It can also be explained by the resource endowment differentials and the heterogeneity of the geographical locations of farmers, which centralised, top-down approaches cannot easily accommodate because they “tend to include a selected, easily accessible population while neglecting the input of more marginalised communities” (Tuttle *et al.*, 2013:199). This suggests scrapping, or at least significantly limiting, the use of top-down, prescriptive approaches that impose remotely developed technologies and innovations to farmers on the assumption that they will accurately address their problems. Instead, more participatory approaches, including farmer-driven technology development and menus of alternatives, should be adopted to ensure farmers are able to decide what they may need (Marume, 2010).

Participatory approaches require support by a highly competent extension workforce with adequate skills to deal with farmers with different and changing capacities, needs and goals. In light of the relative successes of both top-down and participatory approaches in technology adoption and findings from KIIs on extension approaches, the researchers are proposing that the conventional separation of extension approaches be abolished in favour of an adaptive extension system. This proposed system will be built on attributes that promote better linkages/engagement between extension services and farmers so as to take advantage of the capacity of extension agents and researchers alike and uses local indigenous knowledge and deliberately includes, rather than marginalises, farmers. Further, this adaptive extension system will employ ICTs where and when necessary to enable efficient information flow to and from all actors. Given that most farmers prefer to learn by observation (KIIs findings), the ICTs platforms recommended in the proposed extension system are those which allow for audio-visual learning. Then the issue of technology adoption is appropriately contextualised. It becomes less a matter of poor technology adoption *per se*, and more a matter of ensuring that adopting or not adopting technology is a function of wise decision-making and investigation of the technology (preferably even at the stage of developing the technology) by the farmer based on capacities enhanced through engaging with extension, and on the appropriateness of the technology to the production, sustainability and personal circumstances of the farmer.

4. CONCLUSIONS AND RECOMMENDATIONS

Zimbabwe's extension service, AGRITEX and its extension workers, has faced and continues to face multiple challenges, including poor funding, poor remuneration and incentives for extension personnel, lack of in-service training, lack of appropriate technology, poor linkages with research and farmers, as well as poor operational resources like transport to reach all farmers. These challenges have affected the agency's service delivery to small-scale farmers. Furthermore, until recently, AGRITEX appeared to have failed to build on successful indigenous knowledge of farmers. Part of the 'failure' of AGRITEX is found in the extension approaches that they have used and continue to use – most of which are top-down in nature. The paradigm is not a learning partnership but top-down technology development, dissemination and transfer. This has inhibited technology adoption by small-scale farmers, mainly because they exclude the farmers they are meant to help. However, where and when implemented, participatory extension approaches resulted in success stories, albeit in small pockets – including the development of farmer-driven technologies, which led to improved technology adoption. Beyond AGRITEX's challenges, small-scale farmers' technology adoption processes are affected by the farmers' circumstances, the operating environment, and the attributes of technology itself. All these factors are considered by farmers before a decision is made on whether to adopt a technology or not.

As a lasting solution to poor technology adoption, an adaptive extension system that promotes building the capacity of extension workers, researchers and farmers, as well as embracing farmers' 'indigenous knowledge', is proposed. This proposed adaptive extension is predicated upon the realisation that there cannot be a single extension approach that can result in technology adoption at all times and for all farmers. However, for this adaptive extension system to work, extension workers must be motivated, competent and flexible enough to adjust their roles to suit the prevailing circumstances of farmers as well as the goals and objectives of an extension activity/programme. This implies that extension personnel would require regular in-service training to keep abreast with new technologies and modern strategies of engaging farmers – be it in participatory development of technologies or learning about a technology/actual testing of technology before farmers can consider adoption. Furthermore, there is a need for adequate funding to alleviate the operational challenges currently faced by AGRITEX in discharging its mandate. Finally, it must be appreciated that in pursuing this approach, there are no shortcuts; the process might take time. However, the impact will be far more sustainable and reaching well beyond the mere adoption of a specific technology. This will enhance the capacity individually and collectively of the three protagonists (farmers, extension and researchers) to explore their realities and forge a pathway to ever-advancing progress.

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